Name: _____ Date: _____ Block: _____

Physical Science

FINAL STUDY GUIDE

Motion, Momentum and Forces:

Motion and Momentum

SPEED-

1. S=d/t (Speed= Distance/Time)
2. UNIT: m/s

VELOCITY-

1. Speed in a direction (N,S,W,E, Right, Left, + or -)
2. UNIT: m/s with direction.

ACCELERATION-

1. Change velocity in a given amount of time.
2. $a = v_v - v_i / t$ (Final Velocity – Initial Velocity / Time)
3. UNIT: m/s^2 $(\frac{\frac{m}{s} \; \frac{m}{s}}{s})$
4. Acceleration due to gravity- ≈ 10 m/s^2

SCALAR QUANTITY- has magnitude **ONLY** (ex: speed, distance, mass, temperature)

VECTOR QUANTITY- has magnitude ***AND*** direction (ex: velocity, displacement)

INERTIA-

1. Tendency of an object to resist a change in its motion.

MOMENTUM-

1. Measure of how hard it is to stop a moving object.
2. BIGGER the object = harder it is to stop.
3. p=mv (Momentum= mass x velocity)
4. UNIT: kg x m/s kgm/s

LAW OF CONSERVATION OF MOMENTUM-

1. Total momentum of objects that collide with each other doesn't change (Momentum BEFORE collision = Momentum AFTER collision)

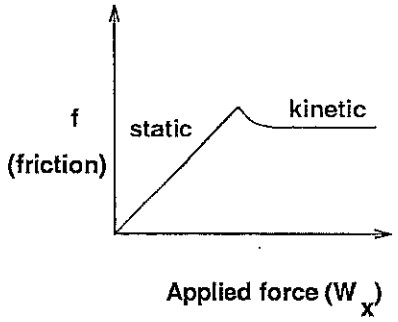
Force and Newton's Laws:

FORCE- push or pull

NEWTON'S FIRST LAW OF MOTION (aka Inertia) – an object at rest/in motion will stay at rest/in motion unless acted upon by an outside force.

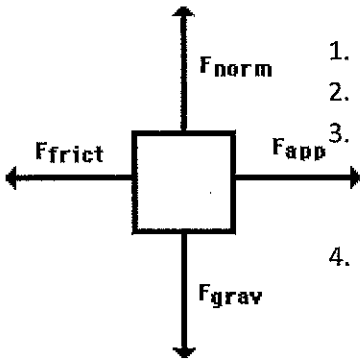
NET FORCE- combination of all the forces acting on an object.

FRICTION- force that opposes motion.

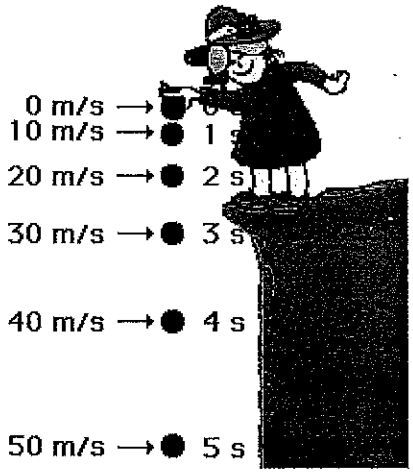


1. Static- force that opposes motion.
2. Sliding/Kinetic
3. Rolling

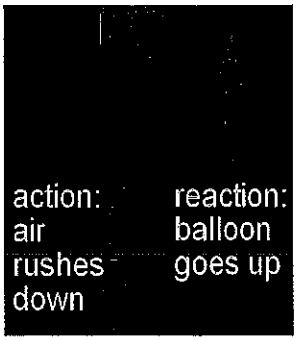
NEWTON'S SECOND LAW OF MOTION- an object acted upon by a force will accelerate in the direction of the force.



1. F=ma (force= mass x acceleration)
2. UNIT: Newtons (N)
3. Circular Motion
   a. Centripetal Force- force that keeps an object moving in a circular path.
4. Air Resistance
   a. Terminal Velocity- point at which air resistance = force of gravity.



NEWTON'S THIRD LAW OF MOTION- For every action, there is an equal and opposite reaction. (Forces ALWAYS act in pairs) ⟶



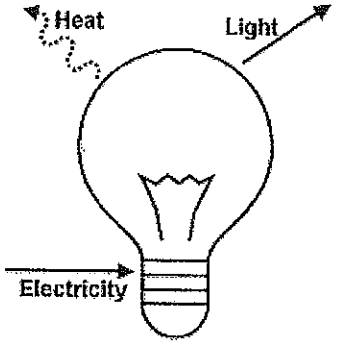
NEWTON'S LAW OF UNIVERSAL GRAVITATION- The gravitational attraction between two objects depends on the **mass** and **distance** between them (I.E.- two objects that are large and close together = strong gravitational attraction)

Energy

ENERGY- ability to cause change

1. **Work**- Cause movement
   a. W=fd (Work = Force x Distance)
   b. UNIT: Joules (J)

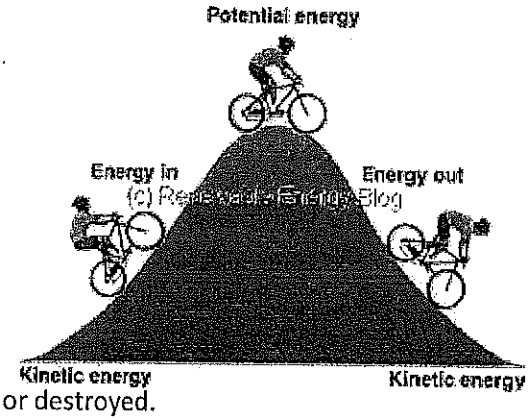
2. **Power**- determined by time (Also causes movement)
    a. P = W/t (Power = Work/ Time; Power = Force x Distance/ Time)
    b. UNIT: Watts (w)



TYPES OF ENERGY-

1. Electrical
2. Water
3. Wind
4. Heat (Thermal)
5. Chemical
6. Kinetic
7. Potential

POTENTIAL ENERGY- energy of *position* or *stored* energy.



1. Energy of position depends on height AND mass
2. GPE= mgh (Mass x Gravity x Height)
3. UNIT: Joules (J)

KINETIC ENERGY- Energy of *motion*

1. $KE=1/2mv^2$ (1/2 x MASS x VELOCITY SQUARED)
2. UNIT: Joules (J)

LAW OF CONSERVATION OF ENERGY- Energy is never created nor destroyed.

1. Energy is converted from one form to another. (Ex. PE → KE: KE → PE; Chemical→ Electrical)

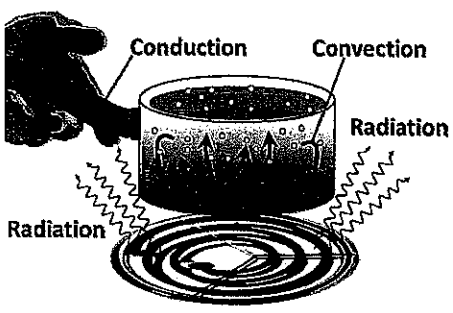
HEAT and HEAT TRANSFER

Temperature – measure of the average Kinetic energy of molecules in a substance

Thermal Energy – measure of kinetic and potential energy of all the particles/molecules in a substance

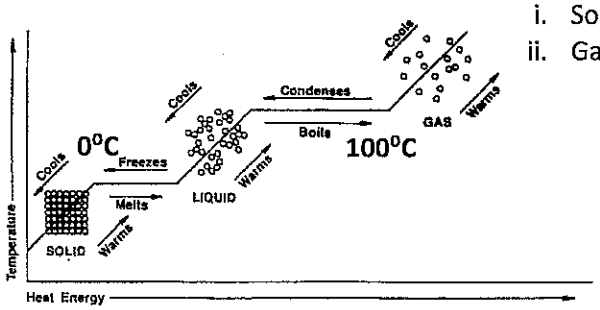
Heat – the transfer of thermal energy between objects **at different temperatures**

1. Heat **always moves** from hot → cold
2. q = mΔtc (HEAT = MASS × CHANGE IN TEMPERATURE × SPECIFIC HEAT)
3. Units: Joules (J) or Calories (c)
4. Specific Heat – measure of how easily/quickly a substance absorbs heat
    a. Units: J/kg×°C or c/kg×°C
5. Transferring Heat:
    a. Conduction – transfer of heat between objects that are touching (direct contact)
        i. Conductor – material that transfers heat easily (ex. Metals)
        ii. Insulator – material that does not transfer heat easily (ex. Plastic, rubber, glass)

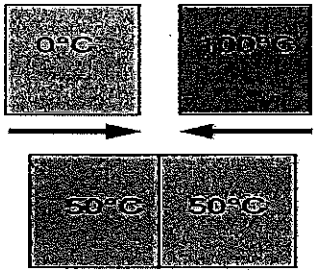


b. Convection – movement of molecules from one part of a material to another. Always involves fluids (liquids and gases)
c. Radiation – (sun) energy is transferred through electromagnetic waves

6. Heating an object:
   a. Phase Changes:
      i. Solid → Liquid → Gas (Heat is being added)
      ii. Gas →Liquid → Solid (Heat is being removed)



7. Thermal Equilibrium – transfer of heat energy from two objects with different temperatures



WAVES

Waves – Carry energy

1. Types of Waves:
   a. Mechanical – need matter to transfer energy through
      i. 2 Varieties:
         1. Transverse – move up and down (ex. Water waves, crowd wave)
            a. Crest
            b. Trough
            c. Wavelength
            d. Amplitude
         2. Compression (longitudinal) – move right to left (ex. Sound wave)
            a. Compressions
            b. Rarefactions
            c. Wavelength

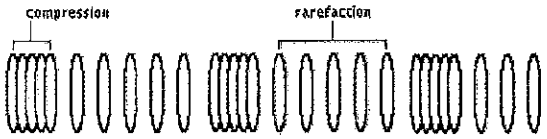


Figure 1: Longitudinal Wave

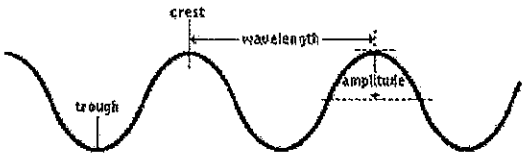


Figure 2: Transverse Wave

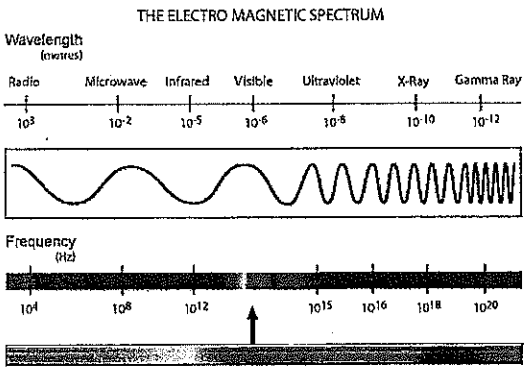
      ii. Frequency – number of waves passing a given point per second
         1. Units: Hertz (Hz)
      iii. Wave Velocity – how fast a wave moves
         1. $v = \lambda f$ (VELOCITY = WAVELENGTH × FREQUENCY)
         2. Units - m/s
      iv. Speed of Waves:
         1. Light – 300,000 km/s
         2. Sound – 340 m/s

a. Travels faster in solids than liquids, and faster in liquids than in gases

v. Doppler Effect – change in frequency or pitch of a sound that occurs when the sound source or listener are moving relative to each other

b. Electromagnetic Waves

i. **Do not** need matter to transfer energy through
ii. can travel through a vacuum
iii. all travel at the speed of light (300,000 km/s) in a vacuum
iv. have wavelength and frequency
v. Consist of 2 parts:
   1. Electric field
   2. Magnetic field
vi. Electromagnetic spectrum
vii. Radio
   1. Longest wavelength
   2. Lowest energy
viii. Microwaves
ix. Infrared
x. Visible light
xi. UV
xii. X-rays
xiii. Gamma

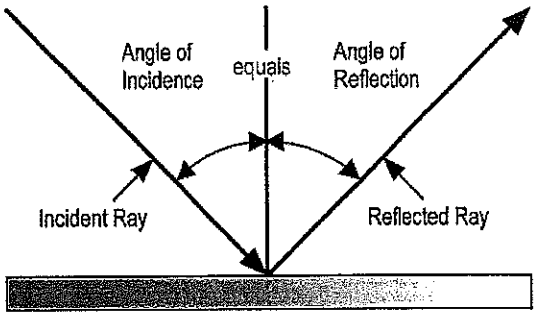


2. WAVE BEHAVIOR

a. Reflection- bouncing of waves off a surface or object. (ex. Echo)
b. Refraction- bending of waves as they change speed moving from one medium to another.
c. Diffraction- bending of waves around a barrier.
d. Interference- when 2 waves meet and overlap to form a new wave.
   i. Constructive interference- waves combine to make a bigger wave.
   ii. Destructive interference- waves combine to make a smaller wave.

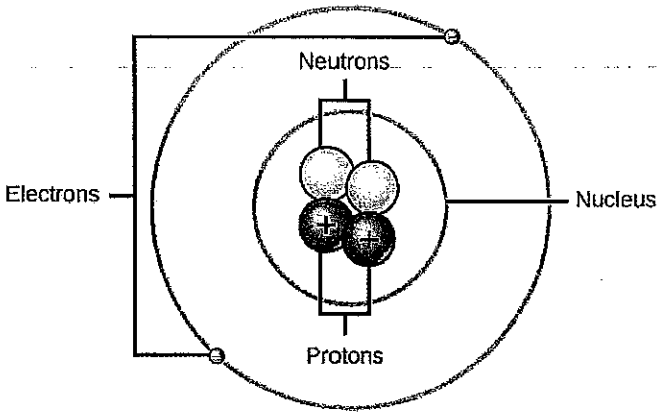
3. LAW OF REFLECTION

Angle of Incidence= Angle of Reflection



PLANE MIRROR

ELECTRICITY AND MAGNETISM

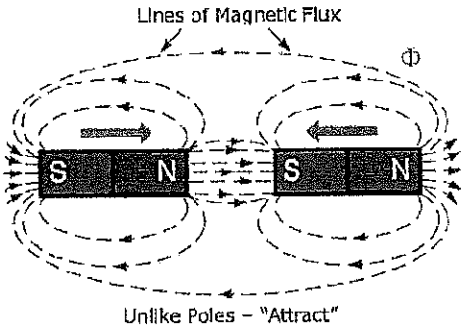


ELECTRICITY:

1. There are two types of electricity
    a. Static (**Does Not Move**)
    b. Current (**Moving**)
2. Electrical Forces
    a. Unlike charges **ATTRACT**
    b. Like charges **REPEL**
    c. Electrical force is strongest near the charged particle (**Coulombs Law**)
    d. Parts of an Atom:
        i. Nucleus
        ii. Neutron – No charge, located in nucleus, doesn't move
        iii. Proton – Positive charge, doesn't move
        iv. Electron – Negative charge, moves
3. Conductors – Allow electricity to flow (Ex: metals)
4. Insulators – Do not allow electricity to flow (Ex: plastic, wood, glass, rubber)
5. Electric Discharge – Rapid movement of an excess charge from one place to another (Ex: Lightning, shocked by a door knob)
6. Current Electricity – Flow of electrons through a closed path/circuit
    a. Wire
    b. Power Source
    c. Load (Is a resister, like a light bulb)
    d. There are **TWO** types of circuits
        i. Series – One path for electricity
            1. Total current: $I_t=I_1=I_2=I_3$ ...
            2. Total resistance: $R_t=R_1+R_2+R_3$ ...
            3. Total voltage: $V_t=V_1=V_2=V_3$ ...
            4. **Volts change Amps stay the same!**
        ii. Parallel – More than one path for electricity
            1. Total current: $I_t=I_1+I_2+I_3$ ...
            2. Total resistance: $R_t=V_t/I_t$
            3. Total voltage: $V_t=V_1=V_2=V_3$ ...
            4. **Amps change Volts stay the same!**
        iii. Parts of Current Electricity
            1. Current: Flow of electrons in a closed circuit
                a. Measured in amperes (amps)
                b. I = Current
            2. Voltage: Measure of electric potential difference
                a. Measured in volts (v) (speed)
            3. Resistance: Opposition to the flow of electric current

a. Measured in ohms (Ω)
b. It depends on ...
    i. Type of material
    ii. Length of wire (short=low resistance)
    iii. Thickness of wire (thick=low resistance)

4. Ohm's Law
    a. V = IR (VOLTAGE = CURRENT X RESISTANCE)



Unlike Poles – "Attract"

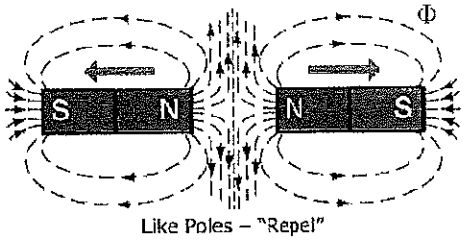
MAGNETISM

Magnets produce forces:

1. Magnetic North Pole
2. Magnetic South Pole

Forces:

1. Like pole ***REPEL*** (N ⟷ N, S ⟷ S)
2. Unlike poles ***ATTRACT*** (N ⟶⟵ S or S ⟶⟵ N)

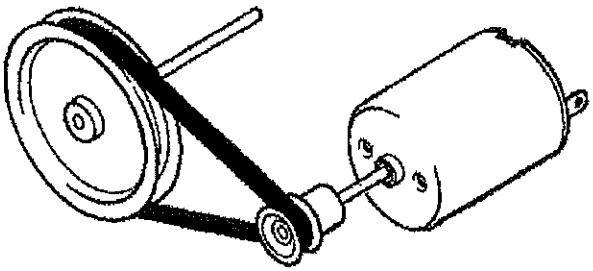


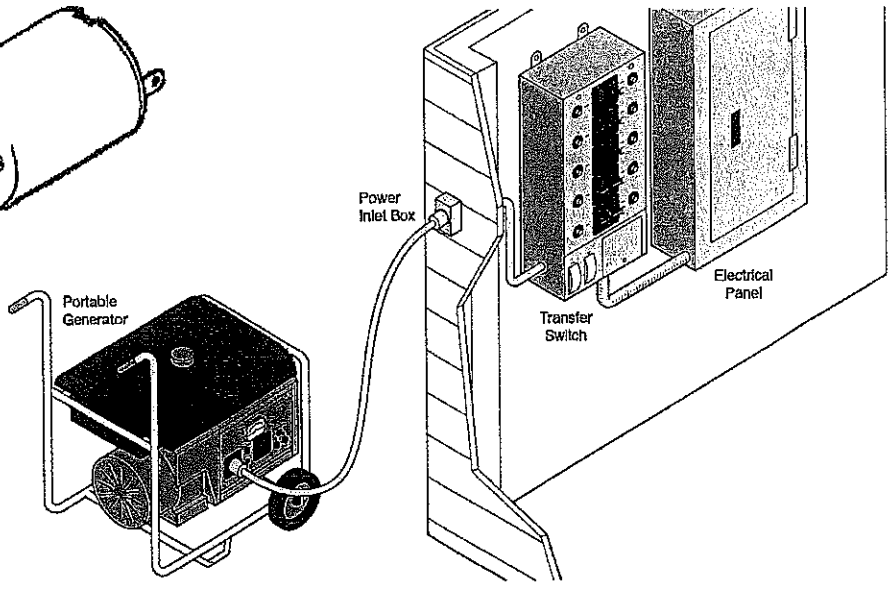
Like Poles – "Repel"

Electromagnetism- Moving electric charges produce magnetic forces and moving magnets produce electric current. Interplay of electric and magnetic forces is basis for electromagnets, motors, and generators.

MOTORS:

1. Convert electrical energy ⟶ mechanical Energy
2. Convert mechanical energy ⟶ electrical Energy





Massachusetts Department of ELEMENTARY & SECONDARY EDUCATION

Massachusetts Comprehensive Assessment System
Introductory Physics Formula Sheet

Formulas

Average Speed $= \frac{d}{\Delta t}$	$F = ma$	$p = mv$
Average Acceleration $= \frac{\Delta v}{\Delta t}$	$F = G\frac{m_1 m_2}{d^2}$	$V = IR$
Average Velocity $= \frac{\Delta x}{\Delta t}$	$F = k\frac{q_1 q_2}{d^2}$	$P = IV$
$v_f = v_i + a\Delta t$	$KE = \frac{1}{2}mv^2$	$Q = mc\Delta T$
$\Delta x = v_i \Delta t + \frac{1}{2}a\Delta t^2$	$PE = mg\Delta h$	$v = f\lambda$
$v_f^2 = v_i^2 + 2a\Delta x$	$W = Fd$	$\lambda = \frac{c}{f}$
Average Velocity $= \frac{v_i + v_f}{2}$	$P = \frac{W}{\Delta t}$	$T = \frac{1}{f}$

Variables

a = acceleration	q = charge of particle
c = specific heat	Q = heat
d = distance	R = resistance
f = frequency	Δt = change in time
F = force	ΔT = change in temperature
Δh = change in height	T = period
I = current	v = velocity
KE = kinetic energy	v_i = initial velocity
λ = wavelength	v_f = final velocity
m = mass	Δv = change in velocity
p = momentum	V = voltage
P = power	W = work
PE = gravitational potential energy	Δx = displacement

Definitions

c = speed of electromagnetic waves = 3.00×10^8 m/s

G = Universal gravitational constant = $6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$

k = Coulomb constant = $8.99 \times 10^9 \frac{N \cdot m^2}{C^2}$

$g \approx 10\ m/s^2$ $\quad 1\ N = 1\frac{kg \cdot m}{s^2}$ $\quad 1\ J = 1\ N \cdot m$ $\quad 1\ W\ (watt) = 1\frac{J}{s}$

Name: _____ Class: _____ Date: _____ ID: A

MCAS REVIEW PACKET

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Electromagnetic waves with low frequencies have been used for long-distance underwater communication. These waves most likely belong to which of the following parts of the electromagnetic spectrum?
a. gamma rays
b. infrared waves
c. radio waves
d. x-rays

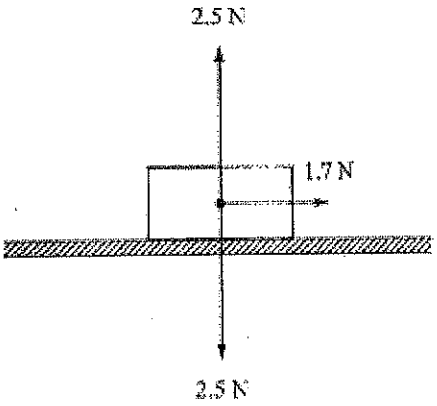
____ 2. During a thunderstorm, which of the following travels at a speed closest to 3.00 ? × 108 m/s?
a. wind from the storm
b. sound from the thunder
c. light from the lightning
d. rain from the storm clouds

____ 3. Which of the following properties is the same for all electromagnetic waves in a vacuum?
a. amplitude
b. frequency
c. speed
d. wavelength

____ 4. Which of the following properties determines a color in the visible light region of the electromagnetic spectrum?
a. acceleration
b. amplitude
c. frequency
d. speed

____ 5. Which of the following statements best describes an electromagnetic wave with a long wavelength?
a. It has a low frequency and can travel in a vacuum.
b. It has a high frequency and can travel in a vacuum.
c. It has a low frequency and can only travel in a medium.
d. It has a high frequency and can only travel in a medium.

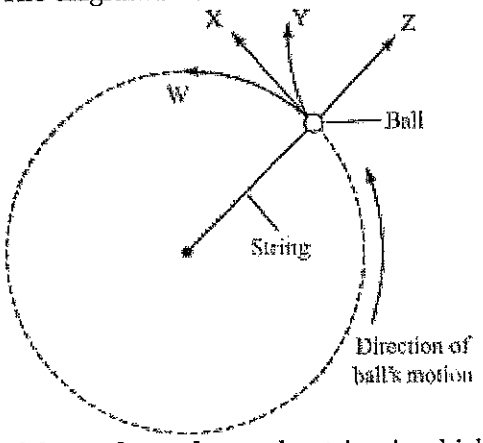
___ 6. The diagram below represents a block sliding across a table at a constant speed. All forces are shown except the frictional force.



What is the magnitude of the frictional force on the block?

a. 0.8 N
b. 1.6 N
c. 1.7 N
d. 2.5 N

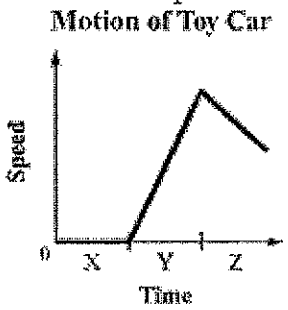
___ 7. The diagram below shows a ball tied to a string. A student is swinging the ball in a horizontal circle.



If the student releases the string, in which direction will the ball travel?

a. direction W
b. direction X
c. direction Y
d. direction Z

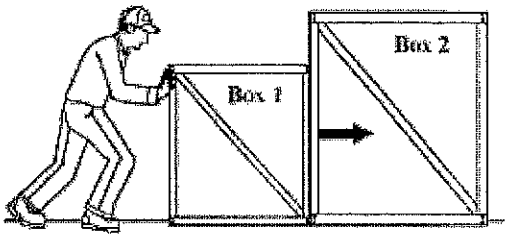
____ 8. The graph below illustrates the motion of a toy car during time intervals X, Y, and Z. The toy car is initially at rest. It is then pushed and released.



Kinetic friction is acting on the toy car during which of the following time intervals?

a. interval X only
b. interval Y only
c. intervals X and Z
d. intervals Y and Z

____ 9. A worker in a warehouse pushes two wooden boxes across a floor at a constant speed, as shown in the diagram below.



The arrow in the diagram represents the force box 1 exerts on box 2. Which arrow represents the reaction force?

a. 
b. 
c. 
d. 

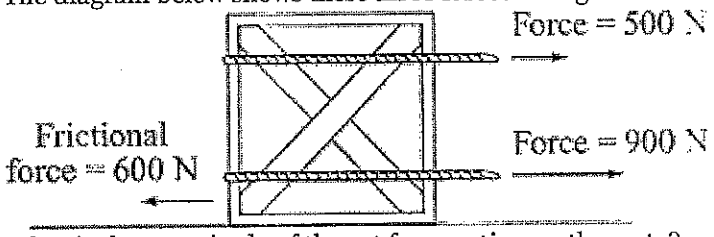
____ 10. A person pushes a heavy cabinet across a level wooden floor. Force X is the force required to start the cabinet moving. Force Y is the force required to maintain a slow, steady forward motion.Which of the following statements describes the two forces, X and Y?

a. Force X is added to force Y.
b. Force X is less than force Y.
c. Force X is unrelated to force Y.
d. Force X is greater than force Y.

___ 11. According to Newton's law of universal gravitation, in which of the following situations does the gravitational attraction between two bodies **always** increase?

a. The masses increase, and the distance between the centers of mass increases.
b. The masses increase, and the distance between the centers of mass decreases.
c. The masses decrease, and the distance between the centers of mass increases.
d. The masses decrease, and the distance between the centers of mass decreases.

___ 12. A crate is being pulled along a floor by means of two ropes. A frictional force opposes the motion of the crate. The diagram below shows these three forces acting on the crate.



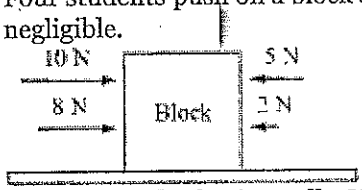
What is the magnitude of the net force acting on the crate?

a. 800 N
b. 1000 N
c. 1400 N
d. 2000 N

___ 13. A student is driving her car when an insect strikes her windshield. Which of the following statements **best** describes the forces in this situation?

a. The insect strikes the windshield with the same force as the windshield strikes the insect.
b. The insect strikes the windshield with a force, and the windshield exerts no force on the insect.
c. The insect exerts no force on the windshield, and the windshield strikes the insect with a large force.
d. The insect strikes the windshield with a small force, and the windshield strikes the insect with a large force.

___ 14. Four students push on a block of wood with the forces shown in the diagram below. Assume friction is negligible.



The block slides horizontally. What is the net force acting on the block of wood?

a. 3 N to the left
b. 8 N to the left
c. 11 N to the right
d. 25 N to the right

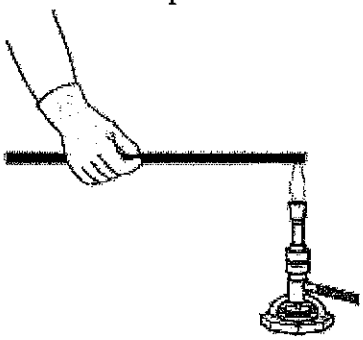
____ 15. Which of the following statements **best** describes the force of Earth's gravity on a rocket moving upward?

a. The gravitational force is constant for all altitudes.
b. The gravitational force is weaker when the rocket is higher.
c. The gravitational force is stronger when the rocket is higher.
d. The gravitational force is zero when the altitude is greater than 10,000 miles.

____ 16. What method of heat transfer allows the Sun's heat energy to reach Earth through the vacuum of space?

a. condensation
b. conduction
c. convection
d. radiation

____ 17. An iron bar is placed in a flame, as shown below, and is heated until the end glows.



The other end of the iron bar soon becomes hot, too. Which of the following statements **best** describes what happens?

a. A convective flow of energy is set up inside the iron bar.
b. Energy is conducted from atom to atom along the length of the iron bar.
c. Radiation moves through the iron bar and is absorbed by the end not in the flame.
d. Air heated by the flame radiates down the iron bar and heats the end not in the flame.

____ 18. A small body of water contains 2,000 kg of water. The specific heat of water is 4,180 J/kg • °C. If the temperature of the water changes from 25°C to 20°C, approximately how much heat moves from the water to the surroundings?

a. 8,400,000 J
b. 42,000,000 J
c. 168,000,000 J
d. 210,000,000 J

____ 19. Popcorn is made by heating corn kernels. Different methods may be used to heat the kernels. Which of the following methods uses radiation as the primary means of transferring energy to the corn kernels?

a. heating corn kernels in a hot air popper
b. heating corn kernels in a microwave oven
c. heating corn kernels in a foil pan on a hot plate
d. heating corn kernels in oil in a pot on an electric stove

____ 20. In which of the following examples is heat transferred **primarily** by radiation?

a. A fan blows warm air around a room.
b. A hot water bottle warms a person's feet.
c. Water vapor from a shower warms the room.
d. A spoon held near the side of a flame gets warm.

____ 21. Which of the following best describes the final temperature of the metal?

a. higher than the final temperature of the water
b. the same as the final temperature of the water
c. lower than the initial temperature of the water
d. the same as the initial temperature of the waterthe same as the initial temperature of the water

____ 22. Which of the following **best** describes the molecules of air inside the balloon when the balloon is left in the sunlight as compared to when it was first inflated?

a. The molecules are moving faster.
b. There are more molecules in the balloon.
c. There are fewer interactions between the molecules.
d. The molecules stop colliding with the walls of the balloon.

____ 23. Which of the following statements **best** explains why there is no change in temperature once thermal equilibrium between two objects in contact is reached?

a. Heat can flow between two objects in contact.
b. Heat does not flow between objects in contact at the same temperature.
c. Heat does not flow spontaneously from a cooler object to a warmer object.
d. Heat flows by conduction, convection, and radiation when the temperatures are the same.

____ 24. Which of the following statements **best** explains why drops of liquid form on the outside of a glass of ice water on a hot day?

a. Water molecules in the air are attracted to the surface of the glass.
b. Water molecules in the ice water lose energy as they transfer heat to the air.
c. Water molecules in the air lose energy as they transfer heat to the cold glass.
d. Water molecules in the ice water move through the glass pores to the outside of the glass.

____ 25. A neutral balloon is rubbed with a piece of wool cloth. As a result, the balloon has a negative static charge. Which of the following statements **best** explains why the balloon has a negative charge?

a. The balloon is a conductor.
b. The balloon is an insulator.
c. The balloon transfers charges to the cloth.
d. The balloon receives charges from the cloth.

____ 26. A light bulb with a potential difference of 120 V across it carries a current of 1.5 A. Which of the following is the power consumption of the light bulb?

a. 0.013 W
b. 80 W
c. 120 W
d. 180 W

____ 27. An appliance draws 4 A of current when connected to 120 V. What is the resistance of the appliance?

a. 0.03 Ω
b. 30 Ω
c. 124 Ω
d. 480 Ω

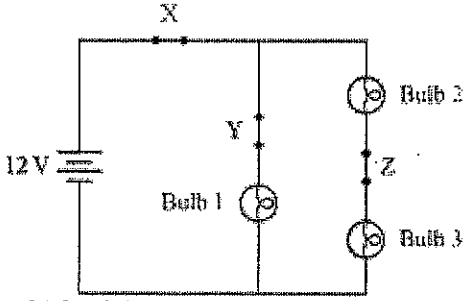
____ 28. A current of 2 A passes through an 8 Ω load. What is the potential difference across the load?

a. 0.25 V
b. 4.0 V
c. 10 V
d. 16 V

____ 29. Which of the following actions would increase the electric force between two positively charged particles?

a. decreasing the mass of the particles
b. decreasing the distance between the particles
c. changing the charges from positive to negative
d. transferring all the charge from one particle to the other

____ 30. The diagram below shows an electrical circuit with three bulbs and three switches. The switches are labeled X, Y, and Z. When all three switches are closed, as shown, all three bulbs are lit.



Which of the following statements describes what will happen if switch Z is opened?

a. Only bulb 1 will be lit.
b. Only bulb 3 will be lit.
c. All three bulbs will be lit.
d. None of the bulbs will be lit.

____ 31. What is the magnitude of the momentum of a 0.50 kg ball moving in a straight line at 5.0 m/s?

a. 0.1 kg • m/s
b. 2.5 kg • m/s
c. 6.3 kg • m/s
d. 10 kg • m/s

____ 32. An electric fan has a power output of 60 W. How much work is done if the fan operates for 120 s?

a. 0.5 J
b. 60 J
c. 120 J
d. 7200 J

____ 33. The potential energy of a 77 kg diver standing on a 20 m high diving tower is 15,400 J. Two-thirds of the way down during the dive into the pool, his potential energy is 5,100 J.Neglecting air resistance, what is the diver's kinetic energy at this point?

a. 2,550 J
b. 7,650 J
c. 10,300 J
d. 12,850 J

____ 34. Which of the following has the **greatest** momentum?

a. 0.2 kg ball moving at 40 m/s
b. 500 kg car traveling at 16 m/s
c. 2000 kg truck traveling at 9 m/s
d. 50 kg child skateboarding at 4 m/s

____ 35. An inventor claims to have designed a perpetual motion machine, a device that creates its own power. Which of the following laws **best** explains why a perpetual motion machine cannot work?

a. law of conservation of energy
b. law of conservation of matter
c. Newton's second law
d. Newton's third law

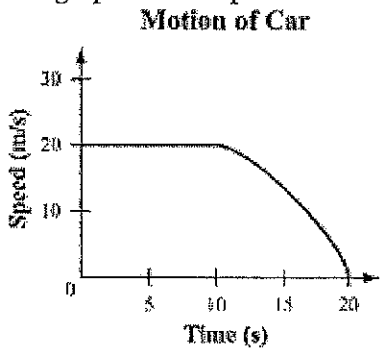
____ 36. A 1000 kg automobile is traveling at an initial speed of 20 m/s. It is brought to a complete stop in 5 s over a distance of 50 m.What is the work done in stopping the automobile?

a. 10,000 J
b. 40,000 J
c. 50,000 J
d. 200,000 J

____ 37. A person starts driving and travels 3 km east to a store. The person then turns around and travels 1 km west to another store. Finally, the person travels 2 km west, back to the starting point.What distance has this person traveled?

a. 0 km
b. 3 km
c. 5 km
d. 6 km

____ 38. The graph below represents the motion of a car as it moves along a straight road for 20 s.



Which statement **best** describes the motion of the car over the 20 s?

a. The car is initially at rest and then backs up for 10 s.
b. The car moves 20 m in the first 10 s and then stops.
c. The car travels at a constant speed for 10 s and then decelerates until it stops.
d. The car travels at a constant speed of 20 m/s and then decelerates until it is traveling at a constant speed of 15 m/s.

____ 39. A car is moving at 25 m/s north. Which of the following is a vector quantity?

a. the speed of the car
b. the velocity of the car
c. the potential energy of the car
d. the distance traveled by the car

____ 40. A student leaving school walks 2.5 km north and then walks 1.0 km south. What is the student's displacement?

a. 1.0 km south
b. 1.5 km north
c. 2.5 km north
d. 3.5 km south

____ 41. A racecar travels at an average speed of 80 m/s in a race. The total distance of the race is 640,000 m.How long does it take the racecar to finish the race?

a. 800 s
b. 8,000 s
c. 6,400,000 s
d. 51,200,000 s

____ 42. The human ear is most sensitive to sound that has a frequency of about 4000 Hz. Assume that the speed of sound in air is 340 m/s.What is the wavelength of a sound heard in the air with this frequency?

a. 0.043 m
b. 0.085 m
c. 12 m
d. 340 m

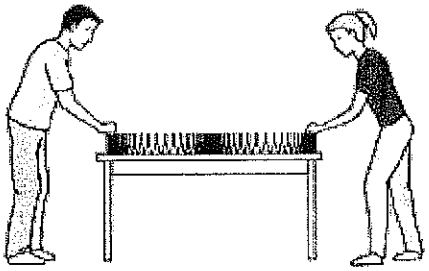
____ 43. Which of the following observed properties of a wave is changed by the Doppler effect?

a. amplitude
b. direction
c. frequency
d. speed

____ 44. A 2 m long pendulum swings back and forth 6 times in 17 seconds. What is the period of the pendulum?

a. 0.4 s
b. 2.8 s
c. 12 s
d. 34 s

____ 45. The diagram below shows two students making a wave with a coiled spring.



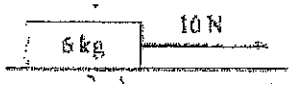
Which of the following waves move most like the wave in the coiled spring?

a. infrared waves
b. microwaves
c. sound waves
d. ultraviolet waves

MCAS OPEN RESPONSE PRACTICE

Motion and Forces

A 10 N force is applied to a 6 kg box, as shown below.



Assume the system is frictionless.

a. Determine the weight of the box in newtons. Show your calculations and include units in your answer.

b. In your Student Answer Booklet, draw a force diagram for the box. Include labels and represent the relative magnitude of each force.

c. Determine the acceleration of the box. Show your calculations and include units in your answer.

Now assume friction is introduced into the system.

d. Describe one change to this system that would allow it to achieve the same acceleration as the frictionless system.

Two athletes are lifting weights. Athlete X lifts 445 N a distance of 2 m in 4 s. Athlete Y lifts 445 N a distance of 2 m in 1 s. Assume that each athlete lifts the weights over his head the same distance from the floor.

a. Calculate the amount of work each athlete does. Show your calculations and include units in your answer.

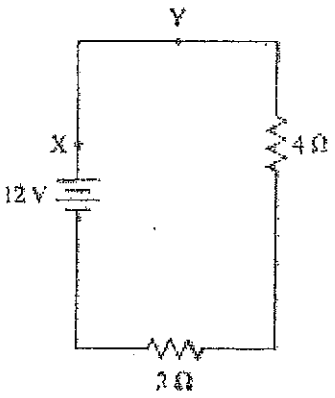
b. Compare the amounts of work done by the two athletes. Explain your answer.

c. Calculate the power each athlete uses. Show your calculations and include units in your answer.

d. Compare the power used by athlete X with the power used by athlete Y. Explain your answer.

Electro-Magnetism

The diagram below shows a circuit with a 12 V battery connected in series with a 4 Ω resistor and a 2 Ω resistor. Two points in the circuit are labeled X and Y.



a. Calculate the current in the circuit. Show your calculations and include units in your answer.

b. Calculate the voltage drop across the 4 Ω resistor. Show your calculations and include units in your answer.

c. Determine the voltage drop between point X and point Y. Explain the reasoning for your answer.

d. Calculate the power of the entire circuit. Show your calculations and include units in your answer.

Waves

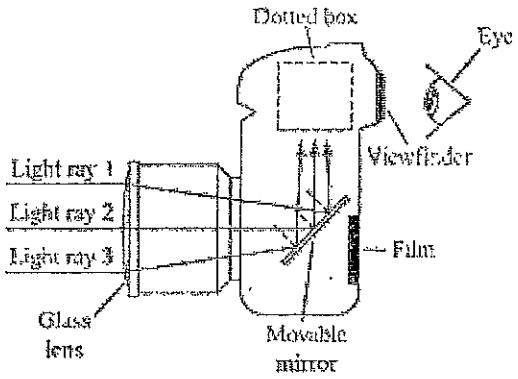
Waves can be classified as either electromagnetic or mechanical.

a. Describe **two** differences between electromagnetic and mechanical waves.

b. Give **two** examples of electromagnetic waves.

c. Give **two** examples of mechanical waves.

The diagram below is a simplified representation of the inside of a certain type of camera.



a. Identify **and** describe the wave behavior as the light rays pass through the glass lens.

b. Identify **and** describe the wave behavior as the light rays strike the mirror.

c. Copy the dotted box from the camera diagram into your Student Answer Booklet. Draw what must happen inside the box for light ray 2 to strike the viewfinder. Be sure to include the following:

- either a lens **or** a mirror that is labeled
- the path of light ray 2
- a line normal to the surface where light ray 2 strikes