Physical Science EXPLORED PLUS

Assignment Key

Lesson 1

Lab Report Example

Exploring the Scientific Method by Melting Different Frozen Liquids

The content of all of these sections will vary to some extent, but should generally follow the example below.

Introduction: *The introduction should include why this lab is being completed: to practice the steps of the scientific method and to see which frozen household liquid melts the fastest. Students could include some research about what factors impact melting rate which would lead to their hypothesis in the next section.*

Hypothesis: *Students should state what they believe will happen and why, such as, "I think the water will melt the fastest because it doesn't have anything else in it to slow it down."*

Materials:

Students should list all the materials used, such as…

Water
Milk
Orange Juice
(Whatever other liquids were used)
Ice Cube Tray
Timer
Plate

Procedure:

Students should list what they did and how they did it with enough detail so that someone else could follow their instructions to do the same lab. For example…

1. *I made two ice cubes for each liquid by pouring them into an ice cube tray and freezing them.*
2. *After I wrote my hypothesis, I took one of the ice cubes out of the freezer, placed it on a plate, and started the timer.*
3. *I waited for the ice cube to completely melt, then I stopped the timer and recorded the time in the data table under Trial 1.*
4. *I repeated steps 2 and 3 with both of the other ice cubes.*

5. *I completed steps 2-4 with a second ice cube and recorded the times in the data table under Trial 2.*

<u>Results:</u>

The results consist of the students' data table. Below is a sample of what the data might look like.

	Type of Liquid	**Trial #1 Time**	**Trial #2 Time**
Substance #1	*Water*	*10.03 minutes*	*10.01 minutes*
Substance #2	*Milk*	*8.87 minutes*	*8.89 minutes*
Substance #3	*Orange Juice*	*9.95 minutes*	*9.92 minutes*

<u>Conclusions:</u>

This section of the lab report is where the data is interpreted. Students should list their answers to the lab discussion questions and state whether their hypothesis was supported. For example…

> *The purpose of this lab was to find out which frozen household liquid melts the fastest. I thought the water would melt the fastest because it didn't have anything extra in it to slow down the melting process, but the data did not support my hypothesis. The water actually took the longest to melt and the milk melted the fastest, so maybe putting things in water makes it melt faster. For future labs, it would be interesting to try different liquids or to see what other factors affect how quickly the ice melts.*

1. What was the independent variable in this experiment?
   The type of substance (water, milk, orange juice).

2. What was the dependent variable?
   The time it took to melt.

3. Which of the ice cubes melted the fastest?
   The milk.

4. Was your hypothesis correct? Why or why not?

My hypothesis was not correct. I thought the water would melt the fastest, but the milk melted the fastest and the water melted the slowest.

5. What is one reason why that ice cube may have melted faster than the other ones?

Milk has things other than water in it, so the other parts of the milk may have made it melt faster.

Lesson 2

Fill in the blanks with the correct unit and the symbol for that unit.

1. Distance is measured in meters, abbreviated m.
2. Temperature is measured in Kelvin, abbreviated K.
3. Mass is measured in grams, abbreviated g.
4. Volume is measured in cubic meters or liters, abbreviated m^3 or L.
5. Force is measured in Newtons, abbreviated N.
6. Pressure is measured in Pascals, abbreviated Pa.
7. Time is measured in seconds, abbreviated s.
8. Energy is measured in Joules, abbreviated J.
9. Electric current is measured in amperes, abbreviated A.
10. Amount of substance is measured in moles, abbreviated mol.
11. Power is measured in Watts, abbreviated W.

Fill in the blanks with whole numbers. The larger unit will have a "1" in the blank. The smaller unit has how many of that unit fits in the bigger unit. For example, 100 centigrams = 1 gram.

12. 1,000 grams = 1 kilogram
13. 1 meter = 100 centimeters
14. 10 moles = 1 dekamole
15. 1 meter = 1,000 millimeters
16. 1 meter = 10 decimeters
17. 100 meters = 1 hectometer

Lesson 3

Article 1: Mars Climate Orbiter

The paragraph should include the following info:

- A climate orbiter was sent to Mars to map out the climate, atmosphere, and surface on Mars and hopefully provide evidence of buried water reserves.
- Commands from Earth for landing the orbiter were given in English units (pound-seconds) instead of being converted into metric units (Newton-seconds).
- The orbiter missed its intended target because of the error and disintegrated due to atmospheric stresses.
- The scientists on the team should have been more careful and checked their numbers against each other to make sure their units agreed before launching the orbiter.

Article 2: Chernobyl Accident

The paragraph should include the following info:

- Scientists conducted (unauthorized) investigations into the operating conditions of turbogenerators in a nuclear power plant while they were out of service.
- The management and specialists did not prepare for the experiments or clear them with the proper authorities. They also did not enforce proper safety procedures during the experiments.
- The reactor exploded, killing 28 people and causing damage to the health of a large number of people, including at least 203 cases of radiation sickness, and cost a lot of money.
- The scientists should have followed proper safety protocols, especially given the dangerous substances they were working with. They also should have gone through the proper channels and ensured they were thoroughly prepared for any experiment before testing it.

Article 3: Consequence of Errors

There are two experiments to summarize in this article

- Memory Molecules

  The paragraph should include the following info:

  - Worms were conditioned to scrunch up their bodies in response to light. Those worms were then fed to littermates, who were able to be conditioned twice as fast as compared with controls.

- The scientist mistakenly concluded that memory was stored in a molecule in your body that could be transferred through cannibalism.
- He failed to take into account background factors and variations that could have affected his results. His experiments weren't really controlled experiments, and he even advised other scientists to continuously change the conditions of the experiments until the desired results were met.
- He should have considered different explanations for his results (such as the fact that the worms may naturally scrunch up their bodies in response to light, other variables could have affected his results so he could have done different controlled experiments to verify them, etc.).

- Chromosome Abnormalities

  The paragraph should include the following info:
  - Scientists tested for chromosome abnormalities among men in an institution for dangerous criminals.
  - They failed to compare those abnormalities against the control of the general population, skewing their results.
  - They deduced that men with XYY chromosomes tend to become criminals, which led to a “genetic predisposition to crime” as a defense strategy in courts, and the myth was perpetuated throughout popular culture and scientific textbooks and sparked a discussion about preventing criminal behavior through genetic screening.
  - The scientists should have established a control group for their experiment so they could compare their results against the general population and avoid erroneous results.

Lesson 4

<u>Name:</u> <u>Hydrogen</u>
Symbol: H
Atomic Number (Lesson 6): 1
Average Atomic Mass (Lesson 6): 1.01 amu
Mass Number (Lesson 6): 1
Protons (Lesson 6): 1
Neutrons (Lesson 6): 0
Electrons (Lesson 6): 1
Bohr Model (Lesson 6): 1P, 0N in nucleus; 1 ring with 1 dot

Period Number (Lesson 7): 1
Group Number (Lesson 7): 1
Valence Electrons (Lesson 7): 1
Ion Charge (Lesson 7): +1
Hyphen Notation (Lesson 7): hydrogen-1
Nuclear Notation (Lesson 7): ${}^{1}_{1}H$
Type of Element (Lesson 7): alkali metal
Electron Dot Diagram (Lesson 8): H with 1 dot on one side
State of Matter at Room Temperature (Lesson 14): gas
Year Discovered (Lesson 14): 1766
Discovered By (Lesson 14): Henry Cavendish
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> <u>Helium</u>
Symbol: He
Atomic Number (Lesson 6): 2
Average Atomic Mass (Lesson 6): 4.00 amu
Mass Number (Lesson 6): 4
Protons (Lesson 6): 2
Neutrons (Lesson 6): 2
Electrons (Lesson 6): 2

Bohr Model (Lesson 6):
2 p, 2 n in nucleus; one ring with 2 dots
Period Number (Lesson 7): 1
Group Number (Lesson 7): 18
Valence Electrons (Lesson 7): 2
Ion Charge (Lesson 7): 0
Hyphen Notation (Lesson 7): helium-4
Nuclear Notation (Lesson 7): $\frac{4}{2}$He
Type of Element (Lesson 7): Noble gas
Electron Dot Diagram (Lesson 8): He with 1 dot on 2 sides
State of Matter at Room Temperature (Lesson 14): gas
Year Discovered (Lesson 14): 1868
Discovered By (Lesson 14): Pierre Janssen and Joseph Norman Lockyer
Interesting Fact (Lesson 14): Answers will vary

Name: Lithium
Symbol: Li
Atomic Number (Lesson 6): 3
Average Atomic Mass (Lesson 6): 6.94 amu
Mass Number (Lesson 6): 7
Protons (Lesson 6): 3
Neutrons (Lesson 6): 4
Electrons (Lesson 6): 3
Bohr Model (Lesson 6):
3 p, 4 n in nucleus; 2 rings - 2 dots on first ring, 1 dot on 2nd ring
Period Number (Lesson 7): 2
Group Number (Lesson 7): 1
Valence Electrons (Lesson 7): 1
Ion Charge (Lesson 7): +1
Hyphen Notation (Lesson 7): lithium-7
Nuclear Notation (Lesson 7): $\frac{7}{3}$Li
Type of Element (Lesson 7): alkali metal
Electron Dot Diagram (Lesson 8): Li with 1 dot on one side
State of Matter at Room Temperature (Lesson 14): solid

Year Discovered (Lesson 14): 1817
Discovered By (Lesson 14): Johan August Arfwedson
Interesting Fact (Lesson 14): Answers will vary

Name: Beryllium
Symbol: Be
Atomic Number (Lesson 6): 4
Average Atomic Mass (Lesson 6): 9.01amu
Mass Number (Lesson 6): 9
Protons (Lesson 6): 4
Neutrons (Lesson 6): 5
Electrons (Lesson 6): 4
Bohr Model (Lesson 6):
4 p, 5 n in nucleus; 2 rings - 2 dots on first ring, 2 dots on 2nd ring
Period Number (Lesson 7): 2
Group Number (Lesson 7): 2
Valence Electrons (Lesson 7): 2
Ion Charge (Lesson 7): +2
Hyphen Notation (Lesson 7): beryllium-9
Nuclear Notation (Lesson 7): $\frac{9}{4}$Be
Type of Element (Lesson 7): Alkaline-earth metal
Electron Dot Diagram (Lesson 8): Be with 1 dot on 2 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1797
Discovered By (Lesson 14): Nicholas-Louis Vauquelin
Interesting Fact (Lesson 14): Answers will vary

Name: Boron
Symbol: B
Atomic Number (Lesson 6): 5
Average Atomic Mass (Lesson 6): 10.81amu
Mass Number (Lesson 6): 11
Protons (Lesson 6): 5

Neutrons (Lesson 6): 6
Electrons (Lesson 6): 5
Bohr Model (Lesson 6):
5 p, 6 n in nucleus; 2 rings - 2 dots on first ring, 3 dots on 2nd ring
Period Number (Lesson 7): 2
Group Number (Lesson 7): 13
Valence Electrons (Lesson 7): 3
Ion Charge (Lesson 7): +3
Hyphen Notation (Lesson 7): boron-11
Nuclear Notation (Lesson 7): $\frac{11}{5}$B
Type of Element (Lesson 7): nonmetal
Electron Dot Diagram (Lesson 8): B with 1 dot on 3 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1808
Discovered By (Lesson 14): Joseph-Louis Gay-Lussac and Louis-Jaques Thenard, Sir Humphry Davy
Interesting Fact (Lesson 14): Answers will vary

Name: Carbon
Symbol: C
Atomic Number (Lesson 6): 6
Average Atomic Mass (Lesson 6): 12.01amu
Mass Number (Lesson 6): 12
Protons (Lesson 6): 6
Neutrons (Lesson 6): 6
Electrons (Lesson 6): 6
Bohr Model (Lesson 6):
6 p, 6 n in nucleus; 2 rings - 2 dots on first ring, 4 dots on 2nd ring
Period Number (Lesson 7): 2
Group Number (Lesson 7): 14
Valence Electrons (Lesson 7): 4
Ion Charge (Lesson 7): +4
Hyphen Notation (Lesson 7): carbon-12

Nuclear Notation (Lesson 7): ${}^{12}_{6}\mathrm{C}$

Type of Element (Lesson 7): nonmetal

Electron Dot Diagram (Lesson 8): C with 1 dot on 4 sides

State of Matter at Room Temperature (Lesson 14): solid

Year Discovered (Lesson 14): 1772

Discovered By (Lesson 14): Antoine Lavoisier

Interesting Fact (Lesson 14): Answers will vary

Name: Nitrogen

Symbol: N

Atomic Number (Lesson 6): 7

Average Atomic Mass (Lesson 6): 14.01amu

Mass Number (Lesson 6): 14

Protons (Lesson 6): 7

Neutrons (Lesson 6): 7

Electrons (Lesson 6): 7

Bohr Model (Lesson 6):

7 p, 7 n in nucleus; 2 rings - 2 dots on first ring, 5 dots on 2nd ring

Period Number (Lesson 7): 2

Group Number (Lesson 7): 15

Valence Electrons (Lesson 7): 5

Ion Charge (Lesson 7): -3

Hyphen Notation (Lesson 7): nitrogen-14

Nuclear Notation (Lesson 7): ${}^{14}_{7}\mathrm{N}$

Type of Element (Lesson 7): nonmetal

Electron Dot Diagram (Lesson 8): N with 1 dot on 3 sides, 2 dots on 1 side

State of Matter at Room Temperature (Lesson 14): gas

Year Discovered (Lesson 14): 1772

Discovered By (Lesson 14): Daniel Rutherford

Interesting Fact (Lesson 14): Answers will vary

Name: Oxygen
Symbol: O
Atomic Number (Lesson 6): 8
Average Atomic Mass (Lesson 6): 16.00 amu
Mass Number (Lesson 6): 16
Protons (Lesson 6): 8
Neutrons (Lesson 6): 8
Electrons (Lesson 6): 8
Bohr Model (Lesson 6):
8 p, 8 n in nucleus; 2 rings - 2 dots on first ring, 6 dots on 2nd ring
Period Number (Lesson 7): 2
Group Number (Lesson 7): 16
Valence Electrons (Lesson 7): 6
Ion Charge (Lesson 7): -2
Hyphen Notation (Lesson 7): oxygen-16
Nuclear Notation (Lesson 7): $\frac{16}{8}O$
Type of Element (Lesson 7): nonmetal
Electron Dot Diagram (Lesson 8): O with 1 dot on 2 sides, 2 dots on 2 sides
State of Matter at Room Temperature (Lesson 14): gas
Year Discovered (Lesson 14): 1774
Discovered By (Lesson 14): Joseph Priestley
Interesting Fact (Lesson 14): Answers will vary

Name: Fluorine
Symbol: F
Atomic Number (Lesson 6): 9
Average Atomic Mass (Lesson 6): 19.00 amu
Mass Number (Lesson 6): 19
Protons (Lesson 6): 9
Neutrons (Lesson 6): 10
Electrons (Lesson 6): 9
Bohr Model (Lesson 6):
9 p, 10 n in nucleus; 2 rings - 2 dots on first ring, 7 dots on 2nd ring

Period Number (Lesson 7): 2
Group Number (Lesson 7): 17
Valence Electrons (Lesson 7): 7
Ion Charge (Lesson 7): -1
Hyphen Notation (Lesson 7): fluorine-19
Nuclear Notation (Lesson 7): $\frac{19}{9}$F
Type of Element (Lesson 7): halogen (nonmetal)
Electron Dot Diagram (Lesson 8): F with 1 dot on 1 side, 2 dots on 3 sides
State of Matter at Room Temperature (Lesson 14): gas
Year Discovered (Lesson 14): 1886
Discovered By (Lesson 14): Henri Moissan
Interesting Fact (Lesson 14): Answers will vary

Name: Neon
Symbol: Ne
Atomic Number (Lesson 6): 10
Average Atomic Mass (Lesson 6): 20.18 amu
Mass Number (Lesson 6): 20
Protons (Lesson 6): 10
Neutrons (Lesson 6): 10
Electrons (Lesson 6): 10
Bohr Model (Lesson 6):
10 p, 10 n in nucleus; 2 rings - 2 dots on first ring, 8 dots on 2nd ring
Period Number (Lesson 7): 2
Group Number (Lesson 7): 18
Valence Electrons (Lesson 7): 8
Ion Charge (Lesson 7): 0
Hyphen Notation (Lesson 7): neon-20
Nuclear Notation (Lesson 7): $\frac{20}{10}$Ne
Type of Element (Lesson 7): noble gas (nonmetal)
Electron Dot Diagram (Lesson 8): Ne with 2 dots on 4 sides
State of Matter at Room Temperature (Lesson 14): gas
Year Discovered (Lesson 14): 1898

Discovered By (Lesson 14): Sir William Ramsay and Morris W. Travers
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> <u>Sodium</u>
Symbol: Na
Atomic Number (Lesson 6): 11
Average Atomic Mass (Lesson 6): 22.99 amu
Mass Number (Lesson 6): 23
Protons (Lesson 6): 11
Neutrons (Lesson 6): 12
Electrons (Lesson 6): 11
Bohr Model (Lesson 6):
11 p, 12 n in nucleus; 3 rings - 2 dots on first ring, 8 dots on 2nd ring, 1 dot on the 3rd ring
Period Number (Lesson 7): 3
Group Number (Lesson 7): 1
Valence Electrons (Lesson 7): 1
Ion Charge (Lesson 7): +1
Hyphen Notation (Lesson 7): sodium-23
Nuclear Notation (Lesson 7): $\frac{23}{11}$Na
Type of Element (Lesson 7): alkali metal
Electron Dot Diagram (Lesson 8): Na with 1 dot on 1 side
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1807
Discovered By (Lesson 14): Humphry Davy
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> <u>Magnesium</u>
Symbol: Mg
Atomic Number (Lesson 6): 12
Average Atomic Mass (Lesson 6): 24.31 amu
Mass Number (Lesson 6): 24
Protons (Lesson 6): 12

Neutrons (Lesson 6): 12
Electrons (Lesson 6): 12
Bohr Model (Lesson 6):
12 p, 12 n in nucleus; 3 rings - 2 dots on first ring, 8 dots on 2nd ring, 2 dots on the 3rd ring
Period Number (Lesson 7): 3
Group Number (Lesson 7): 2
Valence Electrons (Lesson 7): 2
Ion Charge (Lesson 7): +2
Hyphen Notation (Lesson 7): magnesium-24
Nuclear Notation (Lesson 7): $\frac{24}{12}$Mg
Type of Element (Lesson 7): alkaline-earth metal
Electron Dot Diagram (Lesson 8): Mg with 1 dot on 2 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1808
Discovered By (Lesson 14): Humphrey Davy
Interesting Fact (Lesson 14): Answers will vary

Name: Aluminum
Symbol: Al
Atomic Number (Lesson 6): 13
Average Atomic Mass (Lesson 6): 26.98 amu
Mass Number (Lesson 6): 27
Protons (Lesson 6): 13
Neutrons (Lesson 6): 14
Electrons (Lesson 6): 13
Bohr Model (Lesson 6):
13 p, 14 n in nucleus; 3 rings - 2 dots on first ring, 8 dots on 2nd ring, 3 dots on the 3rd ring
Period Number (Lesson 7): 3
Group Number (Lesson 7): 13
Valence Electrons (Lesson 7): 3
Ion Charge (Lesson 7): +3
Hyphen Notation (Lesson 7): aluminum-27

Nuclear Notation (Lesson 7): $^{27}_{13}$Al
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): Al with 1 dot on 3 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1825
Discovered By (Lesson 14): Hans Christian Oersted
Interesting Fact (Lesson 14): Answers will vary

Name: Silicon
Symbol: Si
Atomic Number (Lesson 6): 14
Average Atomic Mass (Lesson 6): 28.09 amu
Mass Number (Lesson 6): 28
Protons (Lesson 6): 14
Neutrons (Lesson 6): 14
Electrons (Lesson 6): 14
Bohr Model (Lesson 6):
14 p, 14 n in nucleus; 3 rings - 2 dots on first ring, 8 dots on 2nd ring, 4 dots on the 3rd ring
Period Number (Lesson 7): 3
Group Number (Lesson 7): 14
Valence Electrons (Lesson 7): 4
Ion Charge (Lesson 7): +4
Hyphen Notation (Lesson 7): silicon-28
Nuclear Notation (Lesson 7): $^{28}_{14}$Si
Type of Element (Lesson 7): nonmetal
Electron Dot Diagram (Lesson 8): Si with 1 dot on 4 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1824
Discovered By (Lesson 14): Jons Jacob Berzelius
Interesting Fact (Lesson 14): Answers will vary

Name: Phosphorus
Symbol: P
Atomic Number (Lesson 6): 15
Average Atomic Mass (Lesson 6): 30.97 amu
Mass Number (Lesson 6): 31
Protons (Lesson 6): 15
Neutrons (Lesson 6): 16
Electrons (Lesson 6): 15
Bohr Model (Lesson 6):
15 p, 16 n in nucleus; 3 rings - 2 dots on first ring, 8 dots on 2nd ring, 5 dots on the 3rd ring
Period Number (Lesson 7): 3
Group Number (Lesson 7): 15
Valence Electrons (Lesson 7): 5
Ion Charge (Lesson 7): -3
Hyphen Notation (Lesson 7): phosphorus-31
Nuclear Notation (Lesson 7): $\frac{31}{15}$P
Type of Element (Lesson 7): nonmetal
Electron Dot Diagram (Lesson 8): P with 1 dot on 3 sides, 2 dots on 1 side
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1669
Discovered By (Lesson 14): Hennig Brandt
Interesting Fact (Lesson 14): Answers will vary

Name: Sulfur
Symbol: S
Atomic Number (Lesson 6): 16
Average Atomic Mass (Lesson 6): 32.07 amu
Mass Number (Lesson 6): 32
Protons (Lesson 6): 16
Neutrons (Lesson 6): 16
Electrons (Lesson 6): 16
Bohr Model (Lesson 6):

16 p, 16 n in nucleus; 3 rings - 2 dots on first ring, 8 dots on 2nd ring, 6 dots on the 3rd ring
Period Number (Lesson 7): 3
Group Number (Lesson 7): 16
Valence Electrons (Lesson 7): 6
Ion Charge (Lesson 7): -2
Hyphen Notation (Lesson 7): sulfur-32
Nuclear Notation (Lesson 7): $\frac{32}{16}S$
Type of Element (Lesson 7): nonmetal
Electron Dot Diagram (Lesson 8): S with 1 dot on 2 sides, 2 dots on 2 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1777
Discovered By (Lesson 14): Antoine Lavoisier
Interesting Fact (Lesson 14): Answers will vary

Name: Chlorine
Symbol: Cl
Atomic Number (Lesson 6): 17
Average Atomic Mass (Lesson 6): 35.45 amu
Mass Number (Lesson 6): 35
Protons (Lesson 6): 17
Neutrons (Lesson 6): 18
Electrons (Lesson 6): 17
Bohr Model (Lesson 6):
17 p, 18 n in nucleus; 3 rings - 2 dots on first ring, 8 dots on 2nd ring, 7 dots on the 3rd ring
Period Number (Lesson 7): 3
Group Number (Lesson 7): 17
Valence Electrons (Lesson 7): 7
Ion Charge (Lesson 7): -1
Hyphen Notation (Lesson 7): chlorine-35
Nuclear Notation (Lesson 7): $\frac{35}{17}Cl$
Type of Element (Lesson 7): halogen (nonmetal)
Electron Dot Diagram (Lesson 8): Cl with 1 dot on 1 side, 2 dots on 3 sides

State of Matter at Room Temperature (Lesson 14): gas
Year Discovered (Lesson 14): 1774
Discovered By (Lesson 14): Carl Wilhelm Scheele
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> <u>Argon</u>
Symbol: Ar
Atomic Number (Lesson 6): 18
Average Atomic Mass (Lesson 6): 39.95 amu
Mass Number (Lesson 6): 40
Protons (Lesson 6): 18
Neutrons (Lesson 6): 22
Electrons (Lesson 6): 18
Bohr Model (Lesson 6):
18 p, 22 n in nucleus; 3 rings - 2 dots on first ring, 8 dots on 2nd ring, 8 dots on the 3rd ring
Period Number (Lesson 7): 3
Group Number (Lesson 7): 18
Valence Electrons (Lesson 7): 8
Ion Charge (Lesson 7): 0
Hyphen Notation (Lesson 7): argon-40
Nuclear Notation (Lesson 7): $\frac{40}{18}$Ar
Type of Element (Lesson 7): noble gas (nonmetal)
Electron Dot Diagram (Lesson 8): Ar with 2 dots on 4 sides
State of Matter at Room Temperature (Lesson 14): gas
Year Discovered (Lesson 14): 1894
Discovered By (Lesson 14): Sir William Ramsay and Lord Rayleigh
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> <u>Potassium</u>
Symbol: K
Atomic Number (Lesson 6): 19
Average Atomic Mass (Lesson 6): 39.10 amu

Mass Number (Lesson 6): 39
Protons (Lesson 6): 19
Neutrons (Lesson 6): 20
Electrons (Lesson 6): 19
Bohr Model (Lesson 6):
19 p, 20 n in nucleus; 4 rings - 2 dots on first ring, 8 dots on 2nd ring, 8 dots on the 3rd ring, 1 dot on the 4th ring
Period Number (Lesson 7): 4
Group Number (Lesson 7): 1
Valence Electrons (Lesson 7): 1
Ion Charge (Lesson 7): +1
Hyphen Notation (Lesson 7): potassium-39
Nuclear Notation (Lesson 7): $\frac{39}{19}$Ar
Type of Element (Lesson 7): alkali metal
Electron Dot Diagram (Lesson 8): K with 1 dot on 1 side
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1807
Discovered By (Lesson 14): Humphry Davy
Interesting Fact (Lesson 14): Answers will vary

Name: Calcium
Symbol: Ca
Atomic Number (Lesson 6): 20
Average Atomic Mass (Lesson 6): 40.08 amu
Mass Number (Lesson 6): 40
Protons (Lesson 6): 20
Neutrons (Lesson 6): 20
Electrons (Lesson 6): 20
Bohr Model (Lesson 6):
20 p, 20 n in nucleus; 4 rings - 2 dots on first ring, 8 dots on 2nd ring, 8 dots on the 3rd ring, 2 dots on the 4th ring
Period Number (Lesson 7): 4
Group Number (Lesson 7): 2

Valence Electrons (Lesson 7): 2

Ion Charge (Lesson 7): +2

Hyphen Notation (Lesson 7): calcium-40

Nuclear Notation (Lesson 7): $\frac{40}{20}$Ca

Type of Element (Lesson 7): alkaline-earth metal

Electron Dot Diagram (Lesson 8): C with 1 dot on 2 sides

State of Matter at Room Temperature (Lesson 14): solid

Year Discovered (Lesson 14): 1808

Discovered By (Lesson 14): Humphry Davy

Interesting Fact (Lesson 14): Answers will vary

Name: Titanium

Symbol: Ti

Atomic Number (Lesson 6): 22

Average Atomic Mass (Lesson 6): 47.87 amu

Mass Number (Lesson 6): 48

Protons (Lesson 6): 22

Neutrons (Lesson 6): 26

Electrons (Lesson 6): 22

Period Number (Lesson 7): 4

Group Number (Lesson 7): 4

Valence Electrons (Lesson 7): n/a

Ion Charge (Lesson 7): n/a

Hyphen Notation (Lesson 7): titanium-48

Nuclear Notation (Lesson 7): $\frac{48}{22}$Ti

Type of Element (Lesson 7): transition metal

Electron Dot Diagram (Lesson 8): n/a

State of Matter at Room Temperature (Lesson 14): solid

Year Discovered (Lesson 14): 1791

Discovered By (Lesson 14): William Gregor

Interesting Fact (Lesson 14): Answers will vary

Name: Manganese
Symbol: Mn
Atomic Number (Lesson 6): 25
Average Atomic Mass (Lesson 6): 54.94 amu
Mass Number (Lesson 6): 55
Protons (Lesson 6): 25
Neutrons (Lesson 6): 30
Electrons (Lesson 6): 25
Period Number (Lesson 7): 4
Group Number (Lesson 7): 7
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): manganese-55
Nuclear Notation (Lesson 7): $\frac{55}{25}Mn$
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1774
Discovered By (Lesson 14): Johan Gottlieb Gahn
Interesting Fact (Lesson 14): Answers will vary

Name: Iron
Symbol: Fe
Atomic Number (Lesson 6): 26
Average Atomic Mass (Lesson 6): 55.85 amu
Mass Number (Lesson 6): 56
Protons (Lesson 6): 26
Neutrons (Lesson 6): 30
Electrons (Lesson 6): 26
Period Number (Lesson 7): 4
Group Number (Lesson 7): 8
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): iron-56

Nuclear Notation (Lesson 7): $^{56}_{26}Fe$
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): Unknown
Discovered By (Lesson 14): Unknown
Interesting Fact (Lesson 14): Answers will vary

Name: Nickel
Symbol: Ni
Atomic Number (Lesson 6): 28
Average Atomic Mass (Lesson 6): 58.69 amu
Mass Number (Lesson 6): 59
Protons (Lesson 6): 28
Neutrons (Lesson 6): 31
Electrons (Lesson 6): 28
Period Number (Lesson 7): 4
Group Number (Lesson 7): 10
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): nickel-59
Nuclear Notation (Lesson 7): $^{59}_{28}Ni$
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1751
Discovered By (Lesson 14): Axel-Frederik Cronstedt
Interesting Fact (Lesson 14): Answers will vary

Name: Copper
Symbol: Cu
Atomic Number (Lesson 6): 29
Average Atomic Mass (Lesson 6): 63.55 amu
Mass Number (Lesson 6): 64

Protons (Lesson 6): 29
Neutrons (Lesson 6): 35
Electrons (Lesson 6): 29
Period Number (Lesson 7): 4
Group Number (Lesson 7): 11
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): copper-64
Nuclear Notation (Lesson 7): $\frac{64}{29}$Cu
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): Unknown
Discovered By (Lesson 14): Unknown
Interesting Fact (Lesson 14): Answers will vary

Name: Zinc
Symbol: Zn
Atomic Number (Lesson 6): 30
Average Atomic Mass (Lesson 6): 65.38 amu
Mass Number (Lesson 6): 65
Protons (Lesson 6): 30
Neutrons (Lesson 6): 35
Electrons (Lesson 6): 30
Period Number (Lesson 7): 4
Group Number (Lesson 7): 12
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): zinc-65
Nuclear Notation (Lesson 7): $\frac{65}{30}$Zn
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1746

Discovered By (Lesson 14): Andreas Marggraf
Interesting Fact (Lesson 14): Answers will vary

Name: Bromine
Symbol: Br
Atomic Number (Lesson 6): 35
Average Atomic Mass (Lesson 6): 79.90 amu
Mass Number (Lesson 6): 80
Protons (Lesson 6): 35
Neutrons (Lesson 6): 45
Electrons (Lesson 6): 35
Period Number (Lesson 7): 4
Group Number (Lesson 7): 17
Valence Electrons (Lesson 7): 7
Ion Charge (Lesson 7): -1
Hyphen Notation (Lesson 7): bromine-80
Nuclear Notation (Lesson 7): $\frac{80}{35}$Br
Type of Element (Lesson 7): halogen (nonmetal)
Electron Dot Diagram (Lesson 8): Br with 1 dot on 1 side, 2 dots on 3 sides
State of Matter at Room Temperature (Lesson 14): liquid
Year Discovered (Lesson 14): 1826
Discovered By (Lesson 14): Carl Jacob Lowig and Antoine Balard
Interesting Fact (Lesson 14): Answers will vary

Name: Strontium
Symbol: Sr
Atomic Number (Lesson 6): 38
Average Atomic Mass (Lesson 6): 87.62 amu
Mass Number (Lesson 6): 88
Protons (Lesson 6): 38
Neutrons (Lesson 6): 50
Electrons (Lesson 6): 38
Period Number (Lesson 7): 5
Group Number (Lesson 7): 2

Valence Electrons (Lesson 7): 2
Ion Charge (Lesson 7): +2
Hyphen Notation (Lesson 7): strontium-88
Nuclear Notation (Lesson 7): $\frac{88}{38}$Sr
Type of Element (Lesson 7): alkaline-earth metal
Electron Dot Diagram (Lesson 8): Sr with 1 dot on 2 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1790
Discovered By (Lesson 14): Adair Crawford
Interesting Fact (Lesson 14): Answers will vary

Name: Silver
Symbol: Ag
Atomic Number (Lesson 6): 47
Average Atomic Mass (Lesson 6): 107.87 amu
Mass Number (Lesson 6): 108
Protons (Lesson 6): 47
Neutrons (Lesson 6): 61
Electrons (Lesson 6): 47
Period Number (Lesson 7): 5
Group Number (Lesson 7): 11
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): silver-108
Nuclear Notation (Lesson 7): $\frac{108}{47}$Ag
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): Unknown
Discovered By (Lesson 14): Unknown
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> <u>Tin</u>
Symbol: Sn
Atomic Number (Lesson 6): 50
Average Atomic Mass (Lesson 6): 118.71 amu
Mass Number (Lesson 6): 119
Protons (Lesson 6): 50
Neutrons (Lesson 6): 69
Electrons (Lesson 6): 50
Period Number (Lesson 7): 5
Group Number (Lesson 7): 14
Valence Electrons (Lesson 7): 4
Ion Charge (Lesson 7): +4
Hyphen Notation (Lesson 7): tin-119
Nuclear Notation (Lesson 7): $\frac{119}{50}$Sn
Type of Element (Lesson 7): transition metal (metal)
Electron Dot Diagram (Lesson 8): Sn with 1 dot on 4 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): Unknown
Discovered By (Lesson 14): Unknown
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> <u>Iodine</u>
Symbol: I
Atomic Number (Lesson 6): 53
Average Atomic Mass (Lesson 6): 126.90 amu
Mass Number (Lesson 6): 127
Protons (Lesson 6): 53
Neutrons (Lesson 6): 74
Electrons (Lesson 6): 53
Period Number (Lesson 7): 5
Group Number (Lesson 7): 17
Valence Electrons (Lesson 7): 7
Ion Charge (Lesson 7): -1
Hyphen Notation (Lesson 7): iodine-127

Nuclear Notation (Lesson 7): ${}^{127}_{53}I$
Type of Element (Lesson 7): halogen
Electron Dot Diagram (Lesson 8): I with 1 dot on 1 side and 2 dots on 3 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1811
Discovered By (Lesson 14): Barnard Courtois
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> Platinum
Symbol: Pt
Atomic Number (Lesson 6): 78
Average Atomic Mass (Lesson 6): 195.08 amu
Mass Number (Lesson 6): 195
Protons (Lesson 6): 78
Neutrons (Lesson 6): 117
Electrons (Lesson 6): 78
Period Number (Lesson 7): 6
Group Number (Lesson 7): 10
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): platinum-195
Nuclear Notation (Lesson 7): ${}^{195}_{78}Pt$
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): 1557
Discovered By (Lesson 14): Julius C. Scaliger
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> Gold
Symbol: Au
Atomic Number (Lesson 6): 79
Average Atomic Mass (Lesson 6): 196.97 amu
Mass Number (Lesson 6): 197

Protons (Lesson 6): 79
Neutrons (Lesson 6): 118
Electrons (Lesson 6): 79
Period Number (Lesson 7): 6
Group Number (Lesson 7): 11
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): gold-197
Nuclear Notation (Lesson 7): $\frac{197}{79}$Au
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): Unknown
Discovered By (Lesson 14): Unknown
Interesting Fact (Lesson 14): Answers will vary

Name: Mercury
Symbol: Hg
Atomic Number (Lesson 6): 80
Average Atomic Mass (Lesson 6): 200.59 amu
Mass Number (Lesson 6): 201
Protons (Lesson 6): 80
Neutrons (Lesson 6): 121
Electrons (Lesson 6): 80
Period Number (Lesson 7): 6
Group Number (Lesson 7): 12
Valence Electrons (Lesson 7): n/a
Ion Charge (Lesson 7): n/a
Hyphen Notation (Lesson 7): mercury-201
Nuclear Notation (Lesson 7): $\frac{201}{80}$Hg
Type of Element (Lesson 7): transition metal
Electron Dot Diagram (Lesson 8): n/a
State of Matter at Room Temperature (Lesson 14): liquid
Year Discovered (Lesson 14): 1772-1774

Discovered By (Lesson 14): Carl W. Scheele and Joseph Priestley
Interesting Fact (Lesson 14): Answers will vary

<u>Name:</u> <u>Lead</u>
Symbol: Pb
Atomic Number (Lesson 6): 82
Average Atomic Mass (Lesson 6): 207.20 amu
Mass Number (Lesson 6): 207
Protons (Lesson 6): 82
Neutrons (Lesson 6): 125
Electrons (Lesson 6): 82
Period Number (Lesson 7): 6
Group Number (Lesson 7): 14
Valence Electrons (Lesson 7): 4
Ion Charge (Lesson 7): +4
Hyphen Notation (Lesson 7): lead-207
Nuclear Notation (Lesson 7): $\frac{207}{82}$Pb
Type of Element (Lesson 7): transition metal (metal)
Electron Dot Diagram (Lesson 8): Pb with 1 dot on 4 sides
State of Matter at Room Temperature (Lesson 14): solid
Year Discovered (Lesson 14): Unknown
Discovered By (Lesson 14): Unknown
Interesting Fact (Lesson 14): Answers will vary

Lesson 5

I. Properties of Gases
    A. Fluid; particles move freely past one another
    B. No definite shape or volume
    C. Very low density
    D. Mostly empty space with rapidly moving particles
    E. Very easy to compress
    F. Exert pressure on the containers they're in

II. Gas Laws
    A. Boyle's law
        1. As the volume of a gas increases, the gas's pressure decreases
        2. Inverse proportionality
    B. Gay-Lussac's law
        1. As the temperature of a gas increases, the pressure also increases
        2. Direct proportionality
    C. Charles's law
        1. As the temperature of a gas increases, the volume of the gas also increases
        2. Direct proportionality

Data Table

Experiment	Hypothesis	Observations	Variables involved (temperature, volume, pressure)	Gas law demonstrated
Balloon & flask	I think the balloon will inflate when the flask is heated, because as temperature increases, volume increases.	As the temperature increased, the balloon slowly inflated.	Temperature and volume	Charles's Law
Marshmallow & syringe	I think pushing the syringe will increase the pressure on the marshmallow, shrinking it, and pulling it will decrease the pressure, causing it to expand.	When the syringe was pushed, the marshmallow shrank. When the syringe was pulled, the marshmallow expanded.	Pressure and volume	Boyle's Law
Soda can & water	I think the can will collapse when it's placed in the cold water because as the temperature drops the pressure inside the gas will decrease.	As soon as the soda can hit the ice water, it collapsed.	Temperature and pressure	Gay-Lussac's Law

Discussion Questions

1. For each experiment, use your knowledge of each of the laws to explain your observations of what happened.
   a. For the balloon and flask experiment, the temperature increased when the flask was placed on the hot plate. This caused the volume of the gas to expand, heating the balloon.
   b. For the marshmallow and syringe experiment, pushing in the syringe increased the pressure on the gas. This caused the volume of the gas to decrease, making the marshmallow shrink. When the syringe was pulled, the opposite happened. The pressure on the gas decreased, which increased the volume of the gas, making the marshmallow expand.
   c. For the soda can and water experiment, heating the gas in the can increased the pressure on the walls of the can. Quickly decreasing the temperature decreased the pressure inside the can. The atmospheric pressure outside of the can was greater than the pressure inside the can, so it collapsed.

2. Were your hypothesis correct for each experiment? Why or why not?
   Yes, all of my hypotheses were correct. When I thought about each experiment, I determined which gas law I thought was being tested and made my guesses based on what I knew about the gas law, so my guesses were accurate.

Lesson 7

The table below shows the minimum information that students should include in their timeline presentation. There may be more details and more students they choose to include.

Scientist	**Year**	**Experiment/ discovery**	**Explanation**
Democritus	400 BC	Asked: how many times can you break a particle in half?	He developed a particle theory of matter saying nature's basic particle is the "atom," which means indivisible
John Dalton	1808	Model of the atom	(1) All matter is composed of extremely small particles called atoms. (2) Atoms of a given element are identical in size, mass, and other properties. Atoms of different elements are different. (3) Atoms cannot be subdivided, created, or destroyed. (4) Atoms of different elements combine in simple whole-number ratios to form chemical compounds. (5) In chemical reactions, atoms are combined, separated, or rearranged..
J.J. Thomson	1897	Cathode rays and electrons	All cathode rays are composed of identical negatively charged particles which were later named electrons. They have a large charge and a tiny mass
Max Planck	1900	Vibration of atoms	When you heat an object until it glows, you can measure the energy released in discrete packets of energy called quanta. This was the beginning of quantum physics.
Albert Einstein	1905	Photoelectric effect	Quanta act like particles, and atoms can emit and absorb photons of

			energy. Light absorption can release electrons from atoms, a phenomenon called the Photoelectric effect. Light has both wave-like and particle-like properties.
Robert Millikan	1908	Oil drop experiments	Determined actual charge and mass of an electron.
Neils Bohr	1912	Bohr model of the atom	(1) Electrons can orbit only at certain distances (energy levels) from the nucleus. (2) Atoms absorb energy when boosted to a higher energy level, and they radiate energy when jumping to a lower energy level.
Ernest Rutherford	1919	Gold foil experiment	First to “split” a nucleus, postulating that the positive charge of an atom came from the “nucleus.” This was later called the proton.
Wolfgang Pauli	1924	Pauli exclusion principle	Predicted that electrons spin like a top, in one direction or the other (“+” or “-“). No two electrons in an atom can have the same characteristics.
Erwin Schrodinger	1926	Wave mechanics, quantum theory, electron cloud, model of the atom	Described mathematically the wave properties of electrons and other small particles. Wave functions give the probability of finding electrons in orbitals or regions where electrons can be found (electron clouds)
Werner Heisenberg	1927	Heisenberg uncertainty principle	Electrons are particles. No experiment can measure the position and momentum of a quantum particle at the same time.
James Chadwick	1932	Beryllium bombardment experiments	Discovered of the neutrally charged neutron

Lesson 8

Metal salt	**Observed flame color**
Calcium chloride	Dark red/orange
Copper chloride	Blue green
Iron chloride	Golden yellow
Potassium chloride	Pink/violet
Sodium chloride	Yellow orange

*Colors students see may be slightly different

Discussion Question

Why do the metals you observed show colors when heated? Did the elements' flame colors match your predictions?

Answers will vary, but these different colors occur because the electrons in each ion become excited as the temperature increases. The electron "jumps" from its original ground state when heated to a higher energy level. As the electrons fall back to their original state, they give off energy in the form of light.

Lesson 10

I. Calculating Percent Composition by Mass
   A. Every compound is made up of specific elements in fixed, whole number ratios
      1. The mass of an element is constant
      2. The percent of each element found in a compound is always same
   B. Percent composition by mass of a substance can be used to find the identity of a compound
   C. Steps to calculating percent composition
      1. Find the mass of the entire compound
      2. Find the mass of each individual element in the compound
      3. Divide the mass of the individual element by the mass of the entire compound, and multiply by 100

II. Examples
   A. What is the percent composition of each element in Na_2SO_4?
      1. Mass of the entire compound

         $2(22.99)\ g\ Na\ +\ 32.07\ g\ S\ +\ 4(16.00\ g)\ O$

         $45.98\ g\ Na\ +\ 32.07\ g\ S\ +\ 64.00\ g\ O\ \ =\ 142.05\ g\ Na_2SO_4$

      2. Na = $\frac{45.98\ g\ Na_2}{142.05\ g\ Na_2SO_4} \times 100\ =\ 32.37\%\ Na$
      3. S = $\frac{32.07\ g\ S}{142.05\ g\ Na_2SO_4} \times 100\ =\ 22.58\%\ S$
      4. O = $\frac{64.00\ g\ O_4}{142.05\ g\ Na_2SO_4} \times 100\ =\ 45.05\%\ O$
   B. What is the percent composition of each element in $Mg(OH)_2$?
      1. Mass of the entire compound

         $24.31\ g\ Mg\ +\ 2(16.00\ g)\ O\ +\ 2(1.01\ g)\ H$

         $24.31\ g\ Mg\ +\ 32.00\ g\ O\ +\ 2.02\ g\ H\ =\ 58.33\ g\ Mg(OH)_2$

      2. Mg = $\frac{24.31\ g\ Mg}{58.33\ g\ Mg(OH)_2} \times 100\ =\ 41.68\%\ Mg$
      3. O = $\frac{32.00\ g\ O_2}{58.33\ g\ Mg(OH)_2} \times 100\ =\ 54.86\%\ O$

4. H = $\frac{2.02\ g\ H_2}{58.33\ g\ Mg(OH)_2} \times 100 = 3.46\%\ H$

C. What is the percent composition of each element in $AgNO_3$?

1. Mass of the entire compound

$107.87\ g\ Ag + 14.01\ g\ N + 3(16.00\ g)\ O$

$107.87\ g\ Ag + 14.01\ g\ N + 48.00\ g\ O = 169.88\ g\ AgNO_3$

2. Ag = $\frac{107.87\ g\ Ag}{169.88\ g\ AgNO_3} \times 100 = 63.50\%\ Ag$

3. N = $\frac{14.01\ g\ Ag}{169.88\ g\ AgNO_3} \times 100 = 8.25\%\ N$

4. O = $\frac{48.00\ g\ O_3}{169.88\ g\ AgNO_3} \times 100 = 28.26\%\ O$

Percent Composition Homework Questions

1. What is the percent composition of each element in $Ca(OH)_2$?

$40.08\ g\ Ca + 2(16.00\ g)\ O + 2(1.01\ g)\ H = 74.10\ g\ Ca(OH)$

$Ca = \frac{40.08\ g\ Ca}{74.10\ g\ Ca(OH)_2} \times 100 = 54.10\%\ Ca$

$O = \frac{2(16.00)\ g\ O_2}{74.10\ g\ Ca(OH)_2} \times 100 = 43.18\%\ O$

$H = \frac{(2)1.01\ g\ H}{74.10\ g\ Ca(OH)_2} \times 100 = 2.73\%\ H$

2. Calculate the percent composition for each element in $CaSO_4$.

$40.08\ g\ Ca + 32.07\ g\ S + 4(16.00\ g)\ O = 136.15\ g\ CaSO_4$

$Ca = \frac{40.08\ g\ Ca}{136.15\ g\ CaSO_4} \times 100 = 29.44\%\ Ca$

$S = \frac{32.07\ g\ S}{136.15\ g\ CaSO_4} \times 100 = 23.55\%\ S$

$O = \frac{4(16.00)\ g\ O_4}{136.15\ g\ CaSO_4} \times 100 = 47.00\%\ O$

3. What is the percent composition of each element in $Mg_3(PO_4)_2$?

$$3(24.31\ g)\ Mg\ +\ 2(30.97\ g)\ P\ +\ 8(16.00\ g)\ O\ =\ 262.87\ g\ Mg_3(PO_4)_2$$

$$Mg\ =\ \frac{3(24.31)\ g\ Mg_3}{262.87\ g\ Mg_3(PO_4)_2} \times 100\ =\ 27.74\%\ Mg$$

$$P\ =\ \frac{2(30.97)\ g\ P_2}{262.87\ g\ Mg_3(PO_4)_2} \times 100\ =\ 23.56\%\ P$$

$$O\ =\ \frac{8(16.00)\ g\ (O_4)_2}{262.87\ g\ Mg_3(PO_4)_2} \times 100\ =\ 48.69\%\ O$$

4. What is the percent composition of each element in $Ba(NO_3)_2$?

$$137.33\ g\ Ba\ +\ 2(14.01\ g)\ N\ +\ 6(16.00\ g)\ O\ =\ 261.35\ g\ Ba(NO_3)_2$$

$$Ba\ =\ \frac{137.33\ g\ Ba}{261.35\ g\ Ba(NO_3)_2} \times 100\ =\ 52.55\%\ Ba$$

$$N\ =\ \frac{2(14.01)\ g\ N_2}{261.35\ g\ Ba(NO_3)_2} \times 100\ =\ 10.72\%\ N$$

$$O\ =\ \frac{6(16.00)\ g\ (O_3)_2}{261.35\ g\ Ba(NO_3)_2} \times 100\ =\ 36.73\%\ O$$

Lesson 11

Ionic Compound Scavenger Hunt

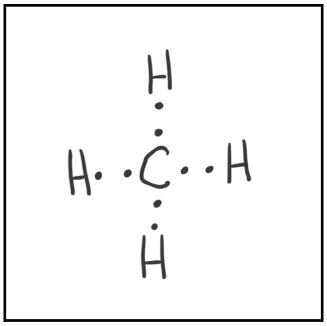
There are many products and compounds that students can find in their houses. Below are just a few examples.

Product	Compound Formula	Compound Name	Purpose of Compound in Product
Tums	$CaCO_3$	Calcium carbonate	The calcium carbonate neutralizes the acid in your esophagus and stomach to help relieve heartburn and upset stomach
Table salt	$NaCl$	Sodium chloride	Table salt is another name for sodium chloride, so it provides all of the properties of salt—taste, color, preservative ability, etc.
Bleach	$NaClO$	Sodium hypochlorite	Sodium hypochlorite provides the disinfecting and corrosive properties of bleach
Drain cleaner	$NaOH$	Sodium hydroxide	Sodium hydroxide is a strong base that decomposes hair and converts fats into water-soluble products, removing clogs from drains
Hot sauce	KCl	Potassium chloride	Potassium chloride provides/enhances flavor, controls pH, and thickens hot sauce

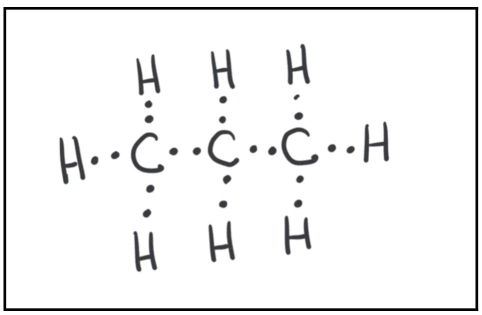
Lesson 12

I. Organic Compounds
   A. Large, typically covalent compounds
   B. Contains carbon, primarily from living things
      1. Carbon has 4 valence electrons
      2. Allows it to bond with other elements in a wide variety of ways
      3. Excellent building block for big, complex compounds
      4. Exceptions: oxides (like CO_2) and carbonates (CO_3^{2-})
   C. Most contain hydrogen
   D. Hydrocarbons: organic compounds containing only carbon and hydrogen

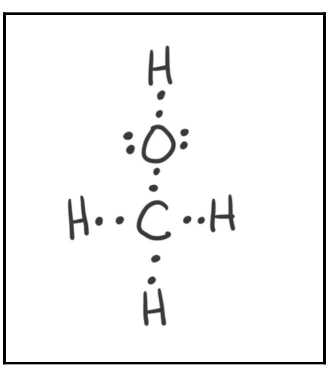
II. Organic compounds have a unique naming system
   A. Unique prefixes
      1. 1: Meth-
      2. 2: Eth-
      3. 3: Prop-
      4. 4: But-
      5. 5: Pent-
      6. 6: Hex-
      7. 7: Hept-
      8. 8: Oct-
      9. 9: Non-
      10. 10: Dec-
   B. Instead of looking at subscripts for all of the elements, you just look at the number of carbons in a chain
   C. If all carbons are bonded together because they share a single pair of electrons (single bond), then the name of the compound ends in -ane
   D. Example: CH_4
      1. There is 1 carbon, so use the prefix meth-
      2. Carbon is bonded with a single bond, so use the suffix -ane
      3. Name: Methane



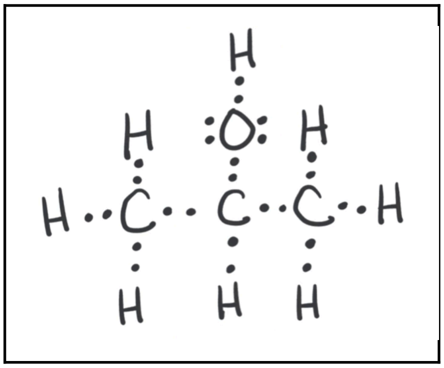
E. Example: C_3H_8
   1. There are 3 carbons, so use the prefix prop-
   2. Carbon is bonded with a single bond, so use the suffix -ane
   3. Name: Propane



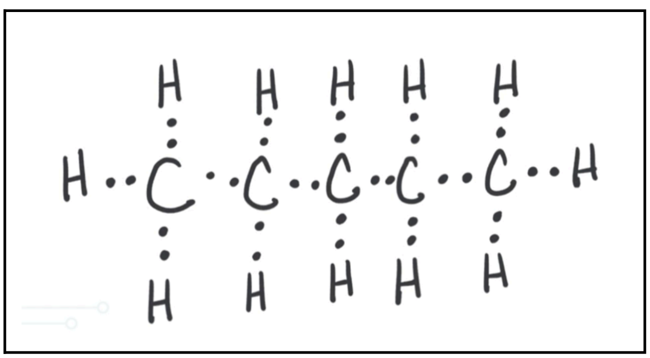
III. More complex organic compounds
   A. Organic compounds can become more complex by replacing some of the hydrogens with whole groups of other elements
      1. Example: Methane becomes methanol
         a) Methane is CH_4
         b) One H atom is replaced with OH
         c) Methanol is CH_3OH



2. Example: Propane becomes isopropanol
    a) Propane is C_3H_8
    b) One H atom is replaced with OH
    c) Methanol is $(CH_3)_2CHOH$



B. A polymer is a long chain made of smaller molecules
    1. Examples: rubber, wood, plastic, and DNA
    2. Example: Polyethylene
        a) Ethylene: C_2H_4
        b) Poly- means many



Discussion Questions

1. What happens to the new material when it is stretched or rolled into a ball and bounced?
   It stretches and bounces, but keeps its shape.
2. Compare the properties of the glue with the properties of the new material.

Answers will vary. Glue is a liquid and flows easily. The new material acts more like a solid.

3. The properties of the new material resulted from the bonds between the borax and the glue particles. If too little borax were used, what do you think would have happened to the new material?

   If too little borax was used, the new material would be more like the glue. It would flow more easily and wouldn't hold its shape well.

4. Do you think the new material has the properties of a polymer? Why or why not?

   Yes, because it is elastic and can return to its original shape, like a rubber band.

Lesson 13

3. Read the following article. Then write a 1-paragraph summary of the article and how the law of conservation of mass is important in the real world.
   Answers will vary. Students should include in their paragraph a summary of what the law of the conservation of mass is—matter is not created or destroyed but only changes form through physical and chemical changes. Students should also give examples of this law in action. One example might be molecules moving from place to place, such as animals eating plants and those substances being broken down in their bodies. One example might be substances changing state (from solid to liquid, or liquid to gas). Another example might be chemical reactions, such as showing that two molecules of hydrogen and one molecule of oxygen can rearrange themselves to create two molecules of water ($2H_2 + O_2 \rightarrow 2H_2O$). The chemical properties of the reactants (hydrogen and oxygen) are different from the properties of the product (water).

Lesson 14

Element Quiz 1

Hydrogen H	Fluorine F	Chlorine Cl	Copper Cu
Helium He	Neon Ne	Argon Ar	Zinc Zn
Lithium Li	Sodium Na	Potassium K	Bromine Br
Beryllium Be	Magnesium Mg	Calcium Ca	Strontium Sr
Boron B	Aluminum Al	Titanium Ti	Silver Ag
Carbon C	SiliconSi	Manganese Mn	Tin Sn
Nitrogen N	Phosphorus P	Iron Fe	Iodine I
Oxygen O	Sulfur S	Nickel Ni	Platinum Pt
Gold Au	Mercury Hg	Lead Pb	

Element Quiz 2

H Hydrogen	F Fluorine	Cl Chlorine	Cu Copper
He Helium	Ne Neon	Ar Argon	Zn Zinc
Li Lithium	Na Sodium	K Potassium	Br Bromine
Be Beryllium	Mg Magnesium	Ca Calcium	Sr Strontium
B Boron	Al Aluminum	Ti Titanium	Ag Silver
C Carbon	Si Silicon	Mn Manganese	Sn Tin
N Nitrogen	P Phosphorus	Fe Iron	I Iodine
O Oxygen	S Sulfur	Ni Nickel	Pt Platinum
Au Gold	Hg Mercury	Pb Lead	

Lesson 15

Data Table

	Na_3PO_4	Na_2CO_3	$CuSO_4$	$CaCl_2$	NaOH
Na_2CO_3	NR				
$CuSO_4$	P	P			
$CaCl_2$	P	P	P		
NaOH	NR	NR	P	P	
$FeCl_3$	P	P	P	NR	P

Discussion Questions

1. How many precipitates formed during this experiment? 11
2. Were any of the reactions difficult to tell whether or not a precipitate formed? If so, why? What might you be able to do to determine if a reaction actually happened?
   Answers will vary, but could say yes because not much precipitate formed or the precipitate was the same color as the spot plate, making it hard to see. You could mix more of the solutions so more precipitate forms or mix them in a different colored container to make it easier to see.

Lesson 17

I. Nuclear Reaction Equations
   A. Reactant: Nucleus before the decay
   B. Products: Nucleus after the decay plus the radiation emitted

II. Nuclear Reaction Equation Examples:
   A. Show the alpha decay of Uranium-238
      $^{238}_{92}U \rightarrow {}^{4}_{2}He + {}^{234}_{90}Th$
   B. Show the beta and gamma decay of Technetium-99
      $^{99}_{43}Tc \rightarrow {}^{0}_{-1}\beta + \gamma + {}^{99}_{44}Ru$
   C. Show the neutron emission of Beryllium-13
      $^{13}_{4}Be \rightarrow {}^{1}_{0}n + {}^{12}_{4}Be$
   D. Radium-226 goes through alpha decay and has a half-life of 1,600 years. What are the products of this decay, and how long will it take for only 1.6% of an ingested sample to remain in someone's body?
      $^{226}_{88}Ra \rightarrow {}^{4}_{2}He + {}^{222}_{86}Rn$
      1. The products are Helium and Radon-222
      2. Half-lives for Radium-226

Half-life	Percent remaining	Total time elapsed
1st	50%	1,600 years
2nd	25%	3,200 years
3rd	12.5%	4,800 years
4th	6.3%	6,400 years
5th	3.2%	8,000 years
6th	1.6%	9,600 years

Homework Questions:

1. Radon-219 undergoes alpha decay
   $^{219}_{86}\text{Rn} \rightarrow {}^{4}_{2}\text{He} + {}^{215}_{84}\text{Po}$
2. Carbon-14 undergoes beta decay
   $^{14}_{6}\text{C} \rightarrow {}^{0}_{-1}\beta + {}^{14}_{7}\text{N}$
3. Radium-226 undergoes alpha and gamma decay
   $^{226}_{88}\text{Ra} \rightarrow {}^{4}_{2}\text{He} + \gamma + {}^{222}_{86}\text{Rn}$
4. Helium-5 undergoes neutron emission
   $^{5}_{2}\text{He} \rightarrow {}^{1}_{0}\text{n} + {}^{4}_{2}\text{He}$
5. Titanium-212 undergoes alpha decay.
   $^{212}_{22}Ti \rightarrow {}^{4}_{2}He + {}^{208}_{20}Ca$
6. Potassium-43 undergoes beta decay
   $^{43}_{19}K \rightarrow {}^{0}_{-1}\beta + {}^{43}_{20}Ca$
7. Chromium-48 undergoes beta and gamma decay.
   $^{48}_{24}Cr \rightarrow {}^{0}_{-1}\beta + \gamma + {}^{48}_{25}Mn$

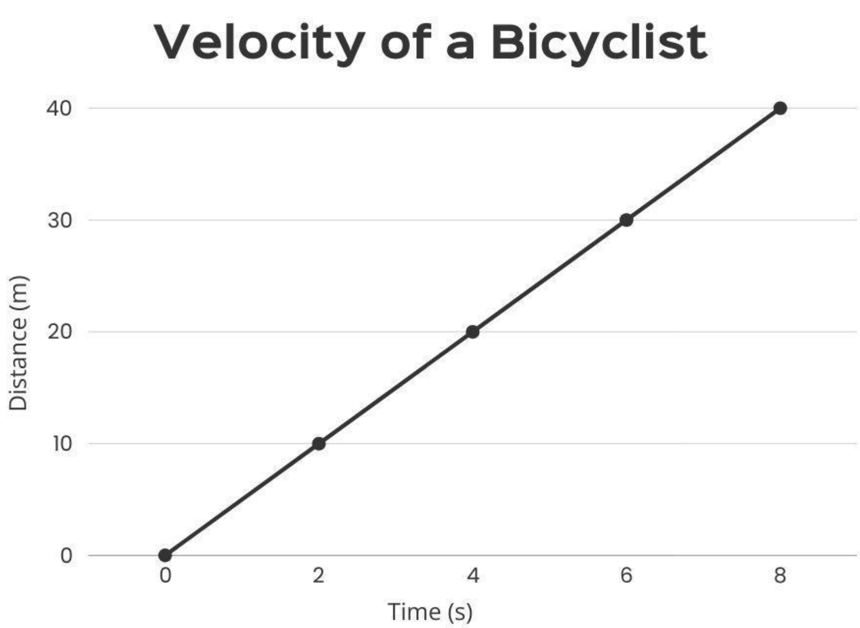
Lesson 19

1. For each section of the graph, describe the skateboarder's motion.
    A. Moving forward (slowly)
    B. Stopped
    C. Moving backward (very slowly)
    D. Stopped
    E. Moving forward (quickly)

2. For each section of the graph, calculate the skateboarder's velocity.
    A. 10 m / 2 s = 5 m/s
    B. 0 m / 3 s = 0 m/s
    C. -5 m / 2 s = -2.5 m/s
    D. 0 m / 1 s = 0 m/s
    E. 20 m / 2 s = 10 m/s

3. Calculate the average velocity of the skateboarder.
    25 m / 10 s = 2.5 m/s

4. Graph the following data for a bicyclist.



5. What is the average velocity for the bicyclist in #5?

40 m / 8 s = 5 m/s

Lesson 20

Trial	Time
#1 (Top of Ramp)	9.17 s
#2 (High Mark)	6.68 s
#3 (Low Mark)	5.55

1.

<u>Trial 1</u>

a = ? v_i = 0.74 m/s v_f = 0 m/s t = 9.17 s

a = $\frac{v_f - v_i}{t}$

a = $\frac{0 - 0.74\ m/s}{9.17\ s}$ a = -0.08 m/s^2

<u>Trial 2</u>

a = ? v_i = 0.60 m/s v_f = 0 m/s t = 6.68 s

a = $\frac{v_f - v_i}{t}$

a = $\frac{0 - 0.60\ m/s}{6.68\ s}$ a = -0.09 m/s^2

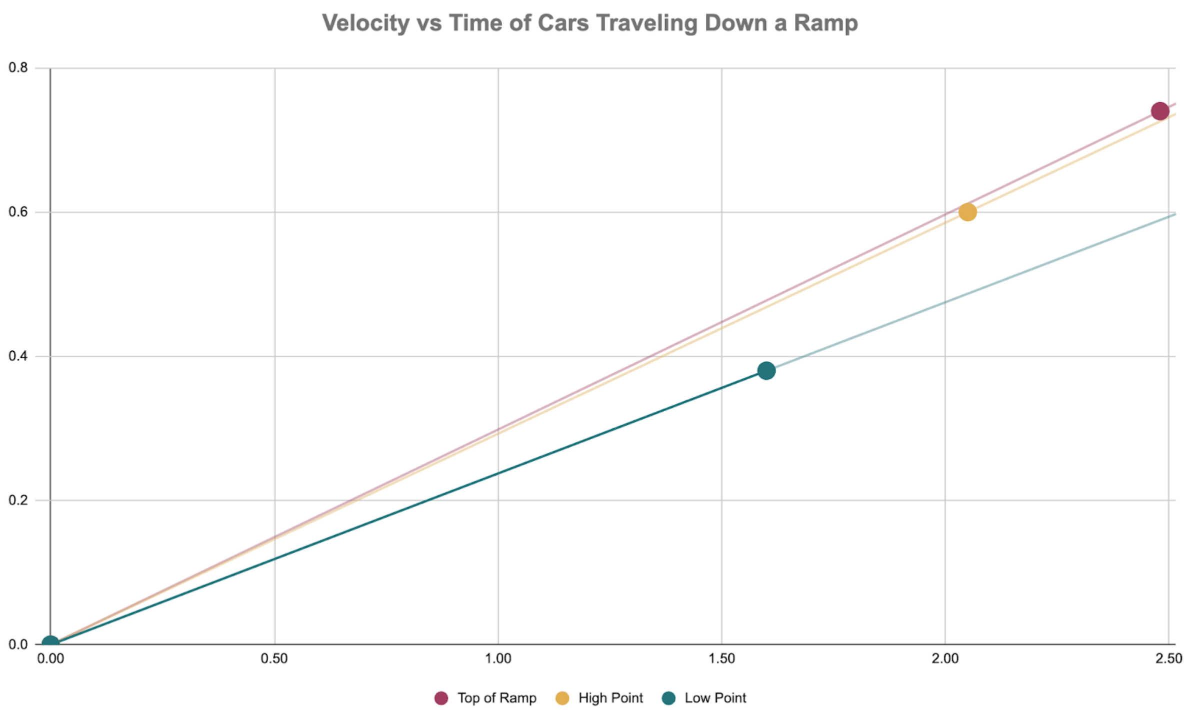
<u>Trial 3</u>

a = ? v_i = 0.38 m/s v_f = 0 m/s t = 5.55 s

a = $\frac{v_f - v_i}{t}$

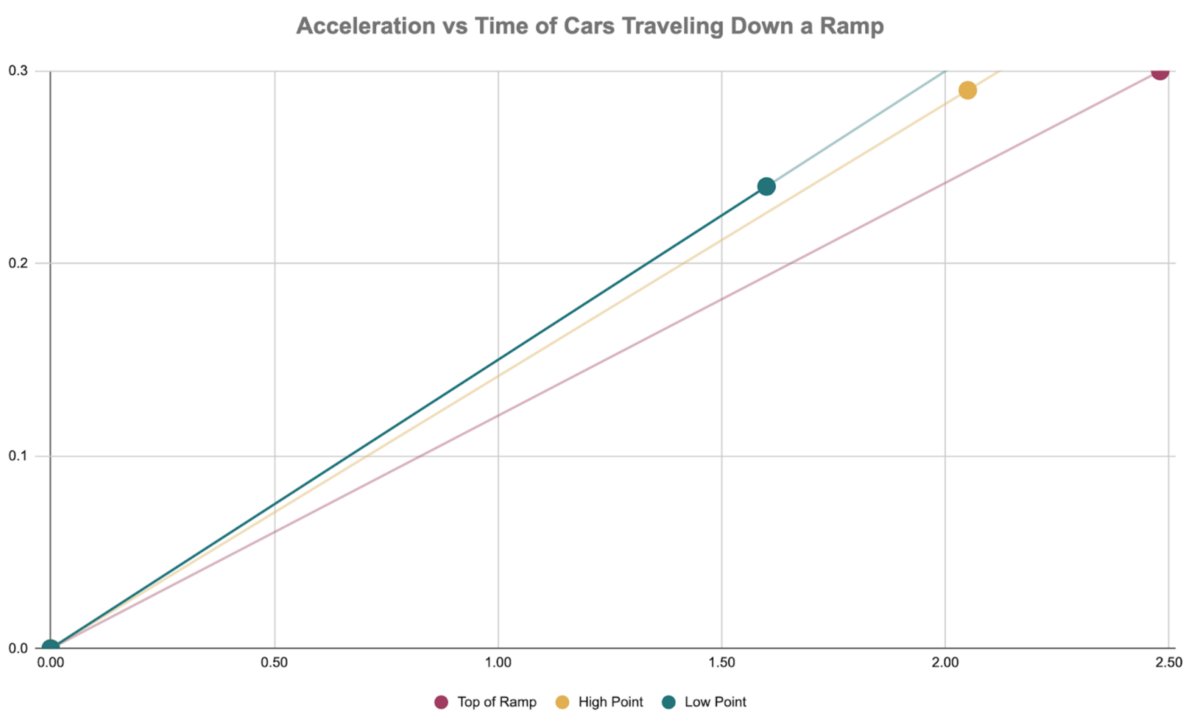
a = $\frac{0 - 0.38\ m/s}{5.55\ s}$ a = -0.07 m/s^2

2.



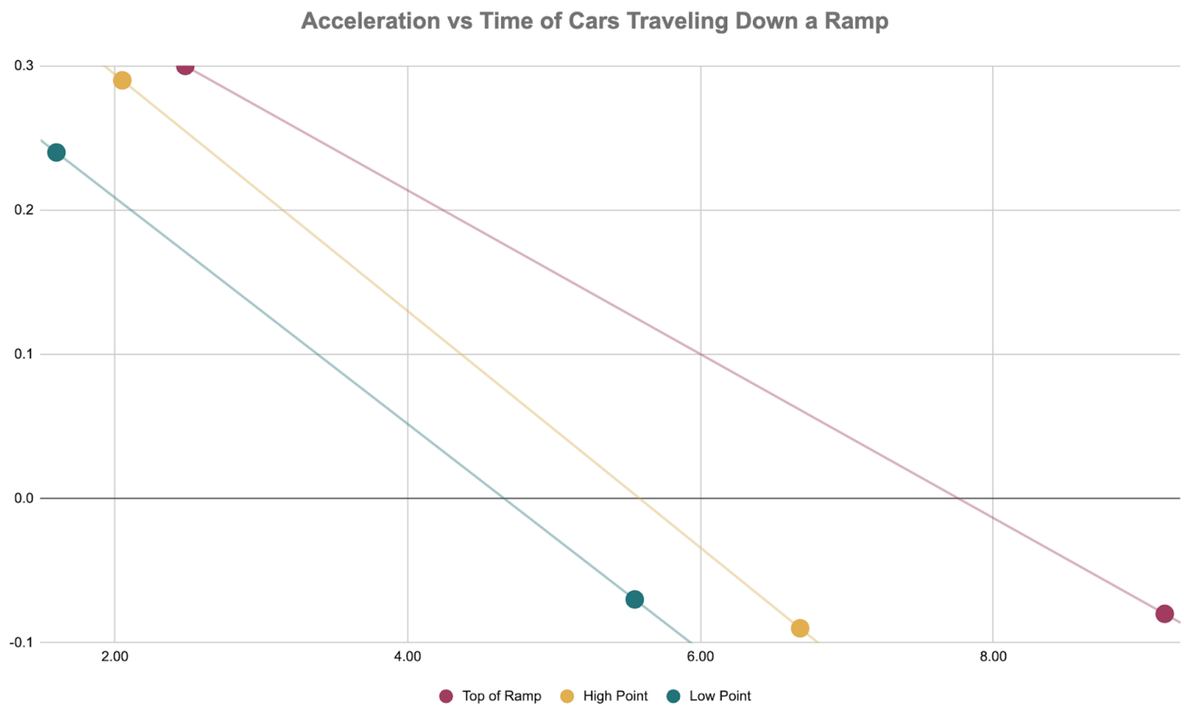
Velocity vs Time of Cars Traveling Down a Ramp
0.8
0.6
0.4
0.2
0.0
0.00
0.50
1.00
1.50
2.00
2.50
Top of Ramp
High Point
Low Point

3.



Acceleration vs Time of Cars Traveling Down a Ramp
0.3
0.2
0.1
0.0
0.00
0.50
1.00
1.50
2.00
2.50
Top of Ramp
High Point
Low Point

4.


Acceleration vs Time of Cars Traveling Down a Ramp
0.3
0.2
0.1
0.0
-0.1
2.00
4.00
6.00
8.00
Top of Ramp
High Point
Low Point

Lesson 21

There are several different types of bridge designs your student should include in their research.

- Beam Bridge
  - The oldest, easiest, and least expensive type of bridge to build
  - Constructed with a horizontal beam that is supported by abutments at each end, or when longer, by piers (or stanchions) spaced evenly underneath
  - When the load is very heavy, the deck of beam bridges can sag under the weight
  - Example: Lake Pontchartrain Causeway in Louisiana
- Arch Bridge
  - One of the oldest, strongest bridge designs, but taking longer to build
  - Arch is supported on both ends by abutments, conveying the downward pressure of gravity towards the center, making the load spread evenly across the arch
  - Example: Rialto Bridge in Venice, Italy
- Suspension Bridge
  - Often used for bridges that span long distances, such as over waterways
  - Roadway is suspended by cables that are spread out and attached to vertical pillars (or pylons) at each end, allowing the load to be spread out
  - Example: Golden Gate Bridge in San Francisco
- Truss Bridge
  - Truss bridges are the strongest type of bridge.
  - Parts are put together to form triangles.
  - Example: Ikitsuki Bridge in Japan
- Combinations: Other bridge designs combine different bridge types together
  - Cantilever bridges combine features of a beam bridge and a truss bridge

    - Tied-arch bridges combine features of an arch bridge and a suspension bridge

There are five types of loads a bridge needs to be able to withstand. Students' summaries should include most or all of the following details.

- Compression:
    - External forces push or squeeze an object, pushing the particles closer together
    - Causes an object to contract or become shorter in the direction of the applied force
    - Example: Any object resting on a table, gravity pulling the object downward
- Tension:
    - External forces pull an object, stretching or elongating the particles further apart
    - Causes an object to become longer in the direction of the applied force
    - Example: A rope bearing a heavy load, gravity pulling the load down
- Shear:
    - Two forces are applied parallel to each other in opposite directions
    - Causes an object to slide or deform relative to the other in a plane parallel to the surface of the material
    - Examples: Tearing a piece of paper or sandpaper on a board
- Bending:
    - External forces bend or curve an object because of both compression and tension happening at the same time
    - Causes structure to flex around a central point
    - Example: Bending a thin piece of wood, the top getting compressed and the bottom getting stretched apart
- Torsion:
    - External forces torque or twist an object
    - Causes object turn
    - Examples: Opening a jar or using a wrench to tighten a bolt

Lesson 23

1. Calculate the strength-to-mass ratio of your bridge. Divide the breaking load measured in grams by the mass of the bridge in grams.
   Answers will vary.

2. Why do you think engineers in the real world would want high strength-to-weight ratios for the bridge they design? In other words, why do they want bridges to have smaller masses but be able to withstand higher masses?
   They want their bridges to be strong so they can withstand the loads they need to carry, but they also want to use the fewest amount of materials to save money.

3. How does this project relate to what we've been learning about forces? Think of at least two things from lessons 21-23 that could be applied to this project. There are many topics students could bring up.
   a. The law of universal gravitation: Every object attracts each other object through the force of gravity, which is directly related to the masses of the objects. In the case of the bridge and any mass that is on top of it, the gravitational attraction between them will be negligible, but both are gravitationally drawn towards the earth. It is this attraction of the mass on top of the bridge towards the earth that gives the mass weight and creates the types of loads (compression, tension, shear, bending, and torsion) a bridge must be designed to withstand.
   b. Law of inertia: Newton's first law of motion states an object at rest remains at rest and an object in motion remains in motion at a constant speed, unless acted on by an outside force. If a bridge has no outside force applied to it (via a weight on top or wind), it will remain at rest.
   c. Law of cause and effect: Newton's second law of motion states the acceleration of the object is determined by the mass of the object and the size of the force. When this is applied to gravity, we can calculate the force any weight on top of a bridge will apply by using the equation

$F_g = mg$. Since acceleration due to gravity is the same for all objects near Earth, it is the mass of the object on the bridge that determines the force that will be applied to it.

d. Net Forces: The net force is the sum of all forces acting on an object. In the case of a stable bridge, if the bridge is not moving (bending or collapsing) then we know the net force on the bridge is zero, meaning the applied force of the weight on top and the forces holding the parts of the bridge in place are in equilibrium, the bridge will not move.

A. Law of Unintended Consequences: Newton's third law of motion states that for every action, there is an equal and opposite reaction. If a car is on a stable bridge, it is exerting a force on the bridge, therefore the bridge must be exerting the same amount of force on the car.

4. What was the main cause of failure for your bridge (what caused it to break in the end)?

   Answers will vary

5. Based on your experience designing and testing your bridge, what could you have done differently to improve your design and give your bridge a greater strength-to-weight ratio? List at least two improvements you could have made.

   Answers will vary

Lesson 26

Time to reach 5 meters: 17.6 seconds
Full distance traveled: 12.5 meters
*Data is just an example. Answers will vary greatly for each car.

Questions:

1. Draw a Sketch of your Mousetrap Car.
2. Calculate the velocity of your mousetrap car using the 5-meter distance and the time it took to reach 5 meters.

   v = ?   d = 5 m   t = 17.6 s

   v = $\frac{d}{t}$

   v = $\frac{5\,m}{17.6\,s}$ v = 0.28 m/s

3. Using the velocity from #1 as your final velocity, calculate the acceleration of the car over that 5 meters (remember, the car started at rest).

   a = ? v_f = 0.28 m/s v_i = 0 m/s

   t = 17.6 s

   a = $\frac{v_f - v_i}{t}$ a = $\frac{0.28\,m/s - 0\,m/s}{17.6\,s}$ a = $\frac{0.28\,m/s}{17.6\,s}$

   a = 0.02 m/s^2

4. Describe how energy was transferred during the testing of your car. How were potential and kinetic energy involved?

   The mousetrap spring had elastic potential energy. When the trap was released, that energy was converted to kinetic energy, moving the trap, which propelled the car forward.

5. What are some simple machines that were present in your mousetrap car?

   Lever on the mousetrap, wheel and axles for the wheels, etc.

6. What are some things you could have done to improve the design of your car? What might have made it travel farther or faster?

Answers will vary. Any suggestions that make sense are acceptable!

Lesson 28

Data

Length along paper	Time (s)	Average wavelength (m)	Average amplitude (m)
1 meter	5 s	.21 m	.08 m

* Data is just an example and will vary greatly based on the force used to start the pendulum and the speed of the paper being pulled.

Questions

1. Calculate the average speed at which the paper was pulled using the length of the paper and time measurements. *(HINT: Remember the velocity equation!)*

   v = ? d = 1 m t = 5 s

   v = $\frac{d}{t}$

   v = $\frac{1\ m}{5\ s}$ v = 0.2 m/s

2. Use the wave speed equation shown below to calculate the average wave frequency. *Average frequency* = $\frac{average\ wave\ speed}{average\ wavelength}$ *(f* = $\frac{v}{\lambda}$*)*

   f = ? v = 0.2 m/s $\lambda = 0.21\ m$

   $f = \frac{v}{\lambda}$

   $f = \frac{.02\ m/s}{0.21\ m}$ f = 0.10 Hz

3. If you repeated this experiment, what do you think you could do to change the wavelength of the wave? How could you change the amplitude?

   To change the wavelength, I could pull the paper faster or slower. To change the amplitude, I could change how hard I swing the pendulum.

Lesson 29

I. Calculating the Period & Frequency of a Wave

A. Equation: $T = \frac{1}{f}$

1. T = period, s
2. F = frequency, Hz

B. Example: What is the period of a wave with a frequency of 445 Hz?

f = 445 Hz T = ?

$T = \frac{1}{f}$

$T = \frac{1}{445\ Hz}$ T = .0022 s

T = 2.2 x 10^{-3} s

C. Equation: $f = \frac{1}{T}$

D. Example: What is the frequency of a wave with a period of 10 s?

T = 10 s f = ?

$f = \frac{1}{T}$

$f = \frac{1}{10\ s}$ f = 0.1 Hz

II. Calculating the Speed of a Wave

A. Equation: $v = \frac{\lambda}{T}$

1. v = speed, m/s
2. λ = wavelength, m
3. T = period, s

B. Example: What is the speed of a wave with a wavelength of 2.7 m and a period of 4.4 s?

λ = 2.7 m T = 4.4 s v = ?

$v = \frac{\lambda}{T}$

$v = \frac{2.7\ m}{4.4\ s}$ v = 0.61 m/s

C. Equation: v = λf

D. Example: If the wavelength of a wave is 2 m and the frequency of the wave is 0.25 Hz, what is the velocity of the wave?

λ = 2 m f = 0.25 Hz v = ?

v = λf

v = (2 m)(0.25 Hz)   v = 0.5 m/s

Homework Questions:

1. If the frequency of a certain event is 0.00025 Hz, what is the period of the event?

   f = 0.00025 Hz   T = ?

   $T = \frac{1}{f}$

   $T = \frac{1}{0.00025\ Hz}$

   $T = 4,000\ s$

2. A ship anchored at sea is rocked by waves occurring every 2 s that have a wavelength of 14 m. Calculate the velocity of the waves.

   T = 2 s   λ = 14 m   v = ?

   $v = \frac{\lambda}{T}$

   $v = \frac{14\ m}{2.0\ m}$

   T = 7.0 m/s

3. A wave with a frequency of 60.0 Hz travels through steel with a wavelength of 85.5 m. What is the speed of this wave?

   v = ?   f = 60.0 Hz   λ = 85.5 m

   v = λf

   v = (85.5 m)(60.0 Hz)   v = 5,130 m/s

4. Waves at the beach pass by you every 5 s,12 m apart. How fast are they traveling?

   $\lambda = 12\ m$ T = 5 s   v = ?

   $v = \frac{\lambda}{T}$

   $v = \frac{12\ m}{5\ s}$ $v = 2.4\ m/s$

5. If an earthquake's waves are 5 m apart, and 10 waves shake your house each second, how fast are the waves traveling?

   λ = 5 m   f = 10 Hz   v = ?

   $v = \lambda f$

   $v = (5\,m)(10\,Hz)$ $v = 50\,m/s$

6. Waves traveling out from an earthquake have a period of 0.05 s.

   a) What is the frequency of the wave?

      f = ?   T = 0.05 s

      $f = \frac{1}{T}$

      $f = \frac{1}{0.05\,s}$ f = 20 Hz

   b) What is the velocity of the waves if the wavelength is 350 m?

      v = ?   λ = 350 m   f = 20 Hz   T = 0.05 s

      $v = \frac{\lambda}{T}$ OR   v = λf

      $v = \frac{350\,m}{0.05\,s}$ v = (350 m/s)(20 Hz)

      v = 7,000 m/s   v = 7,000 m/s

Lesson 30

Pre-lab questions

1. Research the difference between additive color mixing and subtractive color mixing and explain the difference.
   Additive color mixing involves combining different colors of light to create new colors. Subtractive color mixing involves combining pigments or paints, which absorb certain wavelengths of light and reflect others. Light mixes add wavelengths together, while pigments mix by absorbing wavelengths.
2. What are the primary colors of light, and how do they differ from the primary colors of pigments?
   The primary colors of light are red, green, and blue, while the primary colors of pigments are cyan, magenta, and yellow (red, blue, and yellow are often used when exploring this concept).

Data Table

Red & blue	Blue & yellow	Yellow & red	Red, blue, & yellow
Purple	Green	Orange	Brown or gray

Questions:

1. Did the observed results match your hypothesis?
   Answers will vary depending on the student's hypothesis.

2. How did mixing red and blue paints differ from mixing red and blue colored lights?
   Red and blue paint would mix to make purple, whereas red and blue lights mixed to make magenta.

3. How did mixing all three paint colors differ from mixing all three light colors? Why were there different results?
   All three paint colors are mixed together to make gray or brown, whereas all three light colors are mixed together to create white. Mixing all primary colors of light produces white because additive mixing covers the full spectrum of visible light. Mixing all primary colors of pigment absorbs most wavelengths, resulting in a color.

Lesson 31

I. Concave reflective boundaries
    A. Concave: curved inward
    B. Because the mirror surface is curved inward, all the reflected rays will reflect inward
        1. Focal point: the point where the rays meet together, or converge
        2. Real image: the inverted image we see past the point where rays converge

II. Convex reflective boundaries
    A. Convex: curved outward
        1. The mirror surface is curved outward, so all the reflected rays will reflect outward away from each other
        2. Virtual image: image appears, seems smaller and further away than it actually is
        3. The focal point is behind a convex mirror

III. Double convex lenses
    A. A lens with two curved surfaces that bulge outward, converging rays of light on the other side
    B. Example: Lens of human eye or magnifying glass

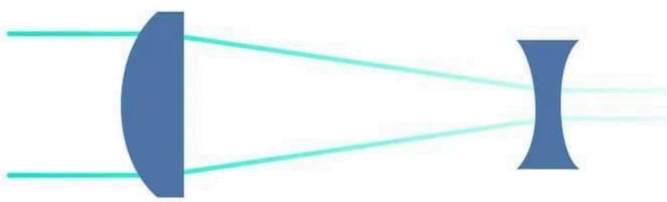
IV. Double concave lenses
    A. A lens with two curved surfaces that bulge inward, diverging rays of light
    B. Example: Glasses for near-sightedness

Assignment: Compare Galilean and Keplerian Telescopes

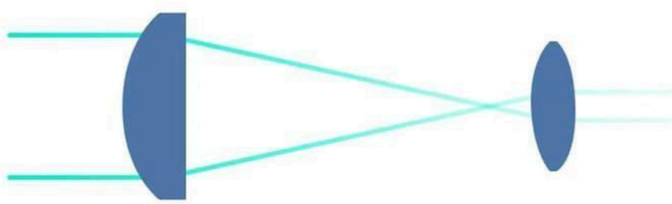
Galileo Galilei and Johannes Kepler were some of the most influential astronomers in human history, but they used different types of telescopes. Write a 2-paragraph paper, with any helpful accompanying diagrams, to explain the difference between the Keplerian telescope and the Galilean telescope and their use of different types of lenses.

Simple telescopes have two lenses: an objective lens which gathers light from objects in the sky and the eyepiece lens which presents that light to our eyes.

The Galilean telescope uses two types of lenses: the objective lens is a convex lens (bulging out) and the eyepiece is a concave lens (caving in). When parallel incident rays come into the objective lens, this bends the light so the refracted rays begin to converge on the other side. However, before the light can reach its focal point, it goes into the eyepiece lens which bends the light so the refracted rays diverge in such a way that the rays are now parallel again, only in a smaller field of vision. This has the effect of magnifying what the telescope is looking at.



The Keplerian telescope uses one type of lens: the objective lens and the eyepiece are both convex (bulging out). When parallel incident rays come into the objective lens, this bends the light so the refracted rays converge on the other side. This light passes the focal point and then goes into the eyepiece lens which bends the light so the refracted rays converge again, but in such a way that the rays are now parallel again, and now the image is inverted. This has the effect of magnifying what the telescope is looking at even more than a Galilean telescope can do.



Lesson 32

As you're assessing your students' presentation next week, consider if they included appropriate information from each of the categories below. Student's only need to choose one type of energy for their project. We've included *possible* answers for nuclear energy, fossil fuels, solar power, wind power, and hydroelectric power below.

1. Definition and Origin

- **Nuclear Energy**
    - **Definition:** Energy produced from nuclear reactions, primarily fission.
    - **Origin:** Derived from uranium or plutonium atoms in nuclear reactors.
    - **Conversion:** Heat from fission creates steam, driving turbines to generate electricity.
- **Fossil Fuels**
    - **Definition:** Energy sources formed from ancient organic matter, including coal, oil, and natural gas.
    - **Origin:** Created over many years from the decomposition of plants and animals under heat and pressure.
    - **Conversion:** Combustion releases energy, which heats water to produce steam for turbines.
- **Solar Power**
    - **Definition:** Energy harnessed from sunlight.
    - **Origin:** Comes from nuclear fusion in the sun.
    - **Conversion:** Photovoltaic cells convert sunlight directly into electricity.
- **Wind Power**
    - **Definition:** Energy generated from the movement of air.
    - **Origin:** Results from atmospheric changes and the Earth's rotation.
    - **Conversion:** Wind turbines capture kinetic energy from wind and convert it into electricity.
- **Hydroelectric Power**
    - **Definition:** Energy generated from flowing or falling water.

    - **Origin:** Harnesses the gravitational force of water, usually from rivers or dams.
    - **Conversion:** Water flows through turbines, generating electricity.

2. Historical Context

- **Nuclear Energy**
    - **Pioneers:** Marie Curie and Enrico Fermi made significant contributions to nuclear research.
    - **Development:** The first nuclear reactors were built in the 1940s; commercial nuclear power began in the 1950s.
- **Fossil Fuels**
    - **Pioneers:** Early uses date back to ancient civilizations (coal in China, oil in Persia).
    - **Development:** The Industrial Revolution spurred the extraction and use of fossil fuels, with significant technological advancements in drilling and refining in the 19th and 20th centuries.
- **Solar Power**
    - **Pioneers:** Alexandre-Edmond Becquerel discovered the photovoltaic effect in 1839; practical solar cells were developed in the 1950s by Bell Labs.
- **Wind Power**
    - **Pioneers:** Windmills have been used since ancient times; modern wind turbines were developed in the late 20th century.
    - **Development:** Growth in the 1970s due to the energy crisis; significant advancements in turbine technology since then.
- **Hydroelectric Power**
    - **Pioneers:** The first hydroelectric power plant was built in 1882 in Appleton, Wisconsin.
    - **Development:** Rapid growth in the early 20th century, with large dams like Hoover Dam and global expansion in hydroelectric capacity.

3. Current Applications

- **Nuclear Energy**

    - **Uses:** Powers homes, industries, and is used in submarines and aircraft carriers.
    - **Significance:** Accounts for about 10% of global electricity generation.
- **Fossil Fuels**
    - **Uses:** Primarily used for electricity generation, heating, and transportation (gasoline, diesel).
    - **Significance:** Represents about 80% of global energy consumption.
- **Solar Power**
    - **Uses:** Powers residential and commercial buildings, solar farms, and portable devices.
    - **Significance:** Provides approximately 3% of global electricity, with rapid annual growth.
- **Wind Power**
    - **Uses:** Generates electricity for homes and businesses, increasingly utilized in large wind farms.
    - **Significance:** Accounts for around 8% of global electricity generation and is growing rapidly.
- **Hydroelectric Power**
    - **Uses:** Supplies electricity for homes, industries, and irrigation.
    - **Significance:** Accounts for about 16% of global electricity generation and is the largest renewable energy source.

4. Feasibility

- **Nuclear Energy**
    - **Pros:** High energy density, low greenhouse gas emissions.
    - **Cons:** Concerns about nuclear waste, accidents, and high initial costs.
- **Fossil Fuels**
    - **Pros:** Established infrastructure, high energy output, and reliability.
    - **Cons:** Major greenhouse gas emissions, finite resources, and environmental degradation.
- **Solar Power**
    - **Pros:** Renewable, reduces electricity bills, scalable installations.
    - **Cons:** Intermittency (daylight-dependent), land use for solar farms, initial installation costs.

- **Wind Power**
    - **Pros:** Renewable, low operational costs, and low emissions.
    - **Cons:** Intermittent energy source, noise concerns, and impact on wildlife.
- **Hydroelectric Power**
    - **Pros:** Renewable, reliable, and capable of providing large-scale electricity.
    - **Cons:** Environmental impacts on aquatic ecosystems, high initial construction costs, and geographic limitations.

5. Pros and Cons

- **Nuclear Energy**
    - **Benefits:** Low carbon emissions, stable energy supply, high efficiency.
    - **Drawbacks:** Radioactive waste disposal, risk of accidents, public opposition.
- **Fossil Fuels**
    - **Benefits:** High energy output, established technology and infrastructure, cost-effective.
    - **Drawbacks:** Environmental pollution, greenhouse gas emissions, resource depletion.
- **Solar Power**
    - **Benefits:** Renewable, low operational costs, energy independence.
    - **Drawbacks:** Initial costs, reliance on sunlight, energy storage challenges.
- **Wind Power**
    - **Benefits:** Clean, renewable energy, job creation in manufacturing and installation.
    - **Drawbacks:** Variability in energy production, visual and noise concerns.
- **Hydroelectric Power**
    - **Benefits:** Reliable and consistent energy source, flood control, and water supply benefits.
    - **Drawbacks:** Impact on ecosystems, displacement of communities, and dependency on water availability.

Lesson 33

I. Electric Power Equation
   A. Equation: P = IV
      1. P = Power, measured in watts (W)
      2. Another unit for power is kW (1 kW = 1,000 W)
   B. Example: A calculator has a 0.1 A current flowing through it. It operates with a potential difference of 9 V. How much power does the calculator use?

      I = 0.1 A   V = 9 V   P = ?

      P = IV   P = (0.1 A)(9 V)   P = 0.9 W

II. Energy Consumption Equation
   A. Measured in kilowatt-hour (kWh)
   B. Equation: E = Pt
   C. Example: If your refrigerator uses 700 watts of power and runs for 10 hours a day. How much energy does it consume in one day?

      P = $\frac{700\,W}{1} \times \frac{1\,W}{1000\,kW} = \ 0.7\,kW$

      t = 10 hr   E = ?

      E = Pt   E = (0.7 kW)(10 hr)   P = 7 kWh

   D. A 100 watt light bulb is on for 5.5 hours. How many kilowatt-hours of energy are used?

      P = $\frac{100\,W}{1} \times \frac{1\,W}{1000\,kW} = \ 0.1\,kW$

      t = 5.5 hr   E = ?

      E = Pt   E = (0.1 kW)(5.5 hr)   E = 0.55 kWh

Homework Questions

1. A microwave uses 1,000 W of power. The voltage is 120 V. What is the current running through the microwave?

   P = 1,000 W   V = 120 V   I = ?

   P = IV   I = P/V

   I = 1,000 W/120 V   I = 8.33 A

2. A lamp that operates with a current of 0.625 A has a potential difference of 120 V. How much power does the lamp use?

   I = 0.625 A   V = 120 V   P = ?

   P = IV   P = 0.625 A x 120 V   P = 75 W

3. If the lamp in the previous question is on for 210 hours a month, how much electrical energy in kWh does the lamp use in 1 month?

   P = $\frac{75\ W}{1} \times \frac{1\ kW}{1000\ W} = 0.075\ kW$ t = 210 h

   E = ?

   E = Pt   E = (.075 kW)(210 h)   E = 15.75 kWh

4. If your electric company charges $0.15 per kilowatt-hour, how much does it cost to use your lamp for one month?

   $0.15 x 15.75 kWh = $2.36

Lesson 34

Data Table

	Trial 1	Trial 2	Trial 3	Average
50 coil electromagnet with steel nail core	7	6	6	6
100 coil electromagnet with steel nail core	17	17	14	16
100 coil electromagnet with pencil core	0	0	0	0
100 coil electromagnet with tin foil core	0	0	0	0

Questions

1. How did the strength of the electromagnet change as you increased the number of coils from 50 to 100?
   The strength increased significantly. The 100-coil magnet lifted over twice the number of paperclips as the 50-coil magnets.

2. How did the type of core material affect the strength of the electromagnet? Which core material provided the strongest electromagnet and why do you think that is?
   The iron nail had the strongest lifting capacity. The iron nail was the strongest because it is ferromagnetic—it is highly susceptible to becoming magnetic—allowing it to concentrate the magnetic field produced by the coils.

3. What do you think would happen if you used more or fewer batteries?
   The battery provides the current needed to create the magnetic field. Using more batteries would increase the voltage and potentially make the electromagnet stronger while using fewer might weaken it.