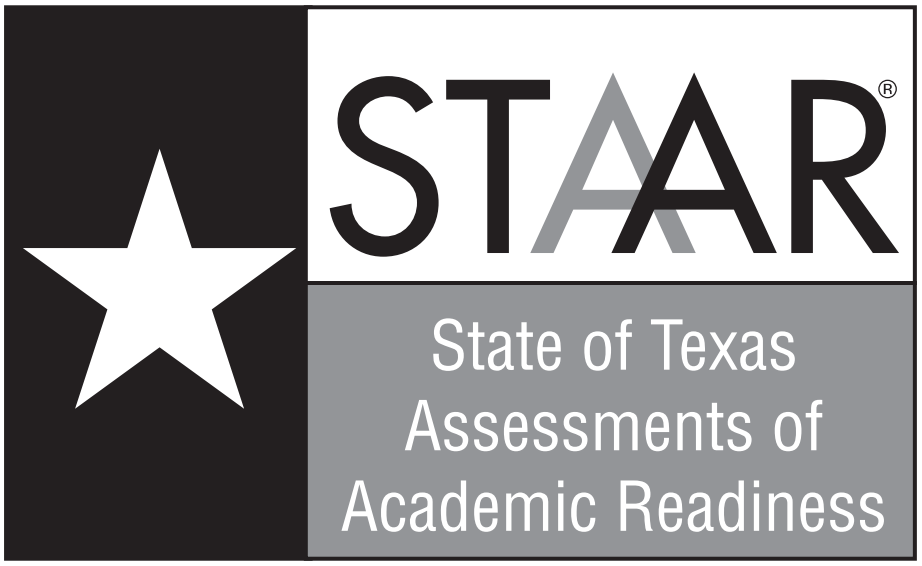

Physics

Administered May 2013

RELEASED

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STAAR PHYSICS REFERENCE MATERIALS

FORCE AND MOTION

Average velocity $= \dfrac{\text{displacement}}{\text{change in time}}$	$v_{avg} = \dfrac{\Delta d}{\Delta t}$
Acceleration $= \dfrac{\text{final velocity} - \text{initial velocity}}{\text{change in time}}$	$a = \dfrac{v_f - v_i}{\Delta t}$
Acceleration $= \dfrac{(\text{final velocity})^2 - (\text{initial velocity})^2}{2(\text{displacement})}$	$a = \dfrac{v_f^2 - v_i^2}{2\Delta d}$
Displacement $= \begin{pmatrix}\text{initial}\\ \text{velocity}\end{pmatrix}\begin{pmatrix}\text{change}\\ \text{in time}\end{pmatrix} + \frac{1}{2}\,(\text{acceleration})\begin{pmatrix}\text{change}\\ \text{in time}\end{pmatrix}^2$	$\Delta d = v_i \Delta t + \frac{1}{2} a \Delta t^2$
Centripetal acceleration $= \dfrac{(\text{tangential velocity})^2}{\text{radius}}$	$a_c = \dfrac{v_t^2}{r}$
Net force = (mass)(acceleration)	$F_{net} = ma$
Work = (force)(distance)	$W = Fd$
Torque = (force)(lever arm)	$\tau = Fr$
Power $= \dfrac{\text{work}}{\text{time}}$	$P = \dfrac{W}{t}$
Pythagorean theorem	$a^2 + b^2 = c^2$

GRAVITATIONAL, ELECTRICAL, AND MAGNETIC FORCES

Force of gravitational attraction between 2 objects $= \begin{pmatrix}\text{universal}\\ \text{gravitation}\\ \text{constant}\end{pmatrix}\left(\dfrac{\begin{pmatrix}\text{mass of}\\ \text{1st object}\end{pmatrix}\begin{pmatrix}\text{mass of}\\ \text{2nd object}\end{pmatrix}}{\begin{pmatrix}\text{distance between}\\ \text{centers of objects}\end{pmatrix}^2}\right)$	$F_g = G\left(\dfrac{m_1 m_2}{d^2}\right)$
Force between 2 charged particles $= \begin{pmatrix}\text{Coulomb's}\\ \text{constant}\end{pmatrix}\left(\dfrac{\begin{pmatrix}\text{charge of}\\ \text{1st particle}\end{pmatrix}\begin{pmatrix}\text{charge of}\\ \text{2nd particle}\end{pmatrix}}{(\text{distance between particles})^2}\right)$	$F_{electric} = k_C\left(\dfrac{q_1 q_2}{d^2}\right)$
Electrical power = (voltage)(current)	$P = VI$
Current $= \dfrac{\text{voltage}}{\text{resistance}}$	$I = \dfrac{V}{R}$
Equivalent resistance for resistors in series	$R = R_1 + R_2 + R_3 + \ldots$
Equivalent resistance for resistors in parallel	$\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3} + \ldots$

STAAR PHYSICS REFERENCE MATERIALS

ENERGY AND MOMENTUM

Kinetic energy $= \frac{1}{2}(\text{mass})(\text{velocity})^2$	$KE = \frac{1}{2}mv^2$
Gravitational potential energy $= (\text{mass})\left(\begin{matrix}\text{acceleration}\\ \text{due to gravity}\end{matrix}\right)(\text{height})$	$PE_g = mgh$
Elastic potential energy $= \frac{1}{2}\left(\begin{matrix}\text{spring}\\ \text{constant}\end{matrix}\right)\left(\begin{matrix}\text{distance stretched}\\ \text{or compressed}\end{matrix}\right)^2$	$PE_{\text{elastic}} = \frac{1}{2}kx^2$
Energy = (power)(time)	$E = Pt$
Work = change in kinetic energy	$W = \Delta KE$
Mechanical energy = kinetic energy + potential energy	$ME = KE + PE$
Law of conservation of energy	$KE_i + PE_i = KE_f + PE_f$
Momentum = (mass)(velocity)	$p = mv$
Impulse = (force)(change in time) = (mass)(change in velocity)	$J = F\Delta t = m\Delta v$
Law of conservation of momentum	$m_1v_{1_i} + m_2v_{2_i} = m_1v_{1_f} + m_2v_{2_f}$
Heat gained or lost $= (\text{mass})\left(\begin{matrix}\text{specific}\\ \text{heat}\end{matrix}\right)\left(\begin{matrix}\text{change in}\\ \text{temperature}\end{matrix}\right)$	$Q = mc_p\Delta T$

WAVES AND LIGHT

Velocity = (frequency)(wavelength)	$v = f\lambda$
$\frac{1}{\text{Focal length}} = \frac{1}{\text{distance to image}} + \frac{1}{\text{distance to object}}$	$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$
Energy = (mass)(speed of light)^2	$E = mc^2$

STAAR PHYSICS REFERENCE MATERIALS

CONSTANTS AND CONVERSIONS

$$c = \text{speed of light} = 3.00 \times 10^{8} \ \frac{\text{m}}{\text{s}}$$

$$g = \text{acceleration due to gravity} = 9.8 \ \frac{\text{m}}{\text{s}^2}$$

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

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

$$m_E = \text{mass of Earth} = 5.97 \times 10^{24} \text{ kg}$$

$$r_E = \text{radius of Earth} = 6.37 \times 10^{6} \text{ m}$$

$$\text{newton (N)} = \frac{\text{kg} \cdot \text{m}}{\text{s}^2}$$

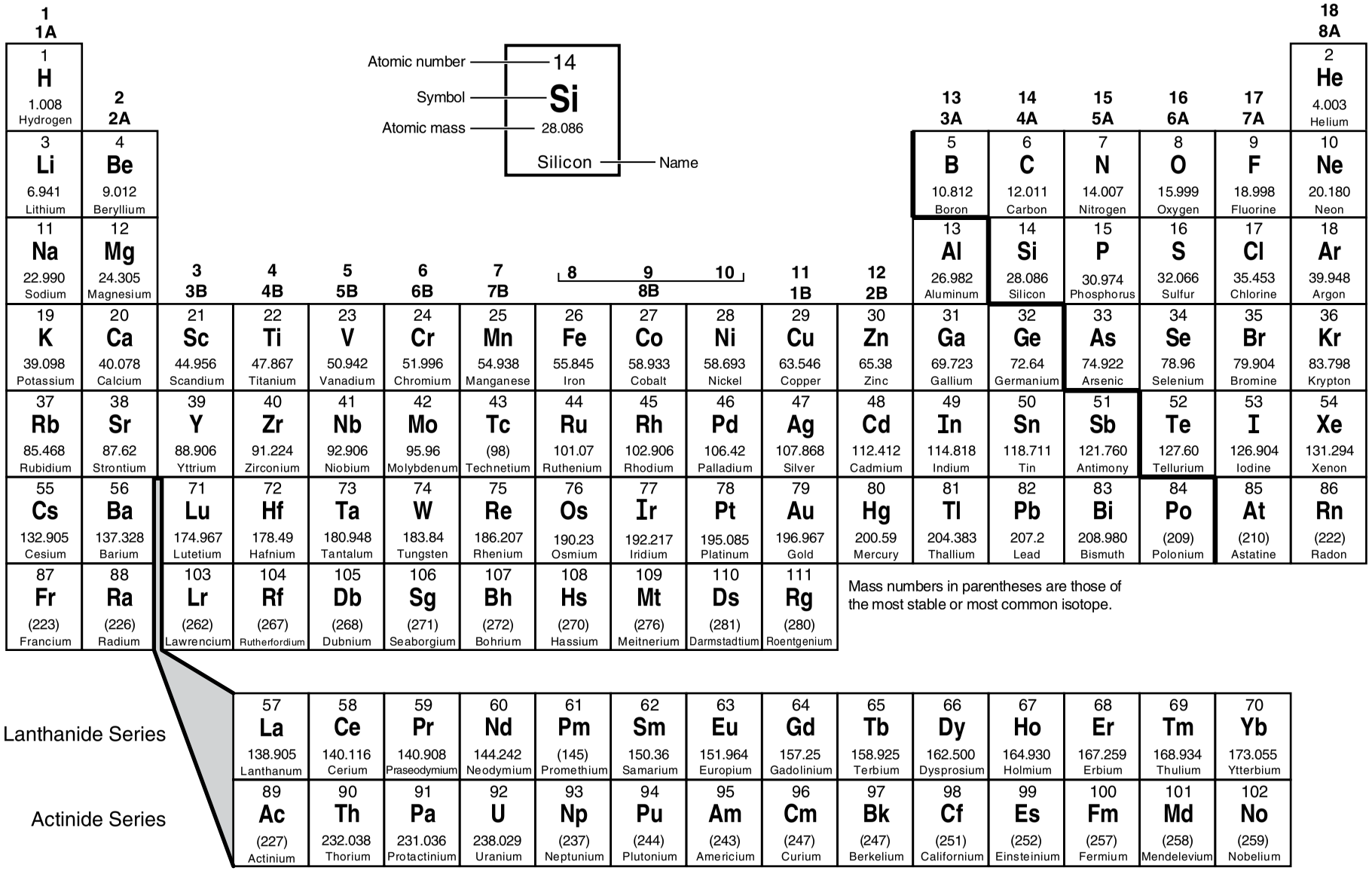
$$\text{joule (J)} = \text{N} \cdot \text{m}$$

$$\text{watt (W)} = \frac{\text{J}}{\text{s}} = \frac{\text{N} \cdot \text{m}}{\text{s}}$$

$$\text{hertz (Hz)} = \frac{\text{cycle}}{\text{s}}$$

STAAR PHYSICS REFERENCE MATERIALS

PERIODIC TABLE OF THE ELEMENTS

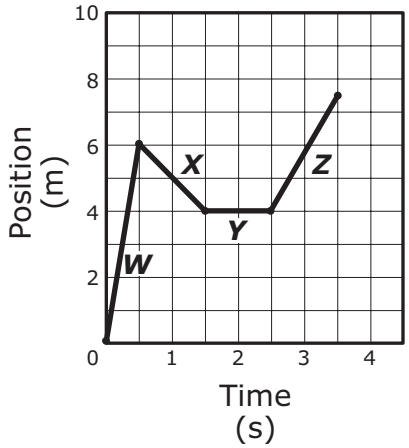


Updated Spring 2011

Physics

DIRECTIONS
Read each question carefully. For a multiple-choice question, determine the best answer to the question from the four answer choices provided. For a griddable question, determine the best answer to the question. Then fill in the answer on your answer document.

1 Motion sensors recorded the following data about a runner during a cross-country race.



During which segment of the race did the runner have the greatest speed?

A *W*

B *X*

C *Y*

D *Z*

---

2 Which situation is a good example of the transfer of energy through radiation?

F A fan cools the CPU in a computer.

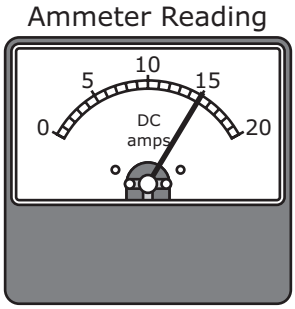
G Energy passes from one person's hand to another person when they shake hands.

H Warm air that is less dense rises to the ceiling of a room.

J A snake's body temperature increases when the snake lies in the sun.

GO ON

3 The ammeter below shows the current produced by a series of solar cells that contain zinc plates being used to power a simple series circuit.



If the circuit's resistance is 0.2 Ω, what voltage is supplied by the cells?

A 750 V

B 15 V

C 3 V

D 25 V

---

4 Two people each have a mass of 55 kg. They are both in an elevator that has a mass of 240 kg. When the elevator begins to move, the people and the elevator have an upward acceleration of 1.00 m/s^2. What is the net force that acts on the elevator as it accelerates upward at 1.00 m/s^2?

F 9.8 N

G 110 N

H 130 N

J 350 N

GO ON

5 The center of a 910 kg satellite is 9.9×10^6 m from Earth's center. What is the gravitational force between the satellite and Earth?

A 4.5×10^3 N

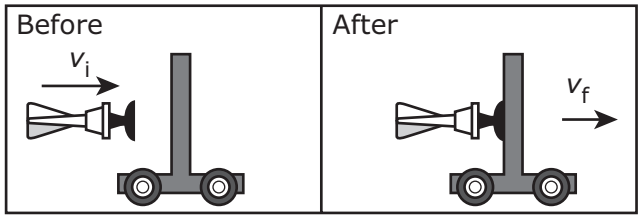
B 3.7×10^3 N

C 8.9×10^3 N

D 1.7×10^6 N

---

6 During a classroom activity a suction-cup dart with a mass of *m* was launched at a stationary cart that had a mass of 5*m*. Four students observed the event, and their descriptions are shown in the table.



Students' Descriptions

Student	Momentum Conserved?	Kinetic Energy Conserved?	Velocity of Cart and Dart After Collision Compared with Velocity of Dart Before Collision
1	Yes	No	Less
2	No	Yes	Less
3	Yes	Yes	Greater
4	No	No	Greater

Which student best described the momentum, kinetic energy, and velocity of the system before and after the collision?

F Student 1

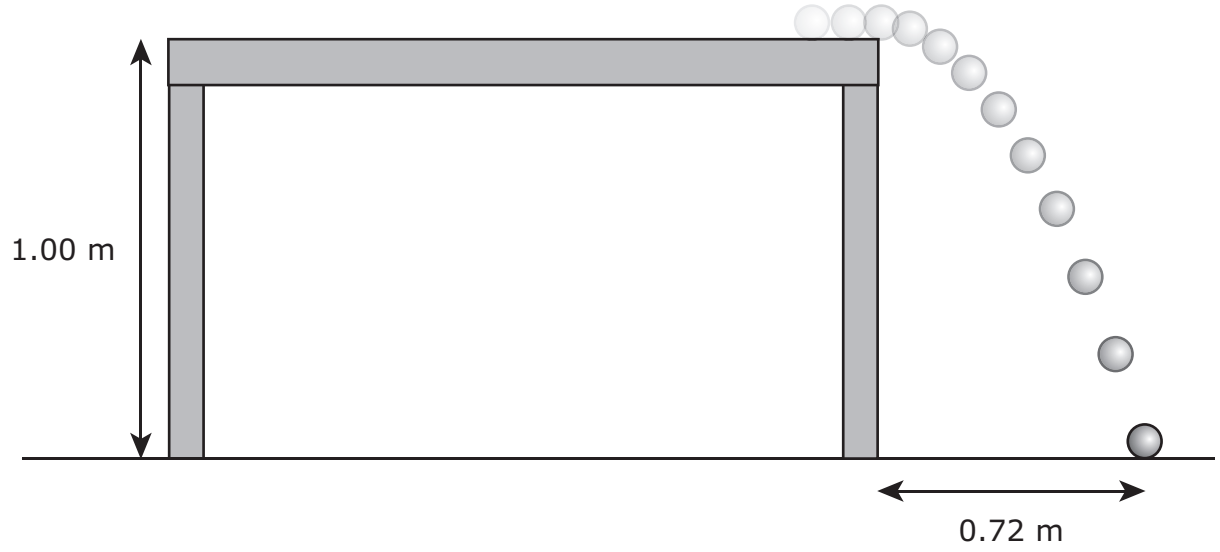
G Student 2

H Student 3

J Student 4

GO ON

7 A tennis ball rolled off the edge of a table that has a height of 1.00 m.



The ball took 0.45 s to hit the ground 0.72 m from the table. What was the horizontal velocity of the ball as it rolled off the table?

A 0 m/s

B 0.63 m/s

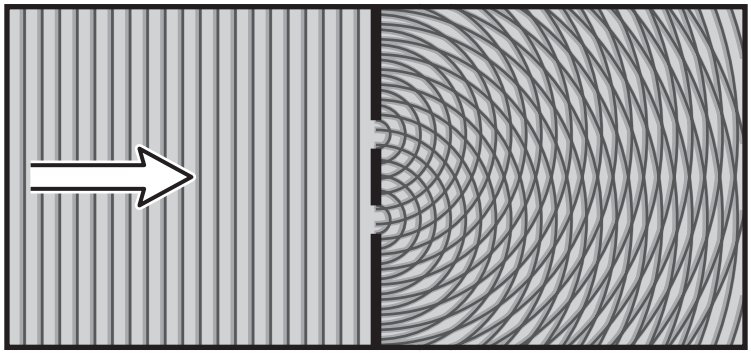
C 1.6 m/s

D 2.2 m/s

GO ON

8 Students set up a water tray with a barrier placed halfway from the ends. The barrier has two openings in it. The students then generate waves that propagate toward the barrier, as shown.

Water Tray with Barrier



As the waves travel from the left through the barrier, they produce a pattern on the right side. In a segment of this pattern, part of the wave tends to disappear. What phenomenon of waves causes this pattern to occur?

F The waves interfere with one another constructively and destructively.

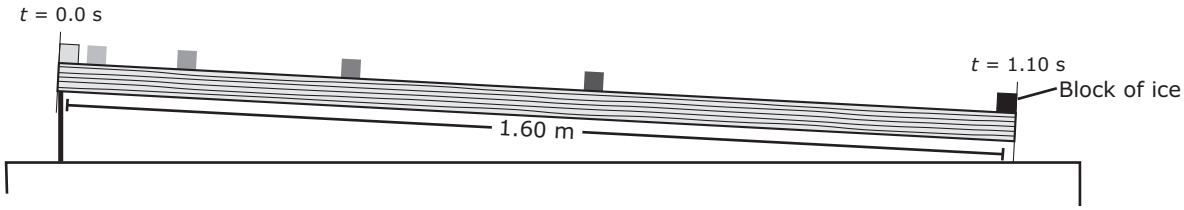
G The waves refract as they travel through the openings.

H The waves reflect back and forth as they travel through the openings.

J The waves change in frequency when they meet one another.

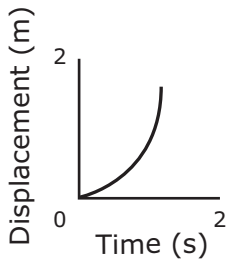
GO ON

9 The diagram shows the position of a block of ice as it moves down a smooth ramp that is 1.60 m long.

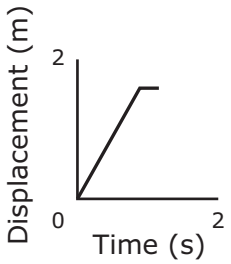


Which graph best represents the motion of the block of ice on the ramp?

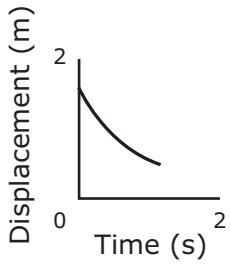
A



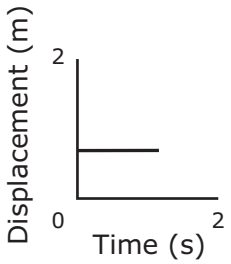
C



B

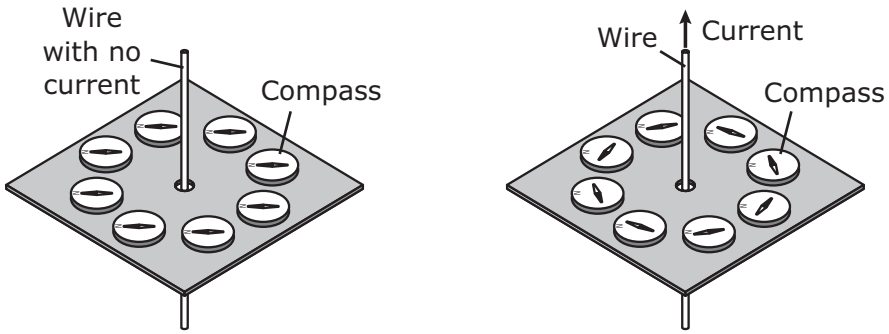


D



GO ON

10



Before 1820 magnetism and electricity were believed to be different types of forces caused by different physical processes. In 1820 Hans Christian Ørsted conducted an experiment with compasses and wire. The diagram above shows the results of his experiment. This experiment was important because it —

F showed how to make a compass point in a direction other than north

G was the first to show electric current flowing in a straight wire

H showed that electricity and magnetism are related

J proved that magnetism is an extremely weak force compared with electricity

---

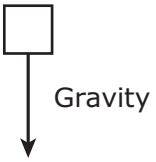
11 A student pushed a box 27.0 m across a smooth, horizontal floor using a constant force of 113 N. If the force was applied for 9.00 s, how much power was developed, to the nearest watt?

Record your answer and fill in the bubbles on your answer document.

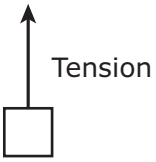
GO ON

12 A high school student holds a backpack one meter above the ground. Which of the following free-body diagrams best represents this situation?

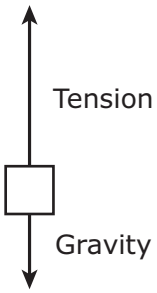
F



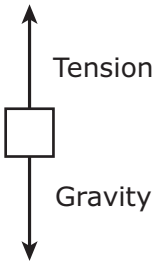
G



H

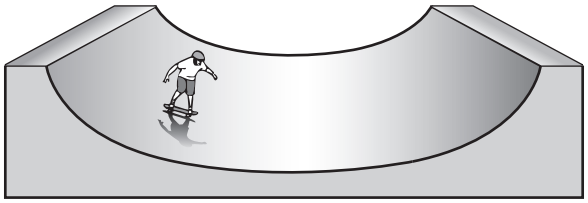


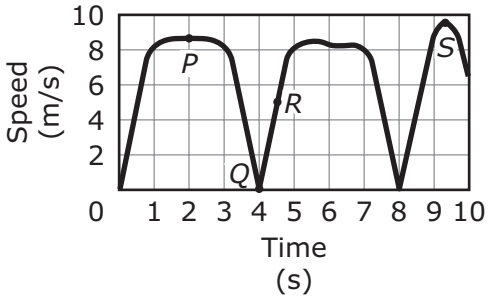
J



GO ON

13 A skateboarder travels back and forth on a U-shaped track during a time trial at a competition. The graph shows the skateboarder's speed as a function of time during the trial.





Which labeled point on the graph identifies the time during the trial that the skateboarder most likely has equal amounts of kinetic energy and potential energy?

A *P*

B *Q*

C *R*

D *S*

---

14 Two charged spheres are 16 cm apart. If the spheres are moved closer to each other so that they are 8 cm apart, how will the force between them change?

F The force will decrease by a factor of 2.

G The force will increase by a factor of 2.

H The force will decrease by a factor of 4.

J The force will increase by a factor of 4.

GO ON

15 A musical note has a frequency of 512 Hz. If the wavelength of the note is 0.685 m, what is the speed of the sound of that note?

A 345 m/s

B 351 m/s

C 841 m/s

D 0.00120 m/s

---

16 A bus is moving forward at 20 m/s. A student on the bus throws a tennis ball horizontally at 15 m/s toward the front of the bus. From the perspective of an observer on the sidewalk outside the bus, the tennis ball appears to move at —

F 5 m/s

G 15 m/s

H 20 m/s

J 35 m/s

GO ON

17 The table below shows the atomic masses in atomic mass units (amu) for a proton, a neutron, and a deuteron. A deuteron consists of one proton and one neutron.

Atomic Masses

Particle	Mass (amu)
Proton	1.0073
Neutron	1.0086
Deuteron	2.0135

Based on the data in the table, how much mass is converted to energy when a deuteron is formed?

A 2.0159 amu

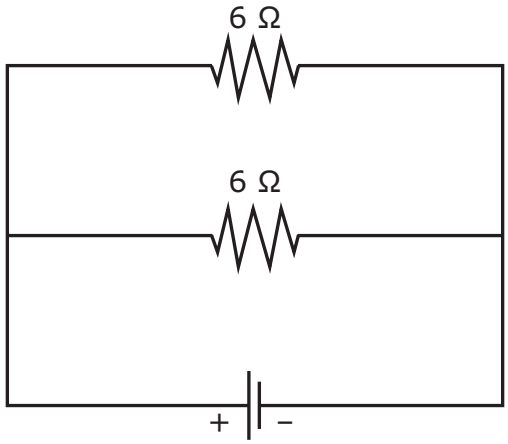
B 1.0080 amu

C 0.0024 amu

D 2.0135 amu

GO ON

18 A schematic diagram of a circuit consisting of two resistors is shown below.



What is the total resistance of the circuit?

F 12 Ω

G 3 Ω

H 2 Ω

J 0.33 Ω

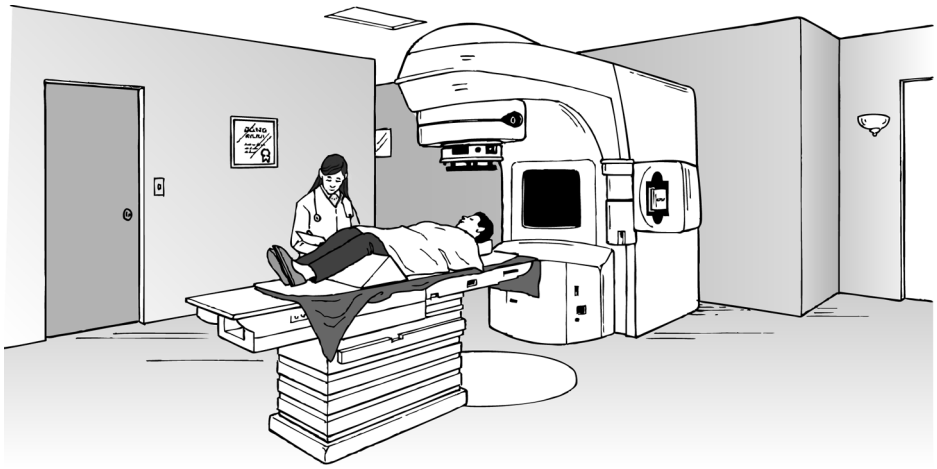
---

19 A net force acting on a 5.0 kg box produces an acceleration of 4.2 m/s^2. What acceleration, to the nearest tenth of a m/s^2, will the same net force cause on a 2.8 kg box?

Record your answer and fill in the bubbles on your answer document.

GO ON

20 The machine in the picture can be used to send gamma rays to destroy cells in specific parts of the body.



Which statement best describes the use of the machine in medicine?

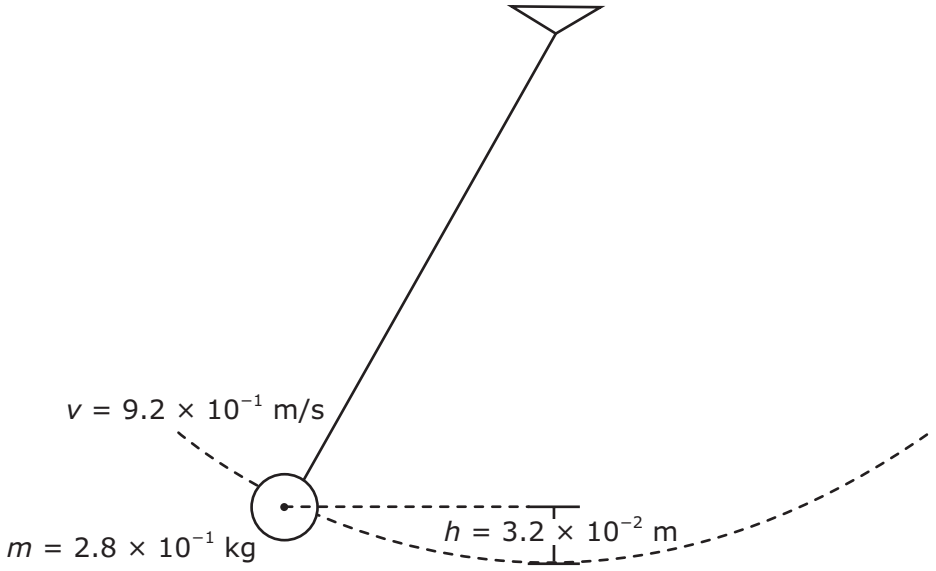
F The machine uses nuclear decay to treat a patient with radiation therapy.

G The machine uses nuclear decay to generate diagnostic images of a patient.

H The machine uses the photoelectric effect to introduce photons into a patient's organs.

J The machine uses the photoelectric effect to take pictures of a patient's organs.

21 A pendulum swings back and forth along the dashed path shown in the diagram. Its instantaneous velocity for the location shown is given in the diagram.



What is the pendulum's total mechanical energy at the given location with respect to the bottom of the swing?

A 3.2×10^{-2} J

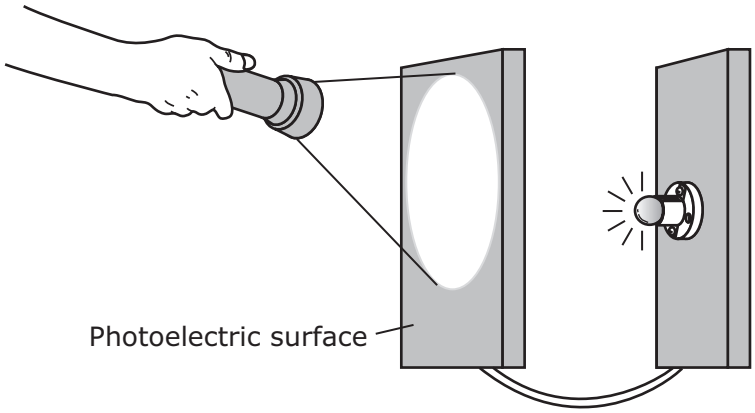
B 8.8×10^{-2} J

C 1.2×10^{-1} J

D 2.1×10^{-1} J

GO ON

22 A light source illuminates a photoelectric surface with ultraviolet light, causing the lightbulb on the right to glow.



The lightbulb glows because the ultraviolet light —

F reflects toward the lightbulb from the photoelectric surface

G ejects electrons from the photoelectric surface

H absorbs electrons from the photoelectric surface

J causes electrons to move from the lightbulb toward the photoelectric surface

23 Which action makes use of a magnetic force?

A A person puts a bank card in an electronic reader to buy an item.

B A store clerk finds the price of an item by moving the item over a laser light.

C A parent measures a child's temperature by touching a thermometer to the child's head.

D A student measures the mass of a book using a spring scale.

---

24 The pressure of a gas is increasing within a sealed container of fixed volume. Four students are asked to explain what must be happening on a molecular level for this to occur. The students' explanations are shown in the table.

Students' Explanations

Student	Explanation
1	The average size of the molecules has increased.
2	The average kinetic energy of the molecules has decreased.
3	The average speed of the molecules has increased.
4	The average potential energy of the molecules has decreased.

Which student best explains the increase in gas pressure?

F Student 1

G Student 2

H Student 3

J Student 4

GO ON

25 Sound travels through air at a speed of 342 m/s at room temperature. What is the frequency of a sound wave with a wavelength of 1.8 m, to the nearest whole Hz?

Record your answer and fill in the bubbles on your answer document.

---

26 Suppose Earth orbited a star whose mass was double the mass of the sun. If the radius of Earth's orbit remained the same as it is now, then compared with the gravitational force between Earth and the sun, the gravitational force between Earth and the star would be —

F half as much

G the same

H two times as much

J four times as much

GO ON

27 A boat travels 12.0 m while it reduces its velocity from 9.5 m/s to 5.5 m/s. What is the magnitude of the boat's acceleration while it travels the 12.0 m?

A 1.3 m/s^2

B 2.5 m/s^2

C 3.0 m/s^2

D 7.5 m/s^2

---

28 A warehouse employee is pushing a 30.0 kg desk across a floor at a constant speed of 0.50 m/s. How much work must the employee do on the desk to change the speed to 1.00 m/s?

F 3.75 J

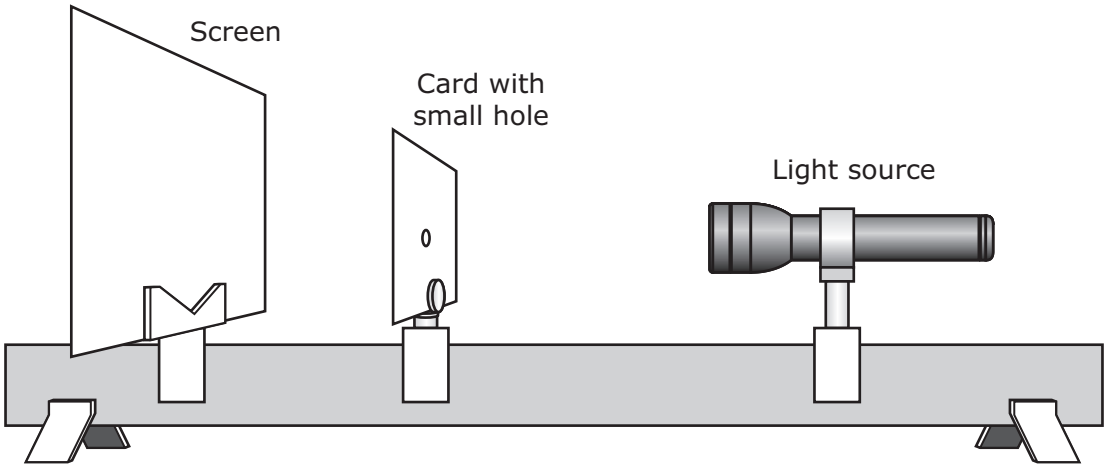
G 7.50 J

H 8.44 J

J 11.3 J

GO ON

29 Students use the setup shown below for a lab activity.



The setup is most useful for demonstrating —

A absorption

B diffraction

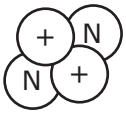
C resonance

D refraction

---

30 The nucleus of a helium atom is an alpha particle, which consists of two protons and two neutrons.

Helium Nucleus



Which statement best explains how the two protons in an alpha particle can be bound so closely together?

F The strong nuclear force and the electromagnetic force are the same.

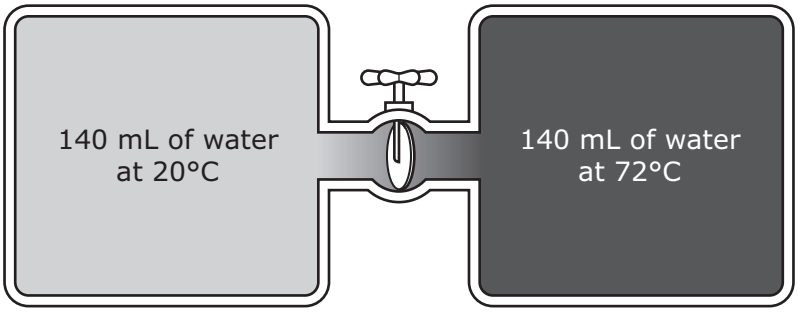
G The strong nuclear force is weaker than the electromagnetic force.

H The strong nuclear force is stronger than the electromagnetic force.

J The strong nuclear force and the electromagnetic force are negligible.

GO ON

31 The diagram below shows a closed system of two tanks that each contain water.

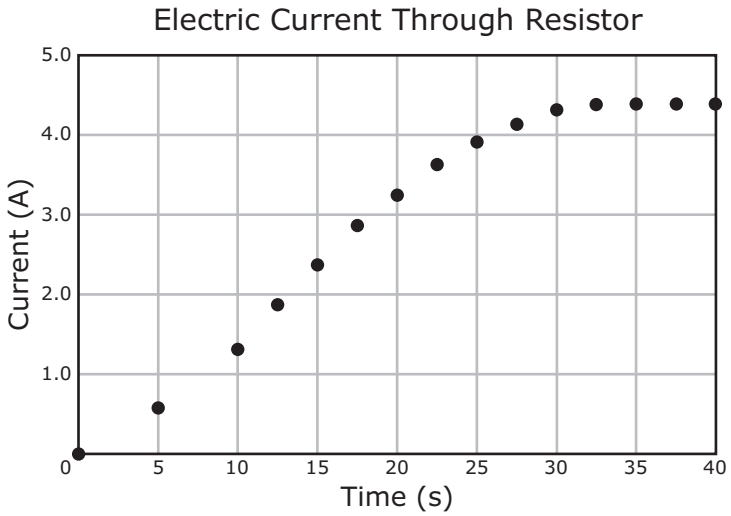


When the valve between the two tanks of water is opened, the temperature of the water in each tank changes. What is the equilibrium temperature to the nearest whole degree Celsius?

Record your answer and fill in the bubbles on your answer document.

GO ON

32 A student makes a graph that shows the electric current through a resistor over time.



Which of the following conclusions does the graph best support?

F The voltage across the resistor decreases until it becomes zero.

G The voltage across the resistor increases until it reaches a constant value.

H A fuse in the circuit blows after approximately 30 seconds.

J The resistance decreases as the voltage increases.

---

33 An object with an initial velocity of 3.50 m/s moves east along a straight and level path. The object then undergoes a constant acceleration of 1.80 m/s^2 east for a period of 5.00 s. How far does the object move while it is accelerating?

A 6.30 m

B 17.5 m

C 27.2 m

D 40.0 m

GO ON

34 Which of the following best determines the amount of energy of a single photon of light?

F The speed of the photon

G The frequency of the photon

H The material the photon moves through

J The time it takes the photon to reach a destination

---

35 The table below shows some data for the moon.

Lunar Data

Mass (kg)	Mean Radius (m)
7.36×10^{22}	1.74×10^{6}

Based on the table, what is the gravitational force on a 1.00 kg rock on the surface of the moon?

A 4.91×10^{12} N

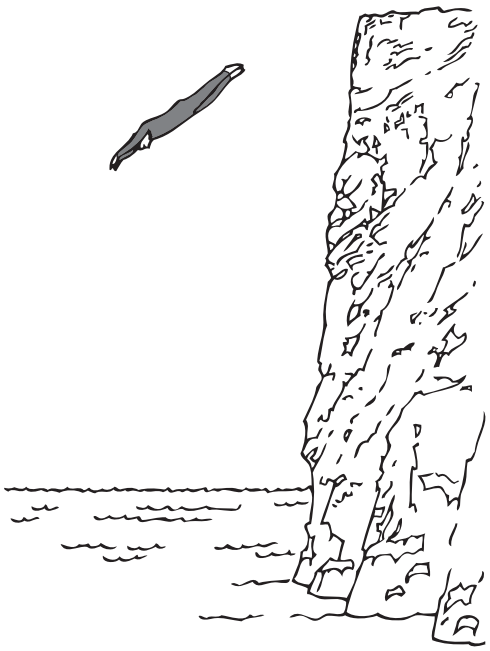
B 1.62 N

C 9.81 N

D 1.28×10^{29} N

GO ON

36 The picture shows a professional diver with a mass of 93.0 kg diving from a 25.0 m high cliff.



Earth's gravity is acting on the diver. Which statement best describes the reaction force to Earth's gravity in this situation?

F The diver is pulling on Earth with a force of 911 N.

G The sun is pulling on Earth with a force of 5.97×10^{24} N.

H Earth is pulling on the water with a force of 5.97×10^{25} N.

J Earth is pulling on the air with a force of 2.28×10^{4} N.

GO ON

37 A car traveling on a level road initially has 440 kJ of mechanical energy. After the brakes are applied for a few seconds, the car has only 110 kJ of mechanical energy. What best accounts for the missing mechanical energy?

A Half the missing mechanical energy has been converted to heat energy, and the other half has been destroyed.

B Most of the missing mechanical energy has been converted to gravitational potential energy.

C Half the missing mechanical energy has been converted to kinetic energy, and the other half has been converted to potential energy.

D Most of the missing mechanical energy has been converted to heat energy through friction.

---

38 Which statement best explains the difference between light waves traveling through a vacuum and light waves traveling through a medium?

F Light waves traveling through a vacuum are transverse, but light waves traveling through a medium are longitudinal.

G Light waves traveling through a vacuum travel faster than light waves traveling through a medium.

H Light waves traveling through a vacuum have no mass, but light waves traveling through a medium have a mass greater than zero.

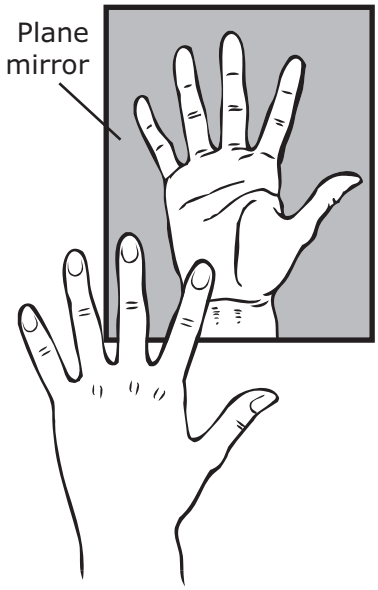
J Light waves traveling through a vacuum have a shorter wavelength than light waves traveling through a medium.

39 A bicyclist starts from rest and accelerates along a straight path to a speed of 12.15 m/s in a time of 4.5 seconds. What is the bicyclist's acceleration to the nearest tenth of a m/s^2?

Record your answer and fill in the bubbles on your answer document.

---

40 A student puts a hand up in front of a plane mirror as shown in the diagram. Four possible observations are shown in the table below.



Students' Responses

Student	Magnification of Image?	Apparent Distance of Image from Surface of Mirror
1	Yes (larger)	Same as the distance of the object from the surface
2	Yes (smaller)	Farther than the distance of the object from the surface
3	No	Farther than the distance of the object from the surface
4	No	Same as the distance of the object from the surface

Which observation correctly describes the image of the hand?

F Observation 1

G Observation 2

H Observation 3

J Observation 4

GO ON

41 Which of the following is the best evidence that work has been done on or by an object?

A The energy of the object has changed.

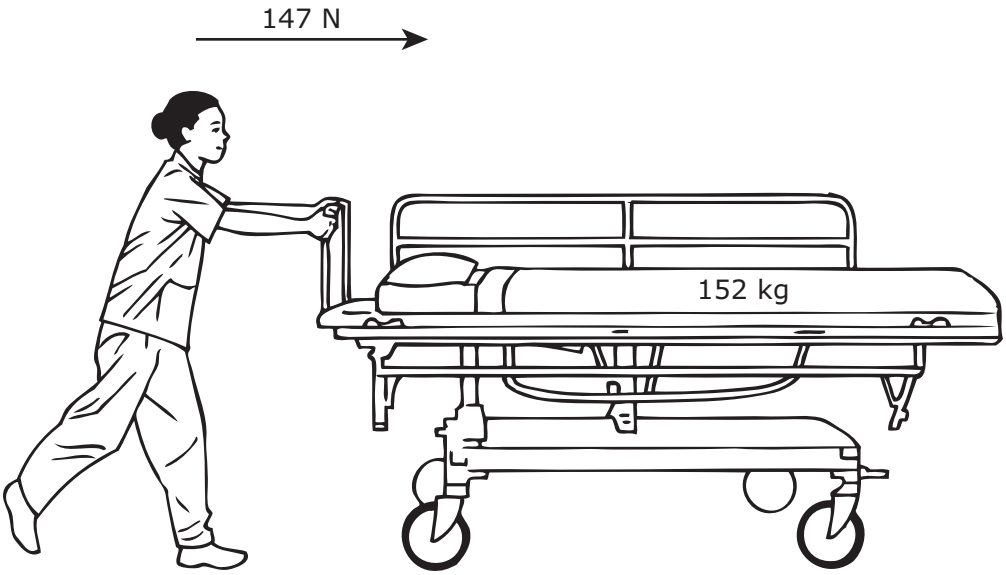
B The velocity of the object remains constant.

C The mass of the object has changed.

D The direction the object is moving remains constant.

---

42 A nurse applies a horizontal force of 147 N on a bed that has a mass of 152 kg, as shown below.



The magnitude of the normal force acting on the bed is —

F 0.967 N

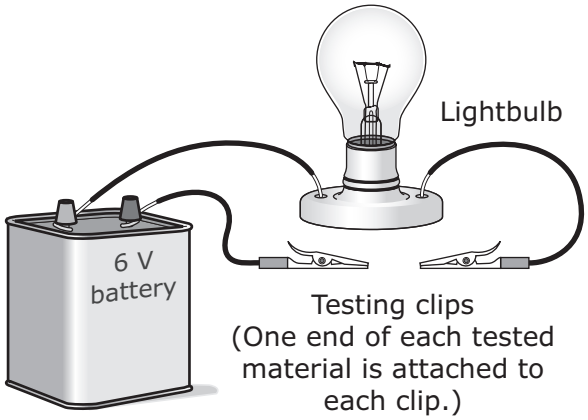
G 5.00 N

H 1440 N

J 1490 N

GO ON

43 The diagram below shows a lab setup and a data table.



Data Table

Testing Materials	Did the Lightbulb Shine?
Ebonite rod	
Copper cylinder	
Brass washer	
Iron nail	
Wood dowel	

Which statement is most likely to be true when the results are obtained and analyzed?

A The ebonite rod and the copper cylinder provide the greatest resistance to current in the circuit.

B The copper cylinder, the brass washer, and the iron nail allow electrons to move freely.

C The iron nail, the copper cylinder, and the brass washer allow protons to move freely.

D Both the wood dowel and the ebonite rod have the lowest resistance to current in the circuit.

---

44 An engineer is designing an instrument to examine the interior of a piece of wood without cutting it. The engineer decides to pass electromagnetic radiation through the wood to a detector on the other side. Which type of electromagnetic radiation would be most suitable for this investigation?

F Visible light

G Radio waves

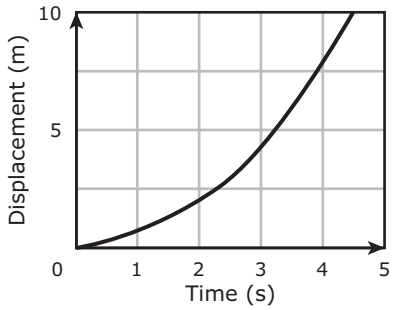
H X-rays

J Ultraviolet light

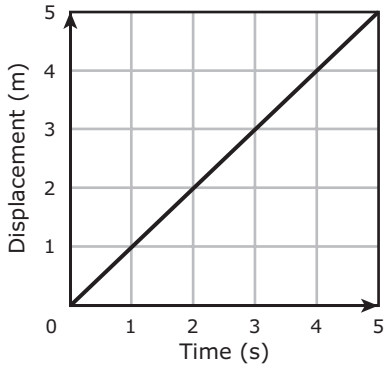
GO ON

45 Which graph best represents the motion of an object that has a positive acceleration for a period of time?

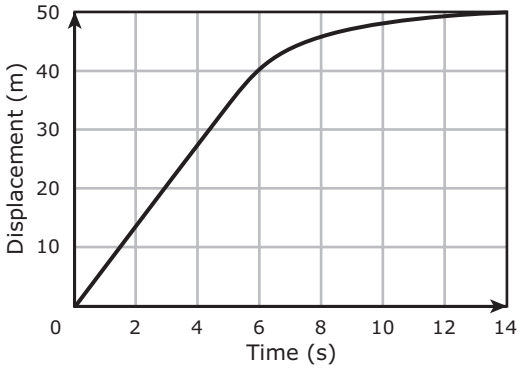
A



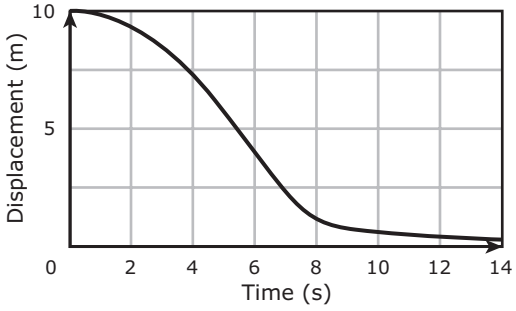
B



C



D



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46 What is the impulse on a 45,000 kg airplane when it changes its velocity from 242 m/s to 258 m/s?

F 16 kg•m/s

G 2,800 kg•m/s

H 440,000 kg•m/s

J 720,000 kg•m/s

GO ON

47 A train passes a stationary observer. Which of the following best describes how the amplitude and the apparent frequency of the sound waves heard by the observer change as the train moves away?

A Both the amplitude and the apparent frequency increase.

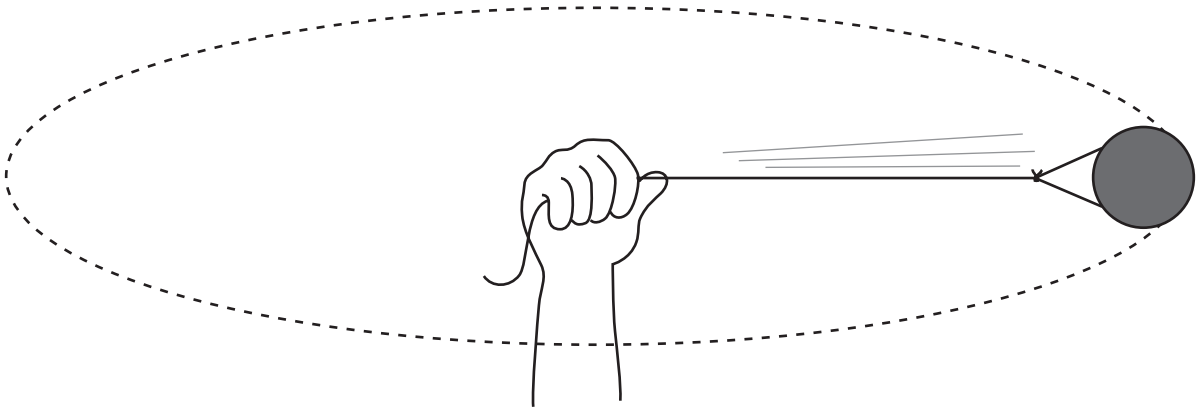
B Both the amplitude and the apparent frequency decrease.

C The amplitude of the sound waves increases, and the apparent frequency decreases.

D The amplitude of the sound waves decreases, and the apparent frequency increases.

---

48 A 0.040 kg ball tied to a string moves in a circle that has a radius of 0.700 m.



If the ball is accelerating at 43.2 m/s^2, what is the tangential velocity of the ball?

F 5.50 m/s

G 30.2 m/s

H 1.73 m/s

J 61.7 m/s

GO ON

49 Which action will not induce a potential difference in a coil of wire?

A Moving a magnet through the coil

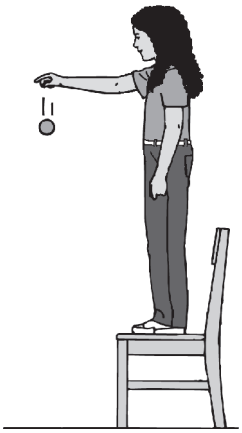
B Holding the coil in a changing magnetic field

C Holding the coil in a stationary magnetic field

D Moving the coil and a magnet toward each other

---

50 A student releases a ball from a height of 1.5 m above the floor.



Which of the following statements best describes the energy of the ball as it falls?

F Its potential energy is changed to kinetic energy.

G The total amount of its mechanical energy increases.

H Its kinetic energy is changed to potential energy.

J The total amount of its mechanical energy decreases.

BE SURE YOU HAVE RECORDED ALL OF YOUR ANSWERS ON THE ANSWER DOCUMENT.

STOP

STAAR
Physics
May 2013

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