

# Physical Science MCAS Study Guide

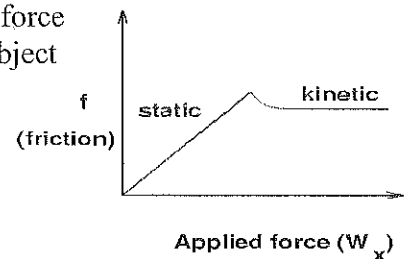
## I. MOTION, MOMENTUM, AND FORCES

### A. MOTION AND MOMENTUM

- i. Speed
  1.  $s = d/t$  (SPEED = DISTANCE /TIME)
  2. Unit - m/s
- ii. Velocity
  1. Speed in a given direction
- iii. Acceleration
  1. Change velocity in a given amount of time
  2.  $a = \frac{v_f - v_i}{t}$  (FINAL VELOCITY - INITIAL VELOCITY)  
TIME
  3. Unit -  $m/s^2$
  4. Acceleration due to gravity =  $10 m/s^2$
- iv. Scalar Quantity-has only magnitude (ex. speed, distance, mass, temperature)
- v. Vector Quantity-has magnitude **and** direction (ex. velocity, displacement)
- vi. Inertia
  1. Tendency of an object to resist a change in its motion
- vii. Momentum
  1. Measure of how hard it is to stop a moving object
  2. Bigger the object = harder it is to stop it
  3.  $p = mv$  (MOMENTUM = MASS x VELOCITY)
  4. Unit - kg x m/s
- viii. Law of Conservation of Momentum
  1. Total momentum of objects that collide with each other doesn't change (momentum before collision = momentum after collision)

### B. FORCE AND NEWTON'S LAWS

- i. Force – pull or push
- ii. 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
- iii. Net force-combination of all the forces acting on an object
- iv. Friction – force that opposes motion
  1. Static (hardest to overcome)
  2. Sliding/kinetic
  3. Rolling
- v. 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
    - Centripetal force - force that keeps an object moving in a circular path.
  4. Air resistance
    - terminal velocity- point at which air resistance = force of gravity
- vi. Newton's Third Law of Motion – for every action, there is an equal and opposite reaction (forces always act in pairs!)



- vii. Newton's Law of Universal Gravitation-the gravitational attraction between two objects depends on the mass of the objects and distance between them (i.e., two objects that are large and close together = strong gravitational attraction)

## II. ENERGY

- i. Energy – the ability to cause change
- ii. Types of energy include:
  1. Electrical
  2. Water
  3. Wind
  4. Heat (thermal)
  5. Chemical
  6. Kinetic
  7. Potential
- iii. Potential Energy
  1. Energy of *position or stored energy*
  2. Energy of position depends on height AND mass
  3.  $GPE = mgh$  (MASS x GRAVITY x HEIGHT)
  4. Unit-Joules (J)
- iv. Kinetic Energy
  1. Energy of *motion*
  2.  $KE = \frac{1}{2}mv^2$  (1/2 MASS x VELOCITY SQUARED)
  3. Unit-Joules (J)
- v. Law of Conservation of Energy
  1. Energy is never created or destroyed. It is converted from one form to another (ex. PE → KE; KE → PE; chemical → electrical)

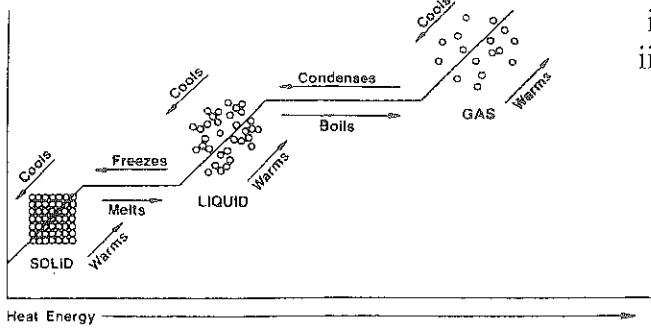
## III. HEAT AND HEAT TRANSFER

- i. Temperature – measure of the average kinetic energy of molecules in a substance
- ii. Thermal energy – measure of the kinetic **and** potential energy of all the particles/molecules in a substance
- iii. Heat – the transfer of thermal energy between objects **at different temperatures**
  1. Heat **always moves** from hot → cold
  2.  $q = m\Delta t c$  (HEAT=MASS x CHANGE IN TEMPERATURE x SPECIFIC HEAT)
  3. Unit-Joules (J) or calories (c)
  4. Specific heat – measure of how easily/quickly a substance absorbs heat
    1. Unit-J/kg .°C or c/kg .°C
  5. Transferring heat
    1. conduction – transfer of heat between objects that are touching
      - i. conductor – material that transfers heat easily (ex. metals)
      - ii. insulator – material that does not transfer heat easily (ex. plastic, rubber, glass)
    2. convection – movement of molecules from one part of a material to another. Always involves fluids (liquids and gases)
    3. radiation – (sun) energy is transferred through electromagnetic waves

## 6. Heating an object

### 1. Phase Changes

- solid  $\rightarrow$  liquid  $\rightarrow$  gas (*heat is being added*)
- gas  $\rightarrow$  liquid  $\rightarrow$  solid (*heat is being removed*)



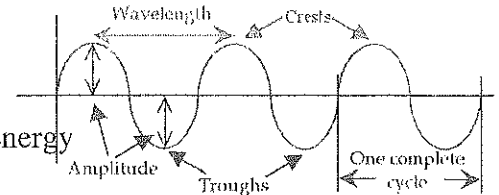
This wave is moving in this direction  $\rightarrow$

## IV. WAVES

### WAVES-CARRY ENERGY

#### i. Types of Waves

1. MECHANICAL- need matter to transfer energy through



#### a. 2 varieties

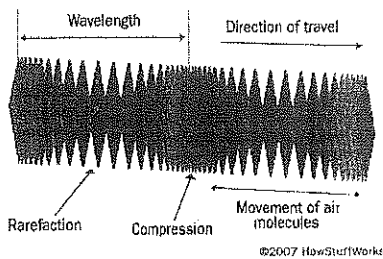
- i. transverse - move up and down (ex. water waves, crowd wave)

1. crest
2. trough
3. wavelength
4. amplitude

- ii. compression (longitudinal) - move right to left (ex. sound wave)

1. compressions
2. rarefactions
3. wavelength

#### Longitudinal Wave



- b. Frequency - number of waves passing a given point per second
- c. Unit- hertz (Hz)

- d. Wave velocity - how fast a wave moves

1.  $v = \lambda f$  (VELOCITY = WAVELENGTH  $\times$  FREQUENCY)
2. Unit-m/s

- e. Speed of waves

1. light -300,000 km/s
2. sound -340 m/s

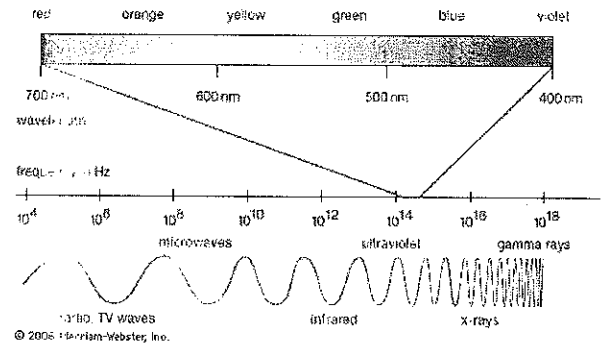
a. travels faster in solids than liquids, and faster in liquids than in gases

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

## 2. 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
- a. electromagnetic spectrum
  - i. radio
    - 1. longest wavelength
    - 2. lowest energy
  - ii. micro waves
  - iii. infrared
  - v. visible light
  - vi. UV
  - vii. X-rays
  - viii. gamma

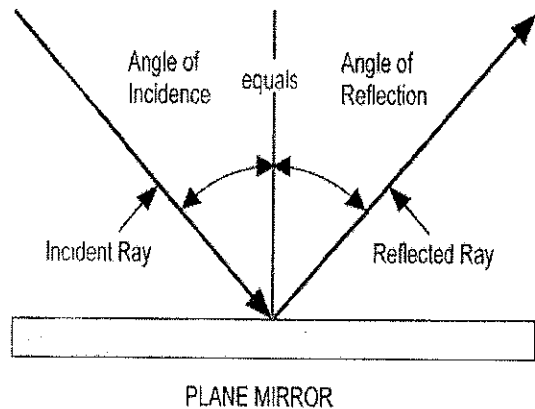


## B. Wave Behavior

- 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
  - Constructive interference-waves combine to make a bigger wave
  - Destructive interference-waves combine to make a smaller wave

## C. Law of Reflection

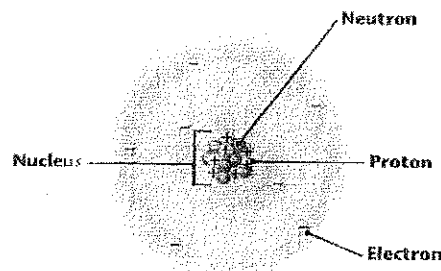
Angle of Incidence = Angle of Reflection



## V. ELECTRICITY AND MAGNETISM

### A. ELECTRICITY

- i. 2 types of electricity
  - 1. static (does not move)
  - 2. current (moving)
- ii. Electrical Forces
  - 1. unlike charges ATTRACT
  - 2. like charges REPEL
  - 3. electrical force is strongest near the charged particle
- iii. Conductors – allow electricity to flow (ex. metals)
- iv. Insulators – do not allow electricity to flow (ex. plastic, wood, glass, rubber)
- v. Electric discharge – rapid movement of an excess charge from one place to another (ex. lightning or getting shocked by a door knob)



vi. Current Electricity-flow of electrons through a closed path/circuit

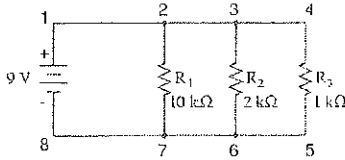
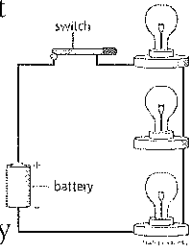
1. 2 types of circuits

i. Series – one path for electricity

1. total current:  $I_t = I_1 = I_2 = I_3 \dots$
2. total resistance:  $R_t = R_1 + R_2 + R_3 \dots$
3. total voltage:  $V_t = V_1 + V_2 + V_3 \dots$

ii. Parallel – more than one path for electricity

1. total current:  $I_t = I_1 + I_2 + I_3 \dots$
2. total resistance:  $R_t = V_t / I_t$
3. total voltage:  $V_t = V_1 = V_2 = V_3 \dots$



2. Parts of current electricity

i. current – flow of electrons in a closed circuit

1. measured in amperes (amps)
2.  $I =$  current

ii. voltage – measure of electric potential energy

1. measured in volts (v)

iii. resistance – opposition to the flow of electric current

1. measured in ohms ( $\Omega$ )
2. depends on...
  - a. type of material
  - b. length of wire (short = low resistance)
  - c. thickness of wire (thick = low resistance)

3. Ohm's Law

$$V = IR \text{ (VOLTAGE = CURRENT x RESISTANCE)}$$

**B. MAGNETISM**

i. Magnets produce forces

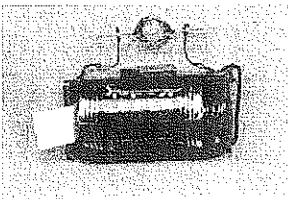
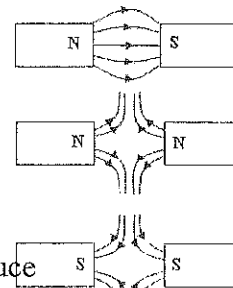
1. magnetic north pole
2. magnetic south pole

ii. Forces

1. unlike poles ATTRACT
2. like poles REPEL

iii. 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.



1. Motors

1. convert electrical energy  $\rightarrow$  mechanical energy

2. Generators

1. convert mechanical energy  $\rightarrow$  electrical energy



### Formulas

$$\text{Average Speed} = \frac{d}{\Delta t}$$

$$F = ma$$

$$p = mv$$

$$\text{Average Acceleration} = \frac{\Delta v}{\Delta t}$$

$$F = G \frac{m_1 m_2}{d^2}$$

$$V = IR$$

$$\text{Average Velocity} = \frac{\Delta x}{\Delta t}$$

$$F = k \frac{q_1 q_2}{d^2}$$

$$P = IV$$

$$v_f = v_i + a\Delta t$$

$$KE = \frac{1}{2} mv^2$$

$$Q = mc\Delta T$$

$$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$$

$$PE = mg\Delta h$$

$$v = f\lambda$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$W = Fd$$

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

$$\text{Average Velocity} = \frac{v_i + v_f}{2}$$

$$P = \frac{W}{\Delta t}$$

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

### Variables

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

### Definitions

$$c = \text{speed of electromagnetic waves} = 3.00 \times 10^8 \text{ m/s}$$

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

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

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

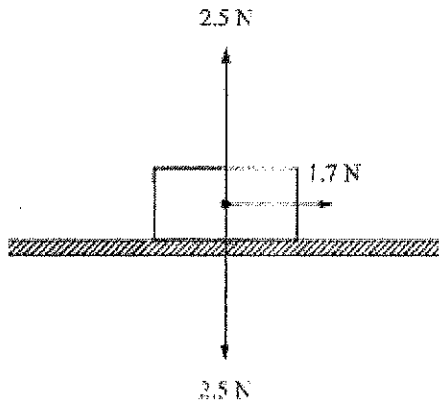
## MCAS REVIEW PACKET

### 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  $3.00 \times 10^8$  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.

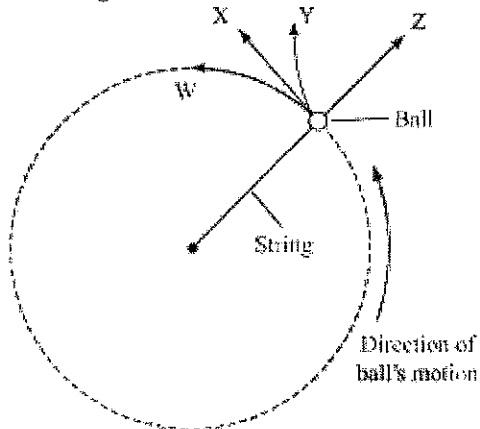
6. The diagram below represents a block sliding across a table at a constant speed. All forces are shown except the frictional force.



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

- |          |          |
|----------|----------|
| a. 0.8 N | c. 1.7 N |
| b. 1.6 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.



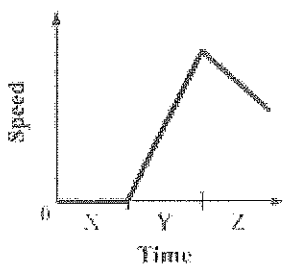
If the student releases the string, in which direction will the ball travel?

- |                |                |
|----------------|----------------|
| a. direction W | c. direction Y |
| b. direction X | 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.

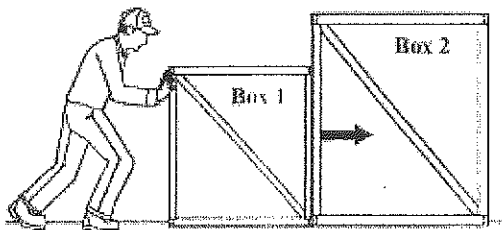
Motion of Toy Car



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?

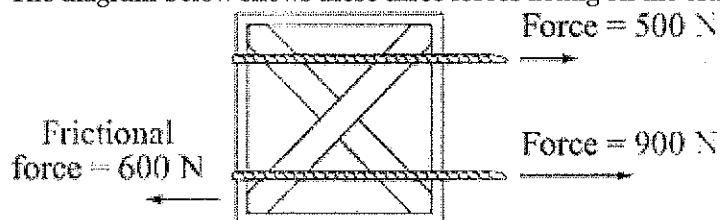
- a.
- b.
- c.
- d.

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.

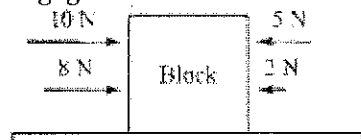
11. According to Newton's law of universal gravitation, in which of the following situations does the gravitational attraction between two bodies **always** increase?
- |   |   |
|---|---|
| a. The masses increase, and the distance between the centers of mass increases. | c. The masses decrease, and the distance between the centers of mass increases. |
| b. The masses increase, and the distance between the centers of mass decreases. | 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  | c. 1400 N |
| b. 1000 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.       | c. The insect exerts no force on the windshield, and the windshield strikes the insect with a large force.         |
| b. The insect strikes the windshield with a force, and the windshield exerts no force on the insect. | 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.

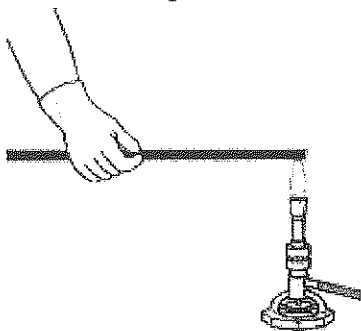


The block slides horizontally. What is the net force acting on the block of wood?

- |                    |                      |
|--------------------|----------------------|
| a. 3 N to the left | c. 11 N to the right |
| b. 8 N to the left | 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?
- The gravitational force is constant for all altitudes.
  - The gravitational force is weaker when the rocket is higher.
  - The gravitational force is stronger when the rocket is higher.
  - 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?
- condensation
  - conduction
  - convection
  - 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?

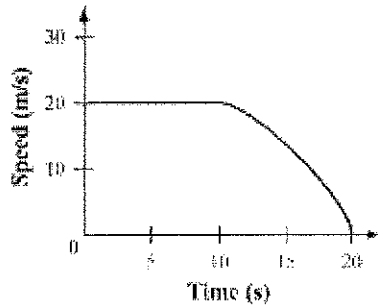
- A convective flow of energy is set up inside the iron bar.
  - Energy is conducted from atom to atom along the length of the iron bar.
  - Radiation moves through the iron bar and is absorbed by the end not in the flame.
  - Air heated by the flame radiates down the iron bar and heats the end not in the flame.
- \_\_\_\_\_ 18. A small body of water contains 2,000 kg of water. The specific heat of water is  $4,180 \text{ J/kg} \cdot ^\circ\text{C}$ . If the temperature of the water changes from  $25^\circ\text{C}$  to  $20^\circ\text{C}$ , approximately how much heat moves from the water to the surroundings?
- 8,400,000 J
  - 42,000,000 J
  - 168,000,000 J
  - 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?
- heating corn kernels in a hot air popper
  - heating corn kernels in a microwave oven
  - heating corn kernels in a foil pan on a hot plate
  - heating corn kernels in oil in a pot on an electric stove





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

Motion of Car



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

- \_\_\_\_\_ 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 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.

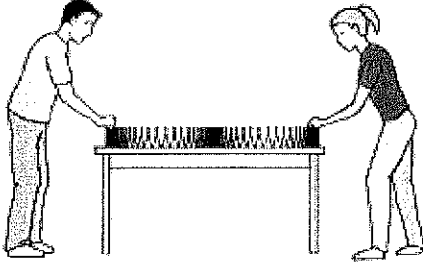
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\_\_\_ 44. A 2 m long pendulum swings back and forth 6 times in 17 seconds. What is the period of the pendulum?

- 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 REVIEW PACKET**  
**Answer Section**

**MULTIPLE CHOICE**

1. ANS: C

PTS: 1

2. ANS: C

PTS: 1

3. ANS: C

PTS: 1

4. ANS: C

PTS: 1

5. ANS: A

PTS: 1

6. ANS: C

PTS: 1

7. ANS: B

PTS: 1

8. ANS: D

PTS: 1

9. ANS: D

PTS: 1

10. ANS: D

PTS: 1

43. ANS: C

PTS: 1

44. ANS: B

PTS: 1

45. ANS: C

PTS: 1

11. ANS: B PTS: 1
12. ANS: A PTS: 1
13. ANS: A PTS: 1
14. ANS: C PTS: 1
15. ANS: B PTS: 1
16. ANS: D PTS: 1
17. ANS: B PTS: 1
18. ANS: B PTS: 1
19. ANS: B PTS: 1
20. ANS: D PTS: 1
21. ANS: B PTS: 1
22. ANS: A PTS: 1
23. ANS: B PTS: 1
24. ANS: C PTS: 1
25. ANS: D PTS: 1
26. ANS: D PTS: 1
27. ANS: B PTS: 1
28. ANS: D PTS: 1
29. ANS: B PTS: 1
30. ANS: A PTS: 1
31. ANS: B PTS: 1
32. ANS: D PTS: 1
33. ANS: C PTS: 1
34. ANS: C PTS: 1
35. ANS: A PTS: 1
36. ANS: D PTS: 1
37. ANS: D PTS: 1
38. ANS: C PTS: 1
39. ANS: B PTS: 1
40. ANS: B PTS: 1
41. ANS: B PTS: 1
42. ANS: B

PTS: 1

