Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – AST 220

Department Outcomes

- Provide freshman and sophomore-level courses in Chemistry, Mathematics, Physics, Physical Sciences, and Astronomy, with emphasis on critical thinking and analytical ability, that are transferable to public institutions of higher learning.
- Offer an appropriate remedial mathematics program accommodating various skill levels.
- Develop and provide courses relevant to the career and professional degree programs of the college.

Astronomy Course Level Outcomes Assessment Rubric

Level 3: Attempted Problem and Solved Correctly
Level 2: Attempted Problem and Did Not Solve Correctly
Level 1: Did Not Attempt Problem

Evaluated Course Objectives

Student mastery of the specific course objectives to follow will be evaluated by analyzing answers to appropriate questions from the comprehensive final exam. The astronomy final will be a comprehensive multiple-choice exam.

The student will demonstrate knowledge of astronomy by his/her ability to:

1. Use analogy to describe size and distance scales between planets in the solar system, distance between star systems in galaxies, and distance between galaxies or galaxy clusters within the universe.
2. Be to describe the time scales for major cosmic events such as the age of the universe, when galaxies began to form, or when our solar system formed.
3. Demonstrate knowledge of basic scientific principles used by astronomers to understand the composition and the dynamics of the universe.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
AST 220 Objective 1 Use analogy to describe size and distance scales between planets in the solar system, distance between star systems in galaxies, and distance between galaxies or galaxy clusters within the universe.	Rubric based assessment of a related final exam question that fits the description given in objective 1	70% of students learning at a rubric level of 3	Internet Campus Level 3 229/372 81% Level 2 42/372 11% Level 1 31/372 8% No no-campus courses offered	81% (271/372) performed at Level 3 or higher. Down from 84% last year. The overall percentage of students that scored at level 3 decreased slightly this academic year. Our recommendation is to add discussion questions on the relative sizes of objects in our universe. See Addendum A.

AST 220 Objective 2 Describe the time scales for major cosmic events such as the age of the universe, when galaxies began to form, or when our solar system formed.	Rubric based assessment of a related final exam problem that fits the description given in objective 2	70% of students learning at a rubric level of 3	Internet Campus Level 3 353/372 75% Level 2 62/372 17% Level 1 10/372 8% No no-campus courses offered	75% (353/372) performed at Level 3 or higher. Down from 83% last year. The overall percentage of students that scored at level 3 increased this academic year. Our recommendation is to continue adding discussion questions about the timing of events since the Big Bang. See Addendum B.
AST 220 Objective 3 Demonstrate knowledge of basic scientific principles used by astronomers to understand the composition and the dynamics of the universe.	Rubric based assessment of a related final exam question that fits the description given in objective 3	70% of students learning at a rubric level of 3	I Internet Campus Level 3 280/372 76% Level 2 57/372 16% Level 1 31/372 8% No no-campus courses offered	86% (277/372) performed at Level 3 or higher. Down from 81% last year. The overall percentage of students that scored at level 3 decreased this academic year. Our recommendation is to continue to add additional discussion questions of the basic scientific principles. See Addendum C.

Addendum A

We will include a question similar to the following in the lab documents or in the lab discussion: How does distance to the nearest star system of Alpha Centauri compare to the size our Milky Way Galaxy?

Addendum B

We will include a question similar to the following: How do the following events compare on the cosmic calendar: the time between the Big-Bang and the emergence of intelligent life on earth?

Addendum C

We will include a question similar to the following: Why does a star spin faster as it collapses?

Astronomy Course Level Outcomes Assessment Rubric

Level 3: Attempted Problem and Solved Correctly
Level 2: Attempted Problem and Did Not Solve Correctly
Level 1: Did Not Attempt Problem

Evaluated Course Objectives and Related Example Questions

The astronomy final will be a comprehensive multiple-choice exam.

The student will demonstrate knowledge of astronomy by his/her ability to:

1. Use analogy to describe size and distance scales between planets in the solar system, distance between star systems in galaxies, and distance between galaxies or galaxy clusters within the universe.

Example question 1

Suppose we imagine the Sun to be about the size of a grapefruit. What sort of area would the portion of our Solar System that includes the orbits of the eight major planets and the dwarf planet Pluto cover?

2. Be to describe the time scales for major cosmic events such as the age of the universe, when galaxies began to form, or when our solar system formed.

Example question 2

What is approximate age of the universe?

3. Demonstrate knowledge of basic scientific principles used by astronomers to understand the composition and the dynamics of the universe.

Example question 3

What does Kepler's first law say about how the planets orbit our sun?

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Evaluated Course Objectives

The student will demonstrate his/her knowledge of physical science using writing skills with correct grammar, spelling and punctuation by being able to:

The student will demonstrate knowledge of mathematics by his/her ability to

1. Make conversions between Fahrenheit, Celsius and Kelvin temperature scales.
2. Calculate density, mass, or volume of an object or substance from the given data.
3. Apply the combined gas law to find the volume of a gas when both the temperature and pressure change.

Instructional Program Outcomes & Assessment Plan – CHM 104

Chemistry 104 Course Level Outcomes Assessment Rubric
For Exam and Quiz Questions

Level 4: Student provides a complete and correct response that is well organized, with no errors.

Level 3: Student provides a complete response that is well organized, but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct response, but lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a response, but demonstrates little understanding of subject required to produce a correct response with expected organization.

Level 0: Student does not attempt a response.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
CHM 104 Objective 1 Make conversions between Fahrenheit, Celsius and Kelvin temperature scales.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 68/89 76.4% Level 3 2/89 2.2% Level 2 2/89 2.2% Level 1 8/89 9.0% Level 0 14/89 10.1%	**Changes/Observations-** Annual Campus-wide total at rubric level 3 or higher: 78.6% This represents a slight increase in success over the previous year and indicates continued success in current instructional methods. The criteria for success are met. We strongly encouraged students to show all calculations on exam problems. Fewer submitted answers with no support. For the 2022 – 2023 year, we plan to continue to stress the importance of showing calculations and continue to include videos on temperature conversion.. Total = 89

CHM 104 Objective 2 Calculate density, mass, or volume of an object or substance from the given data.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 65/89 73.0% Level 3 0/89 0% Level 2 2/89 2.2% Level 1 8/89 9.0% Level 0 14/89 15.7%	**Changes/Observations-** Annual Campus-wide total at rubric level 3 or higher: 73.0% There was a marked improvement in the success rate compared to the 2020-2021 success rate of 46.7 %. We strongly encouraged students to show all calculations on exam problems, and reminded them that they would receive no credit for divine inspiration. Far fewer submitted answers with no support. For the 2022 – 2023 year, we plan to continue use of the density dedicated lab assignment. The criteria for success are met during current instructional methods. Total = 89

CHM 104 Objective 3 Apply the combined gas law to find the volume of a gas when both the temperature and pressure change.	Rubric based assessment of related common final exam and/or midterm exam questions.	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 55/89 61.8% Level 3 0/89 0% Level 2 5/89 5.6% Level 1 10/89 11.2% Level 0 19/89 21.3%	**Changes/Observations-** Annual Campus-wide total at rubric level 3 or higher: 61.8% As with the other Learning Objectives, there was a significant improvement over results for the 2020-2021 academic year. This improvement was primarily due to students including relevant calculations as part of their exam responses. The criteria for success are still not met under current instructional methods. We had 21.3% of students to skip this problem without attempting a response. We believe this may be due to a lack of confidence in the basic algebraic manipulations required to solve this type of Gas Law problem. For the 2022 – 23 academic year we plan to introduce a short review of the algebraic principles required to solve this and other problems related to chemistry. Total = 89

References

Chemistry 104 SLO Rubric:

Level 4: Student provides a complete and correct response that is well organized, with no errors.

Level 3: Student provides a complete response that is well organized, but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct response but lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a response but demonstrates little understanding of subject required to produce a correct response with expected organization.

Level 0: Student does not attempt a response.

CHM 104 SLO Common Final Exam Problems

These three questions are to be included on each CHM 104 Final Exam. They are categorized as Essay questions when included in an on-line assessment. These questions can easily be incorporated into traditional on-campus exams as well.

CHM 104 Objective 1

Make conversions between Fahrenheit, Celsius and Kelvin temperature scales.

Actual question included on the CHM 104 Final Exam for Spring 2022:

Fin 2022 Pro 009

Question Text: James Spann in his weather forecast prognosticates a low of 260K for tonight? Determine the corresponding temperature in C and F degrees. What season would we be in? (8 points

CHM 104 Objective 2

Calculate density, mass, or volume of an object or substance from the given data.

Actual question included on the CHM 104 Final Exam for Spring 2022:

Fin 2022 Pro 004

Question Text: A piece of unknown metal has a volume of 4.8 cm3 and a mass of 72.0 grams. Calculate the density of this metal. (4 points)

CHM 104 Objective 3

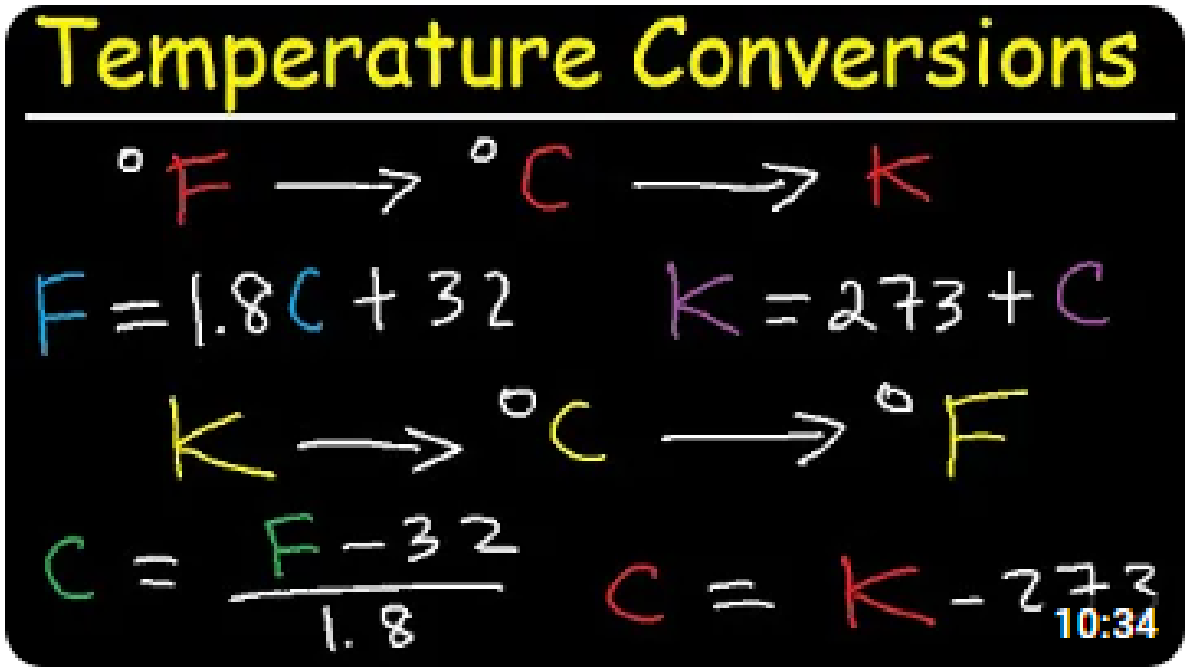
Apply the combined gas law to find the volume of a gas when both the temperature and pressure change.

Actual question included on CHM 104 Final Exam for Spring 2022:

Fin 2022 Pro 003

Question Text: Given 6.0 L of N2 gas at –42oC and 5 atm pressure. What volume will the nitrogen occupy at STP? (8 points)

Evidence in support of SLO 1:
YouTube Video on Temperature Conversion.



Evidence in Support of SLO 2:

Density Supplement and Laboratory Exercise

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2

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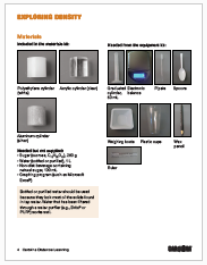

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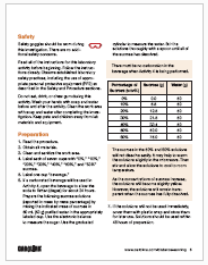

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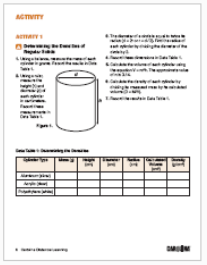

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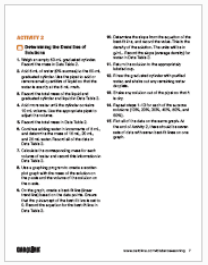

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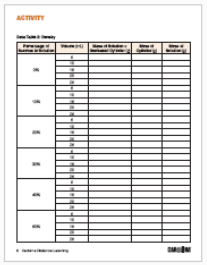

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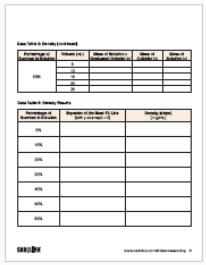
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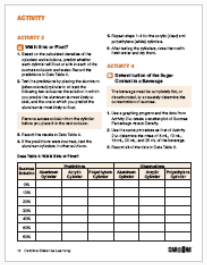

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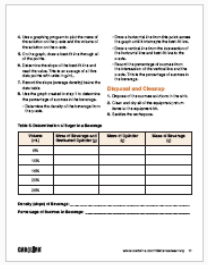
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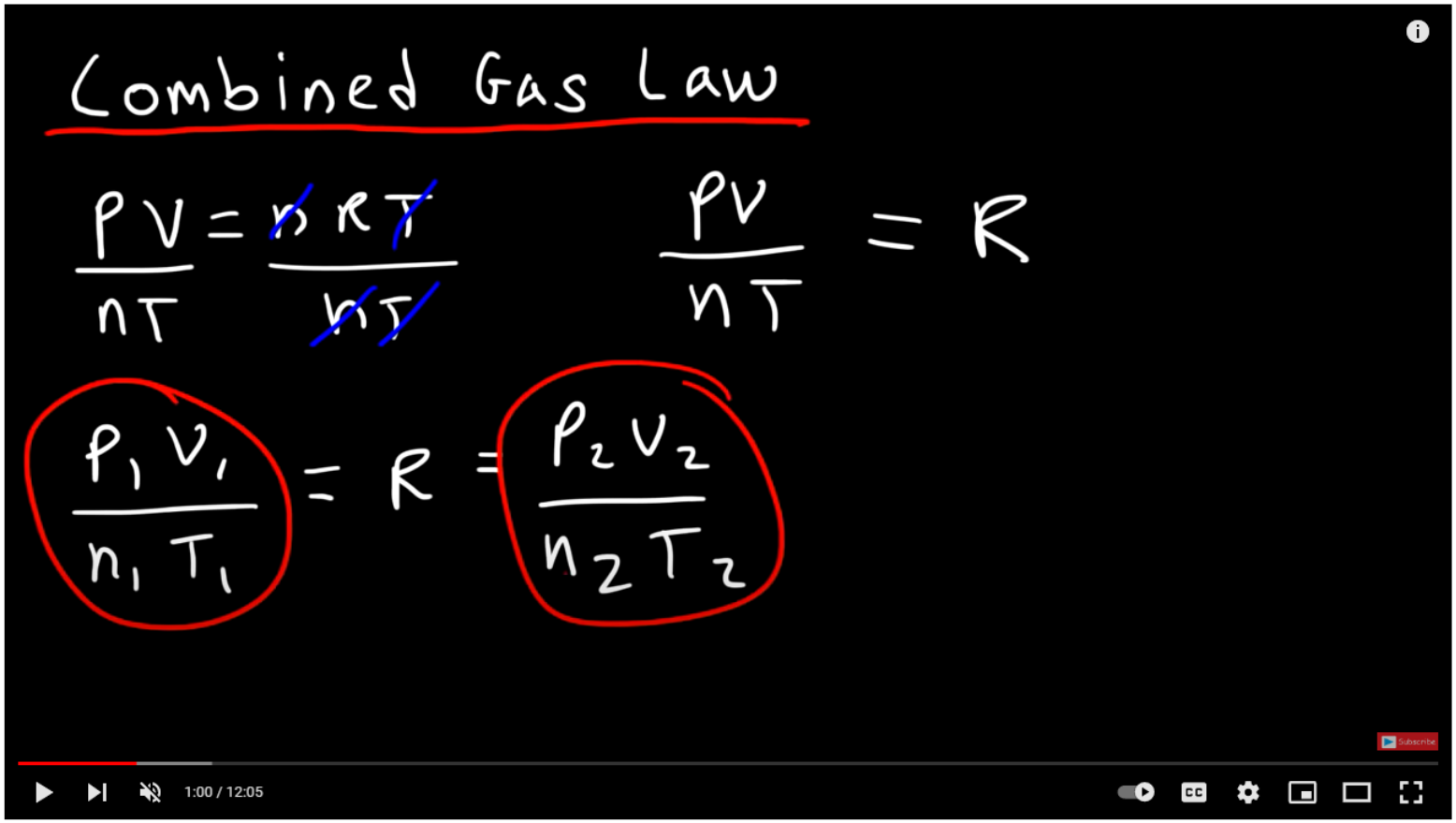
September 6, 2022

Evidence in Support of SLO 3:



Combined Gas Law Problems

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – CHM111

Chemistry Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Evaluated Course Objectives

The student will demonstrate his/her understanding of chemistry by being able to:

1. Carry out calculations relating density, specific gravity, mass, and volume to one another
2. Determine the empirical formula of compound, given the mass percentages of the elements or the analytical data from which these can be calculated, and determine the molecular formula of that compound, given an approximated molecular mass.
3. Given a reaction involving species in solution, relate the volumes or concentrations of two reactant species to the mass of solid precipitated.
4. Use the ideal gas law, determining the moles of a gas sample given its pressure, volume and temperature.
5. Draw the Lewis structure of a molecule or ion and predict its geometry.
6. Draw valid resonance structures including formal charges.
7. Use freezing point depression data to determine the molar mass of a substance.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
SLO 1: Carry out calculations relating density, specific gravity, mass, and volume to one another	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	**90 % schoolwide performed at level 2 or higher. (69/77)** **Jefferson Campus** Level 4 (13/16) 81 % Level 3 (1/16) 6 % Level 2 (0/16) 0 % Level 1 (2/16) 13 % Level 0 (0/16) 0 % **Shelby Campus** Level 4 (20/28) 71 % Level 3 (3/28) 11 % Level 2 (2/28) 7 % Level 1 (3/28) 11 % Level 0 (0/28) 0 % **Online Campus** Level 4 (24/33) 73 % Level 3 (4/33) 12 % Level 2 (2/33) 6 % Level 1 (3/33) 9 % Level 0 (0/33) 0 %	**Observations/Changes:** CHM 111 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance carrying out calculations involving density. CHM 111 instructors will include a corresponding laboratory activity to provide hands-on activities and further opportunities for the students to practice the calculations CHM 111 will be offered as an on-campus course going forward

SLO 2: Determine the empirical formula of compound, given the mass percentages of the elements or the analytical data from which these can be calculated, and determine the molecular formula of that compound, given an approximated molecular mass.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	**90 % schoolwide performed at level 2 or higher. (69/77)** **Jefferson Campus** Level 4 (6/16) 38 % Level 3 (6/16) 38 % Level 2 (2/16) 13 % Level 1 (2/16) 13 % Level 0 (0/16) 0 % **Shelby Campus** Level 4 (15/28) 54 % Level 3 (7/28) 25 % Level 2 (3/28) 11 % Level 1 (3/28) 11 % Level 0 (0/28) 0 % **Online Campus** Level 4 (14/33) 42 % Level 3 (14/33) 42 % Level 2 (2/33) 6 % Level 1 (2/33) 6 % Level 0 (1/33) 3 %	**Observations/Changes:** CHM 111 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance determining empirical and molecular formulae from combustion data. CHM 111 will be offered as an on-campus course going forward

SLO 3: Relate the volumes or concentrations of two reactant species to the mass of solid precipitated	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	**86 % schoolwide performed at level 2 or higher. (66/77)** **Jefferson Campus** Level 4 (8/16) 50 % Level 3 (4/16) 25 % Level 2 (2/16) 13 % Level 1 (2/16) 13 % Level 0 (0/16) 0 % **Shelby Campus** Level 4 (12/28) 43 % Level 3 (9/28) 32 % Level 2 (3/28) 11 % Level 1 (4/28) 14 % Level 0 (0/28) 0 % **Online Campus** Level 4 (16/33) 48 % Level 3 (8/33) 24 % Level 2 (4/33) 12 % Level 1 (4/33) 12 % Level 0 (1/33) 3 %	**Observations/Changes:** CHM 111 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance relating volumes, concentrations and masses precipitated. CHM 111 will be offered as an on-campus course going forward

SLO 4: Use the ideal gas law, determining the moles of a gas sample given its pressure, volume and temperature	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	**91 % schoolwide performed at level 2 or higher. (70/77)** **Jefferson Campus** Level 4 (8/16) 50 % Level 3 (5/16) 31 % Level 2 (1/16) 6 % Level 1 (2/16) 13 % Level 0 (0/16) 0 % **Shelby Campus** Level 4 (17/28) 61 % Level 3 (7/28) 25 % Level 2 (2/28) 7 % Level 1 (2/28) 7 % Level 0 (0/28) 0 % **Online Campus** Level 4 (17/33) 52 % Level 3 (9/33) 27 % Level 2 (4/33) 12 % Level 1 (3/33) 9 % Level 0 (0/33) 0 %	**Observations/Changes:** CHM 111 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance carrying out calculations involving gas laws. CHM 111 will be offered as an on-campus course going forward

SLO 5: Draw the Lewis structure of a molecule or ion and predict its geometry.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	**81 % schoolwide performed at level 2 or higher. (62/77)** **Jefferson Campus** Level 4 (7/16) 44 % Level 3 (4/16) 25 % Level 2 (1/16) 6 % Level 1 (1/16) 6 % Level 0 (3/16) 19 % **Shelby Campus** Level 4 (16/28) 57 % Level 3 (7/28) 25 % Level 2 (1/28) 4 % Level 1 (4/28) 14 % Level 0 (0/28) 0 % **Online Campus** Level 4 (12/33) 36 % Level 3 (10/33) 30 % Level 2 (4/33) 12 % Level 1 (5/33) 15 % Level 0 (2/33) 6 %	**Observations/Changes** CHM 111 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance in drawing Lewis structures and determining geometries from chemical formulae. CHM 111 will be offered as an on-campus course going forward

SLO 6: Draw valid resonance structures including formal charges	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	**91 % schoolwide performed at level 2 or higher. (70/77)** **Jefferson Campus** Level 4 (8/16) 50 % Level 3 (4/16) 25 % Level 2 (1/16) 6 % Level 1 (2/16) 13 % Level 0 (1/16) 6 % **Shelby Campus** Level 4 (18/28) 64 % Level 3 (8/28) 29 % Level 2 (0/28) 0 % Level 1 (2/28) 7 % Level 0 (0/28) 0 % **Online Campus** Level 4 (23/33) 70 % Level 3 (8/33) 24 % Level 2 (0/33) 0 % Level 1 (2/33) 6 % Level 0 (0/33) 0 %	**Observations/Changes:** CHM 111 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance drawing resonance structures and calculating formal charges. CHM 111 will be offered as an on-campus course going forward

SLO 7: The student will demonstrate his/her understanding of chemistry by being able to use freezing point depression data to determine the molar mass of a substance	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	**90 % schoolwide performed at level 2 or higher. (69/77)** **Jefferson Campus** Level 4 (12/16) 75 % Level 3 (1/16) 6 % Level 2 (1/16) 6 % Level 1 (2/16) 13 % Level 0 (0/16) 0 % **Shelby Campus** Level 4 (20/28) 71 % Level 3 (4/28) 14 % Level 2 (1/28) 4 % Level 1 (2/28) 7 % Level 0 (1/28) 4 % **Online Campus** Level 4 (25/33) 76 % Level 3 (3/33) 9 % Level 2 (2/33) 6 % Level 1 (3/33) 9 % Level 0 (0/33) 0 %	**Observations/Changes:** CHM 111 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance carrying out calculations involving density CHM 111 instructors will include a corresponding laboratory activity to provide hands-on activities and further opportunities for the students to practice the calculations. CHM 111 will be offered as an on-campus course going forward
Plan submission date: August 28th, 2020			**Submitted by: Lisa Nagy**	

References

CHM 111 SLO Rubric:

Level 4: Student provides a complete and correct solution process that is well organized, with no errors. Level 3: Student provides a complete solution process that is well organized but contains minor errors. Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant. Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization. Level 0: Student does not attempt a solution.

CHM 111 SLO Common Final Exam Problems:

(Data in **bold** are parameterized).

CHM 111 SLO 1

A sample of metal weighing **32.8** grams was placed in a graduated cylinder containing 25.00 ml of water. The water level rose to **28.12** ml. What is the density of the metal?

CHM 111 SLO 2

A **4.582** g sample of an organic compound containing only carbon, hydrogen, and **nitrogen** is subjected to combustion analysis. **12.429** grams of carbon dioxide and **3.559** g of water are isolated. The molar mass of the compound is between **150** and **180** g/mol. What are the empirical and molecular formulas of the compound?

CHM 111 SLO 3

When aqueous solutions of silver nitrate ($AgNO_3$) and potassium chromate (K_2CrO_3) are mixed, the blood-red precipitate silver chromate (Ag_2CrO_3) is formed. If **10.0 mL** of **0.25** *M* aqueous silver nitrate is mixed with **15.0** mL of **0.14** *M* aqueous potassium chromate, what mass of sliver chromate forms?

CHM 111 SLO 4

How many moles of gas are in a gas sample occupying **0.658** L at **0.598** atm and **32 °**C?

CHM 111 SLO 5

Draw a Lewis structure and state the geometry for the molecule **SF_4**.

CHM 111 SLO 6

Draw **two** resonance structures of **ozone, O_3**, showing all lone pairs and formal charges

CHM 111 SLO 7

What is the molar mass (g/mol) of a nonpolar molecular compound if **2.55** grams dissolved in **50.0** grams of **cyclohexane** begins to freeze at **-1.36 °C**? The freezing point of pure **cyclohexane** is **6.55 °C** and the freezing point depression constant, Kfp, is **20.2** °C/m

Examples of Corresponding Homework Problems

SLO 1 Density

1.

Use the References to access important values if needed for this question.

A general chemistry student found a chunk of metal in the basement of a friend's house. To figure out what it was, **he** used the ideas just developed in class about density.

First **he** measured the mass of the metal to be **120.0** grams. Then **he** dropped the metal into a measuring cup and found that it displaced **16.4** mL of water.

Calculate the density of the metal.
Density = [ ] g / mL

Use the table below to decide the identity of the metal. This metal is most likely [ ] .

Densities of Some Common Substances

Substance	Density (g/mL)
Water	1.00
Aluminum	2.72
Chromium	7.25
Nickel	8.91
Copper	8.94
Silver	10.50
Lead	11.34
Mercury	13.60
Gold	19.28
Tungsten	19.38
Platinum	21.46

Previous Next

2.

A mineral sample has a mass of **59.8** g and a volume of **8.6** cm^3. Which is it?

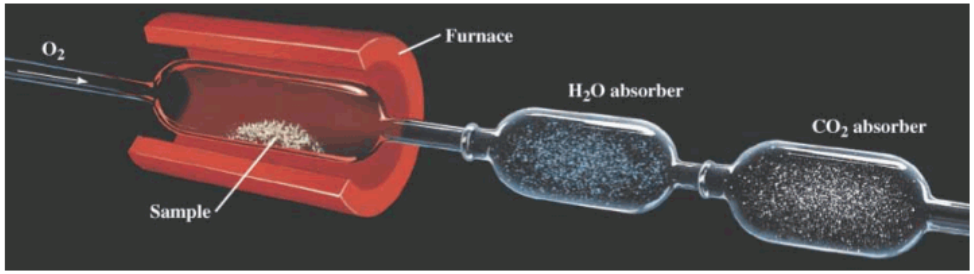
- cassiterite (density = 6.99 g/cm^3)
- cinnabar (density = 8.10 g/cm^3)
- sphalerite (density = 4.00 g/cm^3)

Submit Answer | Retry Entire Group | 9 more group attempts remaining

SLO 2 Combustion Analysis

1.

Use the References to access important values if needed for this question.



A **4.801** gram sample of an organic compound containing C, H and O is analyzed by combustion analysis and **6.091** grams of CO_2 and **1.663** grams of H_2O are produced.

In a separate experiment, the molecular weight is found to be **104.1** amu. Determine the empirical formula and the molecular formula of the organic compound.

Enter the elements in the order C, H, O

empirical formula =

molecular formula =

2.

When 2.56 g of a compound containing only carbon, hydrogen, and oxygen is burned completely, **3.84** g of CO_2 and **1.05** g of H_2O are produced. What is the empirical formula of the compound?

(Enter the elements in the order: C, H, O.)

The empirical formula is

Submit Answer | Retry Entire Group | 9 more group attempts remaining

SLO 3 Limiting Reagent

1.

For the following reaction, **0.660** grams of **hydrogen gas** are allowed to react with **12.6** grams of **ethylene (C_2H_4)** .

hydrogen (**g**) + **ethylene** (C_2H_4) (**g**) $\longrightarrow$ **ethane** (C_2H_6) (**g**)

What is the maximum amount of **ethane** (C_2H_6) that can be formed? [ ] grams

What is the **FORMULA** for the limiting reagent? [ ]

What amount of the excess reagent remains after the reaction is complete? [ ] grams

2.

Calculate the number of milliliters of **0.530** M **NaOH** required to precipitate all of the Cu^{2+} ions in **197** mL of **0.537** M $CuSO_4$ solution as $Cu(OH)_2$. The equation for the reaction is:

$CuSO_4(aq) + 2NaOH(aq) \longrightarrow Cu(OH)_2(s) + Na_2SO_4(aq)$

[ ] mL **NaOH**

[SLO 4 Gas Laws]

A sample of **neon** gas collected at a pressure of **0.539** atm and a temperature of **20.0** °C is found to occupy a volume of **20.6** liters. How many moles of **Ne** gas are in the sample? _____ mol

Submit Answer | Retry Entire Group | 9 more group attempts remaining

SIMULATION Ideal Gas Law

Pressure
1000 mmHg

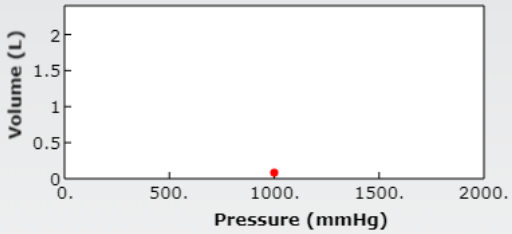
Mass
100 mg

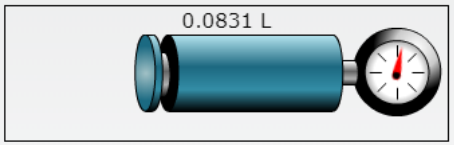
Temperature
100 °C

Gases
- N_2
- O_2
- Ar
- CO_2
- Xe

Plot Volume vs.
- Pressure
- Mass
- Temperature

Calculate | Clear





The behavior of gases near room temperature and 1 atm pressure can be described using four main properties: amount, pressure, volume, and temperature. In this simulation the mass, pressure, and temperature can be varied. The corresponding volume is displayed above the syringe. In creation of a graph using this simulation, volume is on the y-axis and the parameter plotted on the x-axis can be chosen from pressure, mass, or temperature. Through this exercise you will see how such experiments led to the now familiar gas laws.

Next (Introduction)

Submit Answer | Retry Entire Group | 9 more group attempts remaining

SLO 5 Lewis Structure

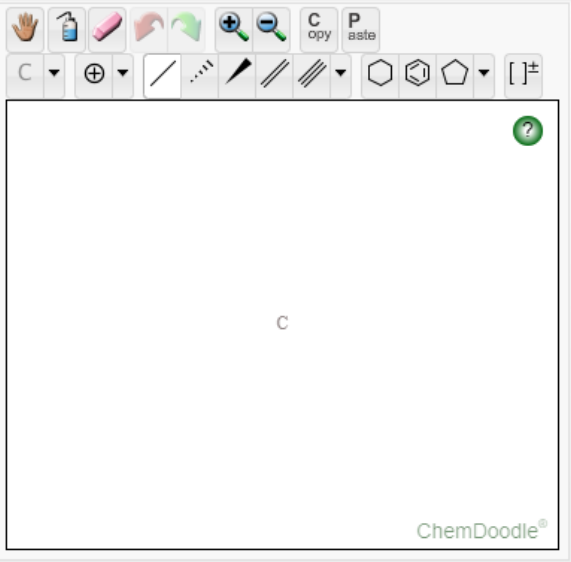
This question has multiple parts. Work all the parts to get the most points.

a

Use the References to access important values if needed for this question.

Draw the Lewis structure for ICl_4^- in the window below and then answer the questions that follow.

- Do not include overall ion charges or formal charges in your drawing.



b What is the **electron-pair** geometry for **I** in ICl_4^- ?

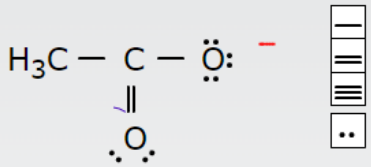
c What is the the shape (molecular geometry) of ICl_4^-?

SLO 6 Resonance

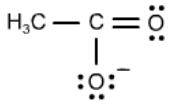
1.

EXERCISE Resonance Structures I

Clear



Below is the Lewis structure of $CH_3CO_2^-$, which has one other resonance structure.



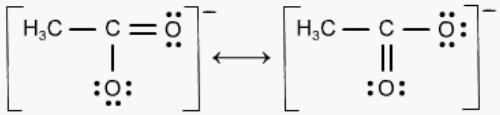
Complete the resonance structure by dragging bonds and electron lone pairs to their appropriate positions.

Then click **Check**.

Check Next (3 of 3)

Correct

The two resonance structures of the acetate ion are:

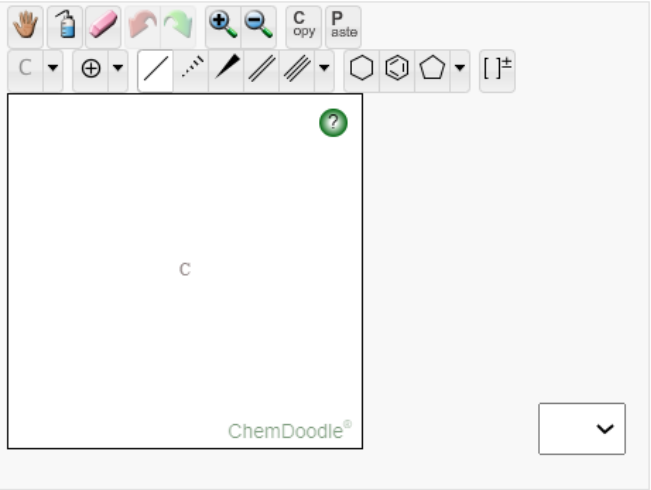


2.

Use the References to access important values if needed for this question.

Draw all resonance structures for the **sulfur dioxide** molecule, SO_2.

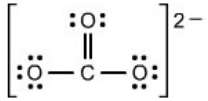
- Explicitly draw all H atoms.
- Include all valence lone pairs in your answer.
- Do not include overall ion charges or formal charges in your drawing.
- Do not draw double bonds to oxygen unless they are needed for the central atom to obey the octet rule.
- Draw one structure per sketcher. Add additional sketchers by selecting ↔ in the drop-down menu



3.

TUTOR **Formal Charge**

Determine the formal charge for the left oxygen atom, the central carbon atom and the top oxygen atom in this structure.



O on left: _____

central C: _____

O on top: _____

Submit Show Approach Show Tutor Steps

SLO 7 MW from Freezing Point Depression

Boiling Point Elevation/Freezing Point Depression

$$\Delta T = m K$$

where, for freezing point depression:

$$\Delta T = T(\text{pure solvent}) - T(\text{solution})$$

and for boiling point elevation:

$$\Delta T = T(\text{solution}) - T(\text{pure solvent})$$

$\boldsymbol{m}$ = (# moles solute / Kg solvent)
$\boldsymbol{K_b}$ = boiling point elevation constant.
$\boldsymbol{K_f}$ = freezing point depression constant.

K_b and K_f depend only on the SOLVENT. Below are some common values. Use these values for the calculations that follow.

Solvent	Formula	K_b(°C / m)	K_f(°C / m)
Water	H_2O	0.512	1.86
Ethanol	CH_3CH_2OH	1.22	1.99
Chloroform	$CHCl_3$	3.67	
Benzene	C_6H_6	2.53	5.12
Diethyl ether	$CH_3CH_2OCH_2CH_3$	2.02	

Safrole is contained in oil of sassafras and was once used to flavor root beer. A 2.39-mg sample of safrole was dissolved in 103.0 mg of diphenyl ether. The solution had a melting point of 25.70°C. Calculate the molecular weight of safrole. The freezing point of pure diphenyl ether is 26.84°C, and the freezing-point-depression constant, K_f, is 8.00°C/m.

Molecular weight = [ ] amu

Submit Answer | Retry Entire Group | 9 more group attempts remaining

Examples of Corresponding Laboratory Exercises

SLO 1 Density

CHM 111 Lab 3
Density

Introduction:

The density of an object is its mass per unit volume. This is a derived unit that may be expressed as

$$d = \frac{m}{V}$$

Where d is the density, m is the mass, and V is the volume. For liquids and solids, the density is usually expressed as g/ml or g/cm³. This is because most liquids and solids have densities from about 0.5-25 g/ml or g/cm³. (note, 1 ml is 1 cm³).

When the object is a regular solid, one can simply measure the object with a ruler or a set of calipers and calculate the volume. This does not work well for an irregularly shaped object, however. In that case, it is easiest to measure the volume by displacement. Another method is to weigh the object in air and in water and to use the difference to compute density (this is difficult with a normal scale). When the substance is a liquid, density is found by simply weighing a known volume.

Objectives:

1. Measure the dimensions of a regular solid using Vernier calipers.
2. Determine the density of the object.
3. Determine the density of a liquid.
4. Determine the volume of an irregular solid by displacement and determine the density.

Materials used in this lab:
1. Vernier calipers
2. 50 ml Graduated cylinder
3. Marbles
4. Household vinegar, rubbing alcohol, or some other liquid (your choice).
5. 1-hole stopper
6. Tap water
7. Pocket scale

Procedure:

Print out your data sheet so that you will be able to record your observations as they happen.

1. Using the Vernier calipers.

Vernier calipers allow measurement to a high degree of precision. They are a little tricky to learn how to use, but once you do figure it out, it's easy. There are video tutorials on the web if you need more help.

Vernier calipers look like this:

SLO 7 MW from Freezing Point Depression

LabQuest 4

Using Freezing-Point Depression to Find Molecular Weight

When a solute is dissolved in a solvent, the freezing temperature is lowered in proportion to the number of moles of solute added. This property, known as freezing-point depression, is a *colligative property*; that is, it depends on the ratio of solute and solvent particles, not on the nature of the substance itself. The equation that shows this relationship is

$$\Delta t = K_f \times m$$

where Δt is the freezing point depression, K_f is the freezing point depression constant for a particular solvent (3.9°C•kg/mol for lauric acid in this experiment[1]), and m is the molality of the solution (in mol solute/kg solvent).

OBJECTIVES

- Determine the freezing temperature of the pure solvent, lauric acid.
- Determine the freezing temperature of a mixture of lauric acid and benzoic acid.
- Calculate the freezing point depression of the mixture.
- Calculate the molecular weight of benzoic acid.

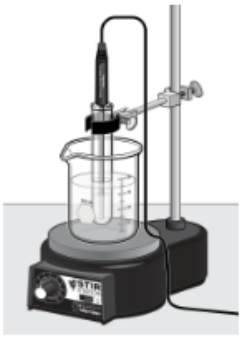


Figure 1

1 "The Computer-Based Laboratory", Journal of Chemical Education: Software, 1988, Vol.1A, No. 2, p. 73.

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – CHM112

Chemistry Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Departmental Objectives:

1. Provide freshman and sophomore level courses in Chemistry, Mathematics, Physics, Physical Sciences and Astronomy with emphasis on critical thinking and analytical ability, that are transferable to public institutions of higher learning.
2. Offer an appropriate remedial mathematics program accommodating various skill levels.
3. Develop and provide courses relevant to the career and professional degree programs of the college.

Evaluated Course Objectives

The student will demonstrate his/her understanding of chemistry by being able to:

1. Use Le Chatelier's Principle to predict the direction in which a system at equilibrium will shift (if it does) when stresses are applied.
2. Predict ΔS (change in entropy) for many kinds of common changes, both chemical and physical.
3. Determine the percent ionization of a weak mono-protic acid or weak base, given the concentration and Ka or Kb
4. For a given redox reaction, use the Nernst equation to calculate the voltage E of a cell, given E°, and the concentrations of all other species.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
SLO 1: Use Le Chatelier's Principle to predict the direction in which a system at equilibrium will shift (if it does) when stresses are applied.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	95 % schoolwide performed at level 2 or higher. (52/55) **Jefferson Campus** Level 4 (11/14) 79 % Level 3 (1/14) 7 % Level 2 (1/14) 7 % Level 1 (1/14) 7 % Level 0 (0/14) 0 % **Shelby Campus** Level 4 (24/30) 80 % Level 3 (3/30) 10 % Level 2 (2/30) 7 % Level 1 (1/30) 3 % Level 0 (0/30) 0 % **Online Campus** Level 4 (7/11) 64 % Level 3 (3/11) 27 % Level 2 (0/11) 0 % Level 1 (1/11) 9 % Level 0 (0/11) 0 % ***This Course is not taught at Pell City or Clanton Campuses**	**Observations/Changes:** CHM 112 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance predicting equilibrium changes. CHM 112 instructors will include a corresponding laboratory activity to provide hands-on activities and further opportunities for the students to practice the concept.

SLO 2: Predict ΔS (change in entropy) for many kinds of common changes, both chemical and physical.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	95 % schoolwide performed at level 2 or higher. (52/55) **Jefferson Campus** Level 4 (10/14) 71 % Level 3 (1/14) 7 % Level 2 (2/14) 14 % Level 1 (1/14) 7 % Level 0 (0/14) 0 % **Shelby Campus** Level 4 (24/30) 80 % Level 3 (3/30) 10 % Level 2 (2/30) 7 % Level 1 (1/30) 3 % Level 0 (0/30) 0 % **Online Campus** Level 4 (7/11) 64 % Level 3 (0/11) 0 % Level 2 (3/11) 27 % Level 1 (1/11) 9 % Level 0 (0/11) 0 % ***This Course is not taught at Pell City or Clanton Campuses**	**Observations/Changes:** CHM 112 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance in predicting changes in entropy.

SLO 3: Determine the percent ionization of a weak mono-protic acid or weak base, given the concentration and Ka or Kb	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	89 % schoolwide performed at level 2 or higher. (49/55) **Jefferson Campus** Level 4 (10/14) 71 % Level 3 (1/14) 7 % Level 2 (1/14) 7 % Level 1 (2/14) 14 % Level 0 (0/14) 0 % **Shelby Campus** Level 4 (21/30) 70 % Level 3 (6/30) 20 % Level 2 (2/30) 7 % Level 1 (1/30) 3 % Level 0 (0/30) 0 % **Online Campus** Level 4 (6/11) 55 % Level 3 (2/11) 18 % Level 2 (0/11) 0 % Level 1 (3/11) 27 % Level 0 (0/11) 0 % ***This Course is not taught at Pell City or Clanton Campuses**	**Observations/Changes:** CHM 112 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance calculating weak acid titration problems. Because the laboratory activities in the internet sections were performed with home kits, the corresponding laboratory activity in those sections was presented as a video. Going forward, all classes will be on-campus and the lab activity will be hands-on

SLO 4: Use the Nernst equation to calculate the voltage E of a cell, given E°, and the concentrations of all other species.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	87 % schoolwide performed at level 2 or higher. (48/55) **Jefferson Campus** Level 4 (9/14) 64 % Level 3 (2/14) 14 % Level 2 (1/14) 7 % Level 1 (2/14) 14 % Level 0 (0/14) 0 % **Shelby Campus** Level 4 (19/30) 63 % Level 3 (5/30) 17 % Level 2 (1/30) 3 % Level 1 (5/30) 17 % Level 0 (0/30) 0 % **Online Campus** Level 4 (6/11) 55 % Level 3 (4/11) 36 % Level 2 (1/11) 9 % Level 1 (0/11) 0 % Level 0 (0/11) 0 %	**Observations/Changes:** CHM 112 instructors will include corresponding homework problems as part of the students' grade to encourage participation and additional practice to improve performance carrying out calculations involving the Nernst Equation. In the internet section, instructors showed a video of the corresponding lab activity (unsuitable for home kits because of instrumentation and chemical requirements). Going forward, the course will be offered only on-campus, and the corresponding lab activity will be hands-on.

Plan submission date: Jan 10th, 2023	**Submitted by: Lisa Nagy**

References

CHM 112 SLO Rubric:

Level 4: Student provides a complete and correct solution process that is well organized, with no errors. Level 3: Student provides a complete solution process that is well organized but contains minor errors. Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant. Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization. Level 0: Student does not attempt a solution.

CHM 112 SLO Common Final Exam Problems:

(Data in **bold** are parameterized).

CHM 112 SLO 1

The reaction

$N_2O_3(g) \leftrightharpoons NO(g) + NO_2(g)$

has ΔH_r of **+**40.5 kJ/mol How will the following changes affect the equilibrium?

Shift to left (reactants), right (products), or no change

a) Adding more $N_2O_3(g)$_____
b) Adding more $NO_2(g)$_____
c) Increasing the volume of the reaction flask_____
d) Lowering the temperature_____
e) Adding a catalyst_____

CHM 112 SLO 2

Predict the sign of $\Delta S°$ for the following reactions:

a. $NaCl(s) \rightarrow NaCl(aq)$
b. $4\ Fe(s) + 3\ O_2(g) \rightarrow 2\ Fe_2O_3(s)$
c. $H_2O(l) \rightarrow H_2O(s)$

CHM 112 SLO 3

A weak acid, (HA), has an acid dissociation constant of $2.50 \cdot 10^{-6}$. A 25.00 ml sample with a concentration of 0.250 M is titrated with 0.150 M NaOH.

a) What is the pH of the original 0.250 M sample of HA?
b) What is the percent ionization of the 0.250 M acid?

CHM 112 SLO 4

The following questions refer to a voltaic cell containing:
Zinc and iron electrodes, aqueous zinc nitrate, aqueous iron (III) nitrate, and a potassium nitrate salt bridge.

Fe^{3+} (aq) + $3e^-$ → Fe (s) E°= -0.040 V

Zn^{2+}(aq) + $2e^-$ → Zn(s) E°= -0.763 V

Calculate the correct cell potential *E* (not zero) at 298K given 0.500 M iron (III) nitrate and 2.00×10^{-3} M zinc nitrate in the half cells.

Examples of Corresponding Homework Problems

SLO 1 Equilibrium

1.

Consider the following system at equilibrium where ΔH° = **108** kJ, and K_c = $\mathbf{1.29\times10^{-2}}$, at **600** K:

$\mathbf{COCl_2}(g) \rightleftharpoons \mathbf{CO}(g) + \mathbf{Cl_2}(g)$

If the **TEMPERATURE** on the equilibrium system is suddenly **increased**:

The value of K_c [ ]
A. Increases
B. Decreases
C. Remains the same

The value of Q_c [ ]
A. Is greater than K_c
B. Is equal to K_c
C. Is less than K_c

The reaction must: [ ]
A. Run in the forward direction to restablish equilibrium.
B. Run in the reverse direction to restablish equilibrium.
C. Remain the same. Already at equilibrium.

The concentration of Cl_2 will: [ ]
A. Increase.
B. Decrease.
C. Remain the same.

Submit Answer | Retry Entire Group | 9 more group attempts remaining | Previous | Next

2.

Consider the following system at equilibrium where K_c = $\mathbf{1.29\times10^{-2}}$ and ΔH° = **108** kJ/mol at **600** K.

$\mathbf{COCl_2}$ (g) $\rightleftharpoons$ **CO** (g) + $\mathbf{Cl_2}$ (g)

The production of **CO** (g) is favored by:

Indicate True **(T)** or False **(F)** for each of the following:

[ ] **1. increasing** the temperature.
[ ] **2. decreasing** the pressure (by changing the volume).
[ ] **3. increasing** the volume.
[ ] **4. removing $COCl_2$** .
[ ] **5. adding Cl_2** .

Submit Answer | Retry Entire Group | 9 more group attempts remaining

SLO 2 Entropy

1.

INTERACTIVE EXAMPLE **Predicting the Sign of the Entropy Change of a Reaction**

a) The following equation represents the essential change that takes place during the fermentation of glucose (grape sugar) to ethanol (ethyl alcohol).

$C_6H_{12}O_6(s) \rightarrow 2C_2H_5OH(l) + 2CO_2(g)$

Is $\Delta S°$ positive, negative, or can the sign not be determined?

b) Is $\Delta S°$ positive, negative, or can the sign not be determined for the preparation of urea from NH_3 and CO_2?

$2NH_3(g) + CO_2(g) \rightarrow NH_2CONH_2(aq) + H_2O(l)$

c) Is $\Delta S°$ positive, negative, or can the sign not be determined for the following reaction?

$CO(g) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$

Submit Show Tutor Steps

Submit Answer Retry Entire Group 9 more group attempts remaining

2.

Without doing a calculation, predict whether the entropy change will be positive or negative when each of the following reactions occurs in the direction it is written.

a. $\mathrm{HCl}(g) + \mathrm{NH_3}(g) \rightarrow \mathrm{NH_4Cl}(s)$

- positive
- negative

b. $\mathrm{C_2H_4}(g) + \mathrm{H_2}(g) \rightarrow \mathrm{C_2H_6}(g)$

- positive
- negative

c. $2\mathrm{SO_2}(g) + \mathrm{O_2}(g) \rightarrow 2\mathrm{SO_3}(g)$

- positive
- negative

d. $\mathrm{CH_3OH}(l) + \frac{3}{2}\mathrm{O_2}(g) \rightarrow \mathrm{CO_2}(g) + 2\mathrm{H_2O}(g)$

- positive
- negative

Submit Answer Retry Entire Group 9 more group attempts remaining

SLO 3 Weak Acid Titration

1.

Calculate the **percent ionization** of a **0.587** M solution of **acetic acid**.

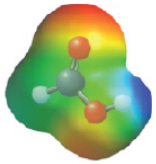
% Ionization = [ ] %

Submit Answer | Retry Entire Group | 9 more group attempts remaining

2.

Formic acid, $\mathrm{HCHO_2}$, is used to make methyl formate (a fumigant for dried fruit) and ethyl formate (an artificial rum flavor). What is the pH of a **0.47** *M* solution of formic acid? What is the degree of ionization of $\mathrm{HCHO_2}$ in this solution?

$$K_a(\mathrm{HCHO_2}) = 1.7 \times 10^{-4}$$



pH = [ ]

Degree of ionization = [ ]

Submit Answer | Retry Entire Group | 9 more group attempts remaining

SLO 4 Nernst Equation

1.Tutorial

VISUALIZATION **Cell Potential: Dependence on Concentration**

$$E = E^{o} - \frac{RT}{nF} \ln Q$$

$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

$E^{o} = +1.10$ V

Show Annotation

The potential of an electrochemical cell is primarily controlled by the nature of the oxidizing and reducing agents. Other factors such as temperature and reactant concentration play a smaller role in determining cell potential. These effects are described by the Nernst Equation. This module examines an experiment designed to test the effect of changing reactant concentration on cell potential. The cell is based on the following reaction:

$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

$E^{o} = +1.10$ V

Watch the video and answer the questions that follow.

Next (Introduction)

2. Calculation problem

What is the calculated value of the cell potential at 298K for an electrochemical cell with the following reaction, when the $\mathbf{Pb^{2+}}$ concentration is $\mathbf{9.40\times10^{-4}}$ M and the $\mathbf{Mg^{2+}}$ concentration is **1.07** M ?

$\mathbf{Pb^{2+}(aq) + Mg(s) \longrightarrow Pb(s) + Mg^{2+}(aq)}$

Answer: [ ] V

The cell reaction as written above is spontaneous for the concentrations given: [ ]

Submit Answer | Retry Entire Group | 9 more group attempts remaining

Examples of Corresponding Laboratory Activities

SLO 1 Home Lab Equilibrium

Equilibrium: LeChatelier's Principle

Safety: HCl is very corrosive to human skin. Handle this substance with extreme care. If any spills occur, wash and wipe up the spill immediately. If you get any on yourself, wash the affected area generously with water and let your instructor know.

Waste Disposal: None of the compounds used in this experiment pose a significant environmental hazard. For acidic solutions, add baking soda until no more bubbling occurs, then discard down the sink. For basic solutions, add two drops of phenolphthalein solution. Add excess or waste acid solution until the purple color just disappears, then discard down the sink.

Purpose: The purpose of this experiment is to determine how a system at equilibrium responds to changing the concentration of reactants or products and changing the temperature.

Overview: This experiment has two parts. In the first part, you will study the equilibrium between iron (III) ion (Fe^{3+}), thiocyanate ion (SCN^{-}), and the iron(III) thiocyanate complex ion ($FeSCN^{2+}$). By visually monitoring the intensity of the color of $FeSCN^{2+}$, you will determine which way the equilibrium shifts upon the addition of several different reagents and upon changing the temperature. In the second part, you will study several equilibria involving Cu^{2+} and NH_3. You will observe the formation and decomposition of several different products as you add NH_3 and as you change the pH of the mixture.

I. Background

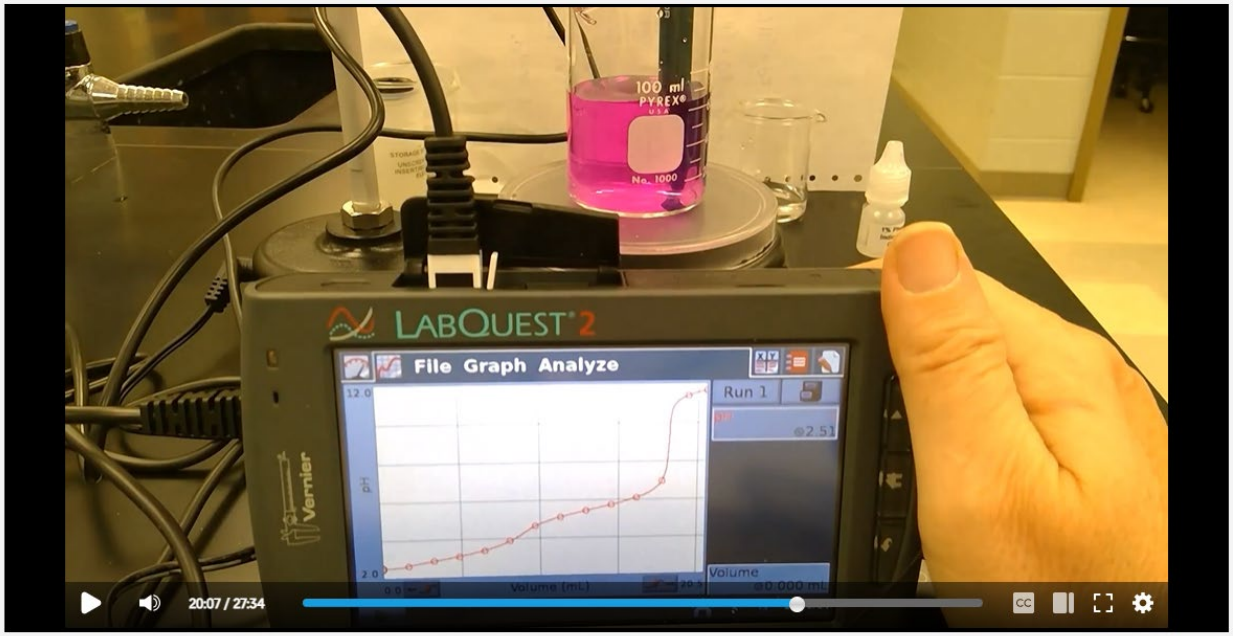
If nitrogen gas and hydrogen gas were added to a reaction vessel under the appropriate conditions, the following reaction would occur:

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

Initially, the vessel would contain only nitrogen and hydrogen, and the concentration of ammonia would be zero. When the reaction commences, the nitrogen and hydrogen would react at some rate, and the concentration of ammonia would be observed to increase while the concentrations of the reactants decreased. An important property of this reaction is that it is *reversible.* This means that the same reaction conditions that drive the forward reaction also drive the decomposition of ammonia, or

$$2NH_3(g) \rightarrow N_2(g) + 3H_2(g) \text{ (the reverse reaction)}$$

[SLO 3 Titration Lab Video]



Titration_Diprotic_ Part 2

RELATED VIDEOS

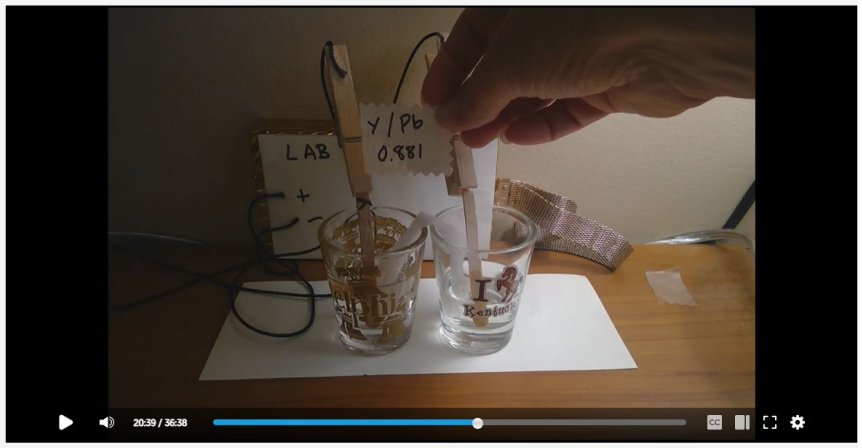
[SLO4 Nernst Equation Lab Video (simulated during quarantine)]

LabQuest **20**

Electrochemistry: Voltaic Cells

In electrochemistry, a voltaic cell is a specially prepared system in which an oxidation-reduction reaction occurs spontaneously. This spontaneous reaction produces an easily measured electrical potential. Voltaic cells have a variety of uses.

In this experiment, you will prepare a variety of semi-microscale voltaic cells in a 24-well test plate. A voltaic cell is constructed by using two metal electrodes and solutions of their respective salts (the electrolyte component of the cell) with known molar concentrations. In Parts I and II of this experiment, you will use a Voltage Probe to measure the potential of a voltaic cell with copper and lead electrodes. You will then test two voltaic cells that have unknown metal electrodes and, through careful measurements of the cell potentials, identify the unknown metals. In Part III of the experiment, you will measure the potential of a special type of voltaic cell called a concentration cell. In the first concentration cell, you will observe how a voltaic cell can maintain a spontaneous redox reaction with identical copper metal electrodes, but different electrolyte concentrations. You will then measure the potential of a second concentration cell and use the Nernst equation to calculate the solubility product constant, K_{sp}, for lead iodide, PbI_2.



CHEM-A 20 Voltaic cells

RELATED VIDEOS

Assessment Record

Program: **Mathematics, Engineering, Physical Sciences** **Assessment period:** **Fall 2021-Summer 2022**

Program or Department Mission:

The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 098

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected

organization.

Level 0: Student does not attempt a solution.

Evaluated Course Objectives

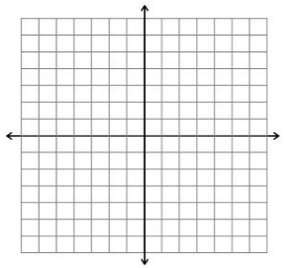
The student will demonstrate his/her understanding of algebraic manipulations, interpretations, and computations by being able to:

1. Solve linear equations, including literal, by applying the properties of equality.
2. Evaluate algebraic expressions using given numerical values.
3. Graph a linear equation.
4. Write the equation of a line given appropriate information.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
Assessment of Objective 1 Solve linear equations, including literal, by applying the properties of equality.	Rubric-based assessment of related final exam problems *Solve linear equations, including literal, by applying the properties of equality.* ***Solve: 2 + 5(x – 5) = 6(x – 1)***	70% of students learning at a rubric level of 2 or higher	**Annual campus-wide total at rubric level 2 or higher: 405/424 = 95.5%** ***Data collected during Fall 2021 and Spring 2022** **Jefferson Campus** Level 4 4/5 80% Level 3 1/5 20% Level 2 0/5 0% Level 1 0/5 0% Level 0 0/5 0% **Shelby Campus** Level 4 63/116 54 % Level 3 21/116 18 % Level 2 23/116 20%	**Observations/Changes:** For the 2022-2023 year, the department recommends reinforcing student learning of this objective by assigning problems using Mathgames.com, a free online tool that allows students to solve math problems in a fun, interactive format. Instructors can assign multiple topics using this tool to individualize instruction as needed, such as, the one listed

			Level 1 7/116 6% Level 0 2/116 2% **<u>Clanton Campus</u>** Level 4 13/13 100% Level 3 0/13 0% Level 2 0/13 0 % Level 1 0/13 0 % Level 0 0/13 0% **<u>Pell City Campus</u>** Level 4 13/13 100 % Level 3 0/13 0% Level 2 0/13 0% Level 1 0/13 0% Level 0 0/13 0% **<u>Online</u>** Level 4 195/277 70% Level 3 40/277 14% Level 2 32/277 12% Level 1 0/277 0% Level 0 10/277 4%	below: https://www.mathgames.com/play/mathmissile.html

Assessment of Objective 2 Evaluate algebraic expressions using given numerical values.	Rubric-based assessment of related final exam problems *Evaluate algebraic expressions using given numerical values.* ***Evaluate the following algebraic expressions, using x = 2, y = -3 and z = 4.*** $\frac{(x+y)^2}{2z}$	70% of students learning at a rubric level of 2 or higher	**Annual campus-wide total at rubric level 2 or higher: 401/424 = 94.6%** **Jefferson Campus** Level 4 4/5 80 % Level 3 0/5 0% Level 2 1/5 20% Level 1 0/5 0% Level 0 0/ 5 0% **Shelby Campus** Level 4 79/116 68% Level 3 18/116 15% Level 2 10/116 9% Level 1 8/116 7% Level 0 1/116 1% **Clanton Campus** Level 4 11/13 85% Level 3 0/13 0% Level 2 2/13 15% Level 1 0/13 0% Level 0 0/13 0% **Pell City Campus** Level 4 8/13 62% Level 3 0/13 0% Level 2 5/13 38 % Level 1 0/13 0% Level 0 0/13 0%	**Observations/Changes:** For the 2022-2023 year, the department recommends reinforcing student learning of this objective by assigning problems using Mathgames.com, a free online tool that allows students to solve math problems in a fun, interactive format. Instructors can assign multiple topics using this tool to individualize instruction as needed, such as, the one listed below: https://www.mathgames.com/skill/6.9-evaluate-multi-variable-expressions

			Online Level 4 181/277 65% Level 3 46/277 17% Level 2 36/277 13% Level 1 0/277 0% Level 0 14/277 5%	
Assessment of Objective 3 Graph a linear equation.	Rubric-based assessment of related final exam problems *Graph the following linear equation:* ***Problem:*** *Graph the following linear equation: y = 12 x - 4* 	70% of students learning at a rubric level of 2 or higher	**Annual campus-wide total at rubric level 2 or higher: 385/424 = 90.8%** **Jefferson Campus** Level 4 2/5 40% Level 3 0/5 0% Level 2 0/5 0% Level 1 3/5 60% Level 0 0/5 0% **Shelby Campus** Level 4 70/116 60.3 % Level 3 12/116 10.3% Level 2 17/116 14.7% Level 1 13/116 11.2% Level 0 4/116 3.5%	**Observations/Changes:** For the 2022-2023 year, the department recommends reinforcing student learning of this objective by assigning problems using Mathgames.com, a free online tool that allows students to solve math problems in a fun, interactive format. Instructors can assign multiple topics using this tool to individualize instruction as needed, such as, the one listed below: https://www.mathgames.com/skill/8.113-graph-a-line-from-an-equation-using-

			<u>Clanton Campus</u> Level 4 11/13 85% Level 3 0/13 0% Level 2 2/13 15% Level 1 0/13 0% Level 0 0/13 0% **<u>Pell City Campus</u>** Level 4 12/13 92% Level 3 0/13 0% Level 2 1/13 8% Level 1 0/13 0% Level 0 0/13 0% **<u>Online</u>** Level 4 200/277 72% Level 3 26/277 9% Level 2 32/277 12% Level 1 0/277 0% Level 0 19/277 7%	algebra

Assessment of Objective 4 Write the equation of a line given appropriate information.	Rubric based assessment of related final exam problems.	70% of students learning at a rubric level of 2 or higher *Find the equation of a line given appropriate information.* ***Problem:*** *Write the equation of the line passing through the point* $6, 0$ *with slope* $-5/9$. *Write the answer in slope-intercept form.*	**Annual campus-wide total at rubric level 2 or higher: 328/424 = 77.4%** **Jefferson Campus** Level 4 1/5 20% Level 3 0/5 0% Level 2 0/5 0% Level 1 4/5 80% Level 0 0/5 0% **Shelby Campus** Level 4 24/116 21% Level 3 18/116 15% Level 2 33/116 28.4% Level 1 32/116 27.6% Level 0 9/116 8% **Clanton Campus** Level 4 6/13 46% Level 3 1/13 8% Level 2 6/13 46% Level 1 0/13 0 % Level 0 0/13 0% **Pell City Campus** Level 4 8/13 62% Level 3 0/13 0%	**Observations/Changes:** MTH 098 Instructors recommend removing this objective going forward since the department voted to reduce the number of objectives to only 3 for each course.

		Level 2 5/13 38% Level 1 0/13 0% Level 0 0/13 0% **Online** Level 4 158/277 57% Level 3 31/277 11.2% Level 2 37/277 13.4% Level 1 12/277 4.3% Level 0 39/277 14.1%	

MTH 098 Rubric

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

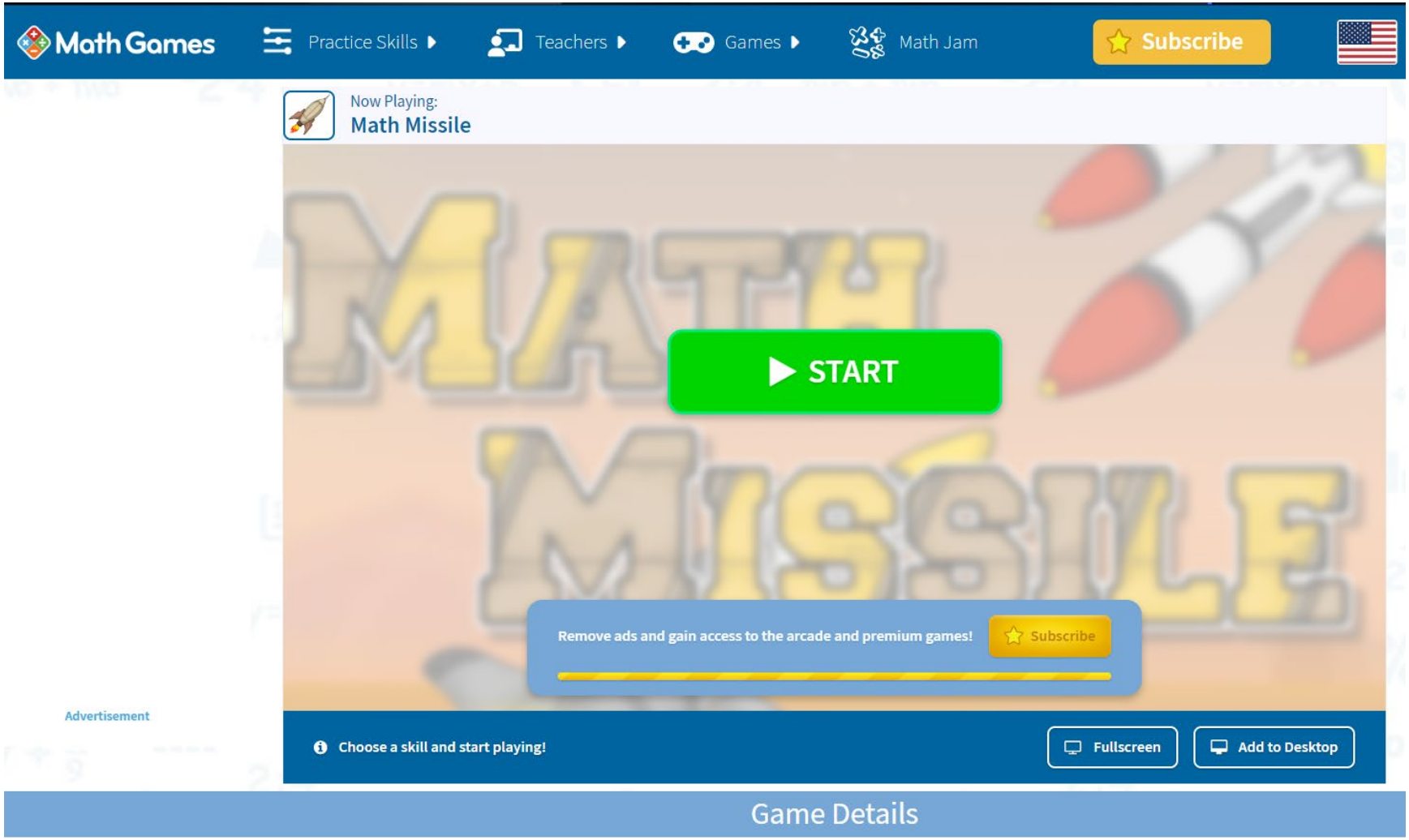
Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

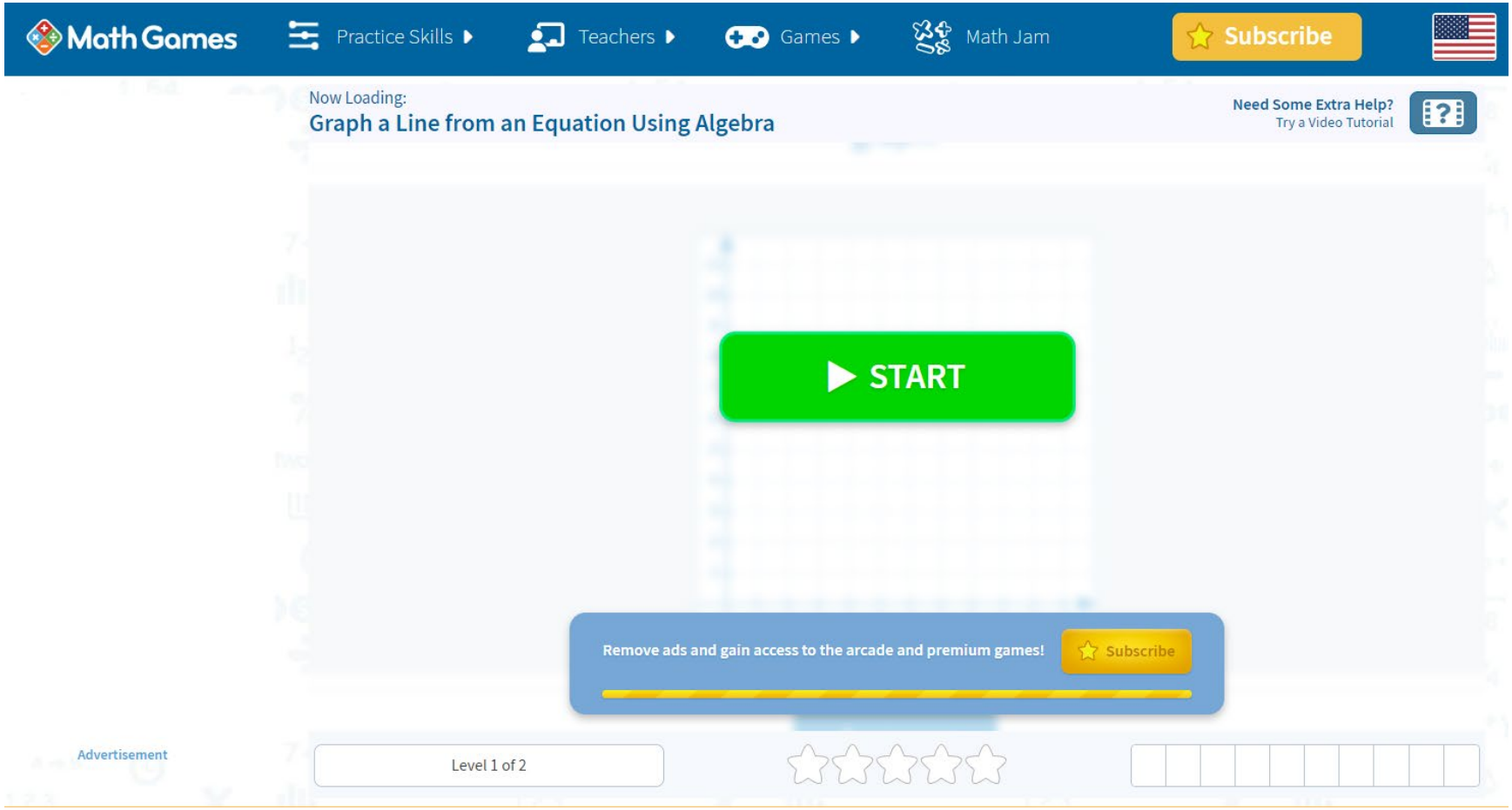
Level 0: Student does not attempt a solution.

SLO 1: Evidence



SLO 2: Evidence

SLO 3: Evidence



Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** 2021 – 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 100

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

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Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Department Outcomes

- Provide freshman and sophomore-level courses in Chemistry, Mathematics, Physics, Physical Sciences, and Astronomy, with emphasis on critical thinking and analytical ability that are transferable to public institutions of higher learning.
- Offer an appropriate remedial mathematics program accommodating various skill levels.
- Develop and provide courses relevant to the career and professional degree programs of the college.

Evaluated Course Objectives

The student will demonstrate his/her understanding of algebraic manipulations, interpretations, and computations by being able to:

1. Simplify radical expressions and perform operations with radical expressions
2. Factor a trinomial.
3. Perform operations with rational expressions
4. Use the quadratic formula to find solutions to equations
5. Apply the rules of exponents to quantities involving integral exponents.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
<u>MTH 100 Objective 1</u> Simplify radical expressions and perform operations with radical expressions	Rubric based assessment of related common final exam problems Objective 1 example common final exam problem: $5\sqrt{72} + 6\sqrt{162} + 7\sqrt{200}$	70% of students learning at a rubric level of 2 or higher	*Data collected during Fall21 and Spr22. Jefferson Campus Level 4 45/75 60.0% Level 3 9/75 12.0% Level 2 8/75 10.7% Level 1 6/75 8.0% Level 0 7/75 9.3% Shelby Campus Level 4 152/262 58.0% Level 3 11/262 4.2% Level 2 32/262 12.2% Level 1 27/262 10.3% Level 0 40/262 15.3% Clanton Campus	**Observations/Changes:** MTH 100 instructors recommend removing this objective going forward since the department voted to reduce the number of objectives to only three for each course. We decided to specifically eliminate this objective since some graphing calculators will now reduce radicals for students. We realized that unless we all adhere to the same calculator policy, there's potential in some MTH 100 classrooms this question is now gauging a student's calculator skills

			Level 4 62/84 73.8% Level 3 1/84 1.2% Level 2 9/84 10.7% Level 1 7/84 8.3% Level 0 5/84 6.0% Pell City Level 4 32/32 100.0% Level 3 0/32 0.0% Level 2 0/32 0.0% Level 1 0/32 0.0% Level 0 0/32 0.0% Online Level 4 338/447 75.6% Level 3 16/447 3.6% Level 2 14/447 3.1% Level 1 0/447 0.0% Level 0 79/447 17.7% MTH 099 Level 4 35/46 76.1% Level 3 0/46 0.0% Level 2 6/46 13.0% Level 1 4/46 8.7% Level 0 1/46 2.2%	instead of a student's radical knowledge. After looking at the data collected, we realized this radical problem is not as straightforward as we thought for our students. To help them be more successful on this type of problem in the future, we have learned we need to focus more on perfect square numbers and perfect cube numbers during our instructional time. If we continually reiterate perfect square and perfect cube numbers during class time, hopefully students will model this same behavior in their own work. This way when they encounter a radical like $\sqrt{72}$, the instantly think to break down this radical as $\sqrt{36}\sqrt{2}$, since 36 is a perfect square number. They would then be able to quickly simplify $\sqrt{36}\sqrt{2}$ to $6\sqrt{2}$.

MTH 100 Objective 2 Factor a trinomial.	Rubric based assessment of related common final exam problems Objective 2 example common final exam problem: $4x^2 + 5x - 6$	70% of students learning at a rubric level of 2 or higher	*Data collected during Fall21 and Spr22. Jefferson Campus Level 4 56/75 74.7% Level 3 7/75 9.3% Level 2 4/75 5.3% Level 1 2/75 2.7% Level 0 6/75 8.0% Shelby Campus Level 4 150/262 58.8% Level 3 5/262 1.9% Level 2 33/262 13.0% Level 1 47/262 17.9% Level 0 22/262 8.4% Clanton Campus Level 4 64/84 76.2% Level 3 1/84 9.1% Level 2 15/84 17.9% Level 1 3/84 3.6% Level 0 1/84 1.2% Pell City Level 4 28/32 87.5% Level 3 2/32 6.3% Level 2 1/32 3.1% Level 1 1/32 3.1% Level 0 0/32 0.0% Online Level 4 353/447 79.0%	**Observations/Changes:** MTH 100 instructors recommend adjusting this objective to a solving a quadratic equation, which will change the current problem. With the problem as it is currently (since it does not contain an equal sign), it requires students to list the factors of a quadratic equation only. The MTH 100 instructors voted that it is important for students to show they can solve a quadratic equation, which is one step beyond just factoring a given quadratic equation. Since Objective 4 also deals with solving a quadratic equation (by using the quadratic formula, whereas this problem asks for factoring), we were able combine Objective 2 and Objective 4 to just one unified objective for the future. After looking at the data collected, MTH 100 instructors recommend reinforcing student learning on this objective by using an online video to offer additional video resources with the following link: Solving Quadratic Equations

			Level 3 12/447 2.7% Level 2 11/447 2.5% Level 1 0/447 0.0% Level 0 71/447 15.9% MTH 099 Level 4 39/46 84.8% Level 3 0/46 0.0% Level 2 6/46 13.0% Level 1 1/46 2.2% Level 0 0/46 0.0%	
<u>MTH 100 Objective 3</u> Perform operations with rational expressions	Rubric based assessment of related common final exam problems Common problem on each MTH 100 instructor's semester exam: $\frac{4+\frac{2}{x}}{\frac{x}{3}+\frac{1}{6}}$	70% of students learning at a rubric level of 2 or higher	*Data collected during Fall21 and Spr22. Jefferson Campus Level 4 39/75 52.0% Level 3 9/75 12.0% Level 2 9/75 12.0% Level 1 9/75 12.0% Level 0 9/75 12.0% Shelby Campus Level 4 127/262 48.5% Level 3 6/262 2.3% Level 2 38/262 14.5% Level 1 41/262 15.6% Level 0 50/262 19.1% Clanton Campus Level 4 42/84 50.0% Level 3 6/84 7.1% Level 2 28/84 33.3% Level 1 1/84 1.2% Level 0 7/84 8.3%	**Observations/Changes:** The data collected here shows on average more than 20% of students at each campus were at a Level 2 level of understanding or lower. We think the issue might be in the common problem itself, because after multiplying the numerator and denominator by 6x, the students would additionally need to realize there is a common factor of x+2 between the numerator and the denominator in order to reach the simplified final answer. MTH 100 instructors decided to update the common problem itself, so there would not be this intermediate step involving a common factor. Here is the updated common problem:

			Pell City Level 4 29/32 90.6% Level 3 1/32 3.1% Level 2 1/32 3.1% Level 1 1/32 3.1% Level 0 0/32 0.0% Online Level 4 336/447 75.2% Level 3 16/447 3.6% Level 2 26/447 5.8% Level 1 1/447 0.2% Level 0 68/447 15.2% MTH 099 Level 4 27/46 58.7% Level 3 2/46 4.3% Level 2 11/46 23.9% Level 1 1/46 2.2% Level 0 5/46 10.9%	$$\frac{4+\frac{2}{x}}{\frac{x}{6}+\frac{1}{6}}$$ After looking at the data collected, MTH 100 instructors recommend reinforcing student learning of this objective by using a graphic organizer to offer additional notes with the following link: Complex Fractions Notebook
MTH 100 Objective 4 Use the quadratic formula to find solutions to equations	Rubric based assessment of related common final exam problems Common problem on each MTH 100 instructor's semester exam: $6n^2 = -12n - 4$	70% of students learning at a rubric level of 2 or higher	*Data collected during Fall21 and Spr22. Jefferson Campus Level 4 52/75 69.3% Level 3 11/75 14.7% Level 2 1/75 1.3% Level 1 1/75 1.3% Level 0 10/75 13.3% Shelby Campus Level 4 120/262 45.8% Level 3 37/262 14.1%	**Observations/Changes:** MTH 100 instructors recommend combining SLO 2 and SLO 4 into only one objective involving a quadratic equation. While the common problem itself has not changed, the directions preceding simply say solve. A student needs to realize this quadratic equation is solvable only with the quadratic formula rather than with factoring.

			Level 2 56/262 21.4% Level 1 16/262 6.1% Level 0 33/262 12.6% Clanton Campus Level 4 45/84 53.6% Level 3 17/84 20.2% Level 2 14/84 16.7% Level 1 5/84 6.0% Level 0 3/84 3.6% Pell City Level 4 27/32 84.4% Level 3 3/32 9.4% Level 2 2/32 6.3% Level 1 0/32 0.0% Level 0 0/32 0.0% Online Level 4 278/447 62.2% Level 3 16/447 3.6% Level 2 84/447 18.8% Level 1 0/447 0.0% Level 0 69/447 15.4% MTH 099 Level 4 22/46 47.8% Level 3 3/46 6.5% Level 2 16/46 34.8% Level 1 1/46 2.2% Level 0 4/46 8.7%	The data collected here shows on average almost 10% of students at each campus were at a Level 0 level of understanding. Level 0 means a student did not even attempt the problem. To encourage students to at least attempt the problem, the MTH 100 instructors could agree to include a similar but simpler question on the final exam immediately preceding this question. For instance, if a student had just solved a problem such as $x^2 - 5x + 6 = 0$, hopefully on the next problem when they saw the SLO question with an equation not equal to 0, this preceding problem would remind them the first step is to set their equation equal to zero. After looking at the data collected, MTH 100 instructors recommend reinforcing student learning on this objective by using an online video to offer additional video resources with the following link: Solving Quadratic Equations

MTH 100 Objective 5 Apply rules of exponents to quantities involving integer exponents.	Rubric based assessment of related common final exam problems Common problem on each MTH 100 instructor's semester exam: $\frac{5(x^5y)^2}{-15(x^3y)^4}$	70% of students learning at a rubric level of 2 or higher	*Data collected during Fall21 and Spr22. Jefferson Campus Level 4 50/75 66.7% Level 3 19/75 25.3% Level 2 3/75 4.0% Level 1 3/75 4.0% Level 0 0/75 0.0% Shelby Campus Level 4 151/262 57.6% Level 3 18/262 6.9% Level 2 45/262 17.2% Level 1 16/262 6.1% Level 0 32/262 12.2% Clanton Campus Level 4 64/84 76.2% Level 3 1/84 1.2% Level 2 14/84 16.7% Level 1 4/84 4.8% Level 0 1/84 1.2% Pell City Level 4 29/32 90.6% Level 3 2/32 6.3% Level 2 1/32 3.1% Level 1 0/32 0.0% Level 0 0/32 0.0% Online Level 4 340/447 76.1% Level 3 12/447 2.7%	**Observations/Changes:** After looking at the data collected, MTH 100 instructors recommend reinforcing student learning of this objective by using a graphic organizer, online practice problems, and applet to offer additional resources with the following link: Laws of Exponents (mathsisfun.com)

			Level 2 31/447 6.9% Level 1 0/447 0.0% Level 0 64/447 14.3% MTH 099 Level 4 33/46 71.7% Level 3 1/46 2.2% Level 2 10/46 21.7% Level 1 1/46 2.2% Level 0 1/46 2.2%	
Plan submission date: August 3, 2022			**Submitted by: J. Brandon Darby and Leah Compton**	

MTH 100 Rubric

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

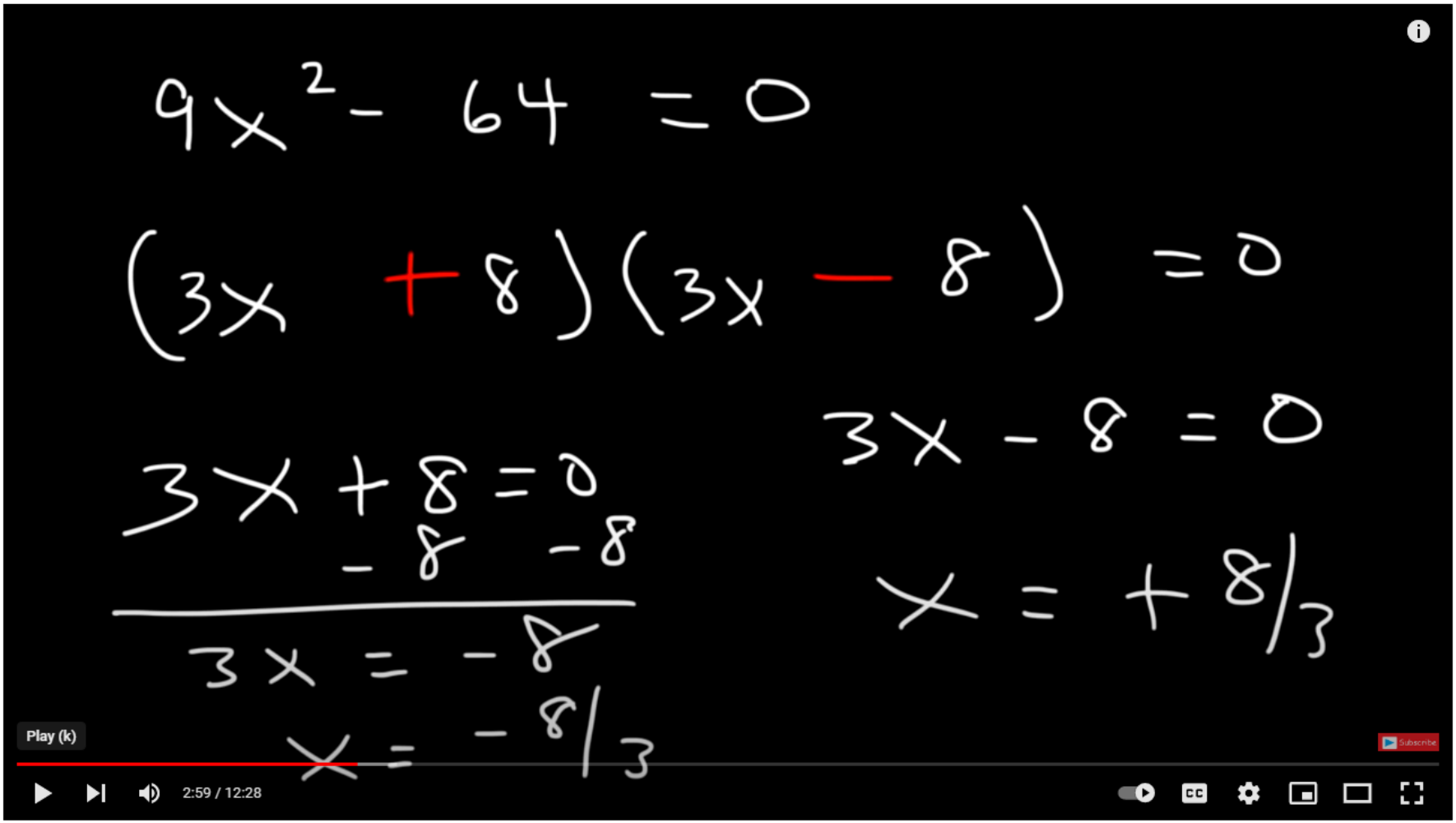
Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

SLO 2: Evidence



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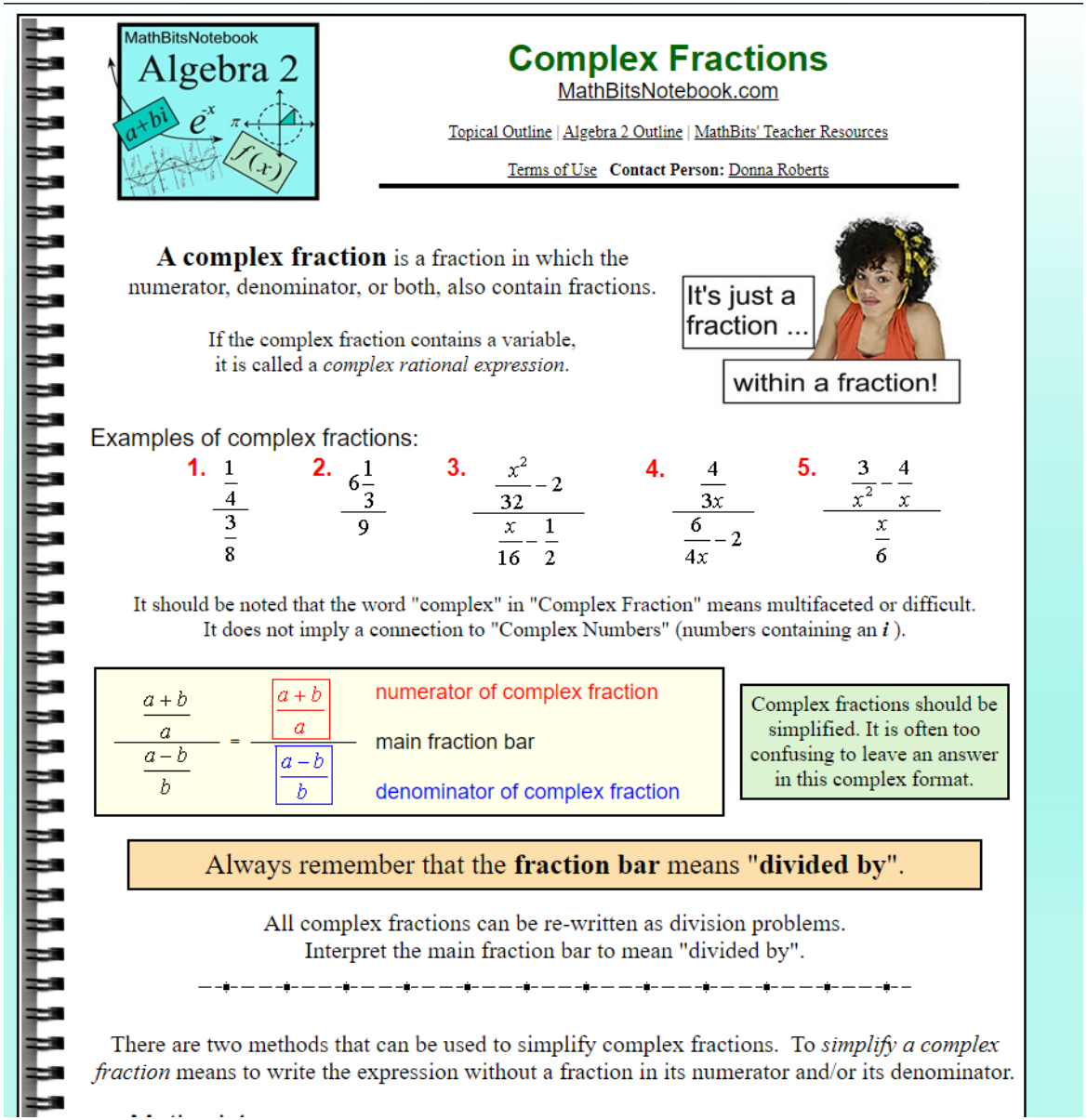
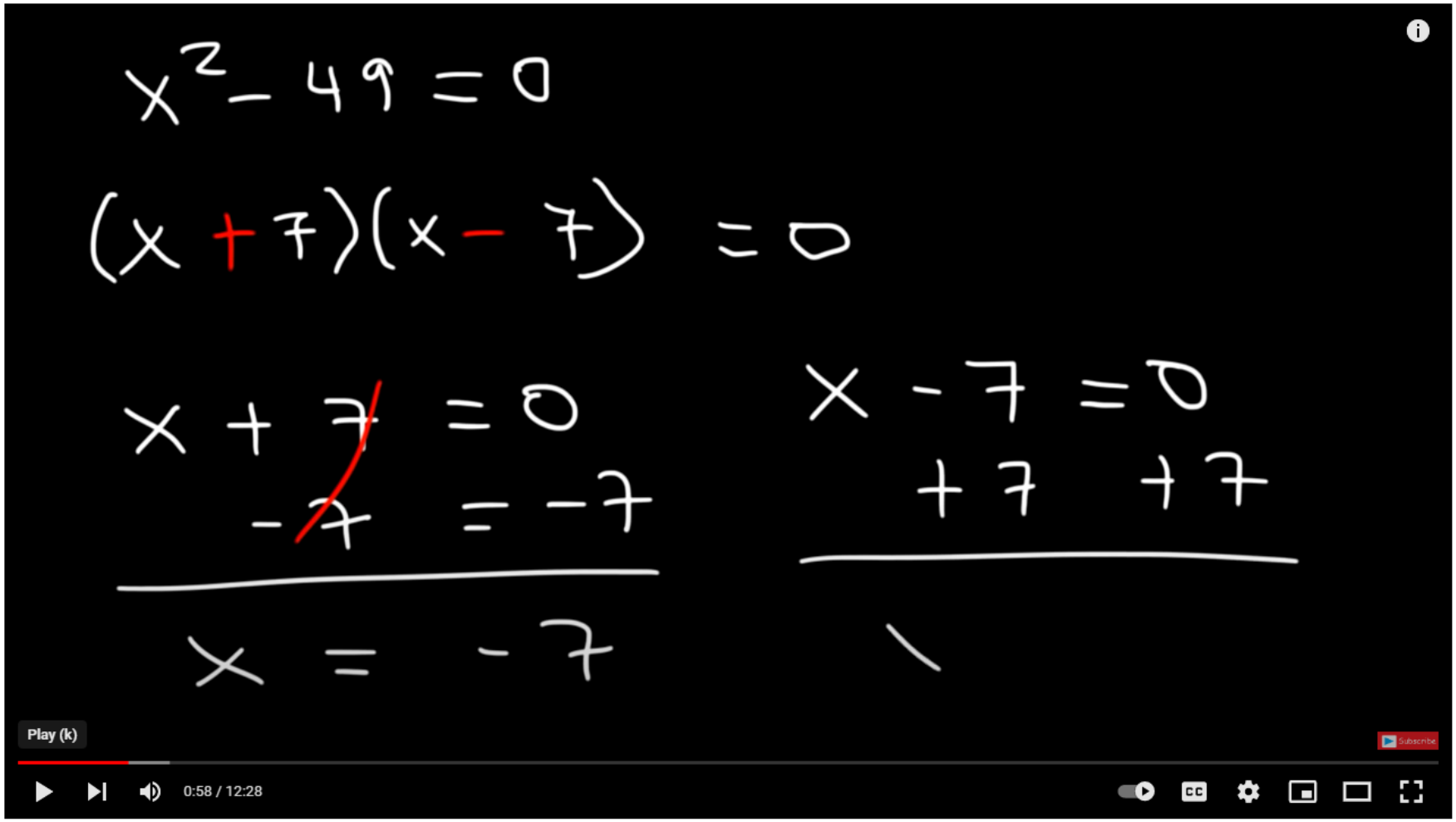
SLO 3: Evidence



SLO 4: Evidence



How To Solve Quadratic Equations By Factoring - Quick & Simple!

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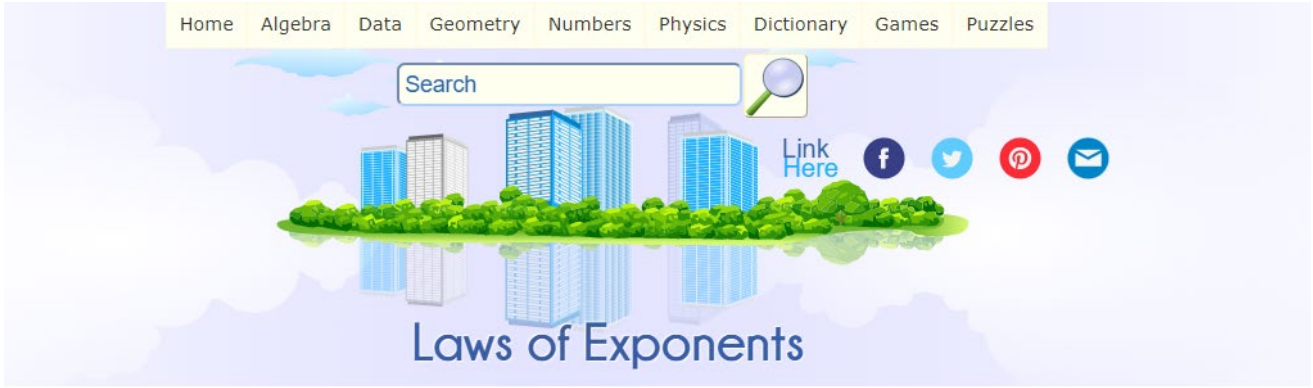
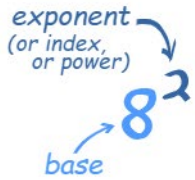
August 2022

SLO 5: Evidence



Exponents are also called **Powers** or **Indices**

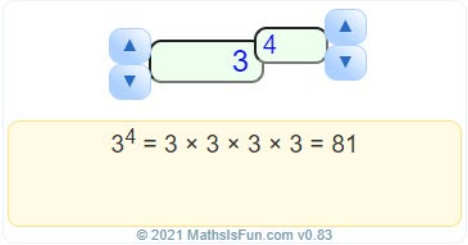


The exponent of a number says **how many times** to use the number in a **multiplication.**

In this example: $8^2 = 8 \times 8 = 64$

In words: 8^2 could be called "8 to the second power", "8 to the power 2" or simply "8 squared"

Try it yourself:



So an Exponent saves us writing out lots of multiplies!

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 112

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Evaluated Course Objectives
The student will demonstrate knowledge of functions and their graphs by his/her ability to
1. Find the inverse of a given function.
2. Use properties of exponents/logarithms to solve given problems.
3. Find the real zeros of a polynomial function.
4. Graph through transformation of basic functions.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment	Use of Results
Assessment of Objective 1 Find the inverse of a given function.	Rubric based assessment of related common final exam problems See Addendum A	70% of students learning at a rubric level of 2 or higher	**Jefferson Campus** Level 4 10/10 100% Level 3 0/10 0% Level 2 0/10 0% Level 1 0/10 0% Level 0 0/10 0% **Shelby Campus** Level 4 76/112 67.9% Level 3 10/112 8.9% Level 2 4/112 3.6% Level 1 11/112 9.8% Level 0 11/112 9.8% **Clanton Campus** Level 4 25/50 50% Level 3 3/50 6% Level 2 14/50 28% Level 1 6/50 12% Level 0 2/50 4%	**Observations/Changes:** 87.7% (505/576) schoolwide performed at level 2 or higher. This is an 9.3% decrease from last year, 2020-2021 but still well above the minimum target of 70%. This change is most likely due to the increase of on-campus class enrollment numbers since students in on-campus classes are better monitored during testing. Suggestions from 2021-2022: MTH 112 instructors recommend adding instructional video on this objective to reenforce the concept and help more students achieve level 4 success.

i			**Pell City Campus** Level 4 29/43 67.4% Level 3 7/43 16.3% Level 2 2/43 4.7% Level 1 5/43 11.6% Level 0 0/43 0% **Online** Level 4 241/337 71.5% Level 3 32/337 9.5% Level 2 28/337 8.3% Level 1 6/337 1.8% Level 0 30/337 8.9% **Dual Enrollment** Level 4 20/24 83.3% Level 3 3/24 12.5% Level 2 1/24 4.2% Level 1 0/24 0% Level 0 0/24 0%	By exceeding the minimum target of 70% scoring level 2 or above this year, it is likely that the instructors' efforts are effective for this objective. Since additional instructional videos appears to be effective, MTH 112 instructors recommend also adding example videos for assignment problems to help more students achieve level 4 success. See screenshot of sample example video at the end of this report or click here: screenshot

Assessment of Objective 2 Use properties of exponents/logarithms to solve given problems.	Rubric based assessment of related common final exam problems See Addendum A	70% of students learning at a rubric level of 2 or higher	**Jefferson Campus** Level 4 8/10 80% Level 3 2/10 20% Level 2 0/10 0% Level 1 0/10 0% Level 0 0/10 0% **Shelby Campus** Level 4 74/112 66.1% Level 3 0/112 0% Level 2 8/112 7.1% Level 1 17/112 15.2% Level 0 13/112 11.6% **Clanton Campus** Level 4 34/50 68% Level 3 0/50 0% Level 2 14/50 28% Level 1 1/50 2% Level 0 1/50 2%	**Observations/Changes:** 87.2% schoolwide performed at level 2 or higher. (502/576) This is a 9.6% decrease from last year, 2020-2021 but still well above the minimum target of 70%. This change is most likely due to the increase of on-campus class enrollment numbers since students in on-campus classes are better monitored during testing. Suggestions from 2021-2022: MTH 112 instructors recommend adding instructional video on this objective to reenforce the concept and help more students achieve level 4 success. By exceeding the minimum target of 70% scoring level 2 or above by 17.2% this year, it is likely that last year's recommendations were effective on this objective.

			Pell City Campus Level 4 22/43 51.2% Level 3 4/43 9.3% Level 2 6/43 14% Level 1 11/43 25.6% Level 0 0/43 0% **Online** Level 4 247/337 73.3% Level 3 36/337 10.7% Level 2 24/337 7.1% Level 1 9/337 2.7% Level 0 21/337 6.2% **Dual Enrollment** Level 4 19/24 79.2% Level 3 2/24 8.3% Level 2 2/24 8.3% Level 1 3/24 12.5% Level 0 0/24 0%	2022-2023: Since additional instructional videos appears to be effective, MTH 112 instructors recommend also adding example videos for assignment problems to help more students achieve level 4 success. See screenshot of sample example video at the end of this report.

Assessment of Objective 3 Find the zeros of a polynomial function	Rubric based assessment of related common final exam problems See Addendum A	70% of students learning at a rubric level of 2 or higher	**Jefferson Campus** Level 4 6/10 60% Level 3 2/10 2% Level 2 2/10 2% Level 1 0/10 0% Level 0 0/10 0% **Shelby Campus** Level 4 62/112 55.4% Level 3 10/112 8.9% Level 2 15/112 13.4% Level 1 12/112 10.7% Level 0 13/112 11.6% **Clanton Campus** Level 4 25/50 50% Level 3 3/50 6% Level 2 17/50 34% Level 1 4/50 8% Level 0 1/50 2%	**Observations/Changes:** 86.5% schoolwide performed at level 2 or higher. (498/576) This is a 11.7% decrease from last year, 2020-2021 but still well above the minimum target of 70%. This change is most likely due to the increase of on-campus class enrollment numbers since students in on-campus classes are better monitored during testing. Suggestions from 2021-2022: MTH 112 instructors recommend adding instructional video on this objective to reenforce the concept and help more students achieve level 4 success. By exceeding the minimum target of 70% scoring level 2 or above by 16.5% this year, it is likely that last year's recommendations were effective on this objective.

			Pell City Campus Level 4 17/43 39.5% Level 3 14/43 32.6% Level 2 6/43 14% Level 1 6/43 14% Level 0 2/43 0% **Online** Level 4 219/337 65% Level 3 35/337 10.4% Level 2 42/337 12.5% Level 1 14/337 4.2% Level 0 27/337 8% **Dual Enrollment** Level 4 21/24 87.5% Level 3 0/24 0% Level 2 2/24 8.3% Level 1 1/24 4.2% Level 0 0/24 0%	2022-2023: Since additional instructional videos appear to be effective, MTH 112 instructors recommend also adding example videos for assignment problems to help more students achieve level 4 success. See screenshot of sample example video at the end of this report.

Assessment of Objective 4 Graph transformations of basic functions.	Rubric based assessment of related common final exam problems See Addendum A	70% of students learning at a rubric level of 2 or higher	**Jefferson Campus** Level 4 1/10 10% Level 3 3/10 30% Level 2 4/10 40% Level 1 2/10 20% Level 0 0/10 0% **Shelby Campus** Level 4 83/112 74.1% Level 3 12/112 10.7% Level 2 6/112 5.4% Level 1 7/112 6.3% Level 0 4/112 3.6% **Clanton Campus** Level 4 27/50 54% Level 3 0/50 0% Level 2 23/50 46% Level 1 0/50 0% Level 0 0/50 0%	**Observations/Changes:** 86.8% schoolwide performed at level 2 or higher. (500/576) This is a 8.6% decrease from last year, 2020-2021 but still well above the minimum target of 70%. This change is most likely due to the increase of on-campus class enrollment numbers since students in on-campus classes are better monitored during testing. Suggestions from 2021-2022: MTH 112 instructors recommend adding instructional video on this objective to reenforce the concept and help more students achieve level 4 success. By exceeding the minimum target of 70% scoring level 2 or above by 16.8% this year, it is likely that last year's recommendations were effective on this objective.

			Pell City Campus Level 4 17/43 39.5% Level 3 11/43 25.6% Level 2 4/43 9.3% Level 1 10/43 23.3% Level 0 1/43 2.3% **Online** Level 4 176/337 52.2% Level 3 41/337 12.2% Level 2 69/337 20.5% Level 1 22/337 6.5% Level 0 29/337 8.6% **Dual Enrollment** Level 4 21/24 87.5% Level 3 1/24 4.2% Level 2 1/24 4.2% Level 1 1/24 4.2% Level 0 0/24 0%	2022-2023: Since additional instructional videos appears to be effective, MTH 112 instructors recommend also adding example videos for assignment problems to help more students achieve level 4 success. See screenshot of sample example video at the end of this report.
Plan submission date: 9/16/2022			**Submitted by: Yu-ing Hargett**	

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Addendum A
Common Final Exam Assessment Problems

Assessment of Objective 1 - Find the inverse of a given function.
Problem: Find f^{-1}, the inverse of f.

$$f(x) = x^3 + 9$$

Assessment of Objective 2 - Use properties of exponents/logarithms to solve given problems.
Problem: Solve for x:

$$\log(3x + 5) + 4 = 6$$

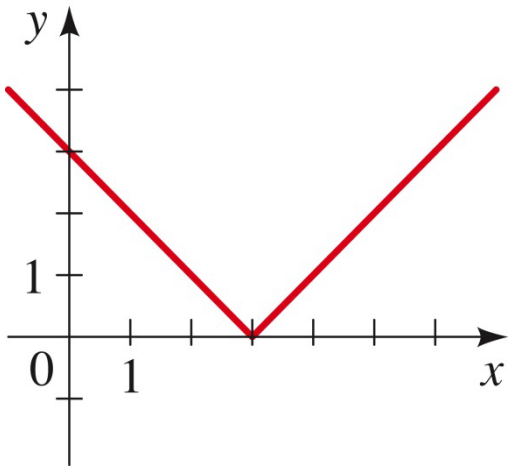
Assessment of Objective 3 - Find the zeros of a polynomial function

Problem: Find all the zeros of P.

$$P(x) = x^3 + 3x^2 - 4$$

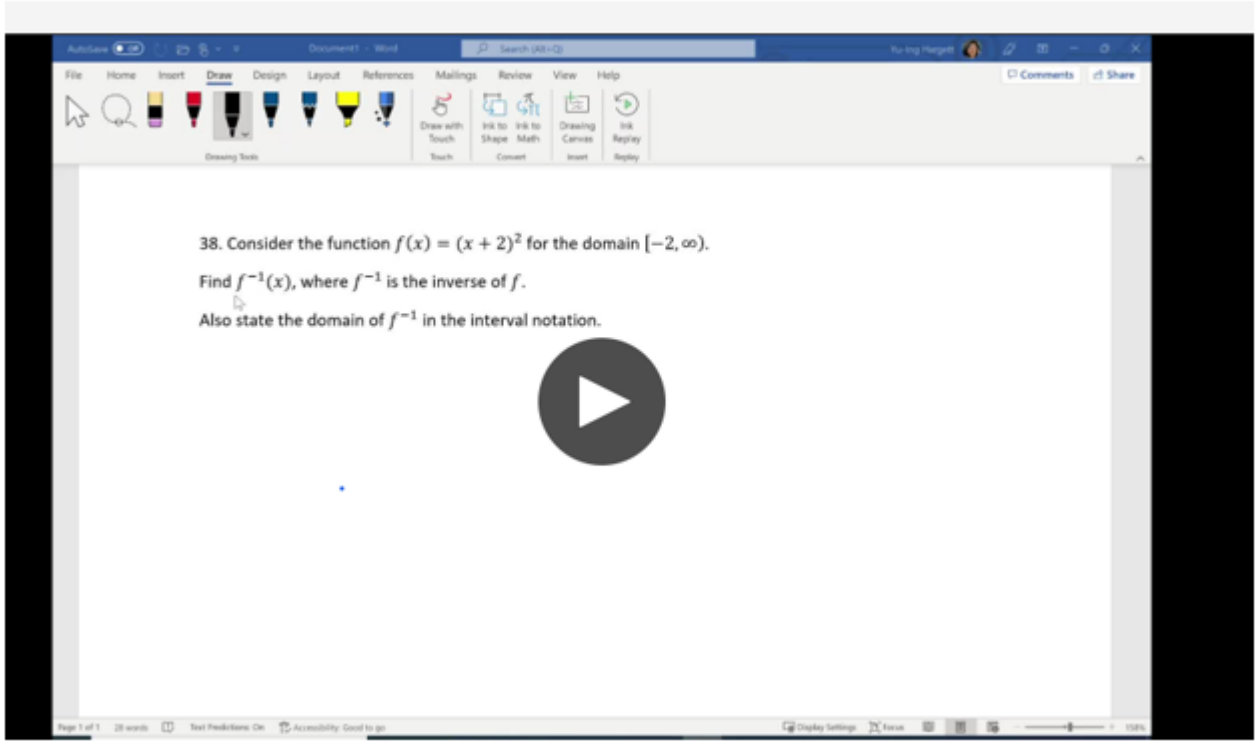
Assessment of Objective 4 - Graph through transformation of basic functions

Problem: Given the graph of function f. Sketch the graph of $g(x) = -f(x - 2) + 1$.



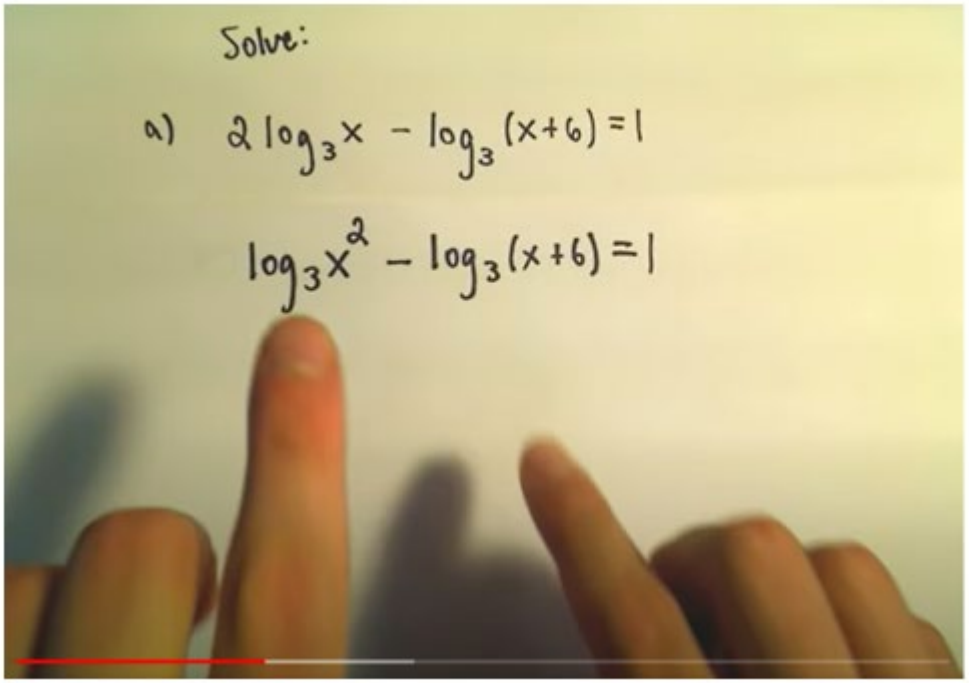
SLO 1: Screenshot of sample example video for assignment problems.

Video screenshot for Objective 1: Find the inverse of a given function.



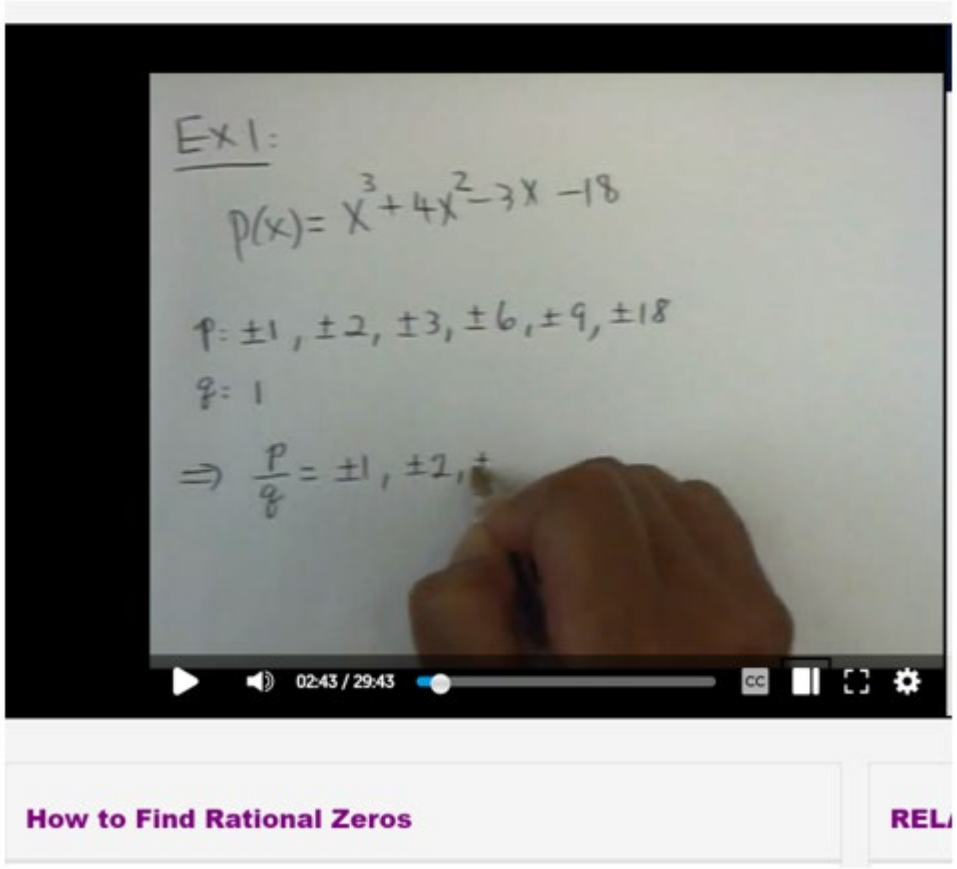
SLO 2: Screenshot of sample example video for assignment problems

Video screenshot for Objective 2: Use properties of exponents/logarithms to solve given problem.



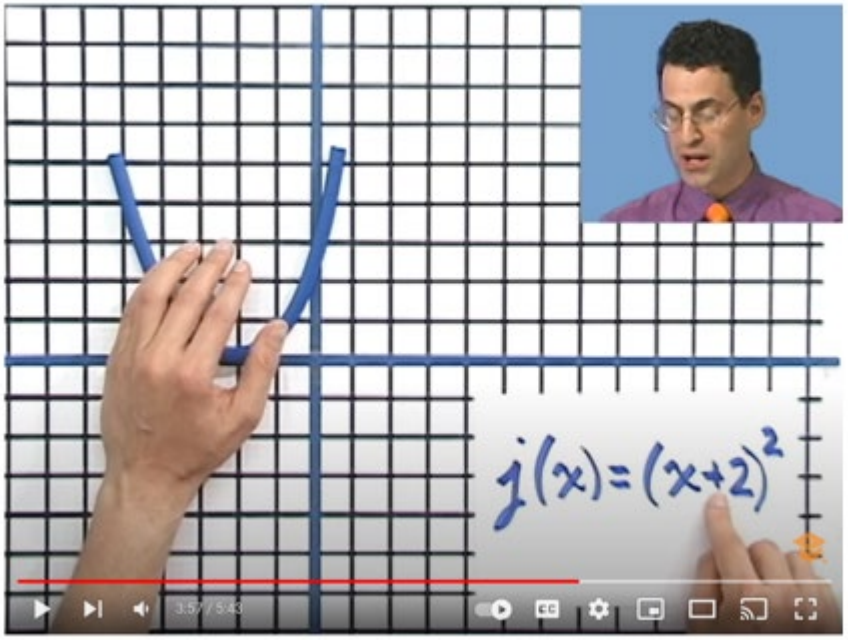
SLO 3: Screenshot of sample example video for assignment problems

Video screenshot for Objective 3: Find the zeros of a polynomial function.



SLO 4: Screenshot of sample example video for assignment problems

Video Screenshot for Objective 4: Graph through transformation of basic functions.



Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021-Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 113

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

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Level 1: Student attempts a solution, but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Evaluated Course Objectives

The student will demonstrate understanding of concepts, develop competent skills, and demonstrate applications by his/her ability to

1. Graph a given trigonometric function
2. Find the values for trigonometric functions using a right triangle.
3. Perform algebraic operations on vectors.
4. Convert and use the trigonometric form of a complex number.
5. Convert an equation from polar form to rectangular form.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence Data collected during SPR21 and SUM21. Online assessments are scored at 4, 2, or 0.	Use of Results
MTH 113 Objective 1 Graph a given trigonometric function	Rubric based assessment of related common test problems **Problem:** Graph the function $y = 2\cos\left(\frac{2}{3}x - \frac{\pi}{2}\right)$	70% of students learning at a rubric level of 2 or higher	**96.1% of the students assessed performed at Level 2 or higher (196/204)** Shelby Level 4: 41/54 75.9% Level 3: 0/54 0.0% Level 2: 13/54 24.1% Level 1: 0/54 0.0% Level 0: 0/54 0.0% Clanton Level 4: 4/6 66.7% Level 3: 0/6 0.0% Level 2: 0/6 0.0% Level 1: 1/6 16.7% Level 0: 1/6 16.7% Online Level 4: 75/87 86.2% Level 3: 1/87 1.2% Level 2: 11/87 12.6% Level 1: 0/87 0.0%	**Observations/Changes:** MTH 113 Objective 1 will be reinforced by assigning worksheets that emphasize graphing a given trigonometric function. Examples: Graph Trigonometric Functions (1), cosine function with solution Graph Trigonometric Functions (3), cosine function with solution

			Level 0: 0/87 0.0% Dual Enrollment Level 4: 35/57 61.4% Level 3: 8/57 14.0% Level 2: 8/57 14.0% Level 1: 6/57 10.6% Level 0: 0/57 0.0%	
MTH 113 Objective 2 Find the values for trigonometric functions using a right triangle.	Rubric based assessment of related common test problems **Problem:** Let θ be an angle in quadrant IV such that $\tan\theta = -\frac{2}{7}$. Find the exact values of cos θ and csc θ	70% of students learning at a rubric level of 2 or higher	**97.5% of the students assessed performed at Level 2 or higher (199/204)** Shelby Level 4: 45/54 83.3% Level 3: 0/54 0.0% Level 2: 9/54 16.7% Level 1: 0/54 0.0% Level 0: 0/54 0.0% Clanton Level 4: 5/6 83.3% Level 3: 0/6 0.0% Level 2: 0/6 0.0% Level 1: 0/6 0.0% Level 0: 1/6 16.7% Online Level 4: 70/87 80.5% Level 3 : 0/87 0.0%	**Observations/Changes:** Through the use of an applications project, Objective 2 will reiterate the concept of finding the values for trigonometric functions using a right triangle. Example: Addendum A

			Level 2: 14/87 16.1% Level 1: 3/87 3.4% Level 0: 0/87 0.0% Dual Enrollment Level 4: 39/57 68.4% Level 3: 9/57 15.8% Level 2: 8/57 14.0% Level 1: 1/57 1.8% Level 0: 0/57 0.0%	
MTH 113 Objective 3 Perform algebraic operations on vectors.	Rubric based assessment of related common test problems **Problem:** Let θ be an angle in quadrant IV such that $\tan\theta = -\frac{2}{7}$.	70% of students learning at a rubric level of 2 or higher	**98.5% of the students assessed performed at Level 2 or higher (201/204)** Shelby Level 4: 46/54 85.2% Level 3: 0/54 0.0% Level 2: 8/54 14.8% Level 1: 0/54 0.0% Level 0: 0/54 0.0% Clanton Level 4: 5/6 83.3% Level 3: 0/6 0.0% Level 2: 0/6 0.0% Level 1: 0/6 0.0%	**Observations/Changes:** After viewing a video that emphasizes performing algebraic operations on vectors, the skills for success on Objective 3 will be reinforced through needed strategies. Example: https://youtu.be/gCWiw5ZqjnA

			Level 0: 1/6 16.7% Online Level 4: 68/87 78.2% Level 3: 0/87 0.0% Level 2: 17/87 19.5% Level 1: 2/87 2.3% Level 0: 0/87 0.0% Dual Enrollment Level 4: 54/57 94.7% Level 3: 2/57 3.5% Level 2: 1/57 1.8% Level 1: 0/57 0.0% Level 0: 0/57 0.0%	
MTH 113 Objective 4 Convert and use the trigonometric form of a complex number.	Rubric based assessment of related common test problems **Problem:** Use DeMoivre's theorem to find $(1+i)^6$. Put your answer in standard form.	70% of students learning at a rubric level of 2 or higher	**92.6% of the students assessed performed at Level 2 or higher (189/204)** Shelby Level 4: 42/54 77.8% Level 3: 0/54 0.0% Level 2: 12/54 22.2% Level 1: 0/54 0.0% Level 0: 0/54 0.0% Clanton Level 4: 2/6 33.4% Level 3: 0/6 0.0% Level 2: 2/6 33.3% Level 1: 2/6 33.3% Level 0: 0/6 0.0% Online Level 4: 76/87 87.4%	**Observations/Changes:** MTH 113 instructors will reinforce student learning by watching a video explanation that emphasizes converting and using the trigonometric form of a complex number. Example: https://youtu.be/ZxhTAiwv_Ck

			Level 3: 0/87 0.0% Level 2: 8/87 9.2% Level 1: 3/87 3.4% Level 0: 0/87 0.0% Dual Enrollment Level 4: 18/57 31.6% Level 3: 20/57 35.1% Level 2: 9/57 15.8% Level 1: 10/57 17.5% Level 0: 0/57 0.0%	
MTH 113 Objective 5 Convert an equation from polar form to rectangular form.	Rubric based assessment of related common test problems **Problem:** Convert the equation $r = 6\cos\theta$ to rectangular form.	70% of students learning at a rubric level of 2 or higher	**96.6% of the students assessed performed at Level 2 or higher (197/204)** Shelby Level 4: 41/54 75.9% Level 3: 0/54 0.0% Level 2: 13/54 24.1% Level 1: 0/54 0.0% Level 0: 0/54 0.0% Clanton Level 4: 3/6 50.0% Level 3: 0/6 0.0% Level 2: 1/6 16.7% Level 1: 0/6 0.0% Level 0: 2/6 33.3%	**Observations/Changes:** MTH 113 instructors will reinforce student learning by watching a video showing the steps needed to convert an equation from polar form to rectangular form. Example: https://www.intmath.com/blog/mathematics/polar-coordinates-and-cardioid-microphones-2496

			Online Level 4: 73/87 83.9% Level 3: 0/87 0.0% Level 2: 10/87 11.5% Level 1: 4/87 4.6% Level 0: 0/87 0.0% Dual Enrollment Level 4: 39/57 68.4% Level 3: 8/57 14.0% Level 2: 9/57 15.8% Level 1: 1/57 1.8% Level 0: 0/57 0.0%	
Plan submission date: September 23, 2022			**Submitted by: Louise Fall**	

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Evidence in support of SLO 2

Example Addendum A

MTH 113 Project Guidelines

1. You may choose to work by yourself or in pairs.

2. Create or find a trig word problem similar to problems we have done in class involving right triangle trig, law of sines, law of cosines, etc. You can NOT use a problem in our textbook. You must submit the problem in written form (typed) and include the name or names of the individuals in the group.

3. Use whatever type of materials you wish to depict the trig problem you have selected. You must turn in a written form of the solution to the problem (typed preferred).

4. Projects will be on display and will be judged by outside judges. Bonus points may be awarded for 1st, 2nd and 3rd place.

5. Project due date:_____

Please note that you this is not a grade based on effort. Just because you turn in a project does not mean you earn 50 points. I do follow the grading criteria described below. The more creative the problem, use of materials and the more difficult the problem, the higher the grade. I have had students earn failing grades on this assignment.

Grading

The project has a maximum value of 50 points. Points will be awarded based on the following criteria:

A. Creativity of problem and use of materials (10 pts)

B. Level of difficulty of the problem - The more difficult it is to solve, the more points you will be awarded. (15 pts). For example, a basic right triangle trig problem would possibly be worth 6 to 8 points where something more difficult, such as law of sines, or cosines would earn the full 15 points.

C. Overall appearance of project (10 pts)

D. Written submission – following directions, neatness, explanation of solution, correctness, etc. (15 pts)

Evidence in Support of SLO 1

From www.analyzemath.com

Trigonometry Worksheet: Graph Trigonometric Functions (1)

Graph the trigonometric function given by

$$y = 2\cos(2x)$$

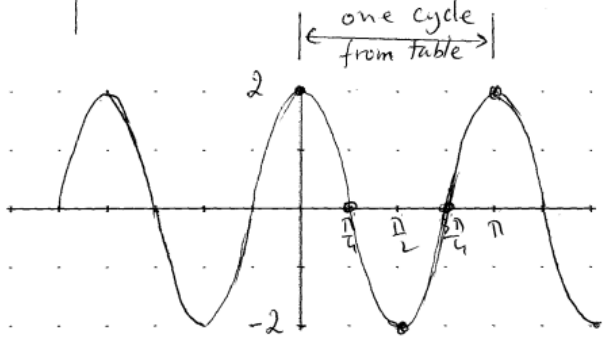
An interval containing exactly one cycle can be found by solving the inequality.

$0 \le 2x \le 2\pi$, 2π is the period of Cosine function.

$\Rightarrow \quad 0 \le x \le \pi.$

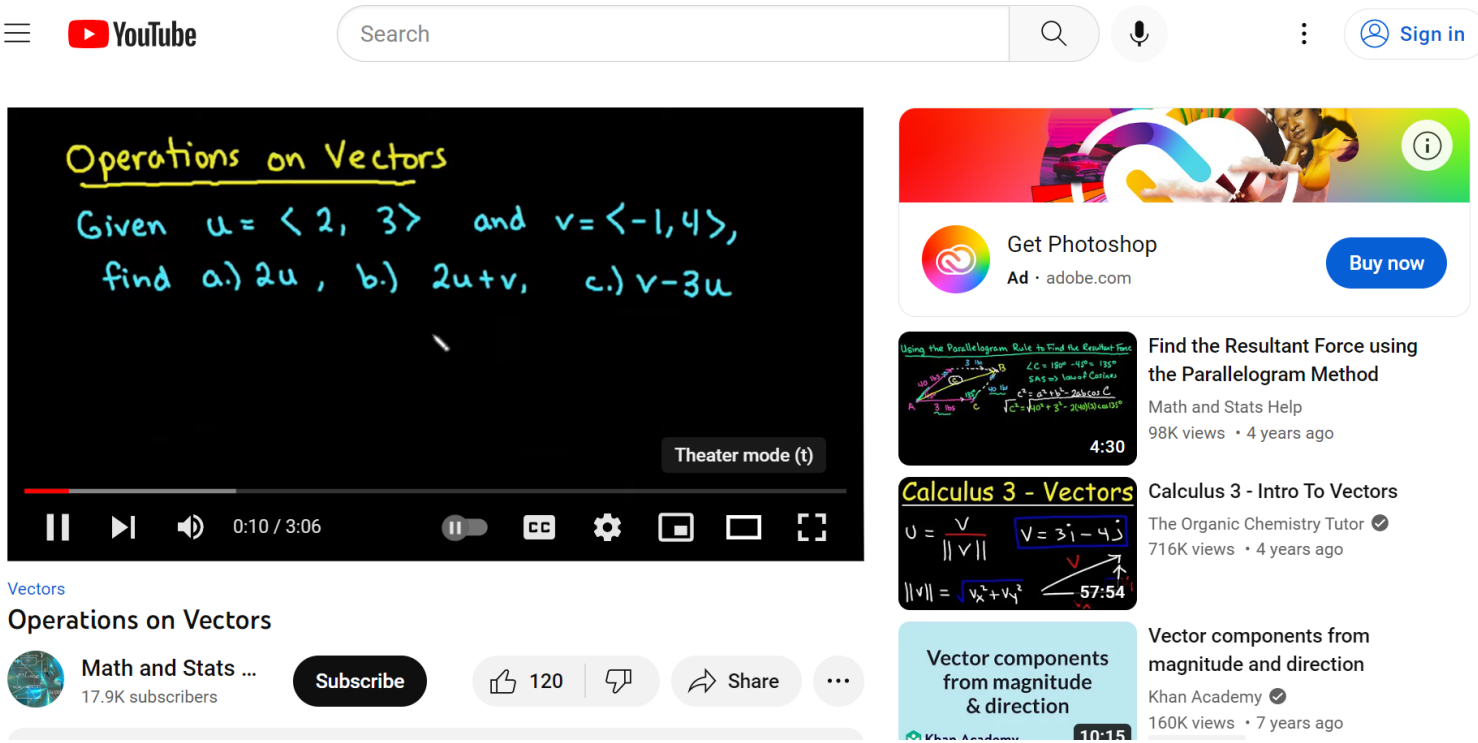
We now construct a table of values

$2x$	0	$\frac{\pi}{2}$	π	$\frac{3\pi}{2}$	2π	} used for easy calculations
$\cos(2x)$	1	0	-1	0	1	
x	0	$\pi/4$	$\pi/2$	$3\pi/4$	π	} value to put in graph.
y	2	0	-2	0	2	

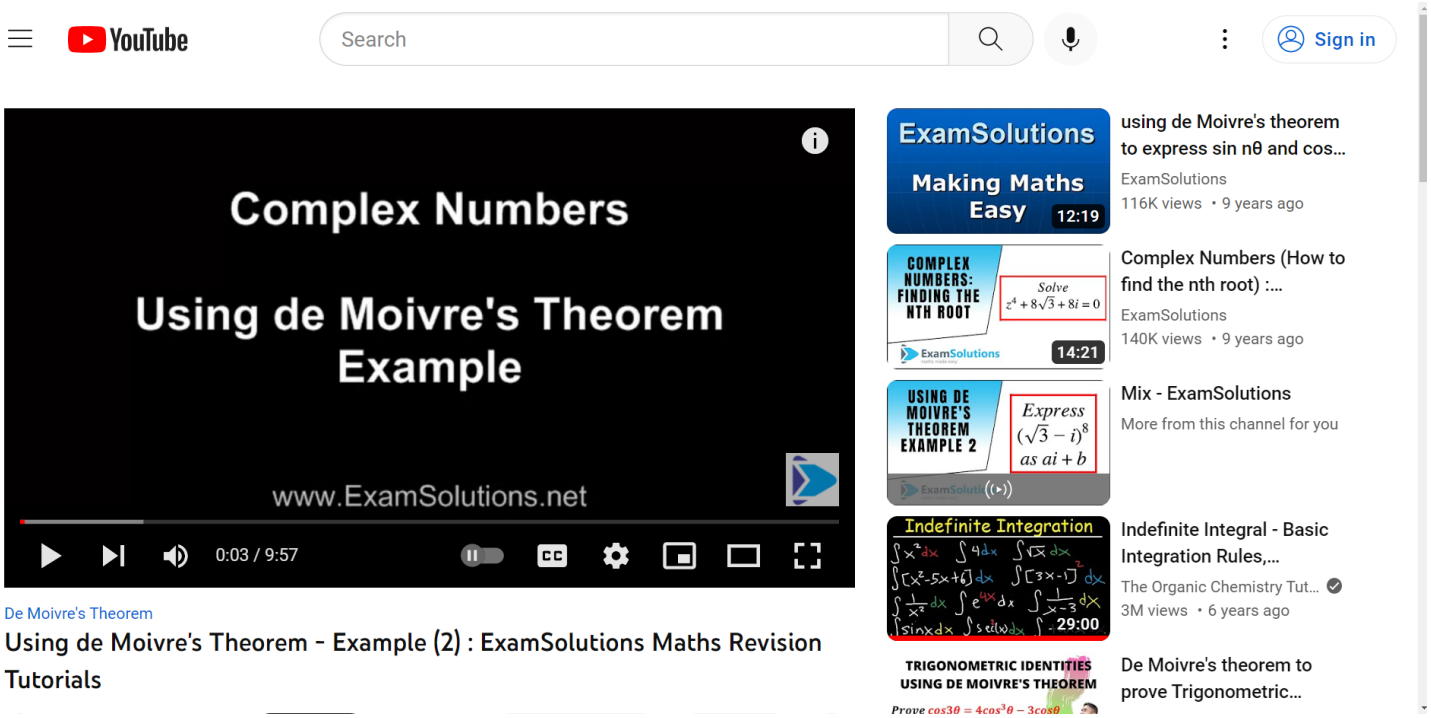


From www.analyzemath.com

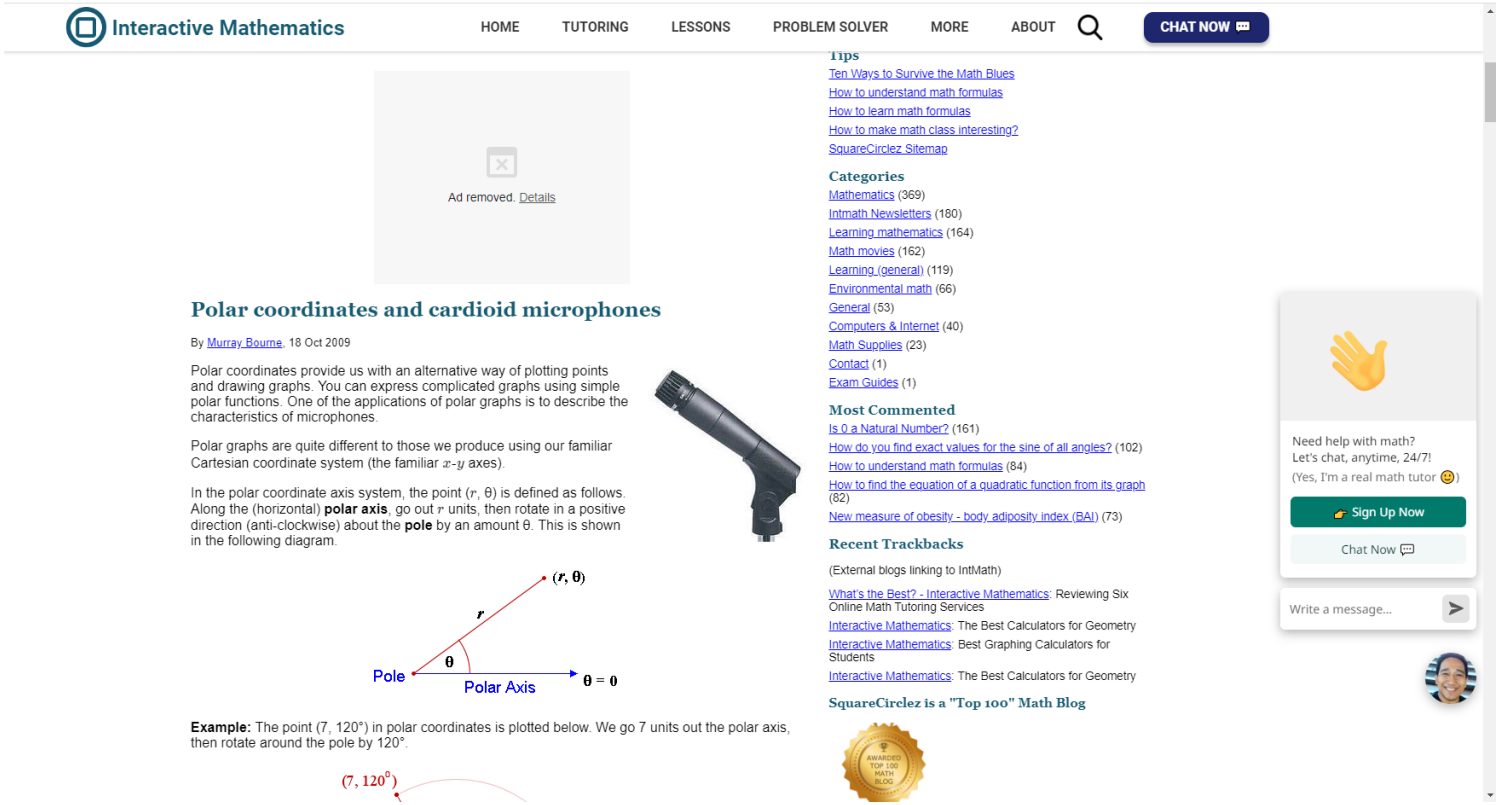
Evidence in Support of SLO 3



Evidence in support of SLO 4



Evidence in Support of SLO 5



Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 116

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Evaluated Course Objectives

The student will demonstrate knowledge of functions and their graphs by his/her ability to

1. Solve a linear equation in one variable
2. Calculate the volume of a solid object or container
3. Calculate percentage

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
Assessment of Objective 1 Solve a linear equation in one variable	Rubric-based assessment of departmental common final exam problems Objective 1 example common final exam problem: $5(x+3) - 6(x+12) = 0$	70% of students learning at a rubric level of 2 or higher	***Data collected from FA21, SPR22.** **Shelby Campus** Level 4 7/14 50.00% Level 3 3/14 21.43% Level 2 1/14 7.14% Level 1 3/14 21.43% Level 0 0/14 0.00% **Online** Level 4 79/90 87.78% Level 3 0/90 0% Level 2 9/90 10.00% Level 1 0/90 0% Level 0 2/90 2.22% **Overall Performance** Level 4 86/104 82.69% Level 3 3/104 2.88% Level 2 10/104 9.62% Level 1 3/104 2.88% Level 0 2/104 1.93%	**Observations/Changes:** To boost student performance on this SLO, instructors will reinforce the methods for solving a linear equation containing distribution by assigning two additional tutorial videos. VIDEO #1 VIDEO #2

Assessment of Objective 2 Calculate the volume of a solid object or container	Rubric-based assessment of departmental common final exam problems Objective 2 example common final exam problem: *A cylindrical container has a radius of 17 inches and a height of 63 inches. How many gallons will it hold? Round your answer to two decimals.*	70% of students learning at a rubric level of 2 or higher	***Data collected from FA21, SPR22.** **Shelby Campus** Level 4 2/14 14.29% Level 3 2/14 14.29% Level 2 3/14 21.42% Level 1 6/14 42.86% Level 0 1/14 7.14% **Online** Level 4 25/90 27.78% Level 3 0/90 0% Level 2 56/90 62.22% Level 1 0/90 0% Level 0 9/90 10.00% **Overall Performance** Level 4 27/104 25.96% Level 3 2/104 1.92% Level 2 59/104 56.73% Level 1 6/104 5.77% Level 0 10/104 9.62%	**Observations/Changes:** Level 2 and higher performance for this SLO is slightly lower this year than in previous years. In addition to assigning the tutorial video addressing the difference in volume and capacity, a worksheet will be assigned that will provide additional practice opportunities for this type of problem.

<table>
<tr>
<td><u>Assessment of Objective 3</u>
Calculate percentage.</td>
<td>Rubric-based assessment of departmental common final exam problems

Objective 3 example common final exam problem:

A salesperson has total sales of $5687.50 and this amount represents 12.5% of her sales goal for the month. What was the amount of her sales goal for the month in dollars? Round your answer to two decimals.</td>
<td>70% of students learning at a rubric level of 2 or higher</td>
<td>*Data collected from FA21, SPR22.

<u>Shelby Campus</u>
Level 4 4/14 28.57%
Level 3 1/14 7.14%
Level 2 1/14 7.14%
Level 1 6/14 42.86%
Level 0 2/14 14.29%

<u>Online</u>
Level 4 39/90 43.33%
Level 3 0/90 0%
Level 2 34/90 37.78%
Level 1 0/90 0%
Level 0 17/90 18.89%

<u>Overall Performance</u>
Level 4 43/104 41.35%
Level 3 1/104 0.96%
Level 2 35/104 33.65%
Level 1 6/104 5.77%
Level 0 19/104 18.27%</td>
<td>Observations/Changes:
Instructors will reinforce student learning of this objective by assigning additional practice problems that specifically address this type of calculation.

Additional Practice Problems</td>
</tr>
<tr>
<td>Plan submission date: 6/7/2022</td>
<td colspan="2">Submitted by: J. Holley</td>
<td></td>
<td></td>
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MTH 116 Rubric

Mathematics Course Level Outcomes Assessment Rubric

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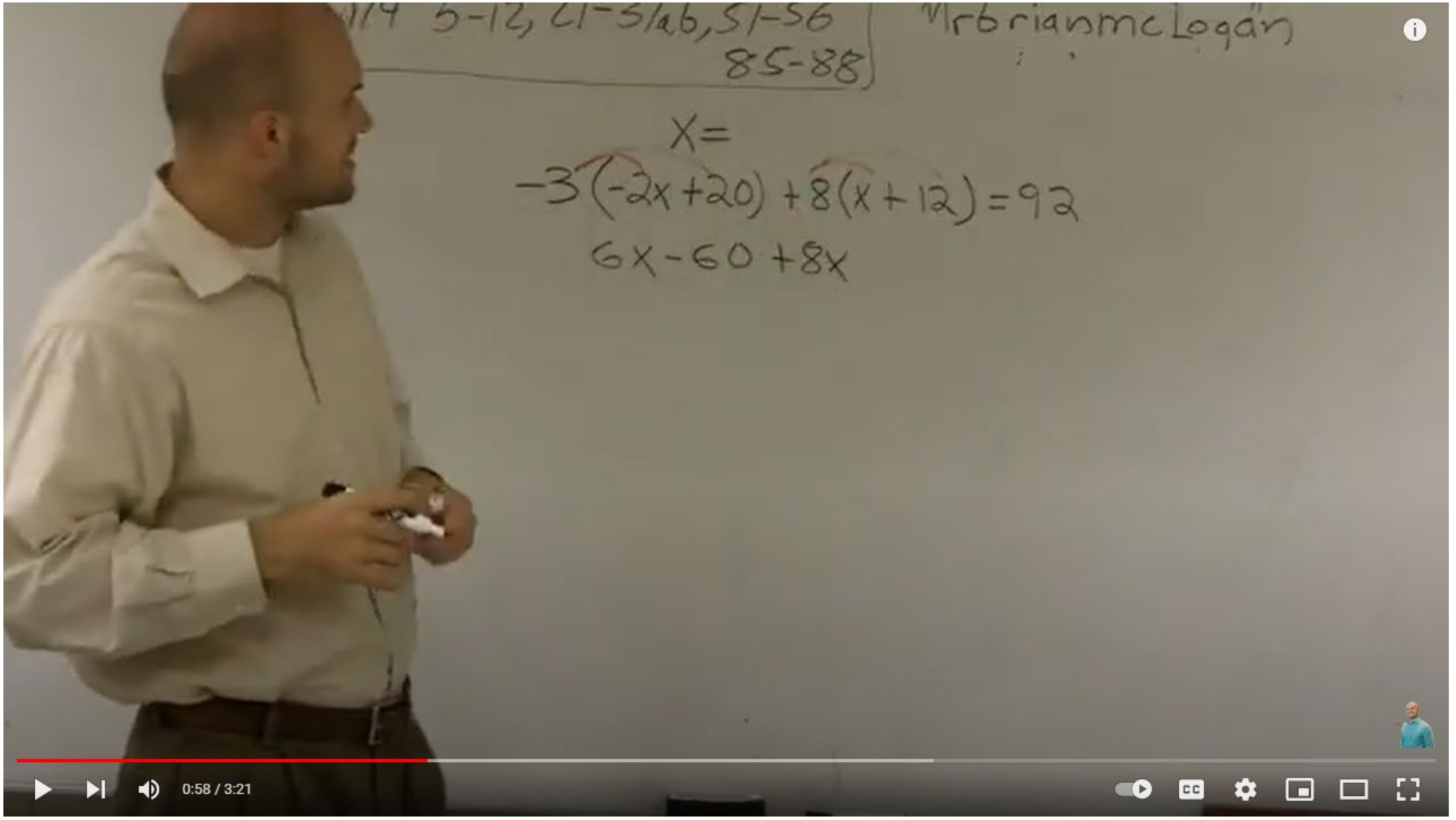
Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

SLO 1: Evidence



Solving an equation for x using distributive property twice

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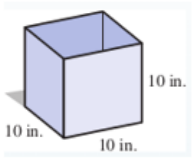
SLO 2: Evidence

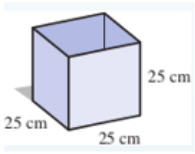
CAPACITY PRACTICE WORKSHEET

What is the capacity for each of the containers below? Give answers in the US system to the nearest tenth of a gallon or in metric to the nearest tenth of a liter.

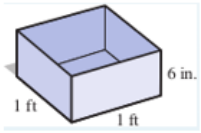
1.



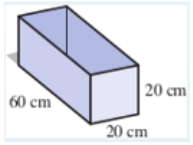
2.



3.



4.



SLO 3: Evidence

Finding the Base

Solve the following problems.

1. 56 is 25% of what number?

2. 5.04 is 12% of what number?

3. John paid $7,500 in capital gains taxes on the sale of his rental property last year. If this amount represents 6.9% of the sale price, what was the sale price? Round your answer to the nearest dollar.

4. Abbie's sales of girl scout cookies totaled $2,750 this year. The amount she sold is 20% of the total sales for her troop. What is the total amount of girl scout cookies sold by her troop?

5. Your neighbor tells you that he has paid down his car loan by $12,500 and this amount is 33% of what he paid for the car. How much did he pay for the car? Round your answer to the nearest dollar.

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 120

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

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Level 0: Student does not attempt a solution.

Evaluated Course Objectives

The student will demonstrate understanding of concepts, develop competent skills, and demonstrate applications by his/her ability to
1. Find an equation of the tangent line to the graph of a given function at a specified point
2. Solve a related rates problem
3. Find the absolute extrema of a given function
4. Solve an initial value problem
5. Determine the Consumers' and Producers' Surplus

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of	Use of Results
Assessment of Objective 1 Find an equation of the tangent line to the graph of a given function at a specified point	Rubric based assessment of related common final exam problems **Problem:** Find an equation of the tangent line to the graph of the function at the point (-2, 27) $f(x) = (1-x)(x^2-1)^2$	70% of students learning at a rubric level of 2 or higher	**Shelby Campus** Level 4 2/9 22.2% Level 3 0/9 0% Level 2 7/9 77.8% Level 1 0/9 0% Level 0 0/9 0% **Online** Level 4 65/88 73.9% Level 3 0/88 0% Level 2 21/88 23.9% Level 1 0/88 0% Level 0 2/8 2.3%	**Observations/Changes:** 97.9% (95/97) schoolwide performed at level 2 or higher. This well above the minimum target of 70%. 2022-2023: Since additional instructional videos appears to be effective, MTH 120 instructors recommend also adding example videos for assignment problems to help more students achieve level 4 success. See screenshot of sample example video at the end of this report.

Assessment of Objective 2 Solve a related rates problem	Rubric based assessment of related common final exam problems **Problem:** Two ships leave the same port at noon. Ship *A* sails north at 15 mph, and ship *B* sails east at 12 mph. How fast is the distance between them changing at 1 p.m.?	70% of students learning at a rubric level of 2 or higher	**Shelby Campus** Level 4 6/9 66.7% Level 3 0/9 0% Level 2 3/9 33.3% Level 1 0/9 0% Level 0 0/9 0% **Online** Level 4 66/88 75% Level 3 0/88 0% Level 2 22/88 25% Level 1 0/88 0% Level 0 0/88 0%	**Observations/Changes:** 100% (97/97) schoolwide performed at level 2 or higher. This well above the minimum target of 70%. 2022-2023: Since 100% of students achieved the targeted 70% success rate, MTH 120 instructors recommend removing this objective in the next 3-year cycle and reduce the number of objectives to 3 per course.

Assessment of Objective 3 Find the absolute extrema of a given function	Rubric based assessment of related common final exam problems **Problem:** Find the absolute maximum value and the absolute minimum value, if any, of the given function. $f(x) = \frac{x}{\sqrt{x^2+7}}$ on [-7, 7]	70% of students learning at a rubric level of 2 or higher	**Shelby Campus** Level 4 1/9 11.1% Level 3 0/9 0% Level 2 8/9 88.9% Level 1 0/9 0% Level 0 0/9 0% **Online** Level 4 58/88 65.9% Level 3 0/88 0% Level 2 29/88 33.0% Level 1 0/88 0% Level 0 1/88 1.1%	**Observations/Changes:** 99% (96/97) schoolwide performed at level 2 or higher. This well above the minimum target of 70%. 2022-2023: Since additional instructional videos appears to be effective, MTH 120 instructors recommend also adding example videos for assignment problems to help students continue to achieve level 4 success. See screenshot of sample example video at the end of this report.

Assessment of Objective 4 Solve an initial value problem	Rubric based assessment of related common final exam problems **Problem:** Find $f(x)$ by solving the initial value problem. $f'(x) = 3e^x - 2x\,; f(0) = 1$	70% of students learning at a rubric level of 2 or higher	**Shelby Campus** Level 4 2/9 22.2% Level 3 0/9 0% Level 2 7/9 77.8% Level 1 0/9 0% Level 0 0/9 0% **Online** Level 4 50/88 56.8% Level 3 0/88 0% Level 2 34/88 38.6% Level 1 0/88 0% Level 0 4/88 4.5%	**Observations/Changes:** 95.9% (93/97) schoolwide performed at level 2 or higher. This well above the minimum target of 70%. 2022-2023: The MTH 120 instructors recommend removing this objective going forward to reduce the number of course objectives to 3 to align with other courses in the department.

Assessment of Objective 5 Determine the Consumers' and Producers' Surplus	Rubric based assessment of related common final exam problems **Problem:** The management of the Titan Tire Company has determined that the quantity demanded x of their Super Titan tires/week is related to the unit price p by the relation $$p = 170 - x^2$$ Where p is measured in dollars and x is measured in units of a thousand. Titan will make x units of the tires available in the market if the unit price is $$p = 74 + \frac{1}{2}x^2$$ dollars. Determine the consumers' surplus and the producers' surplus when the market unit price is set at the equilibrium price. Round your answers to the nearest dollar.	70% of students learning at a rubric level of 2 or higher	**Shelby Campus** Level 4 1/9 11.1% Level 3 0/9 0% Level 2 8/9 88.9% Level 1 0/9 0% Level 0 0/9 0% **Online** Level 4 20/88 22.7% Level 3 0/88 0% Level 2 47/88 53.4% Level 1 0/88 0% Level 0 21/88 23.9%	**Observations/Changes:** 78.4% (76/97) schoolwide performed at level 2 or higher. This well above the minimum target of 70%. 2022-2023: This objective continues to be challenging for the students. However, it is unclear which of the two problems within this objective the students most struggled with. MTH 120 instructors recommend decreasing the number of problems to just one to better pinpoint and address students' difficulties. Furthermore, additional example videos for assignment problems should be included to help more students achieve level 4 success. See screenshot of sample example video at the end of this report.
Plan submission date: 9/16/2022			**Submitted by: Yu-ing Hargett**	

MTH 120 Rubric

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

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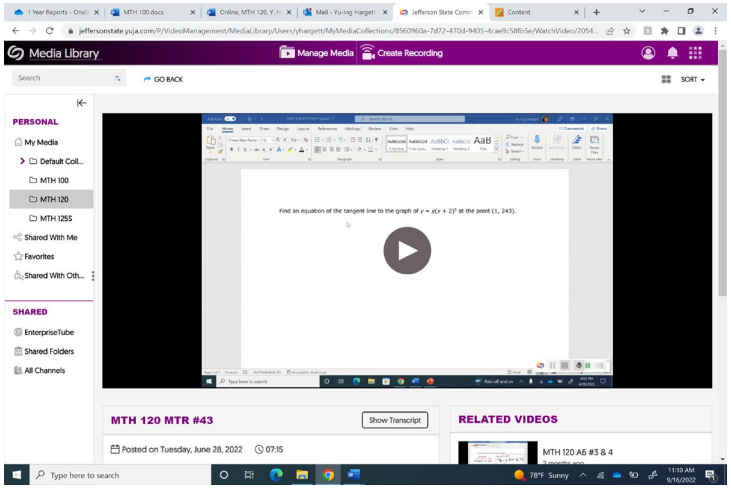
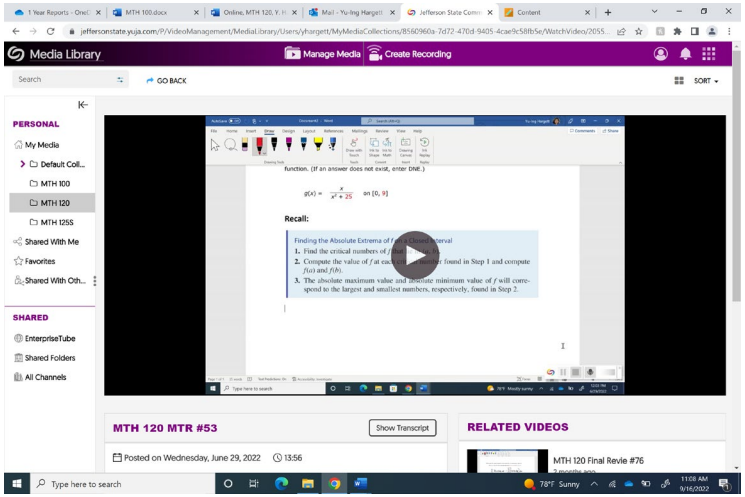
Level 0: Student does not attempt a solution.

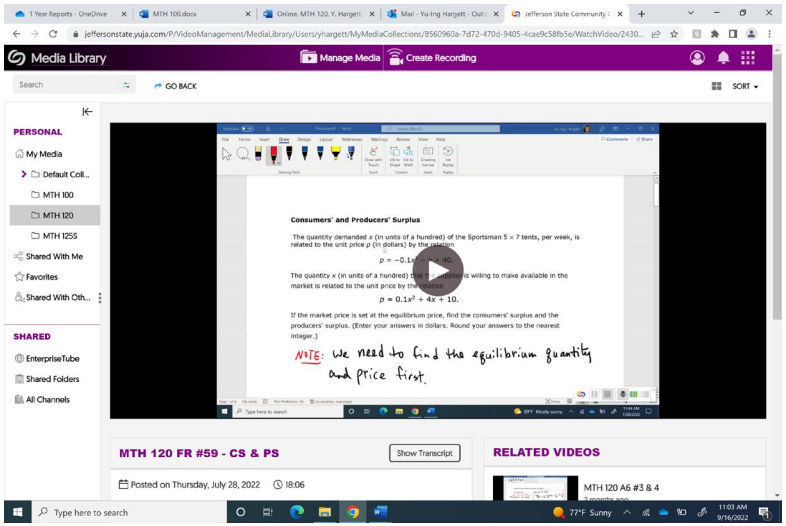
Objective 1 Sample Recommended Example Video:



Objective 3 Sample Recommended Example Video:



Objective 5 Sample Recommended Example Video:



Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment Period:** 2021 – 2022

Program or Department Mission

The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 125S

Mathematics Course Level Outcomes Assessment Rubric

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Level 0: Student does not attempt a solution.

Evaluated Course Objectives
The General Educational Objective is met through the course objectives which require use of mathematical concepts, notations, and manipulations necessary in students' field of study. Student mastery of the specific course objectives that follow will be evaluated by analyzing solutions for appropriate problems from the comprehensive final exam. The final exam will not be a multiple-choice exam. Students are required to show all of their work and will be graded on the quality of their technique, notation, and accuracy.

The student will demonstrate knowledge of calculus by his/her ability to

1. Solve a limit problem.
2. Compute a derivative.
3. Compute an indefinite integral.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
MTH 125S Objective 1 Demonstrate knowledge of the methods presented in this course by his/her ability to calculate the limit of a function.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Shelby Campus Level 4 55/62 88.7% Level 3 0% Level 2 7/62 11.3% Level 1 0% Level 0 0% Clanton Campus Level 4 2/9 22.2% Level 3 0% Level 2 3/9 33.3% Level 1 4/9 44.4% Level 0 0% Online Level 4 121/142 85.2% Level 3 0% Level 2 21/142 14.8% Level 1 0% Level 0 0%	**Observations/Changes:** MTH 125S instructors met and decided to incorporate additional notes from the following website: Limits Notes

MTH 125S Objective 2 Demonstrate knowledge of the methods presented in this course by his/her ability to compute the derivative of a function.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Shelby Campus Level 4 61/62 98.4% Level 3 0% Level 2 1/62 1.6% Level 1 0% Level 0 0% Clanton Campus Level 4 8/9 88.9% Level 3 0% Level 2 0% Level 1 1/9 11.1% Level 0 0% Online Level 4 137/142 96.5% Level 3 0% Level 2 4/142 2.8% Level 1 0% Level 0 1/142 0.7%	**Observations/Changes:** MTH 125S instructors met and decided to incorporate additional notes from the following website. Power Rule Notes

MTH 125S Objective 3 Demonstrate knowledge of the methods presented in this course by his/her ability to compute an indefinite integral.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Shelby Campus Level 4 57/62 91.9% Level 3 0% Level 2 5/62 8.1% Level 1 0% Level 0 0% Clanton Campus Level 4 8/9 88.9% Level 3 0% Level 2 1/9 11.1% Level 1 0% Level 0 0% Online Level 4 131/142 92.3% Level 3 10/142 7.0% Level 2 0% Level 1 0% Level 0 1/142 0.7%	**Observations/Changes:** MTH 125S instructors met and decided to incorporate additional notes from the following website. Indefinite Integral Notes

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

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Level 0: Student does not attempt a solution.

Chapter 2 : Limits

The topic that we will be examining in this chapter is that of Limits. This is the first of three major topics that we will be covering in this course. While we will be spending the least amount of time on limits in comparison to the other two topics limits are very important in the study of Calculus. We will be seeing limits in a variety of places once we move out of this chapter. In particular we will see that limits are part of the formal definition of the other two major topics.

In this chapter we will discuss just what a limit tells us about a function as well as how they can be used to get the rate of change of a function as well as the slope of the line tangent to the graph of a function (although we'll be seeing other, easier, ways of doing these later). We will investigate limit properties as well as how a variety of techniques to employ when attempting to compute a limit. We will also look at limits whose "value" is infinity and how to compute limits at infinity.

In addition, we'll introduce the concept of continuity and how continuity is used in the Intermediate Value Theorem. The Intermediate Value Theorem is an important idea that has a variety of "real world" applications including showing that a function has a root (\emph{i.e.} is equal to zero) in some interval.

Finally, we'll close out the chapter with the formal/precise definition of the Limit, sometimes called the delta-epsilon definition.

Here is a list of topics that are in this chapter.

Tangent Lines and Rates of Change –In this section we will introduce two problems that we will see time and again in this course : Rate of Change of a function and Tangent Lines to functions. Both of these problems will be used to introduce the concept of limits, although we won't formally give the definition or notation until the next section.

The Limit – In this section we will introduce the notation of the limit. We will also take a conceptual look at limits and try to get a grasp on just what they are and what they can tell us. We will be estimating the value of limits in this section to help us understand what they tell us. We will actually start computing limits in a couple of sections.

One-Sided Limits – In this section we will introduce the concept of one-sided limits. We will discuss the differences between one-sided limits and limits as well as how they are related to each other.

Limit Properties – In this section we will discuss the properties of limits that we'll need to use in computing limits (as opposed to estimating them as we've done to this point). We will also compute a couple of basic limits in this section.

Section 3.3 : Differentiation Formulas

In the first section of this chapter we saw the **definition of the derivative** and we computed a couple of derivatives using the definition. As we saw in those examples there was a fair amount of work involved in computing the limits and the functions that we worked with were not terribly complicated.

For more complex functions using the definition of the derivative would be an almost impossible task. Luckily for us we won't have to use the definition terribly often. We will have to use it on occasion, however we have a large collection of formulas and properties that we can use to simplify our life considerably and will allow us to avoid using the definition whenever possible.

We will introduce most of these formulas over the course of the next several sections. We will start in this section with some of the basic properties and formulas. We will give the properties and formulas in this section in both "prime" notation and "fraction" notation.

Properties

1. $(f(x) \pm g(x))' = f'(x) \pm g'(x)$ OR $\frac{d}{dx}(f(x) \pm g(x)) = \frac{df}{dx} \pm \frac{dg}{dx}$

   In other words, to differentiate a sum or difference all we need to do is differentiate the individual terms and then put them back together with the appropriate signs. Note as well that this property is not limited to two functions.

   See the **Proof of Various Derivative Formulas** section of the Extras chapter to see the proof of this property. It's a very simple proof using the definition of the derivative.

2. $(cf(x))' = cf'(x)$ OR $\frac{d}{dx}(cf(x)) = c\frac{df}{dx}$, c is any number

   In other words, we can "factor" a multiplicative constant out of a derivative if we need to. See the **Proof of Various Derivative Formulas** section of the Extras chapter to see the proof of this property.

Note that we have not included formulas for the derivative of products or quotients of two functions here. The derivative of a product or quotient of two functions is not the product or quotient of the derivatives of the individual pieces. We will take a look at these in the next section.

Section 5.1 : Indefinite Integrals

In the past two chapters we've been given a function, $f(x)$, and asking what the derivative of this function was. Starting with this section we are now going to turn things around. We now want to ask what function we differentiated to get the function $f(x)$.

Let's take a quick look at an example to get us started.

Example 1 What function did we differentiate to get the following function.

$$f(x) = x^4 + 3x - 9$$

Show Solution

There were two points to this last example. The first point was to get you thinking about how to do these problems. It is important initially to remember that we are really just asking what we differentiated to get the given function.

The other point is to recognize that there are actually an infinite number of functions that we could use and they will all differ by a constant.

Now that we've worked an example let's get some of the definitions and terminology out of the way.

Definitions

Given a function, $f(x)$, an **anti-derivative** of $f(x)$ is any function $F(x)$ such that

$$F'(x) = f(x)$$

If $F(x)$ is any anti-derivative of $f(x)$ then the most general anti-derivative of $f(x)$ is called an **indefinite integral** and denoted,

$$\int f(x)\,dx = F(x) + c, \qquad c \text{ is an arbitrary constant}$$

In this definition the $\int$ is called the **integral symbol**, $f(x)$ is called the **integrand**, x is called the **integration variable** and the "c" is called the **constant of integration**.

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment Period:** 2021 – 2022

Program or Department Mission

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Instructional Program Outcomes & Assessment Plan – MTH 126S

Mathematics Course Level Outcomes Assessment Rubric

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Evaluated Course Objectives
Student mastery of the specific course objectives that follow will be evaluated by analyzing solutions for appropriate problems from the comprehensive final exam. The final exam will not be a multiple-choice exam. Students are required to show all of their work and will be graded on the quality of their technique, notation, and accuracy.

The student will demonstrate knowledge of calculus by his/her ability to

1. Find the length of an arc of a plane function, using the definite integral.
2. Use the method of partial fractions to evaluate an integral.
3. Write the Taylor series for a given function.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
MTH 126S Objective 1 Demonstrate knowledge of the methods presented in this course by his/her ability to find the length of an arc of a plane function, using the definite integral.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Shelby Campus Level 4 15/16 93.8% Level 3 0% Level 2 1/16 6.3% Level 1 0% Level 0 0% Online Level 4 64/117 54.7% Level 3 0% Level 2 53/117 45.3% Level 1 0% Level 0 0%	**Observations/Changes:** MTH 126S Instructors recommend reinforcing student learning of this objective by using online notes from the following link. Arc Length Notes
MTH 126S Objective 2 Demonstrate knowledge of the methods presented in this course by his/her ability to use the method	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Shelby Campus Level 4 14/16 87.5% Level 3 0% Level 2 2/16 12.5% Level 1 0% Level 0 0% Online	**Observations/Changes:** MTH 126S instructors recommend reinforcing student learning of this objective by using the following link to access

of partial fractions to evaluate an integral.			Level 4 Level 3 Level 2 Level 1 Level 0	74/117 43/117	63.2% 36.8%	notes on the topic. It is good for students to view another approach. Partial Fractions Notes

MTH 126S Objective 3 Demonstrate knowledge of the methods presented in this course by his/her ability to write a Taylor Series for a given function.k	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Shelby Campus Level 4 13/16 81.3% Level 3 0% Level 2 3/16 18.8% Level 1 0% Level 0 0% Online Level 4 69/127 54.3% Level 3 Level 2 58/127 45.7% Level 1 Level 0 0%	**Observations/Changes:** MTH 126S instructors recommend reinforcing student learning of this objective by using the following link to access notes along with practice problems. It is good for students to view another approach. Taylor Expansion Notes

Mathematics Course Level Outcomes Assessment Rubric

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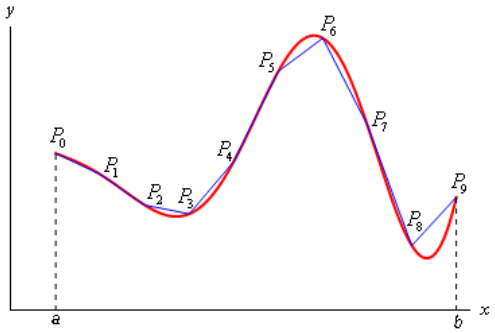
Section 8.1 : Arc Length

In this section we are going to look at computing the arc length of a function. Because it's easy enough to derive the formulas that we'll use in this section we will derive one of them and leave the other to you to derive.

We want to determine the length of the continuous function $y = f(x)$ on the interval $[a, b]$. We'll also need to assume that the derivative is continuous on $[a, b]$.

Initially we'll need to estimate the length of the curve. We'll do this by dividing the interval up into n equal subintervals each of width Δx and we'll denote the point on the curve at each point by P_i. We can then approximate the curve by a series of straight lines connecting the points. Here is a sketch of this situation for $n = 9$.



Now denote the length of each of these line segments by $|P_{i-1}\ P_i|$ and the length of the curve will then be approximately,

$$L \approx \sum_{i=1}^{n} |P_{i-1}\ P_i|$$

and we can get the exact length by taking n larger and larger. In other words, the exact length will be,

$$L = \lim_{n \to \infty} \sum_{i=1}^{n} |P_{i-1}\ P_i|$$

Section 7.4 : Partial Fractions

In this section we are going to take a look at integrals of rational expressions of polynomials and once again let's start this section out with an integral that we can already do so we can contrast it with the integrals that we'll be doing in this section.

$$\begin{aligned}\int \frac{2x-1}{x^2-x-6}\,dx &= \int \frac{1}{u}\,du \quad \text{using } u = x^2-x-6 \text{ and } du = (2x-1)\,dx \\ &= \ln\left|x^2-x-6\right| + c\end{aligned}$$

So, if the numerator is the derivative of the denominator (or a constant multiple of the derivative of the denominator) doing this kind of integral is fairly simple. However, often the numerator isn't the derivative of the denominator (or a constant multiple). For example, consider the following integral.

$$\int \frac{3x+11}{x^2-x-6}\,dx$$

In this case the numerator is definitely not the derivative of the denominator nor is it a constant multiple of the derivative of the denominator. Therefore, the simple substitution that we used above won't work. However, if we notice that the integrand can be broken up as follows,

$$\frac{3x+11}{x^2-x-6} = \frac{4}{x-3} - \frac{1}{x+2}$$

then the integral is actually quite simple.

$$\begin{aligned}\int \frac{3x+11}{x^2-x-6}\,dx &= \int \frac{4}{x-3} - \frac{1}{x+2}\,dx \\ &= 4\ln|x-3| - \ln|x+2| + c\end{aligned}$$

This process of taking a rational expression and decomposing it into simpler rational expressions that we can add or subtract to get the original rational expression is called **partial fraction decomposition**. Many integrals involving rational expressions can be done if we first do partial fractions on the integrand.

So, let's do a quick review of partial fractions. We'll start with a rational expression in the form,

$$\frac{P(x)}{}$$

Section 10.16 : Taylor Series

In the previous section we started looking at writing down a power series representation of a function. The problem with the approach in that section is that everything came down to needing to be able to relate the function in some way to

$$\frac{1}{1-x}$$

and while there are many functions out there that can be related to this function there are many more that simply can't be related to this.

So, without taking anything away from the process we looked at in the previous section, what we need to do is come up with a more general method for writing a power series representation for a function.

So, for the time being, let's make two assumptions. First, let's assume that the function $f(x)$ does in fact have a power series representation about $x = a$,

$$f(x) = \sum_{n=0}^{\infty} c_n (x-a)^n = c_0 + c_1 (x-a) + c_2 (x-a)^2 + c_3 (x-a)^3 + c_4 (x-a)^4 + \cdots$$

Next, we will need to assume that the function, $f(x)$, has derivatives of every order and that we can in fact find them all.

Now that we've assumed that a power series representation exists we need to determine what the coefficients, c_n, are. This is easier than it might at first appear to be. Let's first just evaluate everything at $x = a$. This gives,

$$f(a) = c_0$$

So, all the terms except the first are zero and we now know what c_0 is. Unfortunately, there isn't any other value of x that we can plug into the function that will allow us to quickly find any of the other coefficients. However, if we take the derivative of the function (and its power series) then plug in $x = a$ we get,

$$\begin{aligned} f'(x) &= c_1 + 2c_2 (x-a) + 3c_3 (x-a)^2 + 4c_4 (x-a)^3 + \cdots \\ f'(a) &= c_1 \end{aligned}$$

and we now know c_1.

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** 2021 – 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 227

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized, but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution, but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Evaluated Course Objectives

Student mastery of the specific course objectives that follow will be evaluated by analyzing solutions for appropriate problems from the comprehensive final exam. The final exam will not be a multiple-choice exam. Students are required to show all of their work and will be graded on the quality of their technique, notation, and accuracy.

The student will demonstrate knowledge of calculus by his/her ability to

1. Find the equation of a plane.
2. Compute the directional derivative of a function.
3. Set up and evaluate a double integral.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
MTH 227 Objective 1 Demonstrate knowledge of the methods presented in this course by his/her ability to find the equation of a plane.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Online Level 4 52/64 81.3% Level 3 0% Level 2 12/64 18.7% Level 1 0% Level 0 0%	**Observations/Changes:** MTH 227 Instructors recommend reinforcing student learning of this objective by giving additional notes and practice problems finding the equations of planes using the following link. Plane Notes and Practice
MTH 227 Objective 2 Demonstrate knowledge of the methods presented in this course by his/her ability to compute the directional derivative of a function.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Online Level 4 26/64 40.6% Level 3 0% Level 2 38/64 59.4% Level 1 0% Level 0 0%	**Observations/Changes:** MTH 227 instructors recommend reinforcing student learning of this objective by using the following link to access notes along with practice problems. It is good for students to view another approach.

				Directional Derivative Notes and Practice
MTH 227 Objective 3 Demonstrate knowledge of the methods presented in this course by his/her ability set up and evaluate a double integral.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 2 or higher	Online Level 4 58/64 90.6% Level 3 0% Level 2 6/64 9.4% Level 1 0% Level 0 0%	**Observations/Changes:** MTH 227 instructors recommend reinforcing student learning of this objective by using the following link to access videos and practice problems. It is good for students to have more practice to master the objective. Double Integral Video and Practice

MTH 227 Rubric

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized, but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution, but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

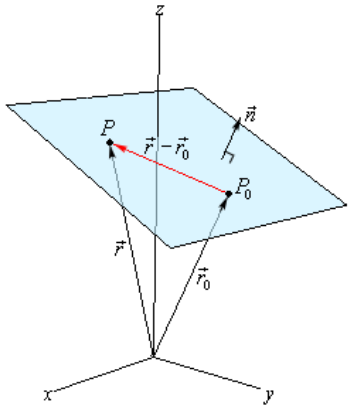
SLO 1: Evidence

Section 12.3 : Equations Of Planes

In the first section of this chapter we saw a couple of equations of planes. However, none of those equations had three variables in them and were really extensions of graphs that we could look at in two dimensions. We would like a more general equation for planes.

So, let's start by assuming that we know a point that is on the plane, $P_0 = (x_0, y_0, z_0)$. Let's also suppose that we have a vector that is orthogonal (perpendicular) to the plane, $\vec{n} = \langle a, b, c \rangle$. This vector is called the **normal vector**. Now, assume that $P = (x, y, z)$ is any point in the plane. Finally, since we are going to be working with vectors initially we'll let $\vec{r_0}$ and $\vec{r}$ be the position vectors for P_0 and P respectively.

Here is a sketch of all these vectors.



Notice that we added in the vector $\vec{r} - \vec{r_0}$ which will lie completely in the plane. Also notice that we put the normal vector on the plane, but there is actually no reason to expect this to be the case. We put it here to illustrate the point. It is completely possible that the normal vector does not touch the plane in any way.

Now, because $\vec{n}$ is orthogonal to the plane, it's also orthogonal to any vector that lies in the plane. In particular it's orthogonal to $\vec{r} - \vec{r_0}$. Recall from the **Dot Product** section that two orthogonal vectors will have a dot product of zero. In other words,

SLO 2: Evidence

Section 13.7 : Directional Derivatives

To this point we've only looked at the two partial derivatives $f_x(x,y)$ and $f_y(x,y)$. Recall that these derivatives represent the rate of change of f as we vary x (holding y fixed) and as we vary y (holding x fixed) respectively. We now need to discuss how to find the rate of change of f if we allow both x and y to change simultaneously. The problem here is that there are many ways to allow both x and y to change. For instance, one could be changing faster than the other and then there is also the issue of whether or not each is increasing or decreasing. So, before we get into finding the rate of change we need to get a couple of preliminary ideas taken care of first. The main idea that we need to look at is just how are we going to define the changing of x and/or y.

Let's start off by supposing that we wanted the rate of change of f at a particular point, say (x_0, y_0). Let's also suppose that both x and y are increasing and that, in this case, x is increasing twice as fast as y is increasing. So, as y increases one unit of measure x will increase two units of measure.

To help us see how we're going to define this change let's suppose that a particle is sitting at (x_0, y_0) and the particle will move in the direction given by the changing x and y. Therefore, the particle will move off in a direction of increasing x and y and the x coordinate of the point will increase twice as fast as the y coordinate. Now that we're thinking of this changing x and y as a direction of movement we can get a way of defining the change. We know from Calculus II that vectors can be used to define a direction and so the particle, at this point, can be said to be moving in the direction,

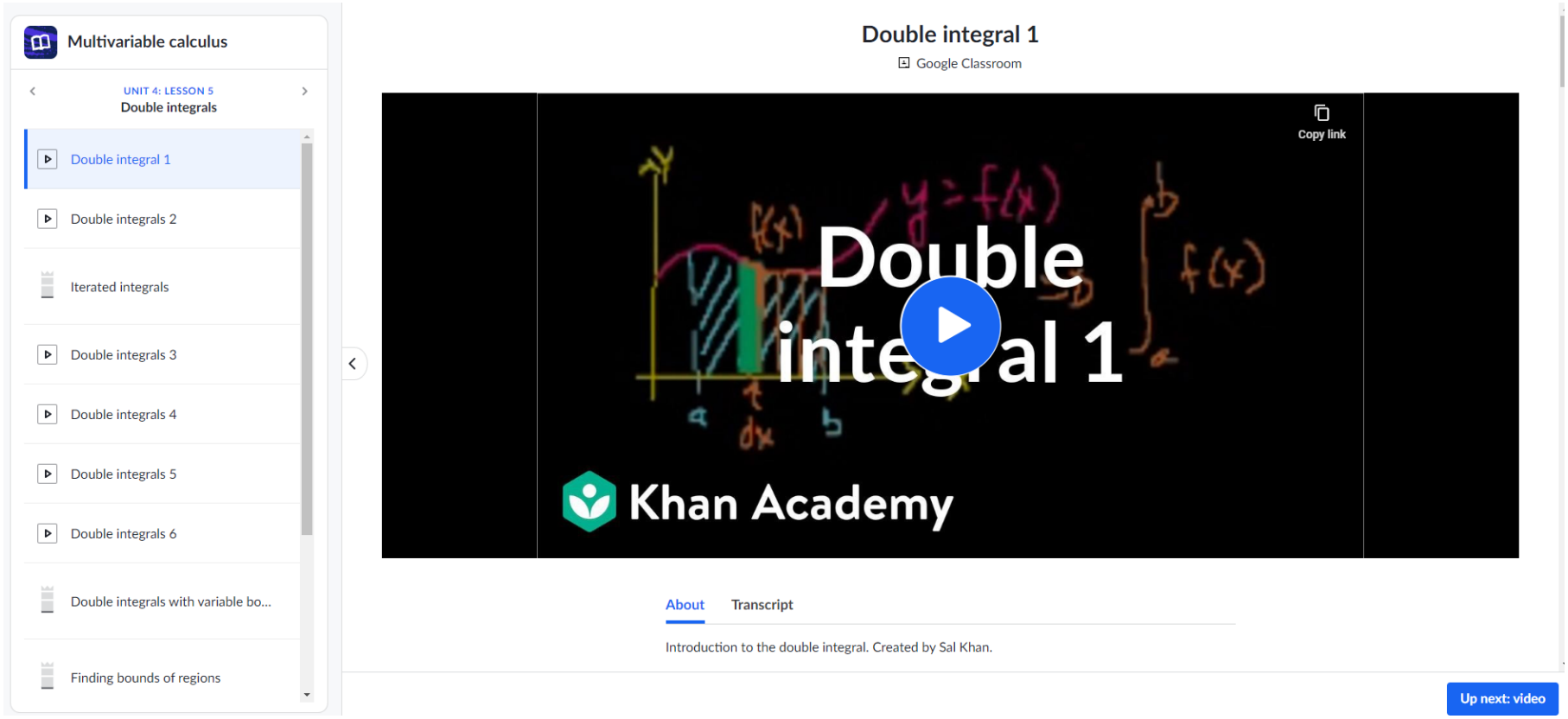
$$\vec{v} = \langle 2, 1 \rangle$$

Since this vector can be used to define how a particle at a point is changing we can also use it to describe how x and/or y is changing at a point. For our example we will say that we want the rate of change of f in the direction of $\vec{v} = \langle 2, 1 \rangle$. In this way we will know that x is increasing twice as fast as y is. There is still a small problem with this however. There are many vectors that point in the same direction. For instance, all of the following vectors point in the same direction as $\vec{v} = \langle 2, 1 \rangle$.

$$\vec{v} = \left\langle \frac{1}{5}, \frac{1}{10} \right\rangle \qquad \vec{v} = \langle 6, 3 \rangle \qquad \vec{v} = \left\langle \frac{2}{\sqrt{5}}, \frac{1}{\sqrt{5}} \right\rangle$$

We need a way to consistently find the rate of change of a function in a given direction. We will do this by insisting that the vector that defines the direction of change be a unit vector. Recall that a unit vector is a vector with length, or magnitude, of 1. This means that for the example that we started off thinking about we would want to use

SLO 3: Evidence



Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 238

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.

Level 3: Student provides a complete solution process that is well organized, but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a solution, but demonstrates little understanding of methods required to produce a correct solution with expected organization.

Level 0: Student does not attempt a solution.

Evaluated Course Objectives

Student mastery of the specific course objectives that follow will be evaluated by analyzing solutions for appropriate problems from the comprehensive final exam. The final exam will not be a multiple-choice exam. Students are required to show all of their work and will be graded on the quality of their technique, notation, and accuracy.

The student will demonstrate knowledge of the methods presented in this course by his/her ability to

1. Use an integrating factor to solve a first order linear equation.
2. Solve second order linear homogeneous equations with constant coefficients.
3. Use the Laplace transform to solve a given initial valve problem.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
MTH 238 Objective 1 Use an integrating factor to solve a first order linear equation.	Rubric based assessment of a final exam problem related to objective 1	70% of students learning at a rubric level of 2 or higher	Internet Campus Level 4 26/38 68% Level 3 10/38 26% Level 2 1/38 3% Level 1 1/38 3% Level 0 0/38 0%	**Observations/Changes:** 97% (37/38) performed at Level 2 or higher. The overall percentage of students that scored at level 2 or higher decreased slightly this academic year from last year. Our recommendation is to add problems that expand the student's experience with various integration techniques. See Addendum A.

MTH 238 Objective 2 Solve second order linear homogeneous equations with constant coefficients.	Rubric based assessment of a final exam problem that pertains to objective 2	70% of students learning at a rubric level of 2 or higher	Internet Campus Level 4 22/38 58% Level 3 11/38 29% Level 2 4/38 11% Level 1 1/38 2% Level 0 0/28 0%	**Observations/Changes:** 97% (37/38) performed at Level 2 or higher. Up from 94% last year. The overall percentage of students that scored at level 2 or higher increased this academic year. Our recommendation is to add additional problems that are slightly more challenging to help increase the student's skill in the area. See Addendum B.Addendum B
MTH 238 Objective 3 Use the Laplace transform to solve a given initial valve problem.	Rubric based assessment of a final exam problem that illustrates objective 3	70% of students learning at a rubric level of 2 or higher	Internet Campus Level 4 18/38 48% Level 3 13/38 34% Level 2 5/38 13% Level 1 2/38 5% Level 0 0/28 0%	**Observations/Changes:** 95% (36/38) performed at Level 2 or higher. Up slightly from 91% last year. The overall percentage of students that scored at level 2 or higher increased slightly this academic year. Our recommendation is to increase the emphasis on more specialized techniques that further help them in in future classes. See Addendum C.

SLO 1,2,3: Evidence

Addendum A

We might include questions similar to the following in the practice problem:

Solve the first order non-linear differential equation. $dy/dx - 12x^3 = 12x^3y^2$. (Since these problems expand the student's experience with various integration techniques.)

Addendum B

We might include questions similar to the following in the homework problem that might include a broader variety of algebraic factoring techniques:

Solve the linear Euler differential equation. $x^2y`` - 4xy` + 6 = 0$. (Since these problems are slightly more challenging to help increase the student's skill in the area.)

Addendum C

Compute the differential equation using Laplace transforms. $y`` - 5y` + 6 = \delta(t)$. (Since these problems increase the emphasis on more specialized techniques that further help them in in future classes.)

Evaluated Course Objectives and Related Example Problems

The General Educational Objective is met through the course objectives which require use of mathematical concepts, notations, and manipulations necessary in students' field of study. Student mastery of the specific course objectives that follow will be evaluated by analyzing solutions for appropriate problems from the comprehensive final exam. The final exam will not be a multiple-choice exam. Students are required to show all of their work and will be graded on the quality of their technique, notation, and accuracy.

The student will demonstrate knowledge of the methods presented in this course by his/her ability to

1. Use an integrating factor to solve a first order linear equation.

   Example Problem 1

   Find the general solution the differential equation by separation of variables.

   $$\frac{dy}{dx} = \frac{28x^3 + \cos x}{5y^4}$$

2. Solve second order linear homogeneous equations with constant coefficients.

   Example Problem 2

   Find the general solution of the homogenous differential equation.

   $$y'' - 10y' + 29y = 0$$

3. Use the Laplace transform to solve a given initial valve problem.

   Example Problem 3

   Solve the initial value problem using the method of Laplace transforms.

   $$\begin{cases} y'' - 9y = \delta(t-3) \\ y(0) = 0 \\ y'(0) = 0 \end{cases}$$

Assessment Record

Program: **Mathematics, Engineering, Physical Sciences** **Assessment Period:** **FALL 2021-SUMMER 2022**

Program or Department Mission

The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to p for college level mathematics.

Instructional Program Outcomes & Assessment Plan – MTH 265

Mathematics Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct solution process that is well organized, with no errors.
Level 3: Student provides a complete solution process that is well organized, but contains minor errors.
Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.
Level 1: Student attempts a solution, but demonstrates little understanding of methods required to produce a correct solution with expected organization.
Level 0: Student does not attempt a solution.

Evaluated Course Objectives

Student mastery of the specific course objectives that follow will be evaluated by analyzing solutions for appropriate problems from the comprehensive final exam. The final exam will not be a multiple-choice exam. Students are required to show all their work and will be graded on the quality of their technique, notation, and accuracy.

The student will demonstrate knowledge of statistics by his/her ability to

1. Calculate variance and standard deviation for a set of sample data
2. Estimate an interval for the true mean from a set of sample data
3. Set up and conduct a statistical test for the mean

Intended Outcomes	Means of Assessment	Means of Assessment	Summary & Analysis of Assessment Evidence	Use of Results
MTH 265 Objective 1 Calculate the variance and standard deviation of	Rubric based assessment of related common final exam problems 1) Calculate variance and standard deviation for a set of sample data.	70% of students learning at a rubric level of 2 or higher	Online Campus Level 4 125/158 79% Level 3 Level 2 30/158 19% Level 1 Level 0 3/158 2%	**Observations/Changes:** Our recommendation is for students to complete practice problems on the mathisfun website. https://www.mathsisfun.com/data/standard-deviation.html

a set of sample data.	*For the mallard ducks and Canada geese the following percentages of successful nests were obtained in a study:* *x: Percentage success for mallard duck nests* *56 85 52 13 39* *y: Percentage success for Canada goose nests* *24 53 60 69 18* *Compute the variance and standard deviation for x and y and their corresponding coefficient of variation to compare and identify which set of data is more consistent.*			It uses real-world examples on calculating standard deviation and variance of a data set.
MTH 265 Objective 2 Estimate an interval for the true mean from a set of sample data.	Rubric based assessment of related common final exam problems 2) Estimate an interval for the true mean from a set of sample data. *For this problem, carry at least four digits after the decimal in your calculations. Answer s may vary slightly due to rounding.* *In a combined study of northern pike, cutthroat*	70% of students learning at a rubric level of 2 or higher	Online Campus Level 4 120/158 76% Level 3 Level 2 30/158 19% Level 1 Level 0 8/158 5%	**Observations/Changes:** Our recommendation is for students to practice confidence intervals using a statistical applet. https://digitalfirst.bfwpub.com/stats_applet/stats_applet_4_ci.html This website has a statistical applet that allows students to change the confidence level and sample size on their own and it then automatically produces a visual representation to show students what this confidence interval looks like graphically with respect to the normal distribution.

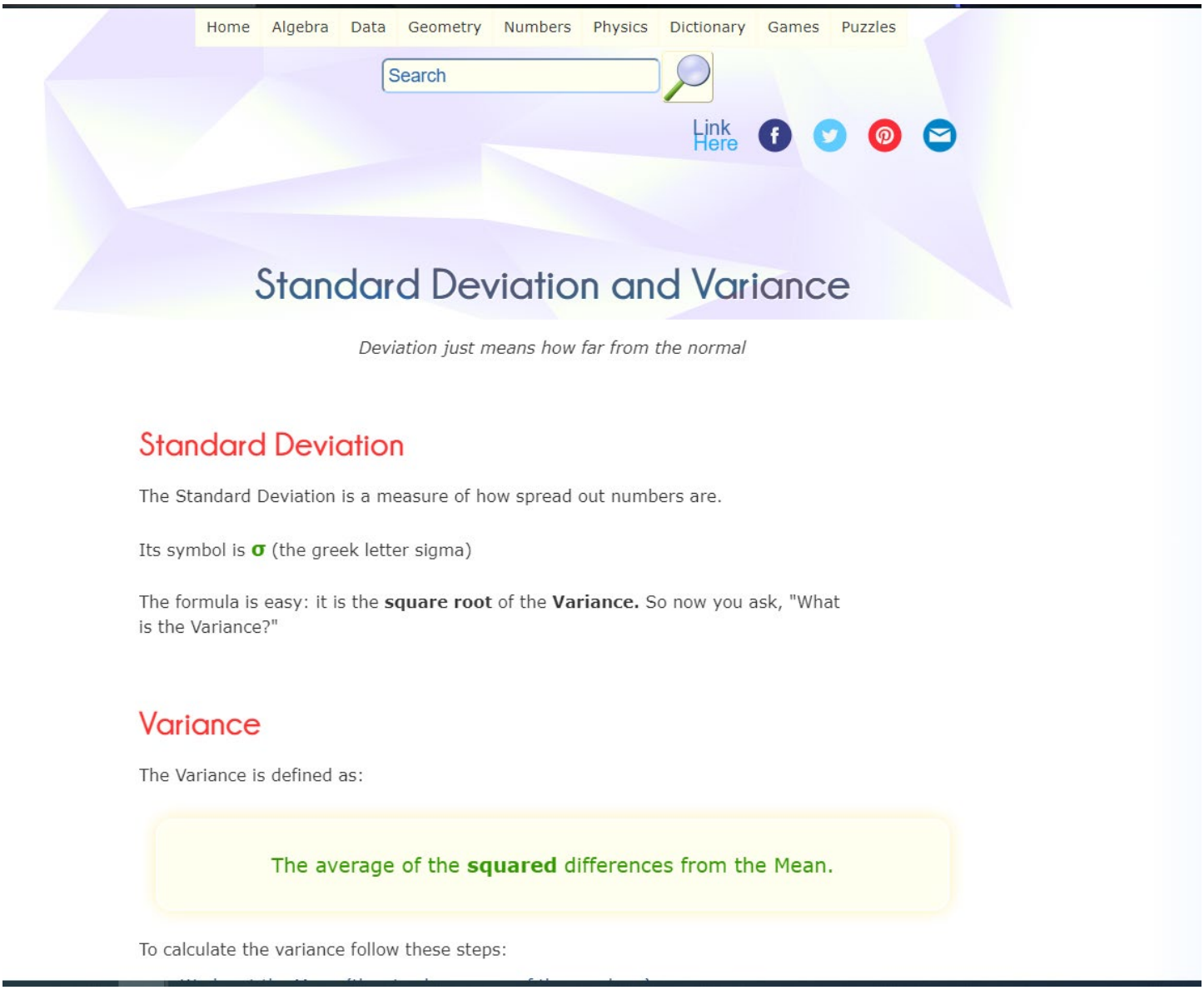
	trout, rainbow trout, and lake trout, it was found that 26 out of 855 fish died when caught and released using barbless hooks on flies and lures. All hooks were removed from the fish. Let p represent the proportion of all pike and trout that die (i.e., p is the mortality rate) wen caught and released using barbless hooks. Find a 99% confidence interval for p. (Round your final answers to three decimal places.)			
MTH 265 Objective 3 Set up and conduct a statistical test for the mean.	Rubric based assessment of related common final exam problems 3) Set up and conduct a statistical test for the mean. *Let x be a random variable that represents hemoglobin count (HC) in grams per 100 milliliters of whole blood. Then x has a distribution that is approximately normal, with population mean of about 14 for healthy adult women. Suppose that a female patient has taken 10 laboratory blood tests during the past year. The HC data sent to the patient's doctor are*	70% of students learning at a rubric level of 2 or higher	Online Campus Level 4 132/158 83.5% Level 3 Level 2 22/158 14% Level 1 Level 0 4/158 2.5%	**Observations/Changes:** Our recommendation is for students to watch and complete notes from the YouTube video on statistical test. https://youtu.be/zJ8e_wAWUzE

	15 18 16 19 *14 12 14 17* *15 11* *Using α=0.01, does this information indicate the population average HC for this patient is higher than 14?*			

MTH 265 Rubric

Mathematics Course Level Outcomes Assessment Rubric
Level 4: Student provides a complete and correct solution process that is well organized, with no errors.
Level 3: Student provides a complete solution process that is well organized, but contains minor errors.
Level 2: Student demonstrates understanding of methods required to produce a correct solution, but the solution process lacks expected organization and/or contains errors deemed more significant.
Level 1: Student attempts a solution, but demonstrates little understanding of methods required to produce a correct solution with expected organization.
Level 0: Student does not attempt a solution.

SLO 1: Evidence



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Standard Deviation and Variance

Deviation just means how far from the normal

Standard Deviation

The Standard Deviation is a measure of how spread out numbers are.

Its symbol is **σ** (the greek letter sigma)

The formula is easy: it is the **square root** of the **Variance.** So now you ask, "What is the Variance?"

Variance

The Variance is defined as:

The average of the **squared** differences from the Mean.

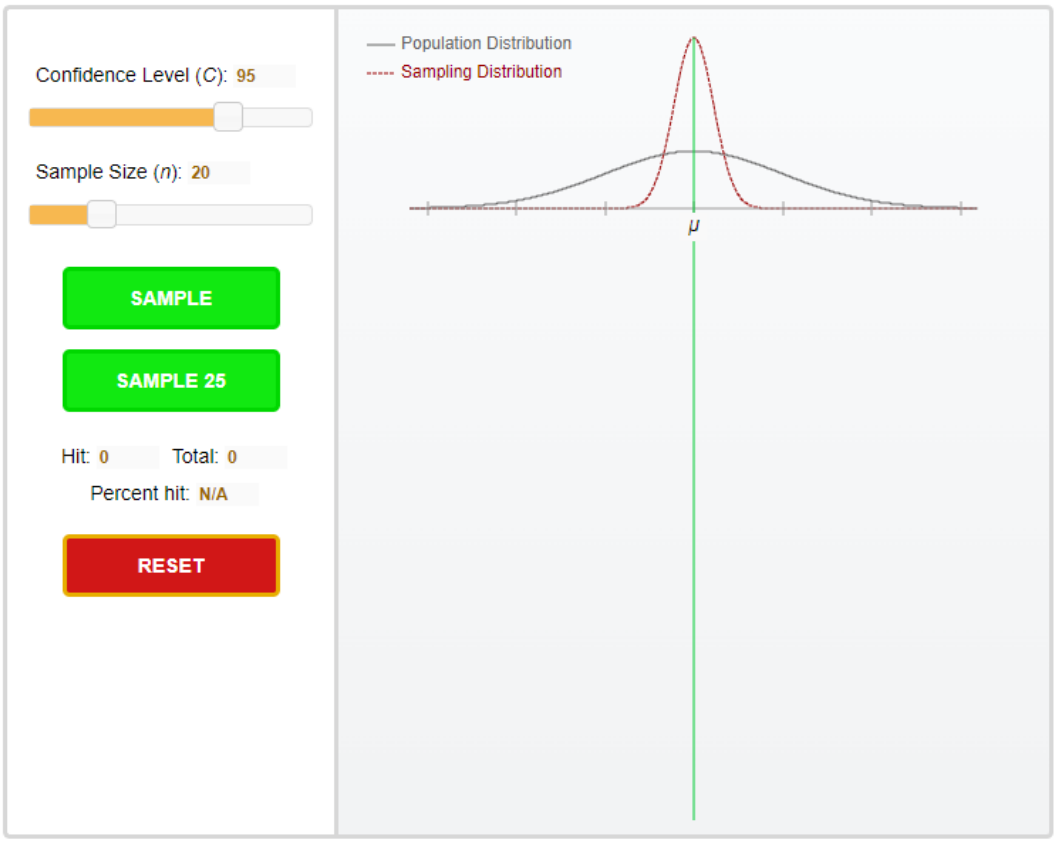
To calculate the variance follow these steps:

SLO 2: Evidence

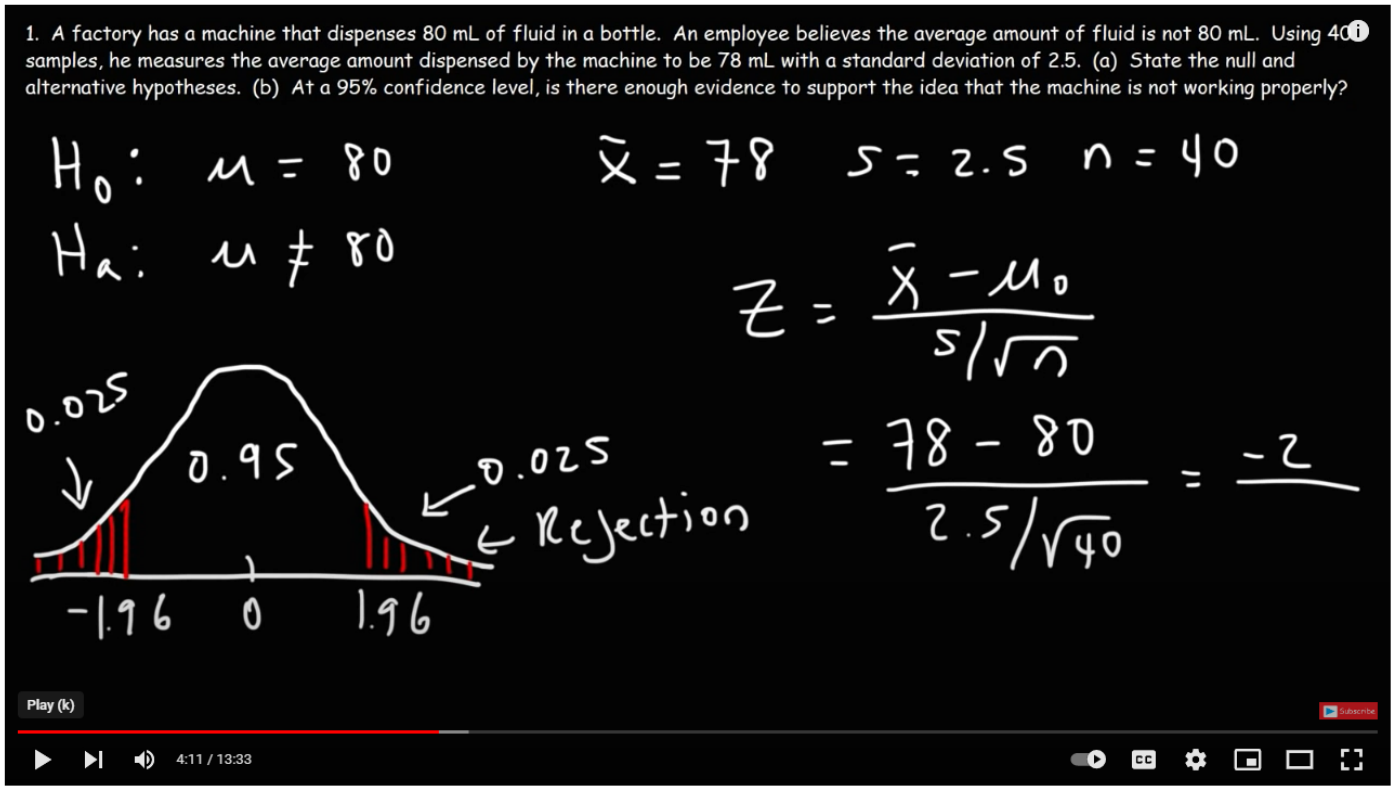
Statistical Applets
Confidence Intervals

A level *C* confidence interval for a parameter is an interval computed from sample data by a method that has probability *C* of producing an interval containing the true value of the parameter. In this applet we construct confidence intervals for the mean (μ) of a Normal population distribution. Each interval is based on a SRS of size *n*. The dot marks the sample mean, which is the center of the interval. The lines on each side of the dot span the confidence interval. The total number of SRSs, the number that "hit" (i.e., the confidence interval contained μ), and the percent hit are tallied for you.

Set the desired confidence level and sample size with the sliders, then click SAMPLE to take a sample. On the right you'll see the sampled values as small yellow dots; the large dot will show the sample mean, and the lines on each side of this dot span the confidence interval. Click SAMPLE 25 take 25 samples all at once. Intervals that contain the population mean μ ("hits") will be colored gray; "misses" will be colored red. Click on any confidence interval to show the sample data that the interval is based on.



SLO 3: Evidence



Hypothesis Testing Problems - Z Test & T Statistics - One & Two Tailed Tests 2

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Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Department Outcomes

- Provide freshman and sophomore-level courses in Chemistry. Mathematics, Physics, Physical Sciences and Astronomy, with emphasis on critical thinking and analytical ability that are transferable to public institutions of higher learning.
- Offer an appropriate remedial mathematics program accommodating various skill levels.
- Develop and provide courses relevant to the career and professional degree programs of the college.

Evaluated Course Objectives

The student will demonstrate his/her knowledge of physical science using writing skills with correct grammar, spelling and punctuation by being able to:

1. Describe and differentiate between comets, meteors and asteroids.
2. Describe different kinds of weather fronts and their associated characteristics.
3. List the three types of rocks and describe their formation.

Instructional Program Outcomes & Assessment Plan – PHS 111

Physical Science 111 Course Level Outcomes Assessment Rubric

For Exam and Quiz Questions

Level 4: Student provides a complete and correct response that is well organized, with no errors.

Level 3: Student provides a complete response that is well organized, but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct response, but lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a response, but demonstrates little understanding of subject required to produce a correct response with expected organization.

Level 0: Student does not attempt a response.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
PHS 111 Objective 1 Describe and differentiate between comets, meteors and asteroids	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 94/114 82.5% Level 3 7/114 6.1% Level 2 7/114 6.1% Level 1 0/114 0.0% Level 0 3/114 2.6%	**Observations/Changes:** Annual Campus-wide total at rubric level 3 or higher: 88.6% This represents a slight decrease in the success as the previous year, but still indicates success in current instructional methods. The criteria for success are met. Note that only Internet courses are reported for this course since on-campus courses were unavailable due to the pandemic. We did not introduce the planned links to videos that illustrate plainly the differences between these entities. For the 2022 – 2023 year, we plan to introduce the above-mentioned videos. Total = 114

PHS 111 Objective 2 Describe different kinds of weather fronts and their associated characteristics.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 81/114 71.1% Level 3 15/114 13.2% Level 2 8/114 7.0% Level 1 2/114 1.8% Level 0 5/114 4.4%	**Observations/Changes:** Annual Campus-wide total at rubric level 3 or higher: 84.3% There was a slight decrease in the success rate compared to the 2020-2021 success rate of 86.5 %. This indicates the criteria for success are met during current instructional methods. Note that only Internet courses are reported for this course since on-campus courses were unavailable due to the pandemic. For the 2021 – 2022 year, we planned to introduce videos online that illustrate the development and effects of different weather fronts. A tutorial video was included in the homework assignment for the Chapter in which weather and types of fronts are covered. Total = 114

<u>PHS 111 Objective 3</u> List the three types of rocks and describe their formation.	Rubric based assessment of related common final exam and/or midterm exam questions.	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 98/114 86.0% Level 3 2/114 1.8% Level 2 6/114 5.3% Level 1 0/114 0 % Level 0 8/114 7.0%	**Observations/Changes:** Annual Campus-wide total at rubric level 3 or higher: 87.8 Unfortunately, this question was inadvertently left off the final and midterm exams, so we don't have a success rate for the previous academic year for this Objective. The criteria for success are met during current instructional methods. Only Internet courses were offered for this course since on-campus courses were unavailable due to the pandemic. For the 2021 – 2022 year, we planned to a) ensure this question is included on major exams, and b) introduce a learning exercise focused on the rock cycle to help cement student understanding of rock formation and metamorphosis. The question was included on major exams as planned. The learning exercise focused on rock formation was not added, however we plan to include that component during the 2022-2023 academic year.

References

Physical Science 111 SLO Rubric:

Level 4: Student provides a complete and correct response that is well organized, with no errors.

Level 3: Student provides a complete response that is well organized, but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct response but lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a response but demonstrates little understanding of subject required to produce a correct response with expected organization.

Level 0: Student does not attempt a response.

PHS 111 SLO Common Final Exam Problems

These three questions are to be included on each PHS 111 Final Exam. They are categorized as Essay questions when included in an on-line assessment. These questions can easily be incorporated into traditional on-campus exams as well.

PHS 111 Objective 1

Describe and differentiate between comets, meteors and asteroids.

PHS 111 Objective 2

Describe different kinds of weather fronts and their associated characteristics.

PHS 111 Objective 3

List the three types of rocks and describe their formation.

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Department Outcomes

- Provide freshman and sophomore-level courses in Chemistry. Mathematics, Physics, Physical Sciences and Astronomy, with emphasis on critical thinking and analytical ability that are transferable to public institutions of higher learning.
- Offer an appropriate remedial mathematics program accommodating various skill levels.
- Develop and provide courses relevant to the career and professional degree programs of the college.

Evaluated Course Objectives

The student will demonstrate his/her knowledge of physical science using writing skills with correct grammar, spelling and punctuation by being able to:

1. Calculate the formula weight of a compound.
2. Calculate the %-age composition of a compound.
3. Compound the speed of a falling object given the time and initial speed.

Instructional Program Outcomes & Assessment Plan – PHS 112

Physical Science 112 Course Level Outcomes Assessment Rubric

For Exam and Quiz Questions

Level 4: Student provides a complete and correct response that is well organized, with no errors.

Level 3: Student provides a complete response that is well organized, but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct response, but lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a response but demonstrates little understanding of subject required to produce a correct response with expected organization.

Level 0: Student does not attempt a response.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
PHS 112 Objective 1 Calculate the formula weight of a compound.	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 30/42 71.4% Level 3 0/42 0.0% Level 2 1/42 2.4% Level 1 2 /42 4.8% Level 0 9/42 21.4%	**Observations/Changes:** Annual Campus-wide total at rubric level 3 or higher: 71.4% There represents a less than 1% drop in success rate compared to 2020 – 2021. The criteria for success are met, but barely. Note that only Internet courses are reported for this course since on-campus courses were unavailable due to the pandemic. We plan to introduce videos that illustrate how to solve formula weight problems. Instructional videos were not introduced, but we plan to remedy that during the 2022 – 2023 academic year. The 21% of students who did not attempt a solution is disturbing. There is no math requirement for students who enroll in PHS 112, so there is a

				wide variance of student preparedness and comfort level where math is concerned. During the 2022 – 2023 year a stronger math review component will be introduce to help improve confidence levels where math applications are concerned. Total = _42___
PHS 112 Objective 2 Calculate the %-age composition of a compound..	Rubric based assessment of related common final exam problems	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 22/42 52.4% Level 3 4/42 9.5% Level 2 0/42 0.0% Level 1 6/42 14.3% Level 0 10/42 23.8%	**Observations/Changes:** Annual Campus-wide total at rubric level 3 or higher: 61.9 % There was an increase in the rate of success of 8.8% compared to 53.1% for 2019 – 2020. This indicates a significant improvement of success in current instructional methods, and two consecutive years of improvement in this area. However, the criteria for success are still not met. As with SLO 1 almost 24% of the students did not even attempt to solve this problem. There is no math requirement for students who enroll in PHS 112, so there is a wide variance of student preparedness and comfort level where math is concerned.

				During the 2022 – 2023 year a stronger math review component will be introduce to help improve confidence levels where math applications are concerned. Note that only Internet courses are reported for this course since on-campus courses were unavailable due to the pandemic. To help students learn steps for calculating the %-age composition, we plan to introduce practice problems for these calculations. Total = 42
<u>PHS 112 Objective 3</u> Compute the speed of a falling object given the time and initial speed.	Rubric based assessment of related common final exam and/or midterm exam questions.	70% of students learning at a rubric level of 3 or higher	**Online Campus** Level 4 30/42 71.4% Level 3 2/42 4.8% Level 2 0/42 0.0% Level 1 8/42 19.0% Level 0 2/42 4.8%	**Observations/Changes:** Annual Campus-wide total at rubric level 3 or higher: 76.2% There was a significant 32.5% increase in the rate of success of 76.2% compared to 43.7% for 2020 – 2021. Current instructional methods are successful. We believe this to be at least partially due to the inclusion of homework problems related to this objective. Note that only Internet courses are reported for this course since on-campus courses were unavailable due to the pandemic.

				For the 2022 – 2023 year, we plan to continue including problems related to this type of problem application in homework assignments. As with Objectives 1 and 2, deficits in math preparedness plays a part in the significant number of students who did not show proficiency in this area. A stronger math review is planned to help improve student success. Total = 42

References:

Physical Science 112 Course Level Outcomes Assessment Rubric

Level 4: Student provides a complete and correct response that is well organized, with no errors.

Level 3: Student provides a complete response that is well organized but contains minor errors.

Level 2: Student demonstrates understanding of methods required to produce a correct response but lacks expected organization and/or contains errors deemed more significant.

Level 1: Student attempts a response but demonstrates little understanding of subject required to produce a correct response with expected organization.

Level 0: Student does not attempt a response.

PHS 112 SLO Example Common Final Exam Problems

These three questions, or ones very similar, are to be included on each PHS 112 Final Exam. They are categorized as Essay questions when included in an on-line assessment to give students plenty of room to show their calculations. These questions can easily be incorporated into traditional on-campus exams as well.

PHS 111 Objective 1

Calculate the formula weight of Copper (II) Sulfate, $CuSO_4$. Refer to a periodic table to find atomic weights for the elements included in the formula. Show all your work.

PHS 111 Objective 2

Calculate the %-age composition of Copper (II) Sulfate, $CuSO_4$. Refer to a periodic table to find atomic weights for the elements included in the formula. Show all your work.

PHS 111 Objective 3

Determine the speed and distance fallen by a 3-kg physical science textbook 3 seconds after you have dropped the book from Vulcan's outstretched hand. Show all your work.

Assessment Record

Program: Mathematics, Engineering and Physical Science **Assessment period:** Fall 2021 - Summer 2022

Program or Department Mission:

The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions. The department also offers developmental mathematics courses to prepare students for college level mathematics.

Course Student Learning Outcomes & Assessment Plan – PHY 213S

Physics Course Level Outcomes Assessment Rubric

Level 3: Attempted Problem and Solved Correctly (full credit)
Level 2: Attempted Problem and Did Not Solve Correctly, Some Understanding of Problem Solution (at least half credit)
Level 1: Failed to Show Understanding of Problem Solution or Did Not Attempt Problem

Note the that the rubric was adjusted to match the new SLO form that was adjusted as a result of the change in format due to the covid-19 pandemic.

Departmental Level Student Learning Outcomes

1. Students will acquire content knowledge of the physical sciences and mathematics.
2. Students will develop problem solving and critical thinking skills
3. Students will be prepared to use mathematics in other disciplines

Course Objectives assessed

The student will demonstrate fundamental skills of physics and mathematics to solve problems by his /her ability to:

1. Solve projectile motion problems.
2. State and apply Newton's second law
3. Calculate potential energy in the gravitational field.

Instructional Program Outcomes & Assessment Plan				
Intended Outcomes	**Means of Assessment**	**Criteria for Success**	**Summary & Analysis of Assessment Evidence**	**Use of Results**
PHY 213S Objective 1 Solve projectile motion problems.	Rubric based assessment of a final exam problem related to objective 1	At least 70% of students will produce solutions at rubric level 2 or higher.	Jefferson Campus (Prob 1) Level 3 24/42 57% Level 2 14/42 33% Level 1 4/42 10%	**Observations/Changes:** For problem 1 (38/42) 90% of students performed at level 2 or higher. The student performance was up significantly from 73% for prob 1 last year. We suggest that we might include more variations of this type to provide more of a challenge. See Addendum A.

PHY 213S Objective 2 State and Apply Newton's second law.	Rubric based assessment of a final exam problem that meets objective 2	At least 70% of students will produce solutions at rubric level 2 or higher.	Internet Campus (Prob 2) Level 3 24/42 57% Level 2 16/42 38% Level 1 2/42 5%	**Observations/Changes:** For problem 2 (40/42) 90% of students performed at level 2 or higher. The student performance was up for both problems from 82% for the objective 2 problems from last year. We suggest that we include more problems involving Newton's Second Law to provide more of a challenge and to give a broader understanding of this important topic. See Addendum B.

PHY 213S Objective 3 Calculate potential energy in the gravitational field.	Rubric based assessment of a final exam problem that illustrates objective 3	At least 70% of students will produce solutions at rubric level 2 or higher.	Internet Campus (Prob 3) Level 3 23/42 55% Level 2 17/42 40% Level 1 2/42 5%	**Observations/Changes:** For problem 3 (40/42) 95% of students performed at level 2 or higher. The student performance was up from 85% from the objective 3 problems from last year. We suggest that concentration on other topics might be useful but we might be able to offer some more challenging problems on this topic in the homework. See Addendum C.
			Submitted by: Department of Mathematics, Engineering and Physical Sciences, Robert Wallace	

PHY 213S Rubric:

Physics Course Level Outcomes Assessment Rubric

Level 3: Attempted Problem and Solved Correctly (full credit)

Level 2: Attempted Problem and Did Not Solve Correctly, Some Understanding of Problem Solution (at least half credit)

Level 1: Failed to Show Understanding of Problem Solution or Did Not Attempt Problem

Note the that the rubric was adjusted to match the new SLO form that was adjusted as a result of the change in format due to the covid-19 pandemic.

SLO 1,2,3: Evidence

Addendum A

We will include questions similar to the following in the practice problems:

A projectile is launched from a height of 50. 0 m above the ground with an initial speed of 175 m/s at an angle of the 55. 0 ° above the horizontal toward a tall building 525 m high that is 40.0 m away. Find the time that it takes the object to reach the other building, (b) the height of the object when it strikes the other building, and (c) the speed of the object when it hits the other building. Write down all of the kinematic formulas before you start.

Addendum B

We will include questions similar to the following in the homework problem that might incorporate more related topics with Newton's Laws:

A 40.0 kg child takes a ride on a Ferris wheel that rotates clockwise four times per minute and has a diameter of 18.0 m. Compute (a) the centripetal acceleration of the child, (b) the magnitude of the force that the seat exerts on the child when she is halfway between the bottom and the top moving upward, and (c) the direction of the force that the seat exerts on the child when she is halfway between the bottom and the top moving upward.

Addendum C

We will include questions similar to the following in the homework problems that might incorporate more advanced use of fundamental principles:

Suppose that a 20.0 kg mass initially at a height of 75.0 m and initially at rest slides downward along a frictionless surface. Just after it reaches ground level it, slides along a rough horizontal surface until it comes to rest, where the coefficient of kinetic friction is 0.125. Calculate (a) the initial mechanical energy of the system, (b) the speed of the object when it is 50.0 m above the ground, (c) the speed of the object when it first reaches ground level, (d) the work done by gravity, (e) the work done by friction on the object, (f) the acceleration of the object as it slides over the horizontal surface, and (g) the distance that the object slides along the horizontal surface.

Course Objectives Assessed and Related Example Problems

The student will demonstrate fundamental skills of physics and mathematics to solve problems by his /her ability to:

1. Solve projectile motion problems.

   Example Problem 1
   A projectile is launched from a height of 25.0 m above the ground with an initial speed of 150.0 m/s at an angle of the 60.0° above the horizontal. Find (a) the maximum height of the object, (b) the maximum horizontal distance traveled, and (c) the speed of the object when it hits the ground.

2. State and apply Newton's second law

   Example Problem 2
   A string directed at a 60.0° angle above the horizontal is attached to a 10.0 kg box on a horizontal surface and the string is pulled with a tension of 50.0 N. The coefficient of kinetic friction between the box and the surface is 0.150. Find (a) the normal force on the box, (b) the kinetic friction, and (c) the acceleration of the box.

3. Calculate potential energy in the gravitational field.

   Example Problem 3
   A 20.0 kg mass slides 100.0 m down a 30.0° incline plane before friction brings the object to rest at the bottom. The initial velocity of the mass is 8.00 m/s. Compute (a) the initial gravitational potential energy of the mass assuming that the potential is zero at ground level and compute (b) the initial kinetic energy of the mass, and (c) the work done by friction?

Assessment Record

Program: Mathematics, Engineering, Physical Sciences **Assessment period:** Fall 2021 – Summer 2022

Program or Department Mission:
The Department of Mathematics/Engineering/Physical Sciences offers a broad range of courses that service the career programs of the college and that will transfer to baccalaureate degree granting institutions.

Instructional Program Outcomes & Assessment Plan – PHY 214S

Physics Course Level Outcomes Assessment Rubric

Level 3: Attempted Problem and Solved Correctly (full credit)
Level 2: Attempted Problem and Did Not Solve Correctly, Some Understanding of Problem Solution (at least half credit)
Level 1: Did Not Attempt Problem or Failed to Show Understanding of Problem Solution (less than half credit)

Evaluated Course Objectives
Student mastery of the specific course objectives that follow will be evaluated by analyzing solutions for appropriate problems from the comprehensive final exam. The final exam will not be a multiple-choice exam. Students are required to show all of their work and will be graded on the quality of their technique, notation, and accuracy. The rubric above was used to evaluate the problems during the previous year including fall of 2020 through summer 2021.

The student will demonstrate knowledge of electromagnetic theory by his/her ability to:

1. Solve problems that involve electric fields.
2. Solve problems that involve magnetic fields.
3. Solve problems that involve electric circuits.

Intended Outcomes	Means of Assessment	Criteria for Success	Summary & Analysis of Assessment Evidence	Use of Results
PHY 214S Objective 1 Solve problems that involve electric fields.	Rubric based assessment of a final exam problem related to objective 1	70% of students learning at a rubric level of 2 or higher	Internet Campus Level 3 15/28 54% Level 2 9/28 32% Level 1 4/28 14%	**Observations/Changes:** 86% (24/28) performed at Level 2 or higher. Up from 76% last year. The overall percentage of students that scored at level 2 or higher increased. Our recommendation is to add more challenging problems to help expand student understanding of this topic. See Addendum A.
PHY 214S Objective 2 Solve problems that involve magnetic fields.	Rubric based assessment of a final exam problem that illustrates objective 2	70% of students learning at a rubric level of 2 or higher	Internet Campus Level 3 17/28 61% Level 2 9/28 32% Level 1 2/28 7%	**Observations/Changes:** 93% (26/28) performed at Level 2 or higher. Down slightly from 95% last year. The overall percentage of students that scored at level 2 or higher decreased very slightly this academic year. Our recommendation is to continue to add additional review on vector cross products in the homework as well as problems that emphasize the conceptual understanding of what

				magnetic fields do. See Addendum B.
PHY 214S Objective 3 Solve problems that involve electric circuits.	Rubric based assessment of a final exam problem that falls under objective 3	70% of students learning at a rubric level of 2 or higher	Internet Campus Level 3 14/28 50% Level 2 12/28 43% Level 1 2/28 7%	**Observations/Changes:** 93% (26/28) performed at Level 2 or higher. This is down very slightly from 95% last year. The overall percentage of students that scored at level 2 or higher decreased very slightly this academic year. Our recommendation is to continue to add additional review on the solution of systems as well as the use of Ohm's law. See Addendum C.

Physics Course Level Outcomes Assessment Rubric

Level 3: Attempted Problem and Solved Correctly (full credit)
Level 2: Attempted Problem and Did Not Solve Correctly, Some Understanding of Problem Solution (at least half credit)
Level 1: Did Not Attempt Problem or Failed to Show Understanding of Problem Solution (less than half credit)

Addendum A

We will include a lab where students have to work carefully through a vector addition problem such as the following:

Given that a charge of 2.50 C is located the point (5.25 m, 7.50 m), another charge of 4.20 C is located the point (-1.25 m, 5.50 m), another charge of 5.75 C is located the point (-3.75 m, -2.50 m), and another charge of -3.15 C is located the point (4.25 m, -7.40 m), find (a) the direction and (b) the magnitude of the force on a charge of 10.0 C located at the origin.

Addendum B

We will include questions similar to the following in the homework problem that provides practice in the computation of cross-products similar to the following as well as problems that emphasize the conceptual understanding of what magnetic fields do.:

Compute (a) the magnitude and (b) the direction of the magnetic induction at the origin due to the current loop below given that I=50.0 A, L_1=1.00 m, L_2=5.00 m, L_3=4.00 m, and L_4=3.00 m. (Diagram not shown here.)

Addendum C

We will include questions similar to the following in the lecture that provides practice in the setting up the required system of equations and of solving the system similar to the following:

Compute (a) the current I_1, (b) the current I_2, and (c) the current I_3 through the indicated segments of the circuit. Also compute (d) the total power delivered to the resistors and (e) the total power supplied by the batteries where ε_1=8.00 V , ε_2=5.00 V , R_1=3.00 Ω , R_2=4.00 Ω , R_3=6.00 Ω , R_4=2.00 Ω , and R_5=4.00 Ω. (Diagram not shown here.)

Evaluated Course Objectives and Related Example Problems

The General Educational Objective is met through the course objectives which require use of mathematical concepts, notations, and manipulations necessary in students' field of study. Student mastery of the specific course objectives that follow will be evaluated by analyzing solutions for appropriate problems from the comprehensive final exam. The final exam will not be a multiple-choice exam. Students are required to show all of their work and will be graded on the quality of their technique, notation, and accuracy. The rubric above was used to evaluate the problems during the previous year including fall of 2020 through summer 2021.

The student will demonstrate knowledge of electromagnetic theory by his/her ability to:

1. Solve problems that involve electric fields.

   Example Problem 1

   Point charges of 2.50 C and 8.75 C are located on the positive *x*-axis at positions of $x = 15.0$ m and $x = 25.0$ m, respectively. Compute (a) the magnitude and (b) the direction of the electric field at the origin, and (c) the magnitude and (d) the direction of the electric force on a point charge of 4.00 C located at the origin.

2. Solve problems that involve magnetic fields.

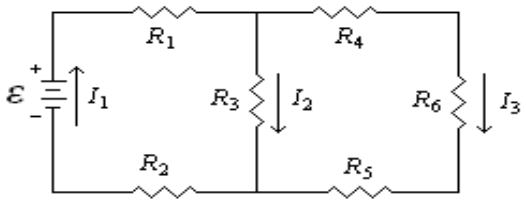
   Example Problem 2

   Suppose that an infinitely long wire lying along the *x*-axis carries a current of 50.0 A in the positive *x*-direction and suppose that a charge of 5.50 C is located 2.75 m above the wire in the *xy*-plane and has a velocity of 4.00 m/s in the negative *x*-direction. Calculate (a) the magnitude of the magnetic field due to the wire at the position of the charge, (b) the direction of the magnetic field due to the wire at the position of the charge, (c) the magnitude of magnetic force on the charge, and (d) the direction of the magnetic force on the charge.

3. Solve problems that involve electric circuits.

   Example Problem 3

   Compute (a) the equivalent resistance of the circuit Req, (b) the current I1, (c) the current I2, and (d) the current I3 where $R1 = 2.50\ \Omega$, $R2 = 4.25\ \Omega$, $R3 = 2.00\ \Omega$, $R4 = 5.25\ \Omega$, $R5 = 2.25\ \Omega$, $R6 = 2.50\ \Omega$, and $E = 16.0$ V.


R_1
R_4
$\mathcal{E}$
+
−
I_1
R_3
I_2
R_6
I_3
R_2
R_5