PHYSICAL SCIENCE EXPLORED

STUDENT GUIDEBOOK

Luke & Trisha Gilkerson
with Bekah Kohlmeier

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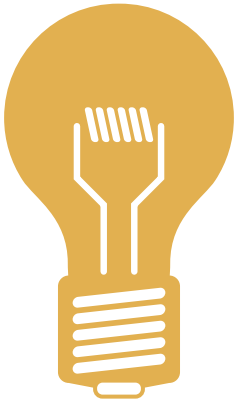
Physical Science Explored: Student Guidebook

Journey Homeschool Academy



WELCOME TO PHYSICAL SCIENCE EXPLORED

Get ready to embark on an exciting journey through the wonders of physical science! This Student Guidebook is crafted for those taking Levels B and C of our program. As you dive into the weekly lecture videos, follow along with the fill-in-the-blank sections.

We've also provided sections for extra notes—use these to draw helpful diagrams or jot down any key points you find particularly useful during the lecture. To kick off each lesson, you'll discover a list of key terms. Some may be new to you, so take a moment to familiarize yourself with them.

Along the way, you'll also encounter study guides for your quarterly exams. These guides focus solely on that quarter's material, highlighting key terms, questions, and concepts to help you prepare effectively.

We're thrilled to have you on this adventure, as we uncover the laws that govern matter and energy—designed by our incredible God. Get ready for a year of exciting exploration!

See you inside the course!

Trisha Gilkerson

CONTENTS

LESSON 1

INTRODUCTION TO PHYSICAL SCIENCE & THE SCIENTIFIC METHOD

In the beginning, God created the heavens and the earth. From the tiniest particle to the tallest mountain, He created it all using only His word. In this course, you will learn how God's creation works, what it's made up of, and how it all works together. This lesson introduces you to physical science and the two main branches of this discipline. In addition, we talk about an important process we use to study science in this course and beyond: the scientific method.

Vocabulary

Controlled experiment	Independent variable	Qualitative data
Dependent variable	Matter	Scientific method
Energy	Physical science	
Hypothesis	Quantitative data	

OUTLINE & NOTES

LESSON 1: INTRODUCTION TO PHYSICAL SCIENCE & THE SCIENTIFIC METHOD

I. The Study of Natural Sciences

A. _____ science: study of _____

B. _____ science: study of the _____

C. _____ science: study of _____ and _____

1. _____ : study of _____ and its _____
2. _____ : study of _____ and _____

II. The Scientific Method: How We Study Science

A. Many _____ scientists use to discover _____

B. Steps to the scientific method

1. State your _____ , the _____ you want to answer
2. _____ and collect _____
3. _____ : an educated guess
4. Test your hypothesis with a _____
   a. _____ are factors that can _____ the _____ of the experiment and should be kept _____ except _____
   b. Types of variables:
      (1) _____ variable: the variable _____ in an experiment
      (2) _____ variable: the variable that _____ as a _____ of changing the _____
5. _____ : record observations and collect data
   a. _____ data: _____ , anything you experience with your five senses

b. _____ data: involves _____ or _____

6. _____

a. _____ with the numbers you have

b. Consider if the _____ of your experiment _____ your _____ or not

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LESSON 2

INVESTIGATING MEASUREMENTS & UNIT CONVERSIONS

Two of the most basic and important skills in science are making accurate measurements and correctly using units of measure. You'll learn about the system of measurement used throughout science (and most of the world) and how to easily convert between units within this system.

Vocabulary

Ampere	Joule	Mole
Base units	Kelvin	Newton
Conversion factor	Liter	Pascal
Cubic meter	Meter	Second
Gram	Metric system	Watt

OUTLINE & NOTES

LESSON 2: INVESTIGATING MEASUREMENTS & UNIT CONVERSIONS

I. Systems of Measurement

A. The importance of _____ of measurement

1. Ensures _____
2. Allows us to _____ with others

B. The United States uses the _____

C. Scientists and most other countries use the _____ or _____

1. Units are based on _____
2. _____ + _____

   a. Prefixes _____ the base unit on the chart represent _____

   b. Prefixes _____ the base unit on the chart represent _____

Metric System Units

Unit	Symbol	Measurement
	m	distance
	g	mass
	s	time
	A	electric current
	K	temperature
	mol	amount of substance
	J	energy
	N	force
	m^3 (L)	volume (liquid volume)
	W	power
	Pa	pressure

Metric System Prefixes

Prefix	Symbol	Meaning	Multiple of base unit
	k	thousand	
	h	hundred	
	da	ten	
	m, L, mol, g, etc.	base unit	
	d	tenth	
	c	hundredth	
	m	thousandth	

II. Unit Conversion

A. Conversion _____ are _____ that help us _____ from one unit to another

B. Example: I buy five dozen eggs from the store. How many individual eggs do I have?

C. Example: How many meters are in 523 centimeters?

D. Example: How many liters are in 46 kiloliters?

NOTES

LESSON 3

TOOLS FOR SCIENTIFIC STUDY

When it comes to taking scientific measurements, we need to be both correct and consistent. Plus, when dealing with very big or very small numbers, we need a handy way to accurately write these numbers. This lesson is all about learning these valuable skills.

Vocabulary

Accuracy

Precision

Scientific notation

Standard notation

OUTLINE & NOTES

LESSON 3: TOOLS FOR SCIENTIFIC STUDY

I. Accuracy & Precision in Measurements

A. In order for a scientific measurement to be _____ , it needs to be both _____ and _____

B. _____ is how _____ a measurement is to the _____

C. _____ is how _____ the values are

D. The more _____ you _____ an experiment and get the _____ , the more _____ your results are

II. Converting Between Scientific Notation & Standard Notation

A. Numbers written in _____ make very _____ and very _____ numbers easier to deal with

B. Scientific notation is a method of expressing _____ in terms of a _____ between 1 and less than 10 _____ by a _____

C. Example: Write the speed of light, 300,000,000 m/s, in scientific notation.

1. Move the _____ so it becomes a number between _____ _____

   a. If the number does not have a decimal point, add one to _____ _____

   b. _____ the number to the nearest _____ _____

2. _____ your number by ____ _____

3. Add an _____ to show how many times you have to _____ _____ to get to the _____

   a. See how many times the _____ place needs to _____ to get back to the _____

   b. If your original number was a _____ number, your exponent will be _____

   c. If your original number was a _____ number, your exponent will be _____

   d. Include _____ in the measurement if you have them _____

D. Convert the following from standard notation to scientific notation

Standard notation	Scientific notation
0.000000125 g	
475,000 s	
0.000000000893 m	

E. You can work backwards to change a number from _____ into _____

1. Move the _____

   a. If the exponent is _____ , move the decimal point to the _____

   b. If the exponent is _____ , we'll move it to the _____

2. Add _____ as placeholders when needed

F. Convert the following from scientific notation to standard notation

Standard notation	Scientific notation
	2.61×10^{7} L
	4.26×10^{-12} kg
	1.87×10^{3} mL

G. Practice converting between standard and scientific notation.

Standard notation	Scientific notation
9,312,000 km	
	5.45×10^{-8} mm
0.000127 cg	

NOTES

LESSON 4

CLASSIFICATION & PROPERTIES OF MATTER

For millennia, human beings have been fascinated with what exactly makes up the universe. And today, we know more than ever about the matter that makes up the world. We study matter and the changes it undergoes in the field of chemistry.

Vocabulary

Atom	Heterogenous mixture	Molecule
Chemical change	Homogenous mixture	Physical change
Chemical properties	Mass	Physical properties
Compounds	Matter	Pure substance
Elements	Mixture	Weight

OUTLINE & NOTES

LESSON 4 : CLASSIFICATION & PROPERTIES OF MATTER

I. Matter, Mass, & Weight

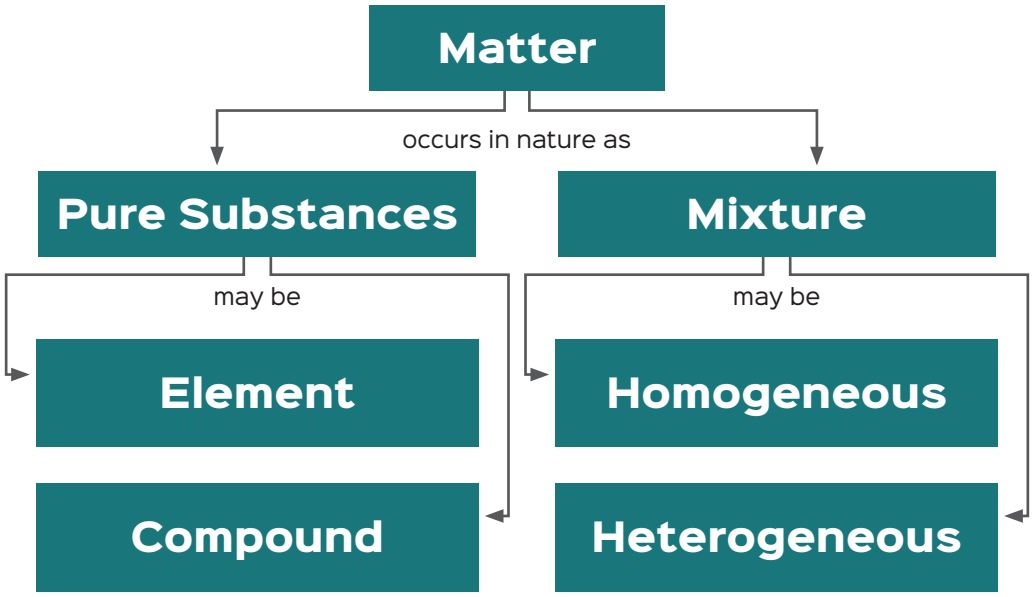
A. Matter is anything that has _____ and takes up _____

B. Mass is the _____ of the amount of _____ in an object

Mass	Weight

C. Space is measured as _____ (solids are measured in _____ , liquids are measured in _____)

II. Types of Substances



A. Pure substance: a _____ of matter that cannot be separated by _____ means

1. Single _____
    a. Elements are the _____ of matter
    b. _____ known elements organized on the _____
    c. Smallest unit of an element is called _____
2. _____
    a. Elements _____ together _____ to form compounds
    b. Smallest unit of a compound is called a _____

B. Mixture: _____ substances that are not _____ , but _____

1. _____ mixtures
    a. Have _____ but look the _____ throughout
    b. Particles are _____ , so you can not easily separate the different parts
    c. Example: _____
2. _____ mixtures
    a. Does _____ throughout
    b. You can easily _____ the different parts
    c. Example: _____

III. Changes & Properties of Matter

A. Physical vs. chemical _____

1. _____ properties
    a. Properties that can be measured without _____ of a sample of matter
    b. Examples: _____ _____

2. _____ properties

   a. Properties that can only be measured by _____ of the substance

   b. Examples: _____ , _____ , _____

B. Physical vs. chemical _____

1. _____ changes

   a. Changing of one or more of the _____

   b. Does not change the _____ of the substance

2. _____ changes

   a. Changing the _____ of the material

   b. _____ of chemical change

      (1) _____ change

      (2) Formation of a _____

         (a) _____ appearing in a liquid

         (b) A new _____

      (3) Formation of a _____

         (a) A precipitate is a _____ formed from combining two _____

         (b) If two liquids are mixed and it becomes _____ or there are _____ floating around in the liquid, a precipitate has formed

      (4) Release or absorption of energy

         (a) A substance changes _____

         (b) Produces _____ or _____

LESSON 5

DENSITY & STATES OF MATTER

You're probably already familiar with the three states of matter: solids, liquids, and gases. But do you know what makes these states different on the molecular level? Do you understand the part that energy plays in changing the state of matter? In this lesson, you'll continue learning about matter, its states, and an intrinsic property of matter called density.

Vocabulary

Boiling/evaporating	Exothermic	Melting
Condensation	Gas	Solid
Density	Intrinsic property	Solidification/freezing
Endothermic	Liquid	

OUTLINE & NOTES

LESSON 5: DENSITY & STATES OF MATTER

I. Density

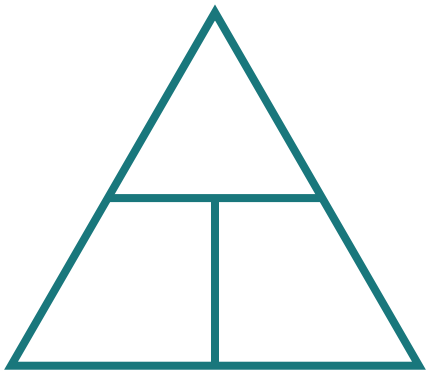
A. The amount of _____ per unit of _____

B. An _____ property of matter: a property that _____

based on the _____ or _____of a substance

C. Equation: _____

1. D = _____
2. m = _____
3. V = _____



Tips for Solving Word Problems

Analyze-**P**lan-**C**ompute-**E**valuate

1. Analyze the problem. Read through it once, then read it again pulling out the important information.
2. Create a plan. Look at the information given and see what equation we can use to solve for the value needed.
3. Compute. Plug the numbers from our "analyze" section into our plan.
4. Evaluate. Solve the equation.

D. Example: Find the density of an object that has a mass of 56.5 g and a volume of 5 cm^3.

E. Example: What is the volume of a block of zinc with a mass of 10 g and a density of 7.14 g/mL?

II. States of Matter

A. Solid

1. _____ dense
2. Particles are _____
3. _____ energy
4. Particles move _____ , vibrating back and forth in _____

B. Liquid

1. _____ dense
2. Particles are _____
3. _____ energy
4. Particles _____ around, _____ past each other

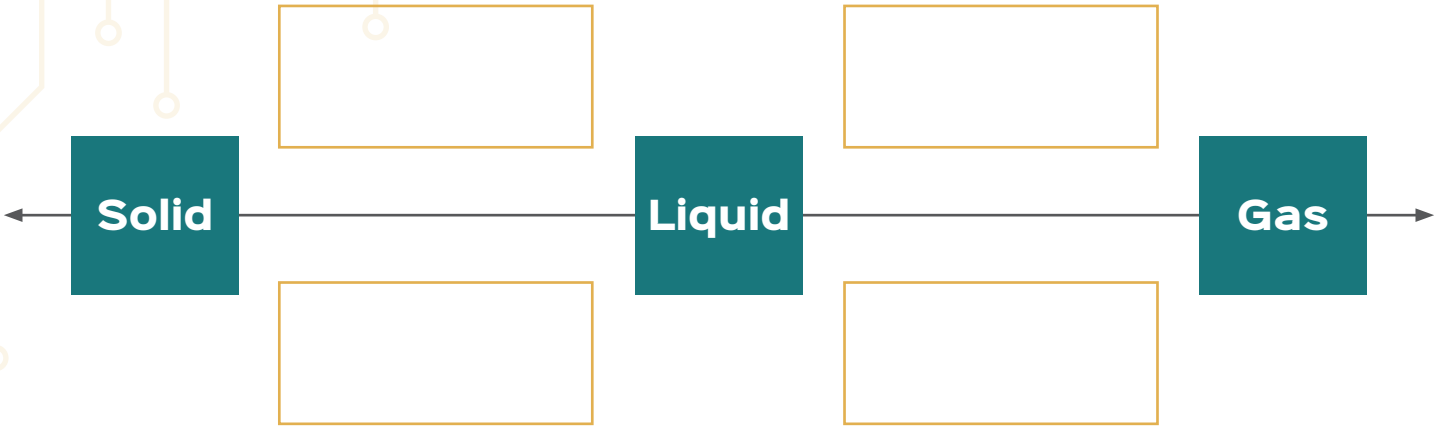
C. Gas

1. _____ dense
2. Particles are _____
3. _____ energy
4. Particles move around _____ and _____

	Solid	Liquid	Gas
Shape			
Volume			

D. _____ : energy being added to a system

E. _____ : energy being released from a system



F. Exception: when certain molecules _____ and arrange in a _____ , the solid is _____ than the liquid

LESSON 6

STRUCTURE OF THE ATOM

Everything in the universe is made of tiny particles called atoms. As it turns out, atoms are made up of three types of particles that are each responsible for something different. This lesson is all about those subatomic particles and how we can model their relative locations in the atom and the numbers of each one of the particles.

Vocabulary

Atomic number

Bohr model

Electron

Mass number

Neutron

Proton

Subatomic particles

OUTLINE & NOTES

LESSON 6: STRUCTURE OF THE ATOM

I. Atoms & Subatomic Particles

A. _____ are the most basic _____ of an _____ and are made up of _____ particles

B. _____ particles

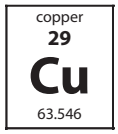
1. _____
   a. _____ charge
   b. Found in the _____ (small, dense region at the _____ of an atom)
   c. Determine an atom's _____
      (1) The _____ is on the _____
      (2) _____ = how many _____ are in an atom
2. _____
   a. Found in the _____
   b. _____ charge
   c. Changing the number of neutrons:
      (1) _____ the element's _____
      (2) _____ the _____ of the element
3. _____
   a. _____ charge
   b. Found _____ the nucleus in an electron _____ or _____
   c. Determine the _____ of an atom
      (1) Atoms, as seen on the _____ , are _____

(2) There is an _____ number of _____ and _____ in a _____ atom

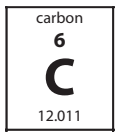
(3) Changing the number of _____ changes an atom's _____

C. Mass of an atom

1. Determined by the number of _____ and _____
2. Neutrons and protons have a _____ of about _____ (atomic mass units)
3. Mass number is listed for each element on the _____
   a. Determine the number of _____
      (1) Round the _____ to the nearest whole number to find the _____
      (2) Mass number - atomic number = _____
   b. Example: How many neutrons does copper have?



      (1) Round 63.546 = _____
      (2) 64 - 29 = _____
   c. Example: How many neutrons does carbon have?



      (1) Round 12.011 = _____
      (2) 12 - 6 = _____

II. The Bohr Model

A. Neils Bohr's model of the atom

1. Electrons occupy _____ around the _____
2. Not the most _____ model
3. Useful for providing a visual of the _____ and _____ of subatomic particles

B. How to draw a Bohr model

1. Determine the number of _____ , _____ , and _____

2. Draw a _____ to represent the _____

   a. Add the _____ of protons with the symbol _____

   b. Add the _____ of neutrons with the symbol _____

3. Look at the _____ to determine the _____

   _____ , the number of electrons that can go in each energy level is the same as the number of _____ in that _____

   a. Energy level 1: row 1 = _____

   b. Energy level 2: row 2 = _____

   c. Energy level 3: row 3 = _____

   d. Energy level 4: row 4 = _____

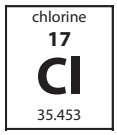
4. Draw the electrons on _____ around the nucleus in _____ on the _____ they belong

C. Examples

1. Draw a Bohr model for carbon

2. Draw a Bohr model for magnesium

3. Draw a Bohr model for chlorine



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LESSON 7

INTRODUCING THE PERIODIC TABLE

In 1913, Henry Moseley organized the elements into a periodic table. This is an important tool we use in chemistry to help us understand the properties of each element. That same table Moseley organized in 1913 is still used today, and we'll use it to learn about patterns it reveals.

Vocabulary

Groups	Nuclear notation	Periods
Hyphen notation	Periodic table	Valence electrons

OUTLINE & NOTES
LESSON 7: INTRODUCING THE PERIODIC TABLE

I. Brief History of the Periodic Table

A. Dmitri Mendeleev

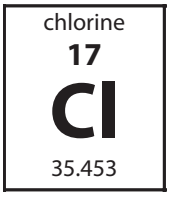
1. The _____ of the _____
2. Organized elements by _____

B. Henry Moseley

1. Organized the elements by _____
2. How our periodic table is _____

II. Reading the Periodic Table

A. Each element on the table has a _____ of information



1. Atomic number: _____
2. Element symbol: _____ with the first letter _____ and the second letter _____
3. Element _____
4. The _____ of _____ of an element
   a. Atomic mass, measured in _____
   b. Molar mass, measured in _____

B. _____ notation

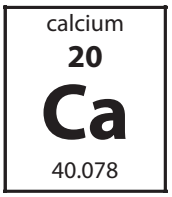
1. Includes:
   a. Element symbol in the _____
   b. Mass number in the _____
   c. Atomic number in the _____
2. Example: Write the nuclear notation for chlorine: _____

C. _____ notation

1. Includes
    a. _____
    b. _____
    c. _____
2. Example: Write the hyphen notation for chlorine: _____

D. Examples:

1. How many protons, neutrons, and electrons does calcium have?
    a. _____ protons
    b. _____ electrons
    c. _____ neutrons



2. What is calcium's average atomic mass and molar mass?
    a. Atomic mass: _____
    b. Molar mass: _____
3. What is the nuclear notation for calcium? _____
4. What is the hyphen notation for calcium? _____

III. Organization of the Periodic Table

A. Demonstrates _____ of the elements that occur _____ , in a _____

B. Organized by _____

C. Periods

1. _____ rows
2. Represents an _____ where _____ are found

D. Groups

1. _____ columns
2. Each group has _____

E. Valence electrons

1. Electrons in the _____
2. They can be _____
3. Determine _____ of elements
4. _____ occur when valence electrons are _____ _____

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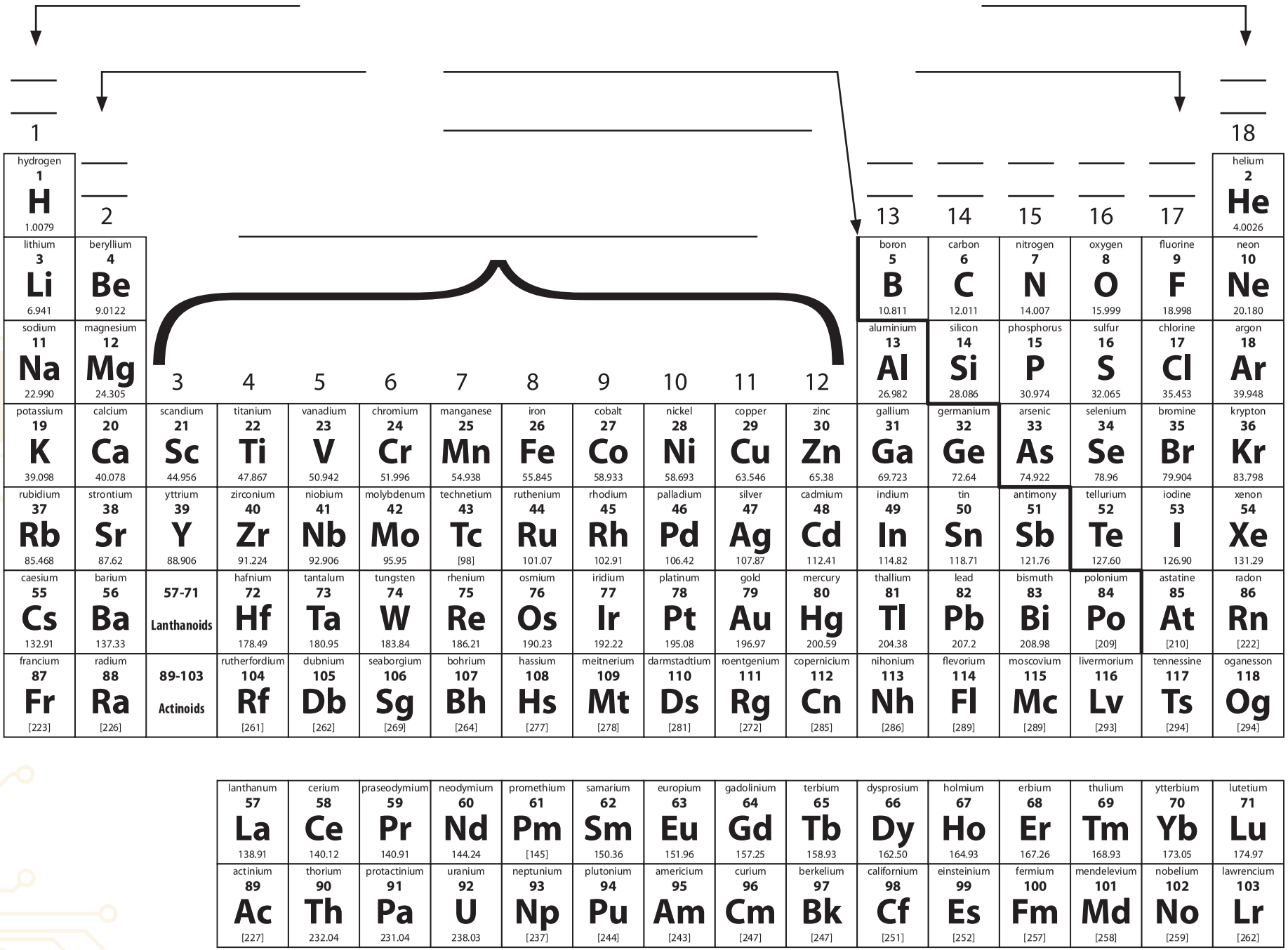
1
18
2
13
14
15
16
17
3
4
5
6
7
8
9
10
11
12
hydrogen 1 H 1.0079
helium 2 He 4.0026
lithium 3 Li 6.941
beryllium 4 Be 9.0122
boron 5 B 10.811
carbon 6 C 12.011
nitrogen 7 N 14.007
oxygen 8 O 15.999
fluorine 9 F 18.998
neon 10 Ne 20.180
sodium 11 Na 22.990
magnesium 12 Mg 24.305
aluminium 13 Al 26.982
silicon 14 Si 28.086
phosphorus 15 P 30.974
sulfur 16 S 32.065
chlorine 17 Cl 35.453
argon 18 Ar 39.948
potassium 19 K 39.098
calcium 20 Ca 40.078
scandium 21 Sc 44.956
titanium 22 Ti 47.867
vanadium 23 V 50.942
chromium 24 Cr 51.996
manganese 25 Mn 54.938
iron 26 Fe 55.845
cobalt 27 Co 58.933
nickel 28 Ni 58.693
copper 29 Cu 63.546
zinc 30 Zn 65.38
gallium 31 Ga 69.723
germanium 32 Ge 72.64
arsenic 33 As 74.922
selenium 34 Se 78.96
bromine 35 Br 79.904
krypton 36 Kr 83.798
rubidium 37 Rb 85.468
strontium 38 Sr 87.62
yttrium 39 Y 88.906
zirconium 40 Zr 91.224
niobium 41 Nb 92.906
molybdenum 42 Mo 95.95
technetium 43 Tc [98]
ruthenium 44 Ru 101.07
rhodium 45 Rh 102.91
palladium 46 Pd 106.42
silver 47 Ag 107.87
cadmium 48 Cd 112.41
indium 49 In 114.82
tin 50 Sn 118.71
antimony 51 Sb 121.76
tellurium 52 Te 127.60
iodine 53 I 126.90
xenon 54 Xe 131.29
caesium 55 Cs 132.91
barium 56 Ba 137.33
57-71 Lanthanoids
hafnium 72 Hf 178.49
tantalum 73 Ta 180.95
tungsten 74 W 183.84
rhenium 75 Re 186.21
osmium 76 Os 190.23
iridium 77 Ir 192.22
platinum 78 Pt 195.08
gold 79 Au 196.97
mercury 80 Hg 200.59
thallium 81 Tl 204.38
lead 82 Pb 207.2
bismuth 83 Bi 208.98
polonium 84 Po [209]
astatine 85 At [210]
radon 86 Rn [222]
francium 87 Fr [223]
radium 88 Ra [226]
89-103 Actinoids
rutherfordium 104 Rf [261]
dubnium 105 Db [262]
seaborgium 106 Sg [269]
bohrium 107 Bh [264]
hassium 108 Hs [277]
meitnerium 109 Mt [278]
darmstadtium 110 Ds [281]
roentgenium 111 Rg [272]
copernicium 112 Cn [285]
nihonium 113 Nh [286]
flevorium 114 Fl [289]
moscovium 115 Mc [289]
livermorium 116 Lv [293]
tennessine 117 Ts [294]
oganesson 118 Og [294]
lanthanum 57 La 138.91
cerium 58 Ce 140.12
praseodymium 59 Pr 140.91
neodymium 60 Nd 144.24
promethium 61 Pm [145]
samarium 62 Sm 150.36
europium 63 Eu 151.96
gadolinium 64 Gd 157.25
terbium 65 Tb 158.93
dysprosium 66 Dy 162.50
holmium 67 Ho 164.93
erbium 68 Er 167.26
thulium 69 Tm 168.93
ytterbium 70 Yb 173.05
lutetium 71 Lu 174.97
actinium 89 Ac [227]
thorium 90 Th 232.04
protactinium 91 Pa 231.04
uranium 92 U 238.03
neptunium 93 Np [237]
plutonium 94 Pu [244]
americium 95 Am [243]
curium 96 Cm [247]
berkelium 97 Bk [247]
californium 98 Cf [251]
einsteinium 99 Es [252]
fermium 100 Fm [257]
mendelevium 101 Md [258]
nobelium 102 No [259]
lawrencium 103 Lr [262]

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LESSON 8

STABILITY & TYPES OF BONDING

Atoms form bonds with one another creating all of the compounds that make up every bit of matter we see around us. However, the bonding of atoms occurs in different ways. This lesson explores the features of ionic, covalent, and metallic bonding.

Vocabulary

Anion	Covalent bond	Ionic bond
Cation	Ion	Metallic bond

OUTLINE & NOTES

LESSON 8: STABILITY & TYPES OF BONDING

I. Diagramming Valence Electrons

A. Electron review

1. Electrons are _____ charged particles
2. Atoms have a _____ charge when the number of _____ and _____ are the _____
3. Valence electrons are the _____ in an atom
   a. They are the _____ from the _____
   b. Positively charged protons have the _____ on them
   c. These electrons can be _____ with other atoms to _____

B. Drawing electron dot diagrams

1. Start by writing the _____
2. Determine how many _____ the element has
3. Draw this number of valence electrons as _____ around the _____ , no more than _____ on each side

Chlorine	Sodium	Phosphorus

II. Ionic Bonds

A. Ionic bonds form when electrons are _____ or _____

B. Ionic bonds are formed between _____ , atoms with a _____ or ___ _____

1. _____ charged ions are _____
2. _____ charged ions are _____

C. _____ are _____ between atoms, creating cations and anions

D. The _____ between _____ charged ions _____ them together to form a new compound

E. Once cations and anions _____ , both elements are _____

F. Ionic bonds form between a _____ and a _____ atom

G. Characteristics of ionic compounds

1. Ionic bonds form rigid patterns, so many ionic compounds form _____ but ___ _____
2. They have high _____ and _____ points
3. Many ionic compounds _____ in water, breaking into the originally charged particles, allowing them to _____

III. Covalent Bonds

A. Covalent bonds form when electrons are _____

B. "Covalent" means jointly sharing _____ electrons

C. Covalent compounds can also be referred to as _____ compounds

D. Covalent bonds form between two _____

E. Characteristics of molecular compounds

1. If they are solids, they are often _____ and _____
2. They have lower _____ and _____ points
3. Many do not _____ in water, and if they do, they form solutions that do not _____

IV. Metallic Bonds

A. Metallic bonds form between two or more _____

B. Characteristics of metallic compounds

1. _____
2. Good _____ of heat and electricity
3. _____ and _____

C. Valence electrons _____ between all atoms in the compound forming a _____ _____

NOTES

LESSON 9: EXAM 1

STUDY GUIDE

Use the following study guide as a practice test to prepare for the exam. If you get a question wrong, look back in your class notes to find the correct answer. Note the terms or concepts you don't remember, to help you study for the exam.

Vocabulary

Accurate
Biology
Chemistry
Controlled
Covalent
Dependent
Endothermic
Exothermic
Gram
Ionic
Independent
Metallic
Meter
Mole
Physics
Precise
Qualitative
Quantitative
Second

Fill in the blanks using the vocabulary words that best complete each sentence. Not all words will be used.

1. The study of matter and its changes is _____
2. The study of energy and forces is _____
3. In a(n) _____ experiment one variable changes, while the rest stay the same
4. A(n) _____ variable is the variable you change in an experiment
5. Data that involves numbers is _____ data
6. Data that is descriptive is _____ data
7. If measurements are _____ , they are close to each other
8. If measurements are _____ , they are close to the actual quantity measured
9. Changes in which energy leaves a system are _____
10. Changes in which energy goes into a system are _____
11. _____ bonds are held together by oppositely charged particles
12. Electrons are shared in _____ bonds
13. _____ bonds contain a sea of electrons
14. _____ is a measurement of distance
15. _____ is a measurement of mass
16. _____ is a measurement of the amount of a substance

17. Put the steps of the scientific method in order by numbering them one through six.

_____ Results	_____ Hypothesis	_____ Conclusions
_____ Experiment	_____ Research and collect data	_____ Problem

18. Convert 2.98 seconds into milliseconds.

_____

19. Convert 73.47 grams into hectograms.

_____

20. Write the following numbers in scientific notation.

    a. 10.72 _____

b. 0.00008726 _____

c. 5,839,124 _____

21. Write the following numbers in standard form.

a. 3.90×10^{-3} _____

b. 8.45×10^{7} _____

c. 2.11×10^{-8} _____

22. Identify the following as elements (E), compounds (C), homogeneous mixtures (HO), or heterogeneous mixtures (HE).

a. Trail mix _____

b. Water _____

c. Carbon _____

d. Milk _____

e. Salt (NaCl) _____

23. Identify the following changes as physical (P) or chemical (C).

a. Sharpening a pencil _____

b. Burning a log _____

c. Digesting food _____

d. Melting glass _____

24. List the signs of a chemical change.

_____

_____

25. Determine whether each statement is describing a solid, liquid, or gas.

a. The most dense state of matter _____

b. Randomly moving particles with lots of energy _____

c. Particles have a definite volume but indefinite shape _____

d. Particles vibrate slightly in fixed positions _____

e. Particles glide past each other _____

f. State of matter with the most energy _____

26. Write the name for each of the following changes of state.

a. Solid to liquid _____

b. Liquid to gas _____

c. Gas to liquid _____

d. Liquid to solid _____

27. What is the density of a substance with a mass of 37.62 g and a volume of 24.85 mL?

28. What is the mass of a piece of lead with a volume of 2.63 cm^3 if the density of lead is 11.29 g/cm^3?

29. Draw Bohr models for the following elements.

a. Fluorine

b. Hydrogen

c. Sulfur

30. Use a periodic table to fill in the chart below.

Element name	Carbon	Sodium	Neon
Nuclear notation			
Hyphen notation			
Protons			
Neutrons			
Electrons			
Average atomic mass			
Molar mass			
Mass number			
Period number			
Group number			
Valence electrons			
Ion charge			

31. Draw the electron dot diagram for each of the elements below.

a. Boron _____

b. Krypton _____

c. Barium _____

d. Tin _____

LESSON 10

READING & WRITING CHEMICAL FORMULAS FOR IONIC COMPOUNDS

What's in a name? A lot, as it turns out. A compound's name gives us a recipe for what is contained in it, and in this lesson, you'll learn to crack the code of a compound's name.

Vocabulary

Chemical formula	III	VIII
Polyatomic ions	IV	IX
Roman numerals	V	X
I	VI	
II	VII	

OUTLINE & NOTES

LESSON 10: READING & WRITING CHEMICAL FORMULAS FOR IONIC COMPOUNDS

I. Reading Chemical Formulas

A. Chemical _____ give us information about a chemical _____

B. Parts of a chemical formula

1. _____ correspond to _____ on the periodic table
2. _____ after the element tell _____ _____ of an element are in the compound
3. Elements with _____ numbers after them have just _____ _____ of that element

C. Example: H_2O = _____ atoms and _____ atom bonded together

D. Example: CO_2 = _____ atom and _____ atoms bonded together

E. Polyatomic ions: a _____ of _____ bonded together with a _____

1. Example: calcium nitrate: $Ca(NO_3)_2$
   a. There is _____ atom
   b. The NO_3 in the parentheses is a _____
   c. The three immediately after _____ , tells us there are _____ atoms

Common Polyatomic Ions	
carbonate	$(CO_3)^{2-}$
nitrate	$(NO_3)^-$
sulfate	$(SO_4)^{2-}$
phosphate	$(PO_4)^{3-}$
hydroxide	$(OH)^-$
ammonium	$(NH_4)^+$

d. The two outside the _____ means there are

_____ , so everything inside the parentheses should be

_____ by _____

e. Totals:

(1) Oxygen: _____

(2) Nitrogen: _____

(3) Calcium: _____

2. Example: magnesium phosphate: $Mg_3(PO_4)_2$

a. Magnesium: _____

b. Phosphorus: _____

c. Oxygen: _____

II. Writing Chemical Formulas From Names

A. Fixed vs. variable charge ions

1. Fixed charge ions: elements always with _____

a. Elements in group 1 have a charge of _____

b. Elements in group 2 have a charge of _____

c. Silver has a charge of _____

d. Zinc has a charge of _____

e. Aluminum has a charge of _____

2. Variable charge ions

a. Elements that can form ions with _____ charges

b. Most _____ metals are variable charge ions

B. Ionic compounds with a _____ (in groups 1 or 2)

1. Ionic compounds name includes:

a. Name of the _____

b. Name of the _____

c. With the ending changed to _____

2. How to write formulas for ionic compounds

   a. Write the _____ and their _____

   b. _____ the _____

   c. _____ subscripts

   d. Goal: compounds must have an _____ of _____

3. Example: sodium oxide

   a. Sodium = _____

   b. Oxide = _____

   c. Cross charges: _____

4. Example: calcium nitride

   a. Calcium = _____

   b. Nitride = _____

   c. Cross charges: _____

5. Example: magnesium oxide

   a. Magnesium = _____

   b. Oxide = _____

   c. Cross charges: _____

   d. Reduce subscripts: _____

C. Compounds with _____ metals (groups 3-12)

1. Transition metals _____

   a. _____ of these compounds have the _____ in them

   b. Charge is shown using a _____

      (1) _____

      (2) _____

      (3) _____

      (4) _____

      (5) _____

(6) _____

(7) _____

(8) _____

(9) _____

(10) _____

2. How to write formulas with transition metals

   a. Write the _____ of the first element and _____

      (1) The _____ is a _____

      _____

      (2) The _____ applies to the _____

      _____ in a compound

   b. Write the _____ and _____

   c. _____ the _____

   d. _____ subscripts

3. Example: nickel(III) chloride

   a. Nickel = _____

   b. Chloride = _____

   c. Cross charges: _____

4. Example: copper(II) phosphate

   a. Copper = _____

   b. Phosphate = _____

   c. Cross charges: _____

5. Example: titanium(IV) oxide

   a. Titanium = _____

   b. Oxide = _____

   c. Cross charges: _____

   d. Reduce subscripts: _____

NOTES

LESSON 11

NAMING IONIC COMPOUNDS

When naming a child, a lot of parents like to look up the meanings of names to find a name they think "fits" their child. Naming elements is a lot like that, but a lot less subjective than naming a child. By following a few simple rules, you can easily name an ionic compound by just knowing what elements are in it.

Vocabulary

Fixed charge ionic compounds

Variable charge ionic compounds

OUTLINE & NOTES

LESSON 11: NAMING IONIC COMPOUNDS

I. Naming Fixed Charge Ionic Compounds

A. Steps for naming fixed charge ionic compounds

1. Look at the _____ ; if it's a _____ _____ element, write the _____ of the element
2. Write the _____ of the second element, _____ the ending to _____
3. If a compound contains a _____ , don't change the _____ , just name the _____

B. Fixed charge ionic compound examples

1. $MgCl_2$ = _____
2. K_3N = _____
3. $Al_2(SO_4)_3$ = _____
4. Na_2O = _____

II. Naming Variable Charge Ionic Compounds

A. Steps for naming variable charge ionic compounds

1. _____ the first element
2. _____ the second element
3. Find the _____ of the _____ element
4. _____ that charge by the _____ to find the overall charge
5. The overall charge of the _____ needs to cancel out the overall charge of the _____
6. _____ the overall charge by the _____ of the first element to find the _____ of the element
7. Write the _____ of the first element as a _____ _____ between names

8. Changing the _____ of the second element to _____

B. Variable charge ionic compound examples

1. $AuCl_3$: Au = _____ ; Cl = _____
   a. Charge of chlorine: _____
   b. Overall charge of chlorine: _____
   c. Overall charge of gold: _____
   d. Charge of gold: _____
   e. Name: _____
2. Mn_2O_7: Mn= _____ ; O= _____
   a. Charge of oxygen: _____
   b. Overall charge of oxygen: _____
   c. Overall charge of manganese: _____
   d. Charge of manganese: _____
   e. Name: _____
3. $Ni_3(PO_4)_2$: Ni = _____ ; PO_4 = _____
   a. Charge of phosphate: _____
   b. Overall charge of phosphate: _____
   c. Overall charge of nickel: _____
   d. Charge of nickel: _____
   e. Name: _____
4. $FeCl_3$: Fe = _____ ; Cl = _____
   a. Charge of chlorine: _____
   b. Overall charge of chlorine: _____
   c. Overall charge of iron: _____
   d. Charge of iron: _____
   e. Name: _____

NOTES

LESSON 12

NAMES & FORMULAS FOR COVALENT COMPOUNDS

God charged Adam with naming each of the creatures in the Garden of Eden and humans have continued this convention of naming and categorizing the things that surround them in the world. However, naming isn't isolated to just naming living organisms but applies to chemistry as well. In this lesson, you'll learn all about naming and writing chemical formulas for covalent compounds.

Vocabulary

Deca	Mono	Tri
Di	Nona	Tetra
Hexa	Octa	
Hepta	Penta	

OUTLINE & NOTES

LESSON 12: NAMES & FORMULAS FOR COVALENT COMPOUNDS

I. Review: Types of Bonding & Compounds

A. Ionic compounds are formed when _____ are _____

1. Metals _____ electrons, forming _____ , or _____ charged ions
2. Nonmetals _____ electrons, forming _____ , or _____ charged ions
3. _____ between positive and negative charges forms the _____ , holding the compound together

B. Covalent (molecular) compounds _____ between two _____

1. When two _____ are in a _____ together, the _____ of the first element changes
2. Electrons are _____ always _____

II. Naming Covalent Compounds

A. Rules for naming covalent compounds

1. Find the _____ of each _____
2. Change _____ to _____ to tell _____ of each element are present
   a. 1: _____
   b. 2: _____
   c. 3: _____
   d. 4: _____
   e. 5: _____
   f. 6: _____

g. 7: _____

h. 8: _____

i. 9: _____

j. 10: _____

3. Every element will have a prefix _____ if there is only _____ of the _____

4. Change the _____ of the second element to _____

B. Example: CO_2

1. C = _____
2. O = _____
3. 2 = _____
4. Name: _____

C. Example: CO

1. C = _____
2. O = _____
3. 1 = _____
4. Name: _____

D. Example: N_2O_5

1. N = _____
2. 2 = _____
3. O = _____
4. 5 = _____
5. Name: _____

E. Example: S_3F_6

1. S = _____
2. 3 = _____
3. F = _____
4. 6 = _____
5. Name: _____

III. Writing Formulas for Covalent Compounds

A. Rules for writing formulas for covalent compounds

1. Write _____ that represent the _____
2. Write _____ for elements based on the _____ in front of them

B. Example: diarsenic pentoxide

1. Diarsenic = _____
2. Pentoxide = _____
3. Formula: _____

C. Example: pentanitrogen octatelluride

1. Pentanitrogen: _____
2. Octatelluride: _____
3. Formula: _____

D. Example: carbon tetrabromide

1. Carbon: _____
2. Tetrabromide: _____
3. Formula: _____

LESSON 13

BALANCING CHEMICAL EQUATIONS

The law of conservation of mass says matter cannot be created or destroyed, but can change forms. This is a fundamental principle in the study of chemistry. It's a principle that will guide us as we learn to balance chemical reactions, ensuring each and every atom in a reaction is accounted for.

Vocabulary

Diatomic elements

Law of conservation of mass

Products

Reactants

Yields sign

OUTLINE & NOTES

LESSON 13: BALANCING CHEMICAL EQUATIONS

I. The Law of Conservation of Mass

A. Matter cannot be _____ nor _____

B. Matter can _____

II. How To Read Chemical Equations

A. Chemical equations use _____ and have _____

B. Reading chemical equations

Example: $H_2(g) + O_2(g) \rightarrow H_2O(l)$

1. _____ : arrow
2. _____ : substance on the left side of the arrow
3. _____ : substances on the right side of the arrow
4. Letters in parenthesis tell you what _____ of matter the elements or compounds are
   a. (g): _____
   b. (l): _____
   c. (s): _____
   d. (aq): _____
5. A single element that has a subscript 2 after it, is called a _____
   a. Certain elements _____ in nature
   b. Diatomic elements are _____ of an _____ element naturally _____ together

III. Balancing Chemical Equations

A. There must be the _____ on both sides of the equation

B. Never add _____ to make an equation balanced, because doing so would change the _____

C. Steps to balance a chemical equation

1. _____ the elements on each side of the equation in the same _____
2. _____ and _____ the number of each atom on both sides
3. Add _____ in front of formulas to change the number of atoms
4. _____ atoms each time a coefficient is added
5. Continue changing _____ until atoms of each element match on both sides of the equation
6. _____ coefficients if they can all be divided by the same _____

___ $H_{2(g)} + O_{2(g)} \rightarrow$ ___ $H_2O_{(l)}$

D. Balancing equation examples:

1. $Al + HCl \rightarrow AlCl_3 + H_2$

2. $Fe + O_2 \rightarrow Fe_2O_3$

NOTES

LESSON 14

TYPES OF CHEMICAL REACTIONS

There are many different ways elements can break apart and combine to form new substances and this occurs in a process known as chemical reactions. Knowing what these different types of reactions are and how they work allows us to predict what new types of substances can be formed.

Vocabulary

Combustion reaction

Decomposition reaction

Double replacement reaction

Single replacement reaction

Synthesis reaction

OUTLINE & NOTES

LESSON 14: TYPES OF CHEMICAL REACTIONS

I. Synthesis or Combination Reaction

A. Starts with _____ separate elements which _____ to form _____ compound

B. Example: $Cu_{(s)} + O_{2(g)} \rightarrow CuO_{(s)}$

II. Decomposition Reaction

A. Starts with _____ compound which _____ into the smaller _____ that make it up

B. Most decomposition reactions require _____ or some sort of _____ to occur

C. Example: $HgO_{(s)} + heat \rightarrow Hg_{(l)} + O_{2(g)}$

III. Single Replacement Reaction

A. Starts with one _____ plus one _____ on the reactants side and ends with a _____ and a _____ on the products side

B. Example: $Zn_{(s)} + HCl_{(aq)} \rightarrow ZnCl_{2(aq)} + H_{2(g)}$

IV. Double Replacement Reaction

A. Starts with _____ compounds on the reactants side and ends with _____ _____ compounds on the products side

B. The _____ in each compound switches places

C. Example: $NaCl_{(aq)} + AgF_{(aq)} \rightarrow NaF_{(aq)} + AgCl_{(s)}$

V. Combustion Reaction

A. Starts with a _____ (a compound containing hydrogen and carbon) and _____ on the reactants side and ends with _____ and _____ on the products side

B. Example: $CH_{4(g)} + O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(l)}$

C. Example: $C_2H_{6(g)} + 7\ O_{2(g)} \rightarrow CO_{2(g)} + H_2O_{(l)}$

NOTES

LESSON 15

SOLUTIONS

We learned about the classification and properties of matter early in this course. In this lesson, you'll learn even more about homogenous mixtures, which are often referred to as solutions. These substances appear everywhere in both everyday life and in chemistry!

Vocabulary

Insoluble	Solubility	Solvent
Molarity	Solution	Supersaturated
Saturated	Solute	Unsaturated

OUTLINE & NOTES
LESSON 15: SOLUTIONS

I. Review: Categories of Matter

A. Pure substances: a _____ of matter that cannot be _____ by _____ means

B. Mixtures: _____ substances combined together by _____ means

1. _____ mixtures
    a. Particles are _____ distributed
    b. Can be _____ by _____ means
2. _____ mixtures or solutions
    a. Particles are _____ distributed
    b. Can be _____ by _____ means, but _____
    c. Also called _____

II. Understanding Solutions

A. Made when one substance is _____ into another substance

1. _____ : substance that is _____
2. _____ : the substance that _____ the _____

B. Example: salt water

1. Salt = _____
2. Water = _____

C. _____ : ability of a substance to _____

1. Substances with _____ will mix easily together
2. The _____ of the substance determines its solubility
    a. The _____ a substance is, the _____ it is to _____
    b. If a substance is _____ , it will _____

3. _____ of the solvent can also affect the solubility

D. Types of solutions

1. _____ : contains _____ the maximum amount of _____ possible
2. _____ : contains the _____ of solute possible
3. _____ : contains _____ the maximum amount of _____ possible at that _____

E. Example: creating a _____ solution of sugar water

1. _____ a solution of sugar water
2. _____ at a higher temperature until it _____
3. _____ the solution and the sugar will remain _____ , it won't settle to the bottom

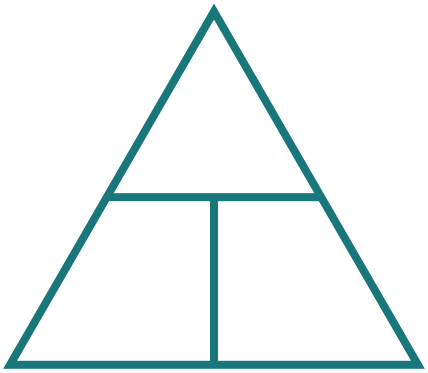
III. Molarity of Solutions

A. Measure of the _____ of a solution, or its _____

B. Ratio of _____ to _____

C. Molarity equation: _____

1. M = _____
2. mol = _____
3. L = _____



D. Sometimes this will require converting our units

1. Example: Convert 25 mL of solution to L.

2. Example: How many liters of solution do you have if you measure the solution to be 1,920 mL?

E. Example: What is the molarity of a solution that has 7.34 mol of NaCl dissolved in 2.85 L of water?

F. Example: How many moles of solute are dissolved in 1,810 mL of water if the solution has a molarity of 0.93 M?

G. Example: What is the molarity of a solution that has 0.45 mol of solute dissolved in 8.32 L of water?

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LESSON 16

ACIDS & BASES

Acids and bases are fundamental to the understanding of how chemical reactions work—and these are substances that can be found in many of the items we use day to day.

Vocabulary

Acid	Electrolyte	Neutralization
Base	Indicator	pH
Dissociation	Ionization	

OUTLINE & NOTES
LESSON 16: ACIDS & BASES

I. Acids vs. Bases

A. pH is a measure of the _____ of an _____ or a _____

1. pH scale: _____
   a. Acid pH: _____
   b. Neutral pH: _____
   c. Base pH: _____
2. Indicators _____ based on the _____ of a substance

B. Recognizing _____

1. When acids _____ in water, they _____ to form _____ ions _____
   a. Review of ionization
      (1) When a compound _____ , it is _____ to an _____
      (2) An ion is a _____ , atoms with a _____ or _____ charge
   b. Example: hydrochloric acid (HCl) ionizes in water
      (1) It forms _____ ions _____ and _____ ions _____
      (2) The hydrogen ion _____ with the water to form _____ ions _____ and _____ ions _____
   c. Example: sulfuric acid (H_2SO_4) ionizes in water

2. _____ taste

3. Acids are _____ that _____

4. _____

C. Recognizing _____

1. When bases _____ in water, they _____ to form _____ ions _____

   a. Dissociation is the _____ of a compound to form _____

   b. Ions in a _____ break apart from each other, but _____ react with _____

   c. Example: the dissociation of sodium hydroxide, NaOH

      (1) Breaks apart into the _____ ion _____ and the _____ ion _____

      (2) Water is _____ but not _____ in the reaction, so we put H_2O _____

   d. Example: calcium hydroxide ($Ca(OH)_{2(s)}$) dissociates in water

2. _____ taste

3. Solutions are _____

4. Bases are _____ that conduct _____

5. _____

II. Strength of Acids & Bases

A. The _____ of an _____ or _____ depends on _____ it ionizes or dissociates

B. Strong acids

1. Ionize _____
2. _____ conductors of _____ than weak acids

C. Weak acids

1. _____ ionize _____ in water
2. Not all of the acid molecules _____

D. Strong bases

1. Completely _____ when they _____ forming ions
2. _____ conductors of _____ than weak bases

E. Weak bases

1. _____ dissociate _____ in water
2. _____ ions are in a solution when a _____ base dissociates
3. Weak bases are _____ of electricity, _____ electrolytes

F. _____ signs look different for strong vs. weak acids/bases

1. Example of a weak acid: the ionization of acetic acid

   $CH_3COOH_{(s)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$

   a. A _____ for the yields sign indicates a _____ _____

   b. Reactants _____ to make the products, but the _____ can also _____ to make the _____

   c. Since the reaction occurs _____ , this _____ the amount of _____ in the solution.

2. For strong acids/bases, we would use a _____ for the yield sign, indicating that _____ of the reactants _____ to form the _____

III. Neutralization Reactions

A. When acids and bases _____ , a _____ _____ takes place

B. A _____ reaction between an _____ and a _____

C. Always form a salt and water: _____

D. Example: _____

E. Example: _____

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LESSON 17

NUCLEAR CHANGES

Our lives are affected by radioactivity in many ways. Technology that uses radioactivity has helped people detect disease, kill cancer cells, generate electricity, and design smoke detectors. However, there are also some risks associated with exposure to too much nuclear radiation. In this lesson, you'll be learning what radiation is and where it's encountered.

Vocabulary

Alpha particles

Beta particles

Gamma rays

Half-life

Neutron emission

Nuclear radiation

Radioactivity

OUTLINE & NOTES
LESSON 17: NUCLEAR CHANGES

I. Radioactivity

A. Emission of _____ : high-speed subatomic _____ or electromagnetic _____ being _____ from an atomic nucleus

B. Nuclei of heavy elements are _____ , so they go through _____ _____ , emitting particles or releasing energy to become _____

C. Materials that undergo radioactive decay are _____

D. Materials that are _____ with nuclear radiation are also _____

II. Types of Nuclear Radiation

A. Alpha particles

1. Composed of two _____ and two _____ : a _____ nucleus
2. Nuclear symbol: _____
3. _____ charged particles
4. Larger _____ than other types of radiation
5. They _____ through materials
6. Because they are _____ charged, they _____ matter, _____ the particles
7. Not very _____ to humans

B. Beta particles

1. Occurs when a neutral neutron _____
   a. Forms a _____ and an _____
   b. Electron is then _____ of the nucleus at _____ , and this electron is called a _____ particle
2. Nuclear symbol: _____ or _____

3. Beta particles move _____ and travel _____ through materials than alpha particles
4. They are _____ charged, so they _____ matter as they pass through, _____ the particles
5. Do _____ penetrate matter _____

C. Gamma rays

1. Not made of _____
2. Does not have an _____
3. Symbol: ____
4. They are a form of _____ energy, like visible light or X-rays, but with a lot more _____
5. Easily _____ matter
6. Because of their high _____ , they can easily cause _____ to matter

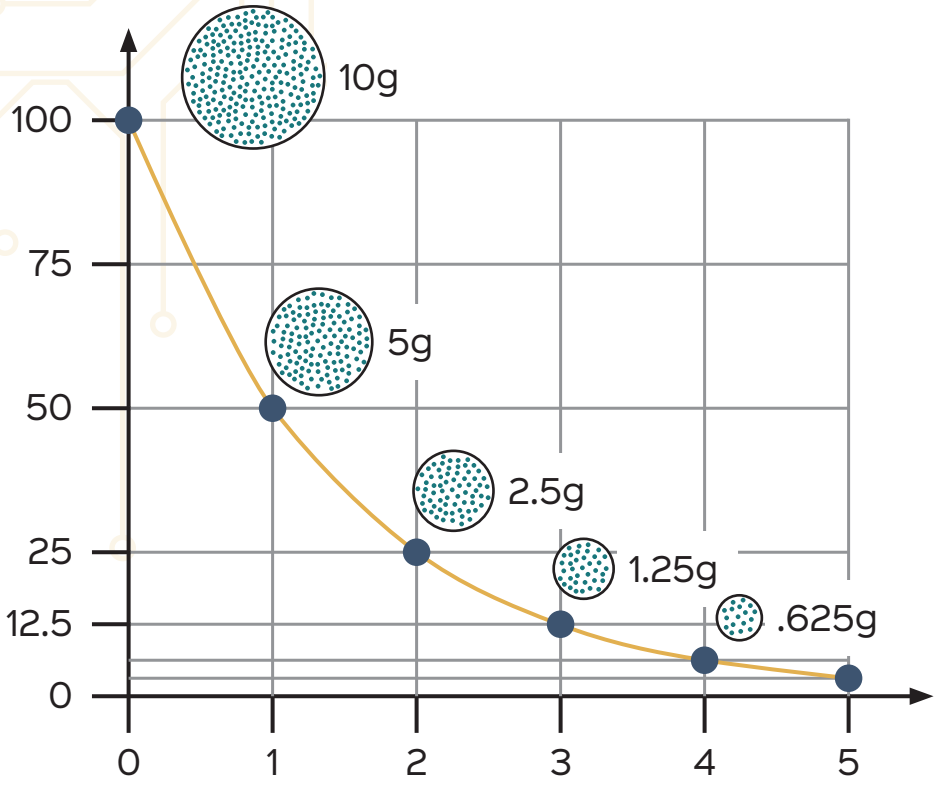
D. Neutron emission

1. Occurs when a _____ is kicked out of a nucleus
2. Nuclear symbol: _____
3. Neutrons have _____ , so they do not _____ materials
4. Able to travel _____ through matter than either alpha or beta particles

III. Half-Life

A. The time it takes _____ to decay

B. Example: The decay of _____ of a radioactive element



C. Example: If the half-life of radon-222 is 3.823 days, how long will it take for a sample to have only 12.5% of the original radioactive isotopes left?

1. It takes ____ half-lives to get to _____
2. ____ half-lives x _____ days = _____

D. Sample values for half-lives

Seaborgium-260	
Cesium-138	
Berkelium-248	
Iodine-131	
Americium-241	

E. Usefulness of knowing half-lives

1. Tells us how long we can _____ until it becomes safe
2. Allows us to _____
3. Allows us to _____ safely in medicine

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LESSON 18: EXAM 2

STUDY GUIDE

Use the following study guide as a practice test to prepare for the exam. If you get a question wrong, look back in your class notes to find the correct answer. Note the terms or concepts you don't remember to help you study for the exam.

Vocabulary

Alpha particles
Aqueous
Beta particles
Chemical formula
Combustion reaction
Decomposition reaction
Diatomic elements
Dissociate
Double replacement reaction
Electrolyte
Gamma rays
Gas
Half-life
Indicator
Insoluble
Ionize
Law of conservation of mass
Liquid
Molarity
Neutralization
Neutrons
Nuclear decay
Polyatomic ion
Organic
Products
Reactants
Saturated
Single replacement reaction
Solid
Solution
Solute
Solvent
Supersaturated
Synthesis reaction
Unsaturated

Fill in the blanks using the vocabulary words that best complete each sentence. Not all words will be used.

1. A(n) _____ is a charged group of bonded atoms
2. According to the _____ , matter cannot be created or destroyed
3. A(n) _____ compound contains carbon
4. The substances formed in a chemical reaction, found on the right side of a chemical equation, are called _____
5. The measure of the strength or concentration of a solution is its _____
6. In a _____ reaction, two individual elements combine to form one compound
7. In a _____ reaction, two compounds react together to form two different compounds
8. The substance dissolved in a solution is called the _____ and the substance it's dissolved in is called the _____
9. A(n) _____ substance cannot dissolve in water
10. A solution that has less than the maximum amount of solute dissolved is _____
11. A solution that has more than the maximum amount of solute dissolved is _____
12. Acids _____ in water
13. Bases _____ in water
14. When an acid and a base react together, this is called _____
15. An _____ changes color based on the pH of a substance
16. A substance that conducts electricity when dissolved in water is called a(n) _____
17. _____ have a larger mass and are slower than any other type of radiation

18. The type of radiation that travels the farthest, is the most dangerous and has no mass or charge is _____

19. In a chemical equation, (aq) means that a solid is dissolved in water, which means it is _____

20. A _____ is the amount of time it takes for half of a sample of a radioactive substance to decay

21. Answer the following about $Al_2(SO_4)_3$
    a. How many Al atoms are there? _____
    b. How many S atoms are there? _____
    c. How many O atoms are there? _____

22. Write the corresponding name or chemical formula for the ionic compounds below
    a. Strontium oxide_____
    b. PbF_3_____
    c. Diphosphorus pentasulfide _____
    d. ZnI_2 _____
    e. Magnesium phosphate _____
    f. NCl_5_____
    g. Titanium (IV) sulfide _____

23. Balance and identify the types of equations below
    a. _____ NiCl + heat → _____ Ni + Cl_2_____
    b. Zn + S → ZnS_____
    c. _____ Al + _____ $ZnCl_2$ → _____ Zn + _____ $AlCl_3$ _____
    d. C_2H_4 + _____ O_2 → _____ CO_2 + _____ H_2O _____
    e. $MgCl_2$ + K_2S → MgS + _____ KCl _____

24. 10 mol of NaCl are placed in 4 L of water. What is the molarity of the solution?

25. How many moles of SO_2 are in 1.50 L of solution with a molarity of 0.05 M?

LESSON 19

DESCRIBING MOTION

Everything in the universe is in constant motion—from the tiny vibrations of atoms to the massive movements of stars around the center of a galaxy. So foundational to all studies of physics is a basic understanding of these changes of position over time.

Vocabulary

Average speed	Distance	Speed
Constant speed	Frame of reference	Velocity
Displacement	Instantaneous speed	Velocity graph
Direction	Motion	

OUTLINE & NOTES
LESSON 19: DESCRIBING MOTION

I. Introduction to Velocity

A. Motion: when an object _____ with respect to a _____ _____

1. Frame of reference is the _____ from which you're _____ the motion
2. A _____ is an object that _____

B. Importance concepts in _____ motion

1. _____
2. _____ : the _____ of the complete path an object took
3. _____ : a direct line from the _____ point to the _____ point

C. Speed vs. velocity

1. _____ describes how _____ an object _____
   a. How _____ it travels in a certain amount of _____
   b. _____ speed: speed that _____
   c. _____ speed: the _____ of motion at any given _____
   d. _____ speed: total _____ traveled over the entire period of _____
2. _____ is the _____ of an object in a particular _____
   a. Velocity is described _____ to a _____
   b. How to change velocity
      (1) _____
      (2) _____
      (3) _____

II. Speed Calculations

A. Speed equation: _____

1. v = _____
2. d = _____
3. t = _____

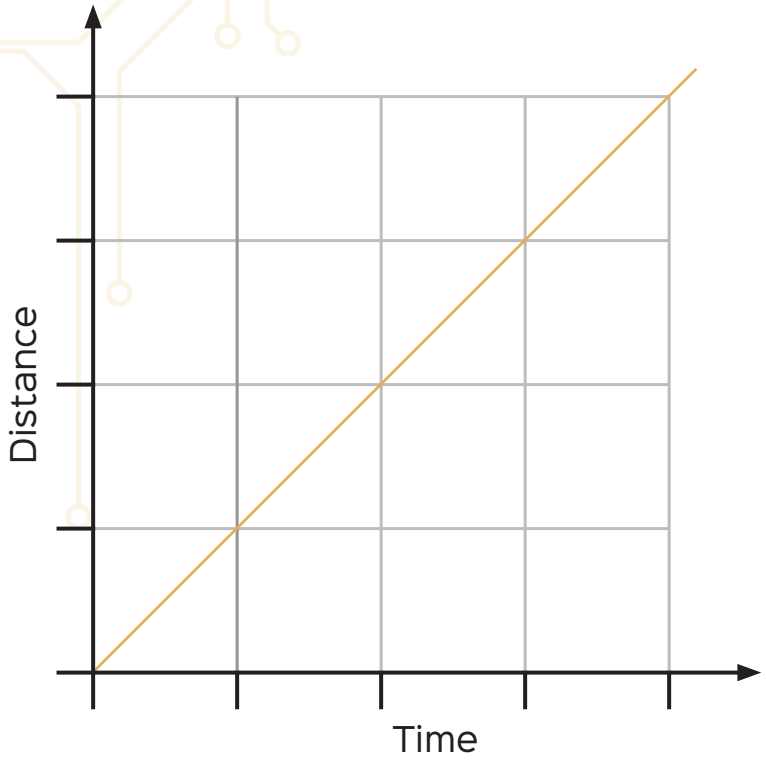
B. Example: Find the speed of a baseball thrown 38 m from third base to first base in 1.7 s.

C. Example: When the Columbia spacecraft was 69,520 mi from Earth, approaching at 4,951 mph, how long did the astronauts have until the ship crashed down?

III. Using Velocity Graphs To Interpret Data

A. Reading a velocity graph

Velocity Curve

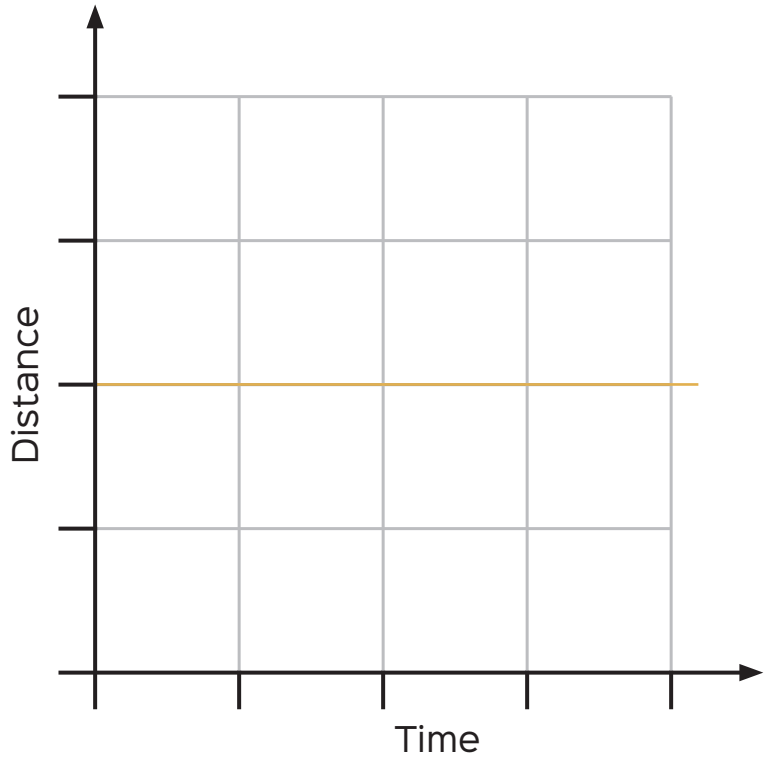


1. Descriptive _____
2. Two axes
   a. _____
      (1) _____ axis
      (2) Shows the _____ variable
   b. _____
      (1) _____ axis
      (2) Shows the _____ variable
3. Slope
   a. Displays _____ in this graph
   b. How _____ the _____ being graphed is
   c. _____ over _____

4. Example: If this curve describes the velocity of a spaceship, what can we tell about the ship?
    a. The ship is going forward
    b. The velocity is the same, at a constant speed

B. Example: If the below curve describes the velocity of a car, what can we tell about the car?

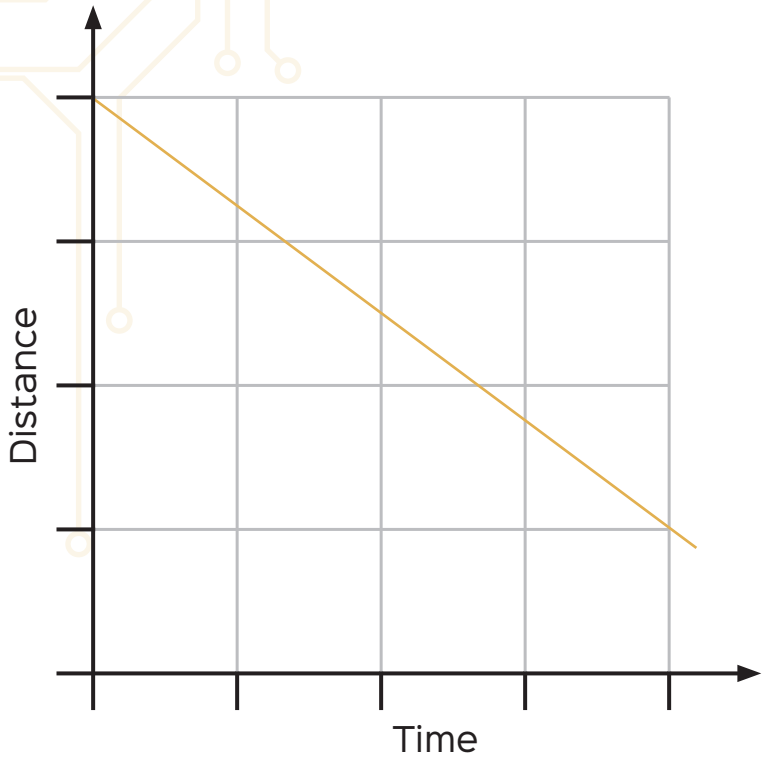
Velocity Curve



1. The line is _____
2. The car is _____

C. Example: If the below curve describes the velocity of a unicycle, what can we tell about the unicycle?

Velocity Curve



1. _____ slope
2. Velocity is _____
3. The unicycle is traveling _____

LESSON 20

ACCELERATION

From long-distance runners to race cars to dragonflies, nearly everything that moves changes its speed at some point, either getting faster or slower. This change in speed is called acceleration, and it is an important key to understanding motion.

Vocabulary

Acceleration

Centripetal acceleration

Negative acceleration

Positive acceleration

OUTLINE & NOTES
LESSON 20: ACCELERATION

I. Introduction to Acceleration

A. Acceleration: the rate at which _____ over _____

B. _____ acceleration

1. _____ velocity
2. In the _____ as the motion

C. _____ acceleration

1. _____ velocity
2. In the _____ as the motion

D. An object accelerates if its _____ , _____ , or _____ change

E. _____ acceleration: acceleration occurring in a _____ motion

II. Acceleration Calculations

A. Acceleration equation: _____

1. a = _____
2. v_f = _____
3. v_i = _____
4. t = _____

B. Interpreting numbers

1. _____ value = _____ increase in velocity
2. _____ value = _____ increase in velocity
3. _____ value = _____ up
4. _____ value = _____ down

C. Example: A car at rest accelerates to 35 m/s in 5 s. What is the car's acceleration?

D. Example: Jenny is running at a rate of 2 m/s. She wants to pass someone in front of her, so she accelerates at a rate of 1 m/s^2 until she reaches a velocity of 3.5 m/s. How long does it take her to accelerate?

E. Example: A truck is moving 15 m/s and slams on the brakes. If it took 3 s to stop, what was its acceleration?

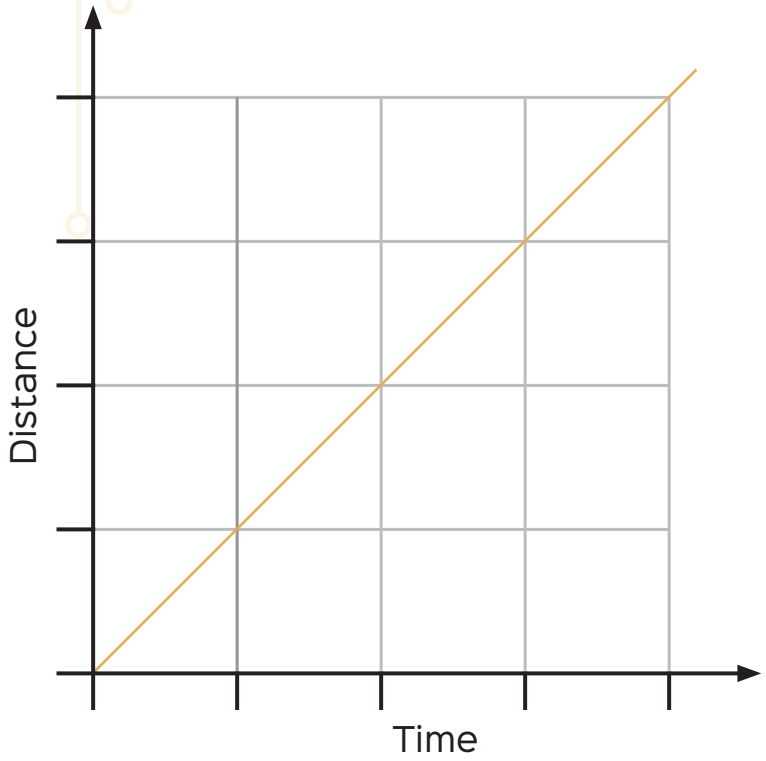
III. Using Acceleration Graphs To Interpret Data

A. Reading an acceleration graph

1. y-axis = _____
2. x-axis = _____

B. Example: If the line on this graph represents the velocity over a period of time, what's happening to this car?

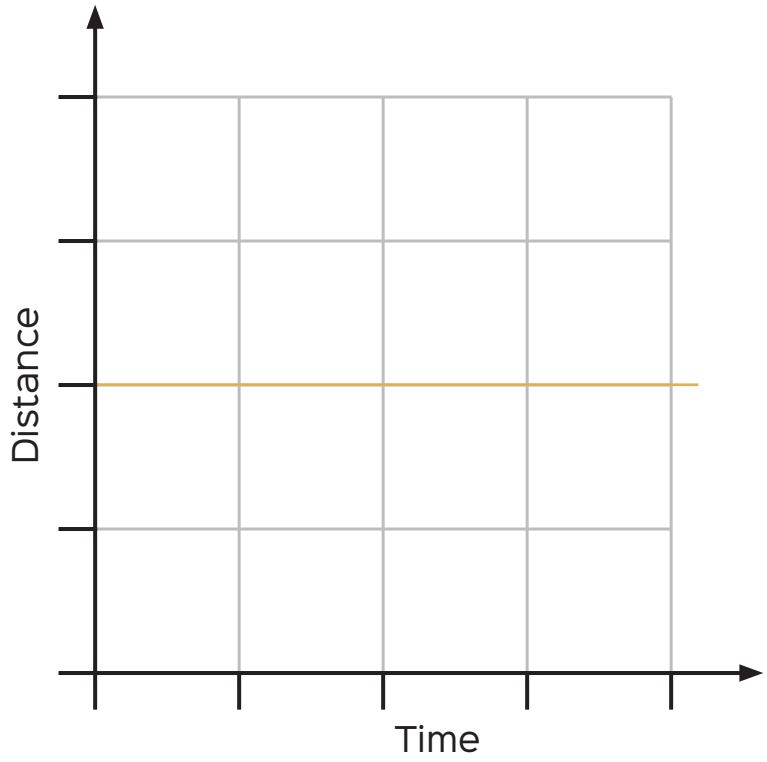
Acceleration Curve



1. The _____ of the car begins at _____ ; the car _____ _____
2. As _____ increases, _____ increases; the car is _____ at a _____ rate

C. Example: If the line on this graph represents the velocity over a period of time, what's happening to this car?

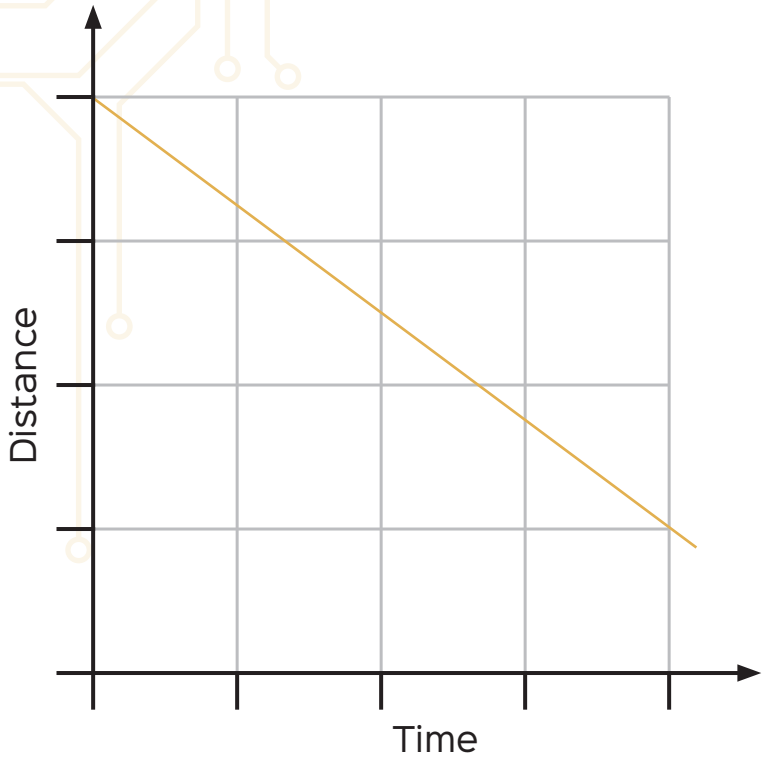
Acceleration Curve



1. Velocity is _____ up the y-axis, so the car is _____
2. The line is _____ and _____
   a. As time moves, velocity is _____
   b. The car is _____ , but it is _____

D. Example: If the line on this graph represents the velocity over a period of time, what's happening to this car?

Acceleration Curve



1. Velocity starts _____ and as _____ goes on, the velocity gets _____
2. The car has _____ acceleration, so it is _____

LESSON 21

NEWTON'S 1ST & 2ND LAWS

The universe is wired with predictable laws designed by the great Law Maker, and the era of classical physics began with the discovery of some of these laws. In this lesson, we explore the first two laws: inertia and cause and effect.

Vocabulary

Newton's first law of motion

Newton's second law of motion

Inertia

Force

Friction

Net force

OUTLINE & NOTES

LESSON 21: NEWTON'S 1ST & 2ND LAWS

I. Newton's First Law of Motion

A. Law of inertia: an object _____ remains _____ and an object _____ remains _____ at a constant speed, unless _____ _____ by an _____

B. Inertia

1. Inertia is the tendency to _____ unless acted on by an _____
2. _____ determines the _____ of an object: the more _____ an object has, the more _____ it has

C. Force

1. A _____ or _____ that one object _____ on another object
2. It _____ the state of _____ or _____ of an object
3. Measured in _____

D. Friction is a _____ that _____ motion between two objects that are _____

1. Dependent on:
   a. The kinds of _____
   b. The forces _____ the surfaces
2. Because of friction, a _____ must be applied to the object to _____
3. Types of friction
   a. _____ friction: friction between two surfaces that are _____
   b. _____ friction: friction between _____ surfaces

II. Force Diagrams

A. Net force: the _____ of _____ of the _____ acting on the object

1. If net force = _____
    a. The forces acting on the object are _____
    b. The object has _____ in motion
2. If there are _____
    a. The net force will _____
    b. The object will _____

B. Net force equation: _____

1. F_{net} = _____
2. F_A = _____
3. F_f = _____

C. Force diagrams help us _____ the _____ acting on an object

D. Example: A car is being pushed with a force of 500 N at a constant speed. Sketch a force diagram, label the forces, and calculate the net force on the car.

E. Example: A box is being pulled across a table with a force of 35 N. If the friction force on the box is 20 N, what is the net force on the box? Sketch a force diagram and label the forces.

III. Newton's Second Law of Motion

A. Law of cause and effect: the _____ of the object is determined by the _____ of the _____ and the _____ of the _____

1. An object with a _____ will have a _____
2. A _____ means a _____

B. Newton's second law equation: _____

1. F_{net} = _____
2. m = _____
3. a = _____

C. Example: How much force is needed to accelerate a 70 kg rider on her 200 kg motorcycle at 4 m/s^2?

D. Example: A sailboat and its crew have a combined mass of 655 kg. If a net force of 895 N is pushing the sailboat forward, what is its acceleration?

LESSON 22

GRAVITY & PROJECTILE MOTION

In the previous lesson, we began exploring forces that move objects in the horizontal plane. In this lesson, we'll begin exploring forces that move objects in the vertical plane—such as the force of gravity, as well as forces that hold objects up, like the solid surfaces upon which we stand.

Vocabulary

Air resistance

Gravity

Normal force

Projectile motion

Terminal velocity

OUTLINE & NOTES

LESSON 22: GRAVITY & PROJECTILE MOTION

I. Mass vs. Weight

A. Mass

1. A _____ of how much _____ is in an object
2. Remains the _____ for an object _____ the object is in the _____

B. Weight

1. A _____ of the _____ on an object
2. _____ depending on _____ the object is in the universe

II. Gravity

A. A _____ causing all objects near a _____ to experience a _____ toward that object

B. _____ due to _____

1. Newton's second law equation applied to gravity: _____
   a. F_g = _____
   b. m = _____
   c. g = _____ ; about _____ on Earth
2. Example: An astronaut has a mass of 70 kg. What is his weight on Earth in Newtons?

3. Example: How much does that astronaut weigh on the moon? The acceleration due to gravity on the moon is only 1.6 m/s^2.

III. Law of Universal Gravitation

A. Every object _____ every other object through the _____ _____

B. Gravitational force is _____ to the _____ of the objects

1. As masses _____ , gravitational force _____
2. As masses _____ , gravitational force _____

C. Gravitational force is _____ to the _____ between objects

1. As distance between objects _____ , gravitational force _____
2. As distance between objects _____ , gravitational force _____

D. The force of Earth's gravity is always _____ of the earth

IV. Forces Resisting Gravity

A. _____

1. Resists _____ and acts in the _____ of _____
2. As the object _____ , the force of air resistance _____

3. When the force of _____ is _____ to the force of _____ …

   a. The object will _____

   b. The object has reached its _____

B. _____ : the force surfaces exert preventing solid objects from _____ each other

C. Example: A 25 kg box is pushed across the floor with a force of 45 N at a constant speed. Draw a force diagram, labeling all of the forces acting on the box, and calculate the net force.

D. Example: You pull your 2.5 kg textbook across the table with a force of 5 N. If the friction force on the textbook is 3 N, draw a force diagram labeling all of the forces and calculate the net force on the textbook.

V. Projectile Motion

A. The _____ an object takes when it is thrown, launched, or otherwise projected near the _____

B. Motion in two dimensions: _____ and _____

1. Each dimension's motion is _____ of the other
2. Only _____ influences can change horizontal motion, and only _____ influences can change vertical motion

NOTES

LESSON 23

NEWTON'S 3RD LAW

When we use the expression "runaway train," we are talking about something with so much momentum that stopping is really difficult. But when we think of literal runaway trains, why are they so hard to stop? In this lesson, we explore the important concept of momentum and a third law of motion originally explored by Isaac Newton.

Vocabulary

Momentum

Newton's third law of motion

The law of conservation of momentum

OUTLINE & NOTES
LESSON 23: NEWTON'S 3RD LAW

I. Newton's Third Law of Motion

A. Law of _____ consequences: for every _____ there is an _____ and _____

B. For every _____ , there is a _____ with its _____

C. _____ and _____ forces

1. Present even when there is _____
2. Forces always come in _____
3. Forces occur at the _____ but _____ act on the _____
4. Equal _____ do not always have equal _____

II. Momentum

A. Momentum is a property of _____

1. Has _____
2. The _____ of the _____ and _____ of an object
   a. The _____ a moving object has, the _____ the object will have
   b. The faster an object is going, the more momentum it has

B. Momentum equation: _____

1. p = _____ , measured in _____

2. Example: A 6.00 kg bowling ball is moving at a rate of 10 m/s down the bowling alley toward the pins. Calculate the momentum of the bowling ball.

3. Calculate the momentum of a 135,000 g ostrich running north at 16.2 m/s.

4. Calculate the velocity of a 0.8 kg kitten with a forward momentum of 5 kg·m/s.

III. Change in Momentum

A. When you force an object to change its motion, a change in momentum occurs

B. The law of _____ of momentum: the _____ momentum of two or more objects after a _____ is the _____ as it was _____ a collision

1. Anytime objects _____ , they may _____ momentum
2. The _____ of the system always stays the _____
3. The _____ after a collision will always be in the _____ the object that had the _____ momentum initially was _____

NOTES

LESSON 24

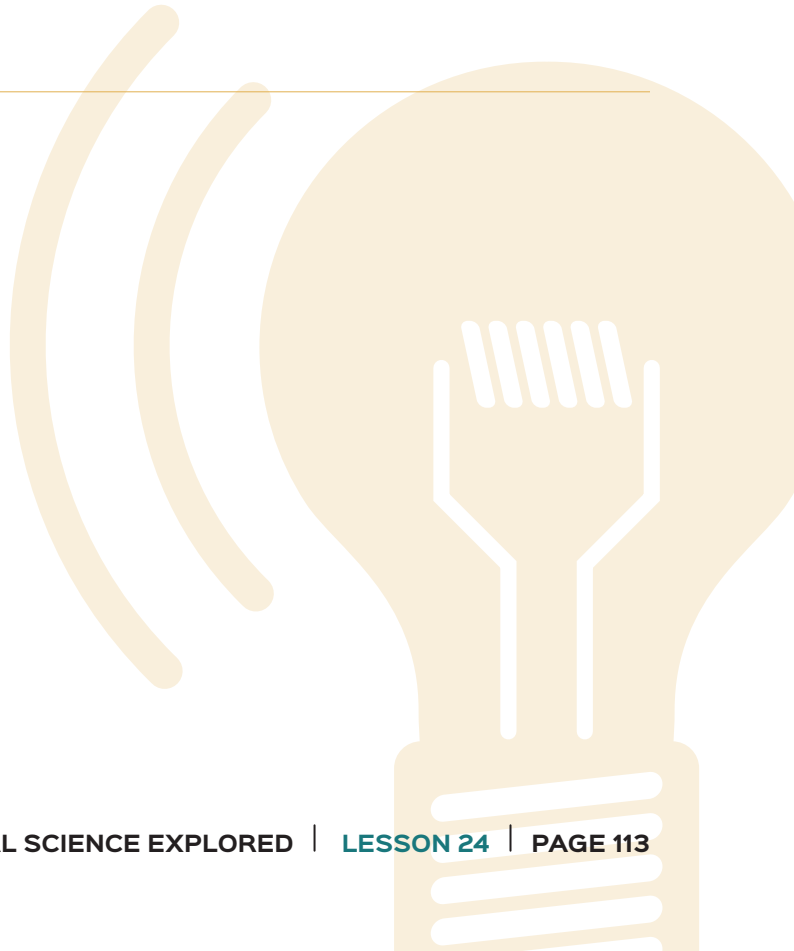
WORK & POWER

In this lesson, we explore the concepts of work and power, explaining how they are calculated and applied in real-world scenarios. You'll learn to differentiate work from power and understand the relationship between force, distance, and time.

Vocabulary

Power

Work



OUTLINE & NOTES
LESSON 24: WORK & POWER

I. Mechanical Work

A. Work relates to how much is _____ with the _____

B. Mechanical work equation: _____

1. F = _____ , measured in _____
2. d = _____ , measured in _____
3. W = _____ , measured in _____

C. Example: A mother lifts her child off the floor up to her hip which is 1.1 m off the ground. If she uses a force of 30 N to do this, how much work did she do?

D. Example: The same mother now lifts her older child off the floor up to her hip which is 1.1 m off the ground. If she uses a force of 45 N to do this, how much work did she do?

E. Example: You must exert a force of 4.5 N on a book to slide it across a table. If you do 2.7 J of work in the process, how far have you moved the book?

II. Power

A. The amount of _____ done in a given amount of _____ is called _____

B. Power equation: _____

1. W = _____ , measured in _____
2. t = _____ , measured in _____
3. P = _____ , measured in _____

C. Example: Lifting an elevator 18 m takes 100 kJ. If the elevator is lifted in 20 s, how much power did it take?

D. Example: If the elevator is lifted in 25 s, how much power does it take now?

E. Example: You walk up the stairs on the way to your room. If the stairs go up 3.25 m vertically and you weigh 565 N, what is your power output to climb the stairs in 12.6 s?

NOTES

LESSON 25

EXPLORING ENERGY, HEAT, & TEMPERATURE

One of the most basic forms of energy is the energy of motion, whether we are talking about roller coasters zooming across a track or microscopic particles vibrating in place. In this lesson, you'll learn about kinetic energy, potential energy, and the laws that govern motion and work. You'll even learn how these concepts apply to everyday objects, like rubber bands and birds!

Vocabulary

Conduction	Gravitational potential energy	Potential energy
Convection	Heat	Radiation
Elastic potential energy	Kinetic energy	Temperature

OUTLINE & NOTES

LESSON 25: EXPLORING ENERGY, HEAT, & TEMPERATURE

I. Introduction to Mechanical Energy

A. Energy is the ability to _____

1. Whenever work is done, energy is _____ or is _____ from _____ to _____
2. _____ are used to measure both _____ and _____

B. Categories of _____

1. _____ energy: energy of _____
2. _____ energy: _____ energy

C. Potential energy

1. Categories of potential energy
   a. _____ potential energy
      (1) Occurs in objects that can be _____ and _____
      (2) Examples: _____
   b. _____ potential energy: dependent on an object having _____ and _____
2. Gravitational potential energy equation: _____
   a. U_G = _____ , measured in Joules
   b. m = _____
   c. g = _____
   d. h = _____

3. Example: Calculate the potential energy of a 0.52 kg bird soaring at an altitude of 550 m.

D. Kinetic energy

1. When an object begins to _____
   a. Potential energy transforms into _____
   b. The object has the ability to do _____
2. Dependent on an object's _____ and _____
3. Kinetic energy equation: _____
   a. K = _____ , measured in _____
   b. m = _____
   c. v = _____
4. Example: What is the kinetic energy of a 44 kg cheetah running at 31 m/s?

E. Relationship between _____ and _____ energy

1. Energy is always conserved, it cannot be created or destroyed
   a. _____ energy can change forms into _____ energy and _____ energy can change forms into _____ energy
   b. There is always the _____ overall
2. Example: If a 0.4 kg ball is thrown straight up at a velocity of 25 m/s…
   a. What is the ball's kinetic energy?

   b. How much kinetic energy does the ball have when it reaches its highest point?
      (1) The ball ball is _____
      (2) Kinetic energy = _____
   c. How much potential energy does it have at its highest point?
      (1) The ball has the _____ of energy as the kinetic energy it _____
      (2) Potential energy = _____

II. Heat & Temperature

A. _____ of matter have kinetic energy, they are _____ _____

1. _____ particles _____ back and forth in a _____ position, _____ moving
2. _____ particles _____ past each other
3. _____ particles _____ all over, _____ moving

B. _____ of a substance is directly related to the _____ _____

1. A measure of how _____ or _____ something is, the _____ _____ of the _____ in an object
2. As the _____ of the particles _____ , the _____

C. Energy _____ between objects of _____ temperatures is called _____

1. Heat always _____ from objects of _____ to objects of _____
2. The greater the _____ in temperature, the _____ the energy will be transferred as heat
3. When both objects approach the _____ , the energy transfer _____

D. Modes of heat energy transfer

1. _____ : occurs when _____ of different temperatures are in _____
2. _____ : energy transfer resulting from the _____ of _____
3. _____ : energy that is transferred as _____

NOTES

LESSON 26

SIMPLE MACHINES

Simple machines are all around us, making our lives easier every day. In this lesson, we'll explore the different types of simple machines and even see how we can make simple calculations to determine how much these machines assist us.

Vocabulary

Compound machine
Fulcrum
Inclined plane
Lever
Mechanical advantage
Pulley
Screw
Simple machines
Wedge
Wheel and axle

OUTLINE & NOTES
LESSON 26: SIMPLE MACHINES

I. Introduction to Machines

A. Simple machines are basic _____ for _____

_____ , and the _____ for all other forms of machines

B. Six types of simple machines divided into _____

1. Lever family

   a. Simple lever: a rigid arm that _____ around a point called a

   _____

   (1) First-class lever

   (a) Fulcrum located _____ input and output forces

   (b) Example: _____

   (2) Second-class lever

   (a) Fulcrum located at _____ of the arm, input force on the

   _____

   (b) Example: _____

   (3) Third-class lever

   (a) Input force applied _____ the _____ and the

   _____

   (b) Example: _____

   b. Pulley

   (1) Modified lever used to _____ things

   (2) Contains a _____ that holds a flexible rope, chain, cord, or belt

   (3) The middle of the pulley is the _____

   c. Wheel and axle

   (1) _____ connected to a _____

   (2) The center of the axle is the _____

(3) Example: _____ of a car

2. Inclined plane family

a. Simple inclined plane

(1) _____ supporting surface tilted at an _____

(2) Example: _____

b. Wedge

(1) Two _____ placed back-to-back

(2) Example: _____

c. Screw

(1) Inclined plane wrapped around a _____

(2) Example: _____

C. Compound Machines

1. _____ two or more _____ machines

2. Example: car jack: a _____ combined with a _____

II. Mechanical Advantage

A. Machines _____ the amount of _____ that you can do

B. Based on the work equation (W=Fd), machines can increase the amount of force or distance, which decreases the other variable

1. Example: If you are trying to load a 225 N box into a truck that is 1.00 m off the ground, how much work does that require?

2. Example: If we use a 3.00 m ramp to get the box into the truck and work is 225 J, how much force is required to move the box into the truck with the help of this simple machine?

C. Mechanical advantage: the _____ between _____ and _____ , tells us how much _____ by using a machine

1. Mechanical advantage equation (force) = _____
2. Mechanical advantage equation (distance) = _____
3. Interpreting mechanical advantage
   a. Less than one: increases _____ and _____ but does not _____
   b. Greater than one: _____ the input force, which can _____ objects
4. Example: Find the mechanical advantage of a ramp that is 6.0 m long and 1.5 m tall.

5. Example: If you pull on the handle of a claw hammer with a force of 15 N and the hammer has a mechanical advantage of 5.2, how much force is exerted on the nail being removed by the hammer?

6. A mover uses a pulley system with a mechanical advantage of 10.0 to lift a piano 3.5 m of the ground. Ignoring friction, how far must the mover pull the rope?

NOTES

LESSON 27: EXAM 3

STUDY GUIDE

Use the following study guide as a practice test to prepare for the exam. If you get a question wrong, look back in your class notes to find the correct answer. Note the terms or concepts you don't remember to help you study for the exam.

Vocabulary

Acceleration

Air resistance

Centripetal acceleration

Compound machine

Conduction

Convection

Displacement

Distance

Elastic potential energy

Force

Friction

Gravitational potential energy

Gravity

Heat

Inertia

Kinetic energy

Kinetic friction

Law of unintended consequences

Law of universal gravitation

Mechanical advantage

Momentum

Motion

Net force

Newton's first law of motion

Newton's second law of motion

Newton's third law of motion

Normal force

Power

Projectile motion

Radiation

Simple machines

Speed

Static friction

Temperature

Terminal velocity

The law of conservation of momentum

Velocity

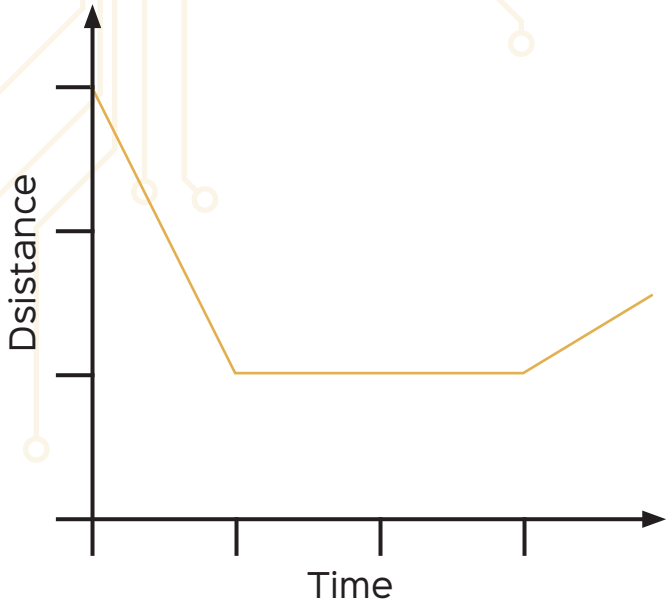
Work

Fill in the blanks using the vocabulary words that best complete each sentence. Not all words will be used.

1. _____ measures the complete path an object takes, while _____ is a direct line from the starting point to the ending point.
2. The _____ of an object is how fast the object moves in a particular direction.
3. _____ happens when an object speeds up, slows down, or changes direction.
4. According to _____ , an object at rest remains at rest unless acted on by an outside force.
5. The tendency of an object to not accelerate unless acted on by an outside force is called _____.
6. The force that opposes motion between two objects that are in motion is _____.
7. _____ states that the acceleration of an object is determined by the mass of the object and the size of the force acting on it.
8. If the _____ is 0, all the forces acting on the object are balanced and the object has no change in motion.
9. The weight of an object is a measure of the force of _____ on the object.
10. A falling object reaches its _____ when the force of air resistance is equal to the force of gravity on the object.
11. _____ is the curved path an object takes when it is launched near the surface of the earth, made up of both horizontal and vertical motion, each of which are independent of the other.
12. _____ is acceleration occurring in a circular motion.
13. According to _____ , every action has an equal and opposite reaction.

14. Someone pushing a box and the box pushing back on the person with an equal, reactive force at the same time is an example of the _____ _____ .
15. The product of the mass and velocity of an object is its _____ .
16. When you use force to move an object a certain distance, you are doing _____ .
17. _____ is the rate at which work is done.
18. _____ is the ability to do work.
19. _____ is friction between two surfaces that are stationary, but _____ is friction between moving surfaces.
20. The stored energy an object on a ledge has is _____ _____ .
21. The stored energy a stretched object has is _____ _____ .
22. The energy a moving object has is _____ .
23. The force surfaces exert preventing solid objects from passing through each other is called the _____ .
24. The energy transferred between objects of different temperatures, from objects of high temperature to objects of low temperature, is _____ .
25. One of the modes of heat energy transfer is _____ , which is when energy is transferred as electromagnetic waves.
26. The _____ states every object attracts every other object through the force of gravity, and the force of Earth's gravity is always toward the center of the earth.
27. _____ tells us how much force is increased by using a machine.

28. Answer the following about the velocity curve below:



a. Describe what is happening to the object represented by this graph.

_____

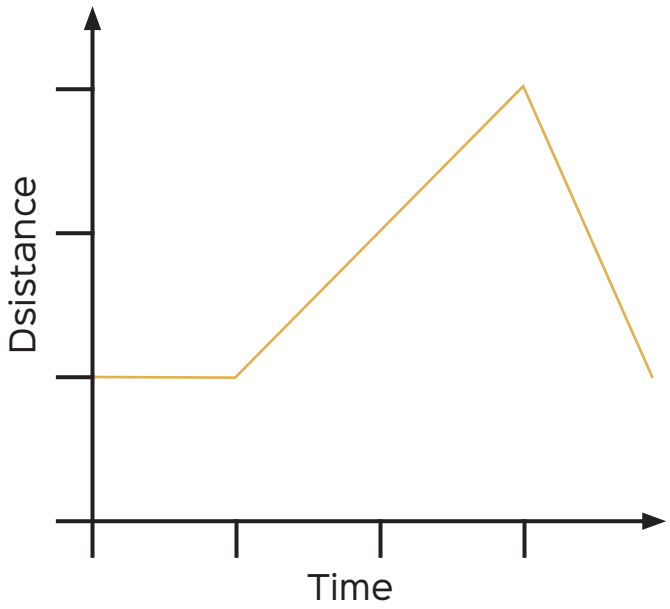
_____

b. What does the slope of this type of graph represent?

_____

_____

29. Answer the following about the acceleration curve below:



a. Describe what is happening to the object represented by this graph.

_____

_____

b. What does the slope of this type of graph represent?

_____

_____

30. Your aunt lives 7,000 m away from you. If you ride your bike at a speed of 9.85 m/s, how long in minutes does it take you to get there?

31. If a runner starts her race and accelerates at a rate of 0.7 m/s^2 and her top speed is 3 m/s, how long does it take the runner to reach her top speed?

32. If the runner is running at a rate of 3 m/s and she gets tired and changes speed to 1.75 m/s over 5 s. What is her acceleration? What does this acceleration tell us about the runner?

33. What is the weight of a 33 kg object?

34. A 25 kg box is being pushed across a table with a force of 85 N. The friction force on the box is 55 N.

    a. Sketch a force diagram, labeling the forces.

b. Calculate the net force on the box.

35. What is the momentum of a car traveling north with a mass of 300 kg and a velocity of 30 m/s?

36. If a house is lifted 1.52 m from its foundation onto a truck bed with 15,000 N of force so it can be moved to a new location, how much work is done on the house?

37. If it takes 93 s to lift the house in #36, how much power is used to lift the house?

38. A 60 kg diver is standing on top of a 10 m diving platform. How much potential energy does the diver have?

39. How much kinetic energy in kilojoules would a 1,587 kg sports car have if it travels at a speed of 53.64 m/s?

40. Find the mechanical advantage of a ramp that is 12.0 m long and 2.0 m tall.

41. Tell which type of simple machine each of the following objects are:

Construction crane: _____

Crow bar: _____

Slide: _____

Knife: _____

Windmill: _____

Bottle cap: _____

NOTES

LESSON 28

WAVES

Ready to dive into the dynamic world of waves? Join us as we unravel the secrets of how waves travel through different mediums, from rolling ocean waves to sound waves that fill our ears. Discover the differences between transverse and longitudinal waves and learn to graph them like a pro!

Vocabulary

Amplitude
Compression
Crest
Electromagnetic wave
Frequency
Longitudinal wave
Mechanical wave
Rarefaction
Surface waves
Transverse wave
Trough
Wavelength

OUTLINE & NOTES
LESSON 28: WAVES

I. Introduction to Waves

A. A _____ that carries _____ through _____

_____

B. Types of waves

1. _____ waves
   a. Waves which require a _____ through which to _____
   b. Examples: _____ waves (water), _____ waves (air), _____ waves (Earth)
2. _____ waves
   a. Waves consisting of _____ and _____
   b. Examples: _____

II. Wave Motion & Particle Movement

A. _____ waves

1. Motion of the _____ is _____ to the _____ motion
2. Particle motion is _____ , while the wave moves _____
3. Examples: _____

B. _____ waves

1. The wave motion is _____ to the _____ motion
2. Particle motion: _____
3. Example: _____

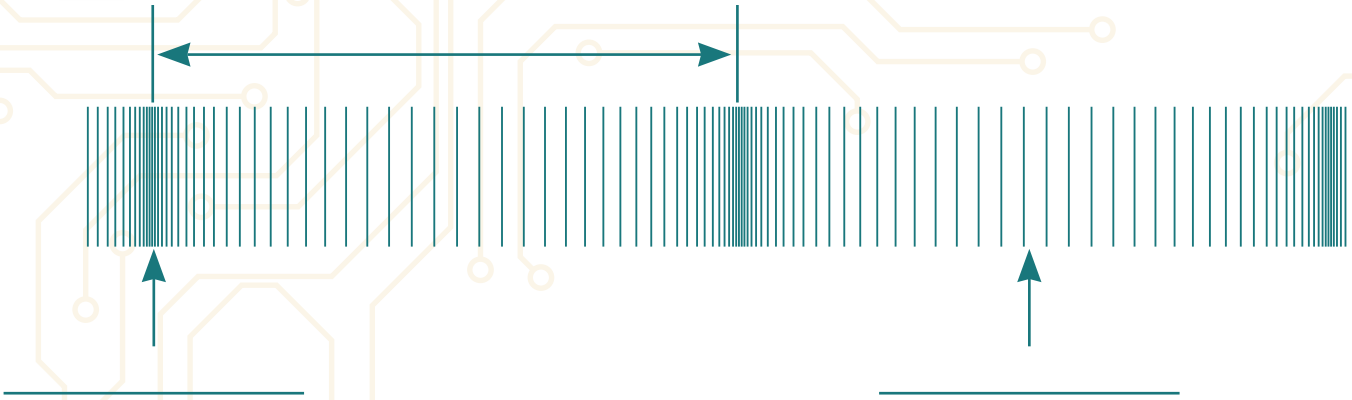
III. Wave Characteristics

A. Transverse waves

1. Crest: _____
2. Trough: _____
3. Amplitude
   a. Height from _____ to crest or trough
   b. The _____ the _____ , the _____ _____ the wave carries or transfers
4. Wavelength = _____
   a. _____ between two _____ or two _____
   b. Measured in _____
5. Period = _____
   a. _____ for one _____ to pass a point
   b. Measured in _____
6. Frequency = _____
   a. _____ of wavelengths _____ in a given time
   b. Measured in _____
   c. Higher _____ = lower _____

B. Longitudinal waves

1. Compressions: areas where particles are _____
2. Rarefactions: areas where particles are _____
3. Wavelength: _____ between any two successive _____ _____ of the wave

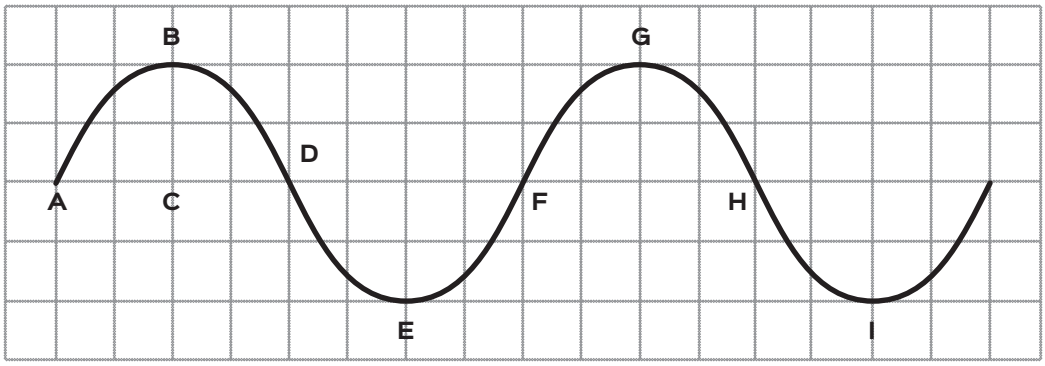


4. Frequency: the number of _____ that pass a place in _____ _____

5. Amplitude: the _____ the wave, the _____ _____ it has

IV. Reading & Graphing Transverse Waves

A. Transverse wave graph



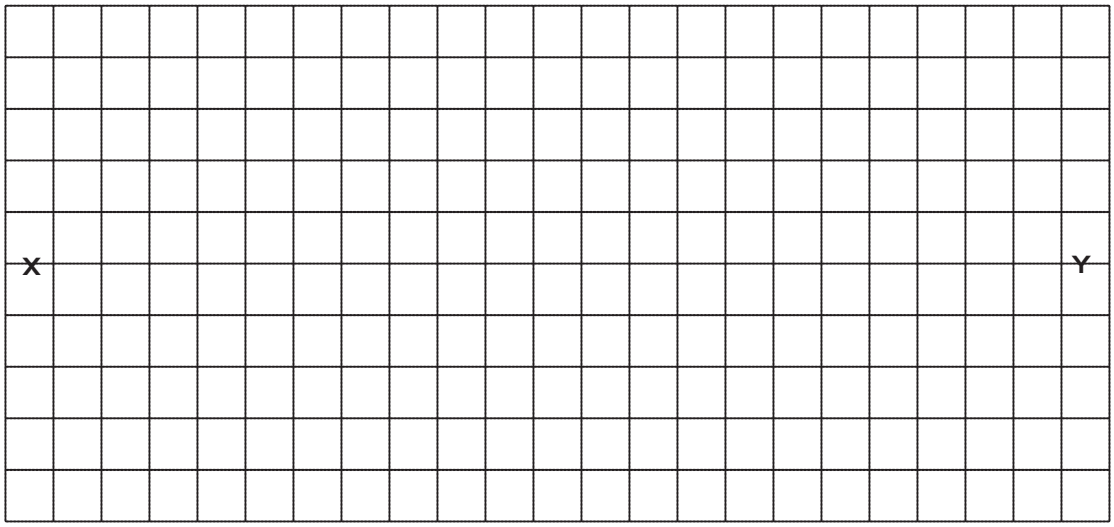
1. Crest: _____
2. Trough: _____
3. Wavelength: _____
4. Amplitude: _____

B. Example: Draw a wave with an amplitude of three units and a wavelength of eight units.

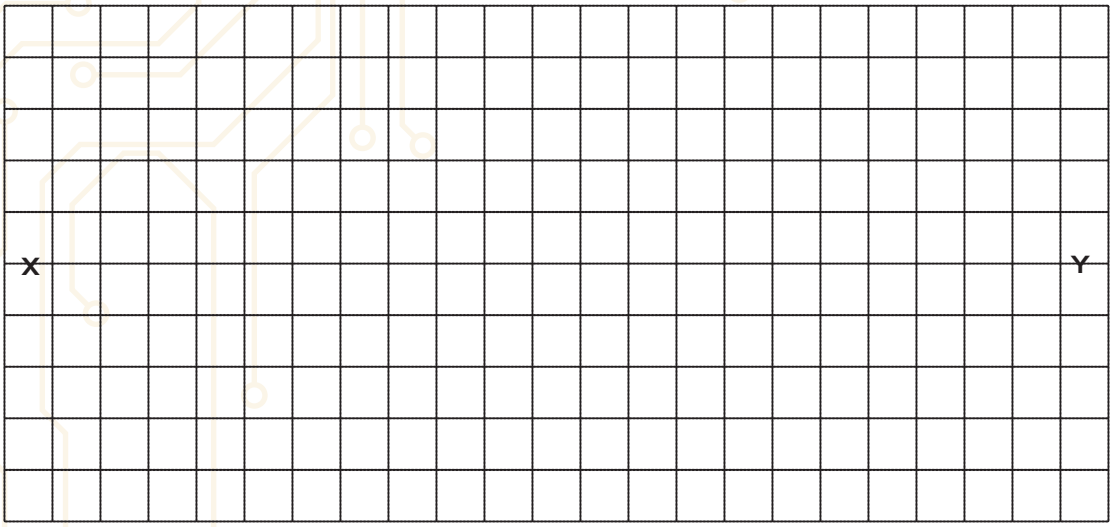
1. Plot the crests
   a. Begin on the far _____ side at the _____
   b. Use the _____ to plot the first _____

c. Plot more _____ based on the _____ until you run out of room

2. Plot the troughs
   a. Begin on the far _____ side at the _____
   b. Use the _____ to determine how far _____ the trough will be
   c. Move _____ a wavelength over to find the location of the _____ _____
   d. Plot more _____ based on the _____ until you run out of room
3. Connect the _____ with a _____



C. Example: Draw the graph of a wave that has a wavelength of two units and an amplitude of five units.



NOTES

LESSON 29

SOUND

In this lesson, we'll dive into the physics of sound waves, exploring how vibrations create the music we hear and how these waves travel through different mediums. From the speed of sound in the air to the intricacies of how our ears decode these waves, you'll discover the science behind every note you hear!

Vocabulary

Decibels

Intensity of sound

Pitch

OUTLINE & NOTES
LESSON 29: SOUND

I. Sound Waves

A. Review

1. _____ waves travel through the medium of _____
2. Caused by _____ objects
3. Have _____ and _____
4. In air, sound waves spread in _____

B. Speed of sound

1. Speed in air at room temperature: _____
2. Factors affecting speed:
    a. Medium
        (1) Fastest in _____
        (2) Slowest in _____
    b. Temperature: faster at _____ temperatures

C. Loudness and intensity

1. Loudness depends partially on the _____ in the sound wave, also called the sound's _____
2. Intensity of a sound wave is the _____ at which a sound wave _____ through a given area
    a. Impacted by the _____ of the wave
    b. Impacted by the _____ from the _____ of the sound
    c. Decibels (dB): _____ for sound intensity
        (1) Threshold of hearing: _____
        (2) Threshold of pain: _____

D. Frequency determines pitch

1. Pitch: how _____ a sound is perceived to be
2. The higher the _____ (number of wavelengths per second), the higher the _____
3. Human hearing range: _____ to _____

II. Human Hearing

A. The _____ consists of the _____ and _____ , concentrating sound towards the eardrum

B. The _____ consists of the _____ and tiny bones (_____) that vibrate the inner ear

C. The _____ is the fluid-filled _____ that sends electrical signals to the brain

D. Hearing loss

1. _____ hearing loss happens when _____ cannot travel freely through the _____ or _____ ear
2. _____ hearing loss happens when the _____ or its _____ are damaged

NOTES

LESSON 30

LIGHT & COLOR

In this lesson, we'll explore how light and color work. We'll unravel the science behind the visible spectrum to discover how interference and amplitude affect what we see. Then we'll uncover light's role in revealing colors and its broader place in the electromagnetic spectrum.

Vocabulary

Cones

Constructive interference

Destructive interference

Electromagnetic radiation

Electromagnetic spectrum

Gamma rays

Infrared waves

Intensity

Interference

Microwaves

Radio waves

Rods

Ultraviolet waves

X-rays

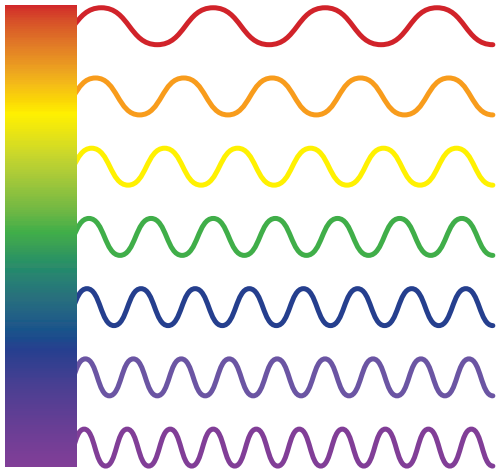
OUTLINE & NOTES
LESSON 30: LIGHT & COLOR

I. Introduction to Light

A. Light is _____ that can be detected by the _____

B. Color

1. Different colors have different _____ and _____
2. Colors towards the _____ end of the spectrum have _____ frequencies and _____ wavelengths
3. Colors towards the _____ end of the spectrum have _____ frequencies and _____ wavelengths



4. White light consists of _____ of the _____
5. Black is _____
6. The color of an object is the color it _____ to our _____ while it _____ others

C. Intensity

1. _____ determines the _____ or _____ of light
2. Related to the amount of _____ passing through a space
   a. Measured in _____
   b. As watts _____ , intensity _____
3. Related to the _____ from the source of the light
   a. As distance _____ , intensity _____
   b. As distance _____ , intensity _____

D. Interference

1. Happens when there is a _____ of multiple waves in the _____ _____
2. Types of Interference
   a. _____
      (1) Occurs when the _____ of two waves _____ or _____ of two waves _____
      (2) Example: If a wave with an amplitude of 2 cm and a wave with an amplitude of 4 cm crests overlap what will the amplitude of the resultant wave be? _____
   b. _____
      (1) Occurs when _____ of one wave meets the _____ of another wave
      (2) Example: If the 4 cm crest of one wave overlaps with the 3 cm trough of another wave, what will the amplitude of the resultant wave be? _____
3. Example of interference: light reflected off _____

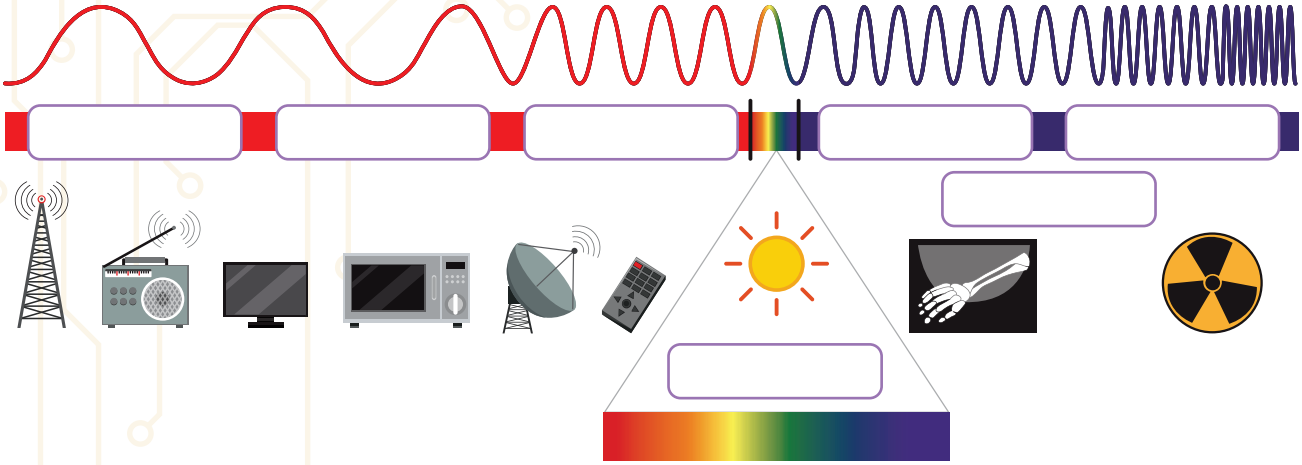
E. Speed of light

1. Speed depends on the _____
2. Speed in a vacuum: _____

II. The Electromagnetic Spectrum

A. All visible light is part of the _____

B. Like color, the electromagnetic spectrum goes from _____ frequencies and _____ wavelengths to _____ frequencies and _____ wavelengths



III. Human Sight

A. The _____ of the eye focuses light on the _____ at the back of the eye

B. The retina has special cells called _____

1. Rods detect _____ and _____
2. Cones detect _____

NOTES

LESSON 31

WAVE BEHAVIORS

Have you ever noticed that light bends when it passes through water or why you can hear music around a corner? In this lesson, we'll dive into the behaviors of waves — reflection, refraction, and diffraction — and discover how they shape our everyday experiences with light and sound.

Vocabulary

Angle of incidence

Angle of reflection

Diffraction

Focal point

Incident ray

Reflected ray

Reflection

Refraction

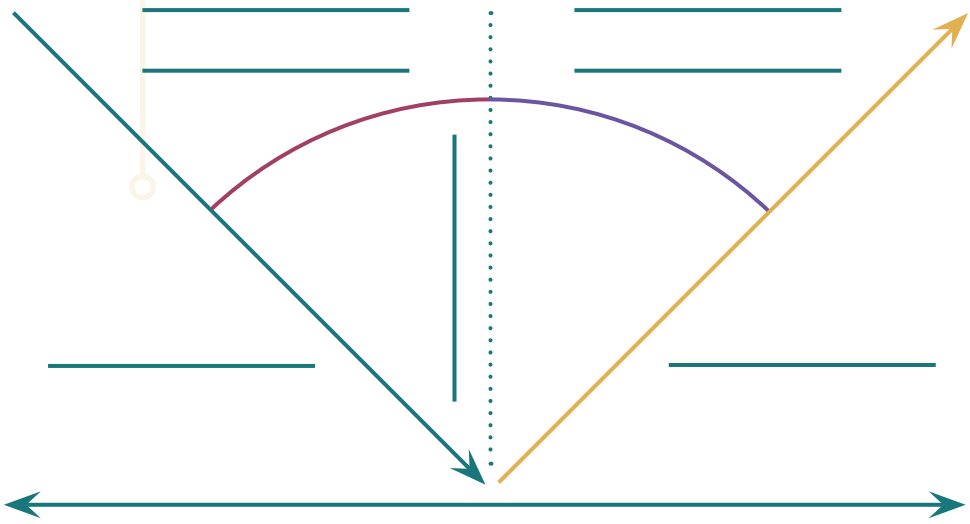
OUTLINE & NOTES
LESSON 31: WAVE BEHAVIORS

I. Reflection

A. The _____ of a wave when it meets a surface or _____

1. Boundary: where one medium _____ and a different one _____
2. Bouncing: an _____ in direction

B. Law of reflection: the angle of _____ equals the angle of _____

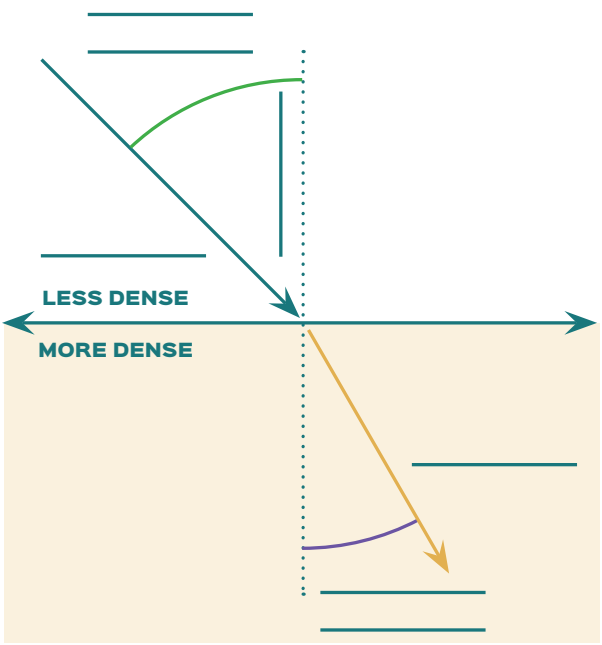


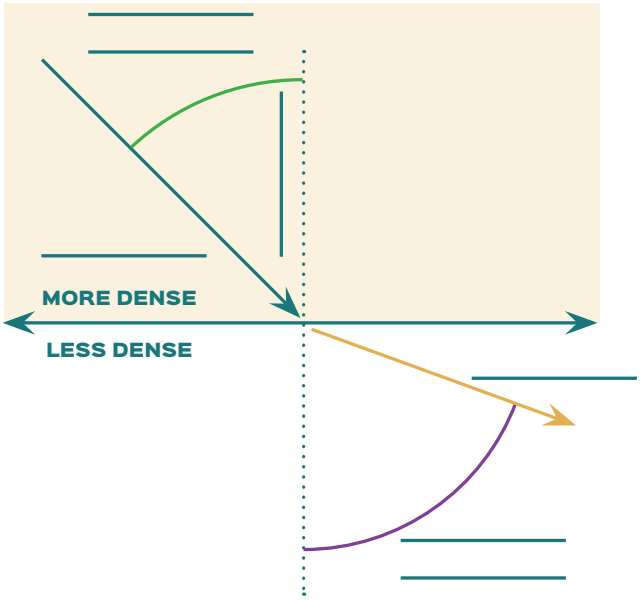
II. Refraction

A. The _____ of waves when they pass from one _____ to _____

B. Refraction is determined by the _____ of the mediums

1. Waves moving from a _____ dense to a _____ dense medium
   a. _____
   b. Bends _____ the normal
2. Waves moving from a _____ dense to a _____ dense medium
   a. _____
   b. Bends _____ the normal





III. Diffraction

A. Occurs when _____ around obstacles or _____ after passing through small openings

B. As waves move through a _____ , they spread out in a _____ _____

C. Diffractions relationship to wavelength

1. Waves with _____ wavelengths _____
2. Waves with _____ wavelengths experience _____

NOTES

LESSON 32

EXPLORING ELECTRICAL CHARGE

Electricity is a force that shapes our modern lives in ways we often overlook. From the simple act of plugging in a device to the complex phenomena of lightning. In this lesson we'll uncover the principles of electric charges, how they move, and a simple diagramming tool to help us visualize these concepts.

Vocabulary

Conductor	Electric force	Grounding
Electricity	Electric field	Insulator
Electric charge	Electric field lines	

OUTLINE & NOTES

LESSON 32: EXPLORING ELECTRICAL CHARGE

I. Electrical Charge

A. Electric charge is a property of _____ caused by an _____ of protons and electrons

1. If an object has _____ electrons, it has an overall _____ charge
2. If an object has _____ electrons, it has an overall _____ charge

B. Electricity: a form of _____ from the _____ of _____ particles

II. Movement of Electrons

A. Friction

1. Two surfaces _____ , causing a temporary buildup of _____ that _____
2. _____ electricity

B. Conduction

1. A _____ object _____ a neutral object and the charged object gives some of its _____ to the neutral object
2. _____ is a form of conduction occurring when a charged object contacts the _____
3. _____ vs. _____
   a. Conductors: allow _____ to flow _____ (example: copper)
   b. Insulators: _____ the flow of _____ (example: plastic)

C. Induction

1. A _____ object _____ to a neutral object, _____ it
2. Charges move and one side becomes _____ and the other side becomes _____

3. Charges have not been _____ , but they _____

III. Electric Fields

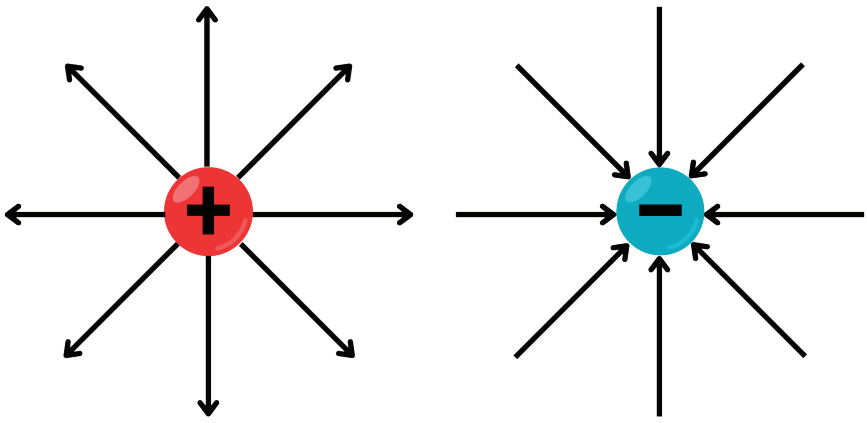
A. Electrical _____ : an _____ surrounding a charged particle where a _____ _____

B. Electric _____ is related to:

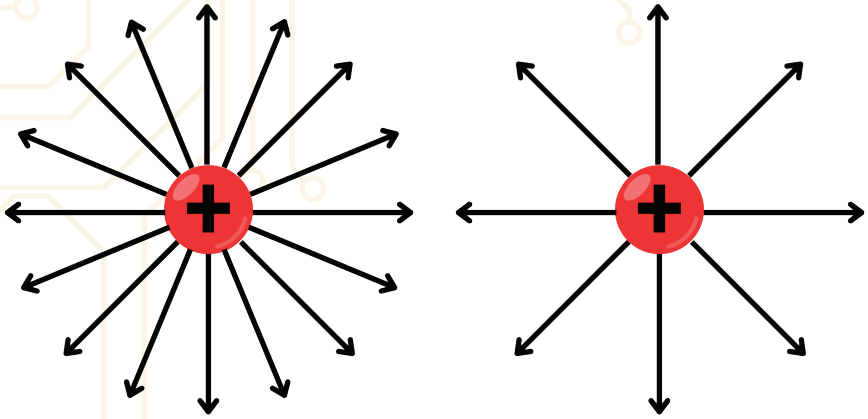
1. The _____ of _____ each object has
   a. The _____ the charge, the _____ the force
   b. The _____ the charge, the _____ the force
2. The _____ between the objects
   a. The _____ the distance, the _____ the force
   b. The _____ the distance, the _____ the force

C. Electric field lines

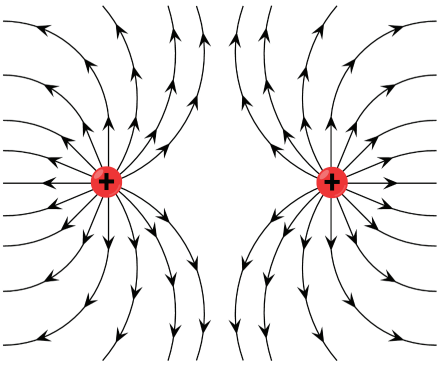
1. A simple _____ tool providing information about the relative amount of _____ in a region of space
2. Indicates both _____ and _____ of an electrical field
   a. Direction of field lines: represent the force that would occur if a _____ _____ were to come near it



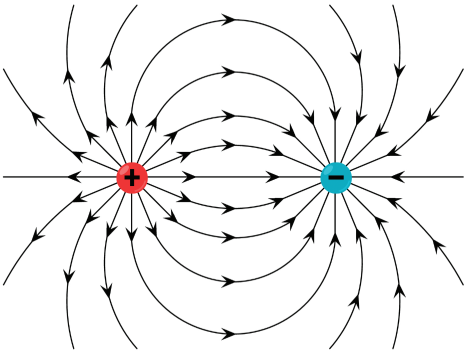
b. _____ of field lines indicates the _____ of the field



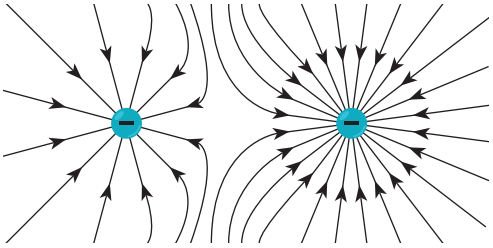
3. Example: Two _____ charges of the _____ strength



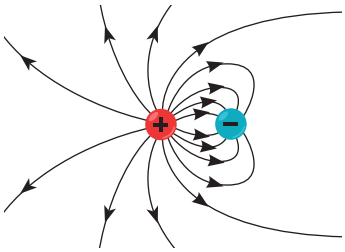
4. Example: One _____ and one _____ charge of the _____ strength



5. Example: Two _____ charges, but one is _____ than the other



6. Example: One _____ and one _____ charge, and the positive charge is _____



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LESSON 33

ELECTRIC CIRCUITS

Get ready to go even deeper into the world of electricity in this lesson! In this lesson, we'll explore how electric charges flow to create currents and learn to visualize them using drawn circuit diagrams. Discover the key components of circuits, the differences between series and parallel setups, and how to apply Ohm's law to understand the relationship between voltage, current, and resistance.

Vocabulary

Battery	Ohm's law	Resistor
Closed circuit	Open circuit	Series circuit
Current	Parallel circuit	Switch
Electrical circuit	Resistance	Voltage

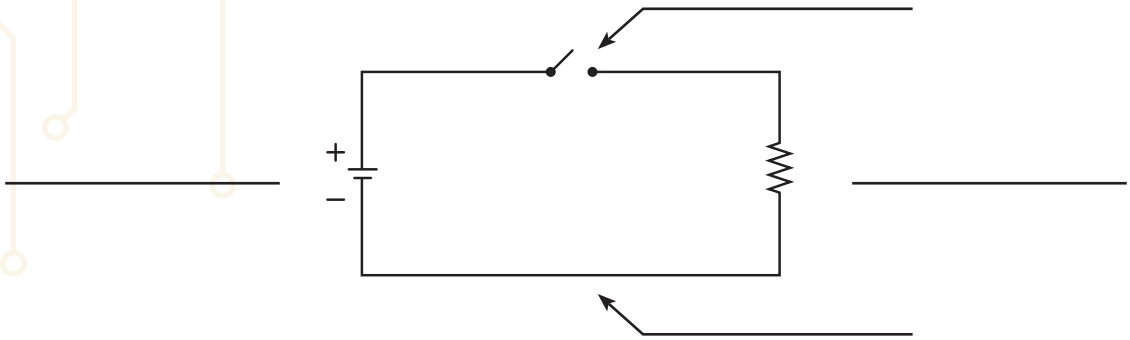
OUTLINE & NOTES
LESSON 33: ELECTRIC CIRCUITS

I. Introduction to Electrical Circuits

A. Electric charges can make a _____ of electricity, a _____ of electric charges

B. Electric _____ : a _____ that allows an electric current to _____

C. Circuit diagrams



1. Battery or power source
   a. The _____ line represents the _____ flow side and _____ line represents the _____ side
   b. When two locations have different _____ , this means there is an _____ between them
   c. This difference is called _____ : the _____ that pushes _____ around a circuit
2. Conducting wire: connects everything
3. Resistor: useful device that uses the electrical charge and _____ it into another form of _____
4. Switch
   (a) _____ switch _____ the flow of electricity, creating an _____ circuit

(b) _____ switch could be indicated by two dots on the _____ , creating a _____ circuit for the current to flow

5. Example: Draw a circuit with two batteries, two resistors, and a closed switch.

II. Series vs. Parallel Circuits

A. Series circuits: all circuit _____ are arranged in a _____

B. Parallel circuits have _____ that do not _____ any _____

C. Example: Draw a parallel circuit with a battery, two light bulbs on different branches, and place the switches so each light bulb can be controlled independently.

III. Ohm's Law

A. Ohm's law equation: _____

1. V = _____ , measured in _____
2. I = _____ , measured in _____ , or _____
3. R = _____ , measured in _____

B. Example: The headlights of a typical car draw 3.0 amperes of current when powered by a 12 volt battery. What is the resistance of the headlights when they turn on?

C. A light bulb has a resistance of 12 Ω. It is attached to a battery with a voltage of 24 V. What is the current in the light bulb?

LESSON 34

MAGNETISM

Discover how ancient navigators relied on the stars and compasses, long before GPS transformed our understanding of direction. In this lesson, we'll explore magnetic fields, the unique properties of magnets, and their essential role in technology today. Learn how magnetism shapes our world and how you can visualize these invisible forces.

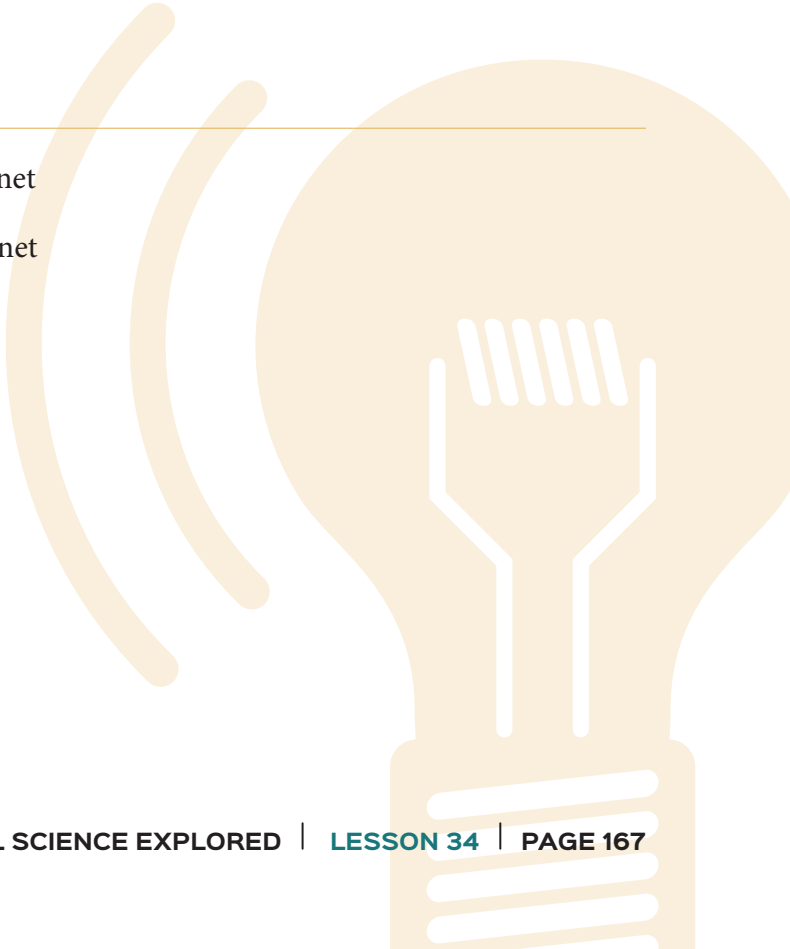
Vocabulary

Lodestone

Magnetite

Permanent magnet

Temporary magnet



OUTLINE & NOTES
LESSON 34: MAGNETISM

I. Introduction to Magnetism

A. Magnets are objects that produce _____ and _____ like iron, nickel, and cobalt

B. Magnetism is caused by the _____

C. Lodestones

1. Naturally occurring _____
2. Composed of _____

D. Properties of magnets

1. Magnets have two poles: _____ and _____
   a. Opposite points where _____ are _____
   b. Opposite poles _____
   c. Like poles _____
2. _____ magnets orient themselves in a _____ direction with the earth
3. _____ of magnetism is impacted by the _____ of the magnet
4. Magnetic force becomes _____ the _____ magnets are and _____ the _____ they are

E. Permanent vs. temporary magnets

1. _____ magnets
   a. Occurs when materials exhibit _____ properties _____ when in the presence of a _____
   b. _____ to magnetize
   c. _____ magnetic properties _____
2. _____ magnets

a. _____ magnetic properties

b. _____ to magnetize

c. Properties of magnetism can be _____ by _____ or _____ the metal

II. Magnetic Fields

A. Regions where a _____ can _____ on another object

B. Magnetic field lines

1. Magnetic field lines always form _____
2. _____ varies with _____ and degree of _____
   a. Lines _____ indicate a _____ field
   b. Lines _____ indicate a _____ field

C. _____ magnetic field

1. Movement of _____ in the outer _____ creates the earth's _____
2. _____ and _____ poles are _____
3. Magnetic field lines would go from magnetic _____ to magnetic _____
4. Forms the _____ which surrounds and _____ the earth from solar radiation

NOTES

NOTES

LESSON 35: EXAM 4

STUDY GUIDE

Use the following study guide as a practice test to prepare for the exam. If you get a question wrong, look back in your class notes to find the correct answer. Note the terms or concepts you don't remember to help you study for the exam.

Vocabulary

Amplitude
Color
Compression
Conductor
Conduction
Cones
Constructive interference
Crest
Current
Destructive interference
Diffraction
Electrical circuit
Electric field
Electricity spectrum
Electromagnetic wave
Energy
Focal point
Frequency
Gamma rays
Grounding
Hertz
Induction
Infrared waves
Insulator
Intensity
Interference
Light
Lodestone
Longitudinal wave
Magnetite
Mechanical wave
Medium
Meters
Microwaves
Negative
North pole

Parallel circuit	Resistance	Temporary magnet
Period	Resistor	Transverse wave
Permanent magnet	Rods	Trough
Pitch	Seconds	Ultraviolet waves
Positive	Series circuit	Voltage
Radio waves	Sonar	Wavelength
Rarefaction	Sound	White light
Reflection	South pole	X-rays
Refraction	Static electricity	

Fill in the blanks using the vocabulary words that best complete each sentence.
Not all words will be used.

1. In a _____ , the particles move perpendicular to the motion of the wave, while in a _____ , particles move parallel to wave motion.
2. The time for one complete wave to pass a point is the _____ and is measured in _____ and the number of wavelengths that pass a point in a given time is called the _____ and is measured in _____ .
3. The part of a longitudinal wave where particles are close together is called a _____ , while the part where particles are spread out is a _____ .
4. As the _____ of a wave increases the _____ increases which corresponds to increased loudness of a sound wave and increased brightness of a light wave.
5. The _____ can impact the speed of a wave; for instance, _____ travels faster in solids than it does in liquids or gases, and _____ travels faster in a vacuum than it does anything else.
6. As the frequency of a sound wave decreases it causes the _____ to decrease.
7. _____ is a system that uses sound waves to measure distance.
8. When two waves meet, changing the amplitude of the resultant wave, this is called _____ .

9. When the crests of two waves overlap, it is _____ ; when the crest of one wave meets the trough of another wave, it is _____ _____ .
10. The part of the eye that detects movement and brightness is the _____ and the part detecting color is _____.
11. An object is said to be a certain _____ if that frequency and wavelength of visible light is reflected from its surface; an object appears to reflect _____ when it reflects every frequency of visible light.
12. When a wave bounces back from a surface or boundary, it's called _____ .
13. _____ is the bending of a wave when it passes from one medium to another.
14. _____ , the bending of waves around obstacles, occurs more easily in a wave with a longer _____.
15. _____ is a form of energy resulting from the movement of charged particles.
16. The charge of an object that has lost electrons is _____ ; the charge of an object that has gained electrons is _____ .
17. _____ occurs when a charged object touches a neutral object, transferring some of its charge. When the neutral object is the Earth, this is called _____ .
18. When friction causes a buildup of electrons that stays in place, it results in _____ _____.
19. _____ occurs when a charged object polarizes a neutral object without touching it.
20. An _____ is the area around a charge where a force is present.
21. A pathway that allows an electric _____ , that is, a flow of charges, to move is called an _____.
22. _____ is the force that pushes electrons around a circuit.
23. A device that uses electrical charge and transforms it into another form of energy is called a _____ .
24. Copper is a good example of a _____ , but plastic is a good example of an _____.

25. When all electrical circuit elements are arranged in a single path, this is a _____ _____ , but when a circuit has two or more branches, this is a _____ _____ .

26. _____ only exhibit magnetic properties in the presence of a magnetic field.

27. _____ are difficult to magnetize but retain their magnetic properties.

28. Indicate whether each of the following are mechanical or electromagnetic waves:

Require a medium through which to travel	
Waves that can travel through a vacuum	
Seismic waves	
Radio waves	
Visible light	
Sound waves	

29. Put the following waves in order from longest to shortest wavelength: blue light, green light, indigo light, orange light, red light, violet light, and yellow light.

_____

_____

_____

_____

_____

_____

_____

30. In the electromagnetic spectrum, put the following waves in order from longest to shortest wavelength: gamma rays, infrared waves, microwaves, radio waves, ultraviolet waves, visible light, and x-rays.

_____

_____

_____

_____

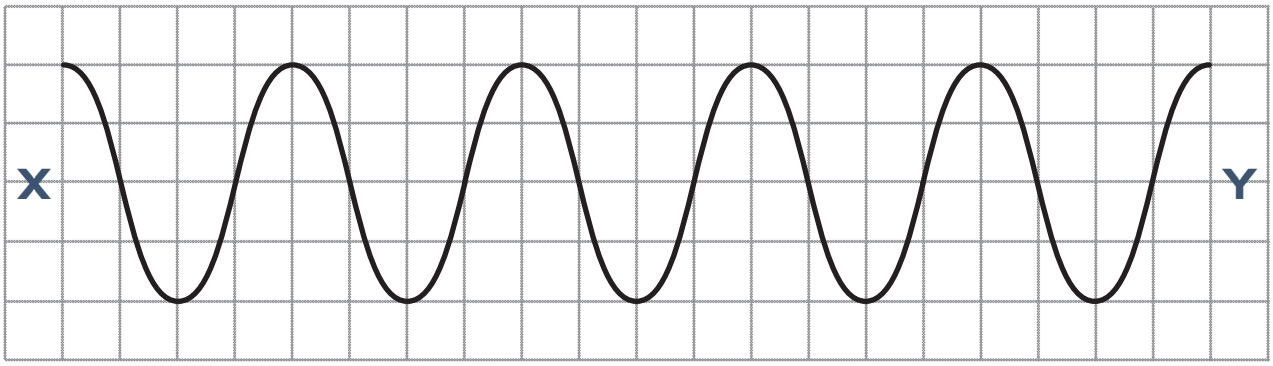
_____

_____

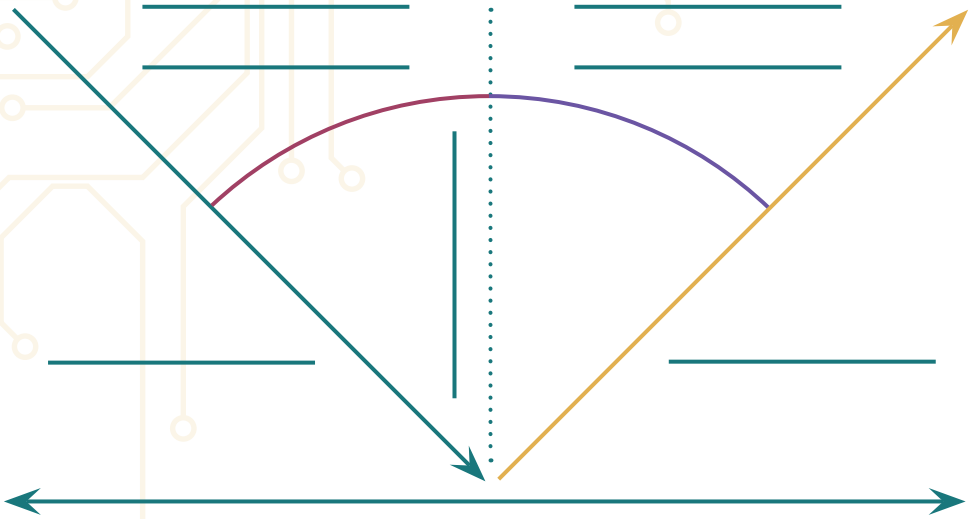
_____

31. Label the diagram below with the words crest, trough, amplitude, and wavelength.

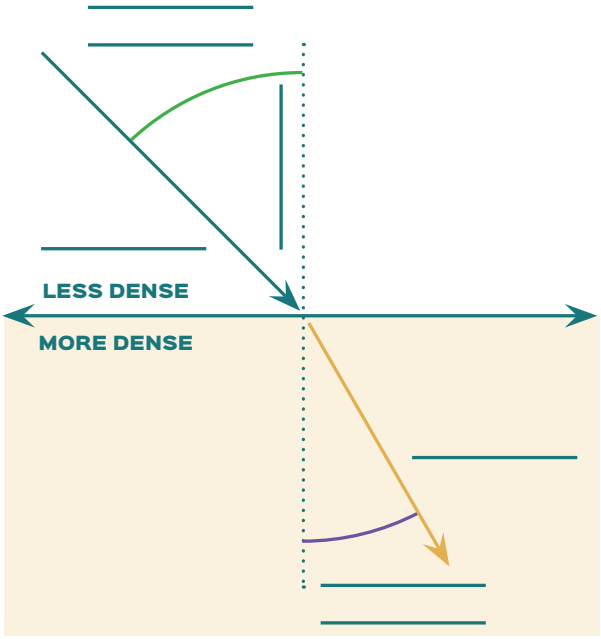
- How many units is the wavelength of this wave? _____
- How many units is the amplitude of this wave? _____



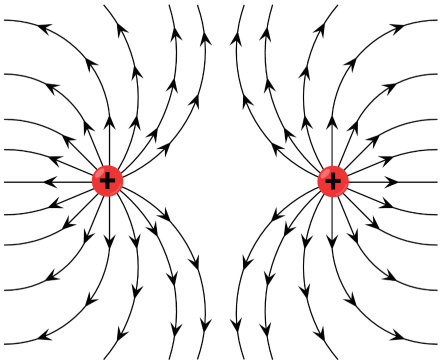
32. Label the reflection diagram below:



33. Label the refraction diagram below:



34. Draw electric field lines for two positive charges with the same strength.



35. If a 2 ft crest of one wave overlaps with a 3 ft crest of another wave, what will the amplitude of the resultant wave be?

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36. The current flowing through a radio is 0.5 amperes and the potential difference across the radio is 120 volts. How much resistance does the radio have?

37. A 1.5 ohm resistor is hooked up to a 9 volt battery. How much current is running through it?

38. Draw a series circuit with one battery, an open switch, and 2 resistors.

39. Draw a parallel circuit with two batteries, two resistors, and a closed switch that controls both resistors.

40. Consider whether the following statements apply to magnets, electricity, or both:

Like repels like	
Opposites attract	
When cut in half have two distinct ends	
Caused by an imbalance of charges	
Force increases as distance decreases	
Occurs with both stationary and moving charges	
Orient themselves in a specific direction when suspended	