California
Subject
Examinations for
Teachers®

TEST GUIDE

SCIENCE SUBTEST II: PHYSICS

Sample Questions and Responses and Scoring Information

CS-TG-QR220X-01

Sample Test Questions for CSET: Science Subtest II: Physics

Below is a set of multiple-choice questions and constructed-response questions that are similar to the questions you will see on CSET: Science Subtest II: Physics. You are encouraged to respond to the questions without looking at the responses provided in the next section. Record your responses on a sheet of paper and compare them with the provided responses.

Scientific calculators **will be provided** for the examinees taking Science Subtest I: General Science , as well as the specialty subtests of Life Sciences, Chemistry, Earth and Space Sciences, and Physics. Refer to the California Educator Credentialing Examinations website for a list of the calculator models that may be provided. Directions for the use of the calculator will not be provided at the test administration. You will not be allowed to use your own calculator for CSET: Science subtests.

CONSTANTS

Description	Value
Acceleration of gravity on Earth (g)	$9.80\ m/s^2$
Speed of light in a vacuum (c)	$3.00 \times 10^8\ m/s$
Planck's constant (h)	$6.63 \times 10^{-34}\ J \bullet s = 4.14 \times 10^{-15}\ eV \bullet s$
Electron rest mass	$9.11 \times 10^{-31}\ kg$
Proton rest mass	$1.67 \times 10^{-27}\ kg$
Charge of electron	$-1.60 \times 10^{-19}\ C$
Coulomb's constant (k_e)	$9.0 \times 10^9\ N \bullet m^2/C^2 = \frac{1}{4\pi\varepsilon_0}$
Boltzmann's constant (k)	$1.38 \times 10^{-23}\ J/K$
Density of water	$1000\ kg/m^3$
Specific heat of water	$4.19 \times 10^3\ J/(kg \bullet °C)$
Heat fusion of water	$3.33 \times 10^5\ J/kg$
Gas constant (R)	$8.31\ m^3 \bullet Pa/(mol \bullet K)$
Gravitational constant (G)	$6.67 \times 10^{-11}\ N \bullet m^2/kg^2$
Permeability of free space (μ_0)	$4\pi \times 10^{-7}\ T \bullet m/A$
Avogadro's number	6.02×10^{23}
Rydberg constant (R_H)	$1.097 \times 10^7/m$

TRIGONOMETRIC FUNCTIONS

angle (θ)	sin θ	cos θ
30°	0.500	0.866
45°	0.707	0.707
60°	0.866	0.500

FORMULAS

Not all formulas necessary are listed, nor are all formulas listed used on this test.

Description	Formula
Quadratic formula	$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
Surface area of a sphere	$A = 4\pi r^2$
Constant acceleration	$v_f = v_i + at$
	$x_f = x_i + v_i t + \frac{1}{2}at^2$
	$v_f^2 - v_i^2 = 2a(x_f - x_i)$
Kinetic energy	$T = \frac{1}{2}mv^2$
Momentum	$\mathbf{p} = m\mathbf{v}$
Impulse	$\mathbf{J} = \Delta\mathbf{p} = \int \mathbf{F}\,dt$
Circular motion	$a_c = \frac{v^2}{r}$
	$\theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2$
	$\omega_f = \omega_i + \alpha t$
	$v = r\omega$
	$a = r\alpha$
	$\tau = I\alpha$
Gravitational potential energy	$U = -\frac{GMm}{r}$
Spring	$F = -kx$
	$PE = \frac{1}{2}kx^2$
	$T = 2\pi\sqrt{\frac{m}{k}}$
	$f = \frac{1}{2\pi}\sqrt{\frac{k}{m}}$
	$\omega = \sqrt{\frac{k}{m}}$

FORMULAS (continued)

Description	Formula
Pendulum	$T = 2\pi\sqrt{\frac{L}{g}}$
	$\omega = \sqrt{\frac{g}{L}}$
Waves	$v = \sqrt{\frac{T}{\mu}}$
	$2L = n\lambda$, n is an integer
	$4L = n\lambda$, n is odd
	$f' = f_0\left(\frac{V \pm V_0}{V \pm V_s}\right)$
Sound intensity	$I = \frac{P}{4\pi r^2}$
Optics	$n_1 \sin \theta_1 = n_2 \sin \theta_2$
	$n = \frac{c}{v}$
	$\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$
	$I = I_0 \cos^2\theta$
Modern Physics	$\Delta x \Delta p \geq \frac{h}{2\pi}$
	$p\lambda = h$
	$E = hf$
	$\frac{1}{\lambda} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$
	$\Delta t = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$
	$\Delta L = \frac{L_0}{\sqrt{1 - \frac{v^2}{c^2}}}$
	$(c\Delta t)^2 - \Delta x^2 =$ invariant

FORMULAS (continued)

Description	**Formula**
Thermodynamics	$T_k = T_c + 273$
	$\Delta U = nC_v\Delta T$
	$\Delta Q = mc\Delta T$
	$\Delta S = \frac{\Delta Q}{T}$
	$PV = nRT$
	$\frac{1}{2}m\overline{v^2} = \frac{3}{2}kT$
Electricity	$F = \frac{kq_1q_2}{r^2}$
	$\oint \mathbf{E} \cdot d\mathbf{A} = 4\pi kq$
	$V = IR$
	$P = IV$
	$E = \frac{F}{q}$
	$V = \frac{W}{q}$
	$Q = CV$
	$\tau = RC$
	$E = \frac{1}{2}CV^2$
	$E = \frac{1}{2}LI^2$
Magnetism	$\mathbf{F} = q\mathbf{v} \times \mathbf{B}$
	$\mathbf{F} = I\boldsymbol{\ell} \times \mathbf{B}$
	$\oint \mathbf{B} \cdot d\mathbf{s} = \mu_0 I$
	$B = \frac{\mu_0 I}{2\pi r}$

Note: In questions on electricity and magnetism, the term *current* refers to "conventional current" and the use of the right-hand rule is assumed.

1. A ball is thrown with an initial velocity of 20 m/s at an angle of 30° above the horizontal. What is the instantaneous vertical velocity of the ball when it is 5.1 m above the release point?

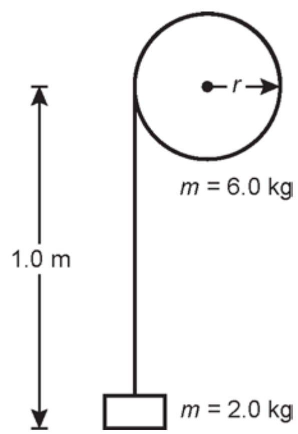
   A. 0.2 m/s

   B. 6.6 m/s

   C. 10 m/s

   D. 17 m/s

2. **Use the diagram below to answer the question that follows.**



   The diagram shows a frictionless wheel with a cable wrapped around it and a block attached to the end of the cable. The wheel has a mass of 6.0 kg and the block has a mass of 2.0 kg. The block is released from rest and drops as the cable unwinds. When the block has dropped 1.0 m, its velocity is 2.8 m/s. What is the kinetic energy of the wheel?

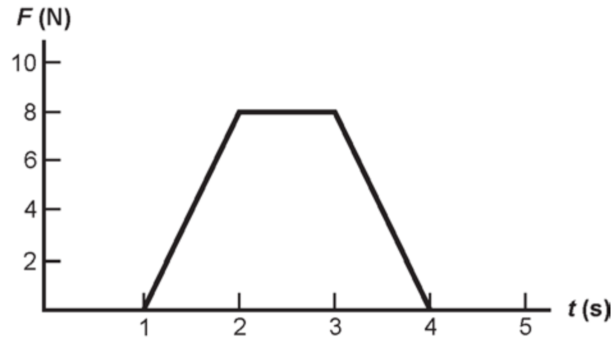
   A. 0 J

   B. 8.4 J

   C. 12 J

   D. 20 J

3. **Use the graph below to answer the question that follows.**



The graph shows the magnitude of a force as a function of time. At t = 0 s, a 10 kg object is moving at 4.0 m/s. The force shown on the graph is applied to the object in the direction of motion. What is the momentum of the object at t = 5 s?

A. 16 kg•m/s

B. 24 kg•m/s

C. 40 kg•m/s

D. 56 kg•m/s

4. A container holds 1 mol of an ideal gas at temperature T_i. The gas is placed in contact with a heat reservoir at T_f with $T_f > T_i$. After a short time, the gas reaches an equilibrium temperature of T_f. According to the kinetic molecular theory, the heat was transferred from the reservoir to the gas primarily through the process of:

A. mass transfer.

B. electron transitions.

C. molecular collisions.

D. magnetic reorientation.

5. An insulated container holds 4.0 mol of nitrogen at a pressure of 10^5 Pa and a temperature of 200 K. What is the size of the container? (1 atm = 101 kPa)

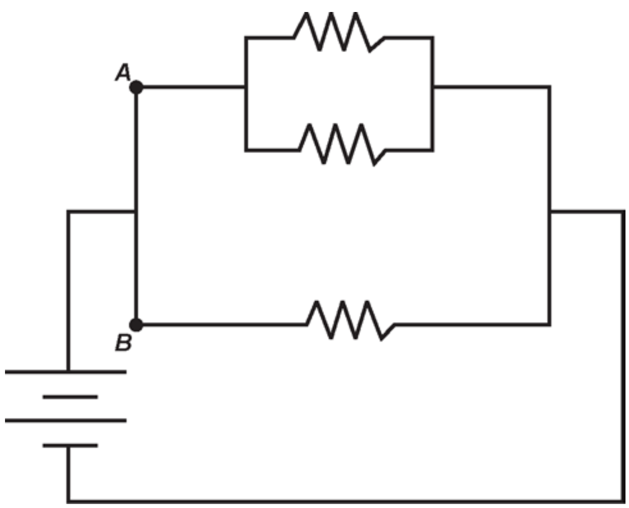
   A. 4 L

   B. 8 L

   C. 17 L

   D. 67 L

6. **Use the circuit diagram below to answer the question that follows.**



The diagram shows a circuit with three identical resistors. What is the ratio of the current through point A to the current through point B?

   A. $\frac{1}{2}$

   B. $\frac{2}{3}$

   C. 1

   D. 2

7. An observer in an inertial reference frame with a stationary charge measures an electric field due to the charge. A second observer moving at a constant velocity with respect to the first observer measures both an electric field and a magnetic field due to the charge. Which of the following statements best explains this apparent paradox?

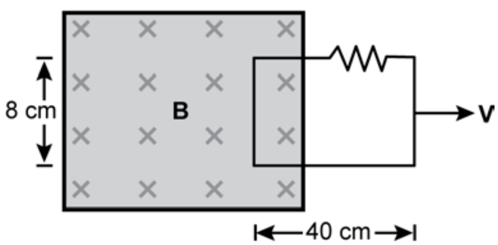
   A. The laws of electromagnetism are not valid in different inertial frames of reference.

   B. The first observer would also measure a magnetic field due to the stationary charge.

   C. The second observer's measurement equipment is altered by the velocity of motion.

   D. The electric field and the magnetic field are different representations of the same phenomenon.

8. **Use the diagram below to answer the question that follows.**



A loop of wire that measures 8 cm by 40 cm is attached to a 4 Ω resistor and is inside a uniform 0.5 T magnetic field that points into the computer screen. The loop is pulled out of the field at a constant speed of 5 cm/s. What is the magnitude and direction of the induced current in the loop?

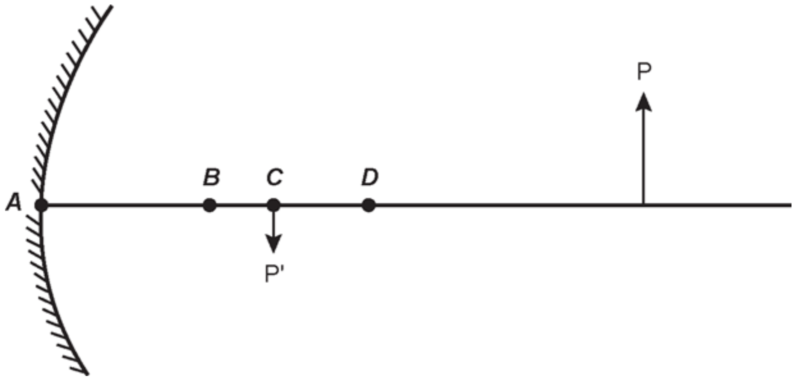
   A. 0.5 mA clockwise

   B. 0.5 mA counterclockwise

   C. 2 mA clockwise

   D. 2 mA counterclockwise

9. **Use the diagram below to answer the question that follows.**



A curved mirror forms an image P' of an object P. Which of the following best indicates the location of the focal point of the mirror?

A. point *A*

B. point *B*

C. point *C*

D. point *D*

10. **Use the diagram below to answer the question that follows.**

The diagram shows a wave pulse with velocity v_1 traveling in a lightweight string attached to a heavier string. Which of the following best represents the shape of the string after the pulse has passed the boundary between the two strings?

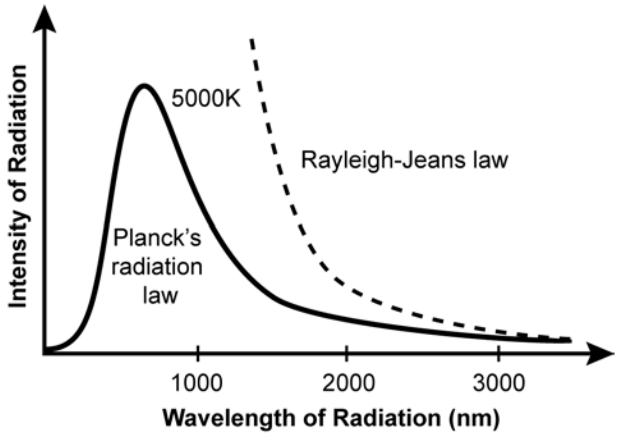
A.

B.

C.

D.

11. **Use the diagram below to answer the question that follows.**



The diagram shows two models for how the intensity of the radiation by a blackbody depends on the wavelength of light. The Rayleigh-Jeans law predicted that the energy would become infinite as $\lambda \longrightarrow 0$. Planck's radiation law better matched empirical evidence and showed the energy radiated goes to 0 as $\lambda \longrightarrow 0$. Which of the following best describes Planck's hypothesis?

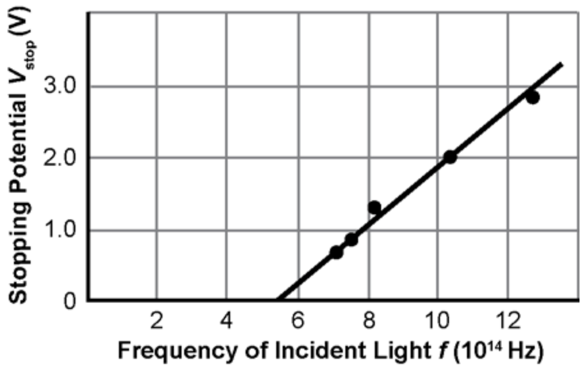
A. Light waves have different phases that cause destructive interference.

B. The energy of light emitted by a harmonic oscillator is quantized.

C. The speed of light is a constant and is independent of the motion of an observer.

D. Electrons in atoms can move in certain orbits without emitting radiation.

12. **Use the graph below to answer the question that follows.**



The graph shows data points and a fitted line in a photoelectric effect experiment. What is the work function for the metal in this experiment?

A. 1.7 eV

B. 2.3 eV

C. 2.9 eV

D. 3.5 eV

13. Two events happen at the same place and 1.0 μs apart in one inertial reference frame. Those same two events are 2.0 μs apart in a second inertial reference frame moving at some velocity relative to the first frame. What is the distance between the two events in the second inertial reference frame?

A. 300 m

B. 520 m

C. 600 m

D. 850 m

14. An electron is moving parallel to an *x*-axis and its speed is measured to be 7.3×10^5 m/s with an uncertainty of 0.50%. What is the minimum uncertainty in a simultaneous measurement of the electron's position along the *x*-axis?

A. 32 nm

B. 200 nm

C. 310 nm

D. 1300 nm

15. **Use the information below to answer the question that follows.**

atomic mass of ^{238}U = 238.05079 u
atomic mass of ^{234}Th = 234.04363 u
atomic mass of ^{4}He = 4.00260 u
1 u = 1.66×10^{-27} kg
1 J = 6.24×10^{18} eV

Uranium-238 decays to thorium-234 by emitting an alpha particle. The atomic masses are given above. How much energy is liberated in this alpha decay?

A. 3.23 MeV

B. 4.26 MeV

C. 5.28 MeV

D. 6.31 MeV

CONSTRUCTED-RESPONSE ASSIGNMENT DIRECTIONS

For each constructed-response assignment in this section, you are to prepare a written response.

Read each assignment carefully before you begin your response. Think about how you will organize your response. You may use the erasable notebooklet to make notes, write an outline, or otherwise prepare your response. ***However, your final response must be either:***

1) typed into the on-screen response box,
2) written on a response sheet and scanned using the scanner provided at your workstation, or
3) provided using both the on-screen response box (for typed text) and a response sheet (for calculations or drawings) that you will scan using the scanner provided at your workstation.

Instructions for scanning your response sheet(s) are available by clicking the "Scanning Help" button at the top of the screen.

Your responses will be evaluated based on the following criteria.

PURPOSE: the extent to which the response addresses the constructed-response assignment's charge in relation to relevant CSET subject matter requirements

SUBJECT MATTER KNOWLEDGE: the application of accurate subject matter knowledge as described in the relevant CSET subject matter requirements

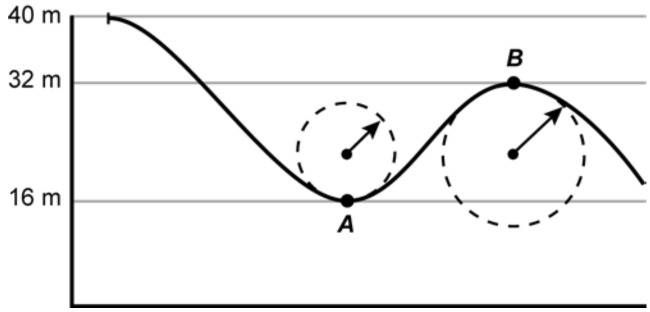
SUPPORT: the appropriateness and quality of the supporting evidence in relation to relevant CSET subject matter requirements

The assignments are intended to assess subject matter knowledge and skills, not writing ability. Your responses, however, must be communicated clearly enough to permit a valid judgment of your knowledge and skills. Your responses should be written for an audience of educators in the field.

Your responses should be your original work, written in your own words, and not copied or paraphrased from some other work. Please write legibly when using the response sheets. You may not use any reference materials during the testing session. Remember to review your work and make any changes you think will improve your responses.

Any time spent responding to an assignment, including scanning the response sheet(s), is part of your testing time. Monitor your time carefully. When your testing time expires, a pop-up message will appear on-screen indicating the conclusion of your test session. Only response sheets that are scanned before you end your test or before time has expired will be scored. Any response sheet that is not scanned before testing ends will NOT be scored.

16. **Use the information below to answer the question that follows.**



The diagram shows a design for a roller coaster. The track at points *A* and *B* can be estimated as circular arcs. The roller coaster cart starts from rest at the top of the highest hill. The roller coaster must meet the following constraints.

1. A person in a roller coaster car at point *A* should experience a force equal to 3 times his or her weight.

2. A person in a roller coaster car at point *B* should feel weightless.

3. The system is considered frictionless.

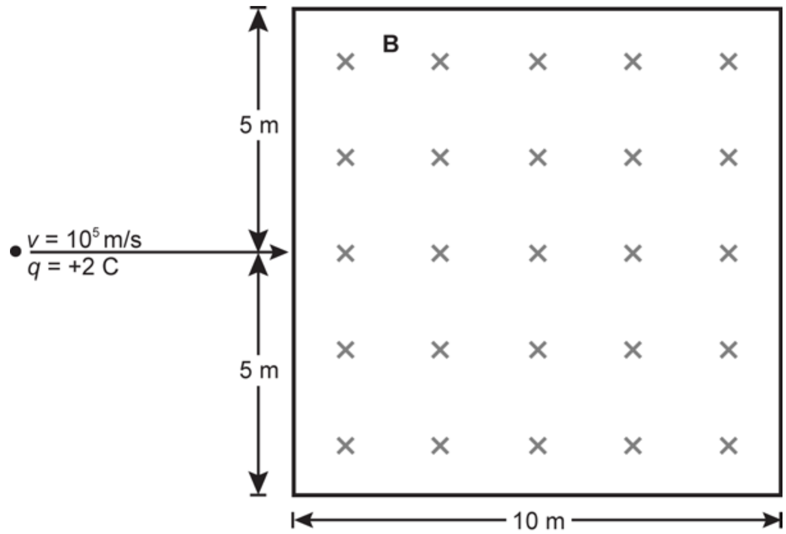
- Draw a free body diagram of the forces on a roller coaster car at point *A*.

- Determine the radius of curvature of the circular arc at point *A*.

- Draw a free body diagram of the forces on the roller coaster car at point *B*.

- Determine the radius of curvature of the circular arc at point *B*.

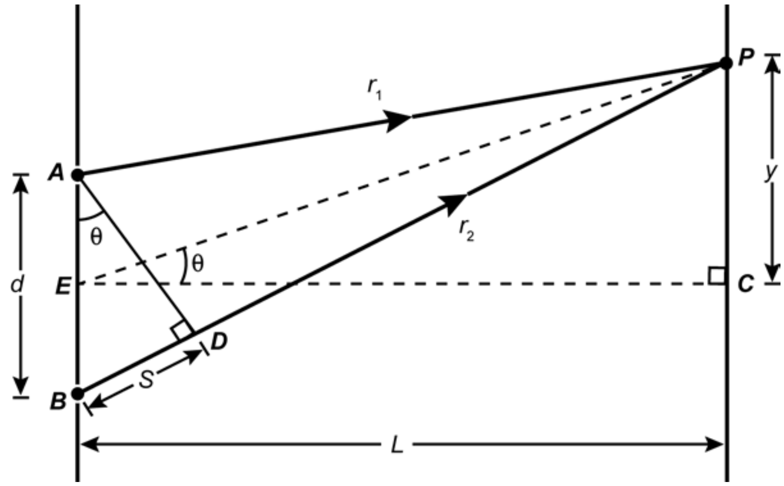
17. **Use the diagram below to complete the exercise that follows.**



A positively charged particle of charge $q = +2$ C and mass $m = 10^{-4}$ kg has a velocity of $v = 10^5$ m/s. The particle enters the center of one side of a magnetic field. The field is $\boldsymbol{B} = 2$ T. Its direction is into the computer screen, and its size is 10 m × 10 m.

- Describe the shape of the path that the particle follows when it is in the magnetic field. Explain your reasoning.
- Find the key dimension(s) of the path. Show your work.
- Draw the path of the particle on a diagram. Show the location and scale.

18. **Use the information below to complete the exercise that follows.**



Plane waves of monochromatic light with a wavelength of 560 nm are incident on two very narrow slits spaced 2.9 μm apart. The waves are in phase. Light from the slits strikes a screen 1.3 m away from the slits. A two-slit diffraction pattern appears on the screen. The geometry for the two slit apparatus is shown above.

- Use the diagram and the small angle approximation ($\sin \theta \approx \theta$, $\tan \theta \approx \theta$) to find an expression for the path length difference in terms of *d*, *y*, and *L*.
- Describe the relationship between the path length difference and the wavelength of light at points of maximum and minimum light intensity on the screen.
- Find the distance of the first-order maximum from the central maximum.

Annotated Responses to Sample Multiple-Choice Questions for CSET: Science Subtest II: Physics

1. **Correct Response: A.** (SMR Code: 1.1e) The initial vertical component of the ball's velocity can be found from triangle trigonometry using $\sin 30° = \frac{v_y}{v_i} = \frac{v_{yi}}{20 \text{ m/s}}$, so $v_{yi} = 10$ m/s. The instantaneous vertical velocity at 5.1 m can be calculated using $v_{yf}^2 = v_{yi}^2 + 2a\Delta y = (10 \text{ m/s})^2 + 2(-9.8 \text{ m/s}^2)(5.1 \text{ m}) = 0.04 \text{ m}^2/\text{s}^2$, so $v_{yf} = 0.2$ m/s.

2. **Correct Response: C.** (SMR Code: 1.1g) As the block falls, it loses potential energy. This becomes translational kinetic energy of the block and rotational kinetic energy of the wheel. In other words, $-\Delta U_{block} = \Delta K_{block} + \Delta K_{wheel}$. The wheel's change in potential energy is $mg\Delta h = (2.0 \text{ kg})(9.8 \text{ m/s}^2)(-1.0 \text{ m}) = -19.6$ J. Since the block and wheel start at rest, the change in kinetic energy for each object is equal to the final kinetic energy for each object. The block's final kinetic energy is $\frac{1}{2}mv^2 = \frac{1}{2}(2.0 \text{ kg})(2.8 \text{ m/s})^2 = 7.84$ J. Substituting these values in the energy equation above yields, to two significant figures, $\Delta K_{wheel} = 12$ J.

3. **Correct Response: D.** (SMR Code: 1.2g) The impulse imparted to an object equals the change in the object's momentum. On a force-versus-time graph, impulse is also the area under the graph, which in this case equals 16 kg·m/s. The 10 kg object, initially moving at 4.0 m/s, has an initial momentum of 40 kg·m/s. Its final momentum, therefore, is 40 kg·m/s + 16 kg·m/s = 56 kg·m/s.

4. **Correct Response: C.** (SMR Code: 2.1a) There are three methods of heat transfer: conduction, convection, and radiation. Although there is always some radiative transfer going on, the equilibrium is reached after a "short time" and is primarily due to conduction because of the contact between the reservoir and the container of gas. Molecules of the reservoir collide with molecules in the container of the gas and molecules in the gas are continually colliding with the container walls and with each other. Hotter objects have higher average kinetic energies for their molecules than colder ones. When two objects of different temperature are in contact, collisions between the molecules of the two objects result in a net transfer of energy from the hotter object to the colder one, which is the mechanism of conduction. The net transfer of energy between the two objects stops when both objects are at the same temperature and have the same average kinetic energies for their molecules. The two objects are then said to be in thermal equilibrium.

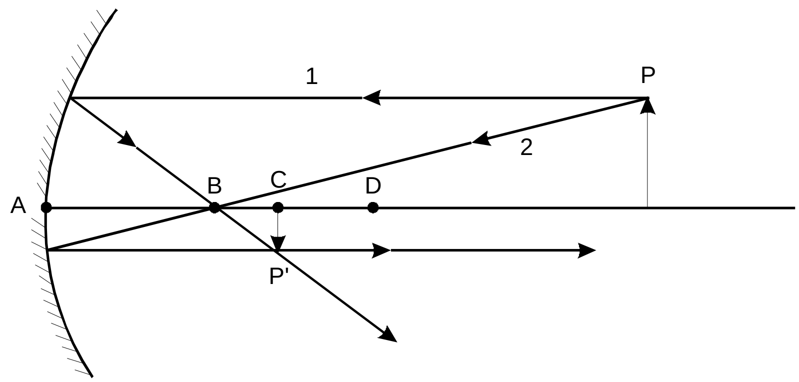
5. **Correct Response: D.** (SMR Code: 2.2c) According to the ideal gas law, $PV = nRT$. Here, $P = 10^5$ Pa = 10^5 N/m^2, n = 4.0 moles, the gas constant R = 8.31 J/K·mol, and T = 200 K. Substituting and solving for V gives V = 0.0665 m^3. Since 1 m^3 = 1000 L, the volume is 66.5 L, so a 67-liter container should be used for the gas.

6. **Correct Response: D.** (SMR Code: 2.3d) The top two resistors are in parallel, so their equivalent resistance is derived from $\frac{1}{R_{\text{eq}}} = \frac{1}{R} + \frac{1}{R} = \frac{2}{R}$, so $R_{\text{eq}} = \frac{R}{2}$. The potential drop across the two branches of the circuit—branch A and branch B—must be equal, since those two branches are also in parallel. If these voltage drops are V_A and V_B, respectively, then $V_A = V_B$, or from Ohm's Law, $I_A R_A = I_B R_B$. Since R_A is half of R_B, I_A must be twice I_B, so the ratio of I_A to I_B is two.

7. **Correct Response: D.** (SMR Code: 2.3d) Einstein showed that the laws of electromagnetism are relativistically invariant, which means they are the same in all inertial reference frames. While each observer measures different fields in different inertial reference frames, the laws of physics must be the same in each frame. This is explained by the unification of electricity and magnetism into the electromagnetic field.

8. **Correct Response: A.** (SMR Code: 2.3f) According to Faraday's law of induction, the induced emf in the loop is equal to the negative change in magnetic flux over time, or $\varepsilon = -\partial\Phi / \partial t$. In this case the flux Φ is equal to the magnetic field times the area of the loop through which the magnetic field passes. The magnetic field is constant, but the area changes at a rate of hv. The rate of change of flux is therefore $\partial\Phi / \partial t = Bhv$, so $\varepsilon = -Bhv = -2\,\text{mV}$ (after converting to m^2). Using Ohm's law, $I = \varepsilon / R$, or 0.5 mA. The direction of current flow can be interpreted with Lenz's law, which says that induced current will flow in a direction that opposes the change in magnetic flux. Since the flux is decreasing as the loop is pulled out, the current will flow in a direction such that the induced magnetic field will be in the same direction as the applied field. Using the right hand rule, we can see the current will run clockwise.

9. **Correct Response: B.** (SMR Code: 3.1e) Since image P' is inverted, the focal point of the mirror must lie between the image and the mirror. As shown in the diagram below, two reference rays passing through the tips of both object P and image P' identify the focal point's location at *B*. Ray 1 goes parallel to the axis from P to the mirror and is reflected through the focal point at point *B*; ray 2 goes through *B* to the mirror and is reflected back parallel to the axis through P'.



10. **Correct Response: C.** (SMR Code: 3.1e) When a wave pulse strikes the boundary between two strings, part of the pulse is transmitted along the heavy string at velocity v_2. Since the second string is denser, however, most of the pulse is reflected back at velocity v_1. The light string exerts an upward force at the boundary, causing an upright transmitted pulse, while the heavy string exerts a downward force, causing an inverted reflected pulse.

11. **Correct Response: B.** (SMR Code: 3.2a) The Rayleigh-Jeans law is related to the what was known as the "Ultraviolet Catastrophe," the name given to the incorrect classical prediction that blackbodies would radiate an infinite amount of energy at short wavelengths. This was derived by treating the blackbody as a collection of harmonic oscillators at a specific temperature. In trying to explain the experimental evidence, Planck made the assumption that radiation could only be emitted in discrete packets with energy inversely proportional to wavelength. This meant that the short-wavelength quanta would have very large energies, making their emission unlikely according to statistical mechanics.

12. **Correct Response: B.** (SMR Code: 3.2c) One of the key features of the photoelectric effect is that there is a minimum frequency of incident light required to eject electrons from a target metal. The quantum energy $E = hf$ corresponding to this frequency, where h = 4.14 × 10^{-15} eV-s is Planck's constant, is called the work function and is equal to the minimum energy required to knock loose an electron from an atom in the metal. Extrapolating the fitted line to the x-axis, the minimum frequency is approximately 5.5 × 10^{14} Hz, so the work function is (5.5 × 10^{14} s^{-1})(4.14 × 10^{-15} eV-s) = 2.3 eV.

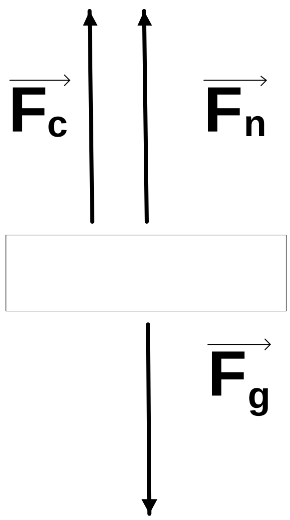
13. **Correct Response: B.** (SMR Code: 4.1c) One of the results of special relativity is the phenomenon of time dilation, which says that if two events happen at the same location in one reference frame, and the time interval between them is the proper time τ, the measured time interval between the events in another reference frame moving with velocity v relative to the first is $\Delta t = \gamma\tau$, where $\gamma = 1/\sqrt{1 - v^2/c^2}$. In this situation τ = 1 μs, $\Delta t = 2$ μs, and γ = 2. Solving with these values gives v = 0.87 c. So relative to the first, the second frame is moving at 87% of the speed of light. The two events are therefore separated by a distance of $v\Delta t$ = 520 m in the second reference frame

14. **Correct Response: A.** (SMR Code: 4.1d) According to the Heisenberg Uncertainty Principle, there is a minimum accuracy with which you can specify both the position and momentum of a particle in the same direction. This is given by $\Delta p_x \Delta x \geq h/2\pi$, where p_x and x are the momentum and position of the particle, respectively, and h = 6.63 × 10^{-34} J-s is Planck's constant. If the electron has a rest mass of 9.11 × 10^{-31} kg, the uncertainty in momentum corresponding to the given velocity measurement is Δp_x = 3.33 × 10^{-27} kg-m/s. Substituting these values to find the lower limit on position uncertainty gives $\Delta x =$ (6.63 × 10^{-34} J-s)/[(2π)(3.33 x 10^{-27} kg-m/s)] = 32 nm.

15. **Correct Response: B.** (SMR Code: 4.2a) The amount of energy released can be found from the difference in initial and final masses using Einstein's equation $E = mc^2$. The combined masses of thorium-234 and the alpha particle are less than the mass of uranium-238 by 0.00456 u, or about 7.57 × 10^{-30} kg. The energy released is therefore 6.8 × 10^{-13} J = 4.26 MeV.

Examples of Strong Responses to Sample Constructed-Response Questions for CSET: Science Subtest II: Physics

Question #16 (Score Point 3 Response)



At point A, the diagram will be as drawn on left. F_n is the normal force, F_g is the gravitational force, and F_c is the centripetal force.

For the radius of curvature:

From Conservation of Energy:

$$\vec{E}_{total} = \overrightarrow{PE} + \overrightarrow{KE}$$

$$mg\Delta h = \frac{1}{2}mv^2$$

$$v^2 = 2g\Delta h$$

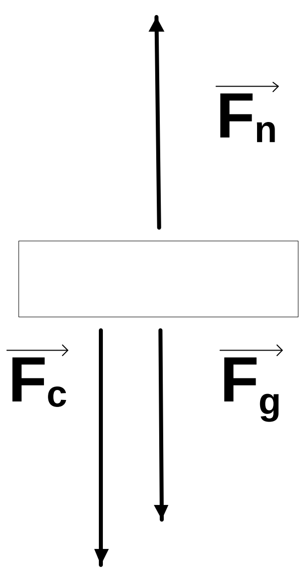
From force, we get:

$$\vec{F}_{total} = \vec{F}_{centripetal} = \vec{F}_{gravity} + \vec{F}_{normal}$$

And because our rider feels a force equal to 3x their weight, the normal force will be 3mg

$$\frac{m2g\Delta h}{r} = -mg + 3mg$$

$$r = \Delta h$$



At point B, the diagram will be as drawn on left. F_n is the normal force, F_g is the gravitational force, and F_c is the centripetal force. For the radius of curvature:

From Conservation of Energy:

$$\vec{E}_{total} = \overrightarrow{PE} + \overrightarrow{KE}$$

$$mg\Delta h = \frac{1}{2}mv^2$$

$$v^2 = 2g\Delta h$$

From force, we get:

$$\vec{F}_{total} = \vec{F}_{centripetal} = \vec{F}_{gravity} + \vec{F}_{normal}$$

And because the rider feels weightless, the normal force is zero

$$-\frac{m2g\Delta h}{r} = -mg + 0$$

$$r = 2\Delta h$$

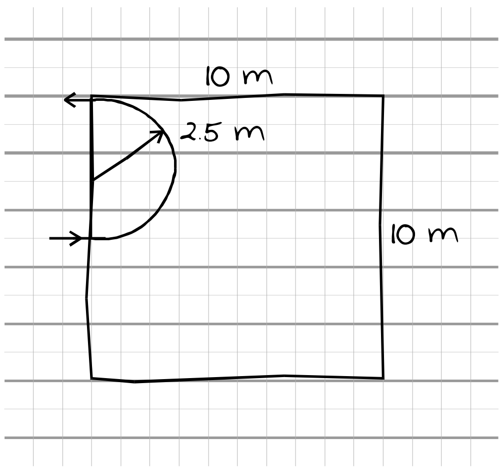
Question #17 (Score Point 3 Response)

A charged q in a magnetic field experiences a force = F = qv × B. The direction of F is ⊥ to both B + v. ∴ the F will be in the plane of the paper and ⊥ to the direction of V. Centripetal F on uniform circular motion shows the motion of the q must be circular if the F_{mag} is perpendicular to the velocity of the charge.

$F = qvB \qquad F = zc \times 10^5\ m/s \times 2T$

$a_B = F/m = (qvb)/m \qquad a_B = 4 \times 10^5/10^{-4} = 4 \times 10^9\ m/s$

$r = mv^2/(qvB) \qquad r = 10^{10}/(4 \times 10)^9 = 2.5\ m$

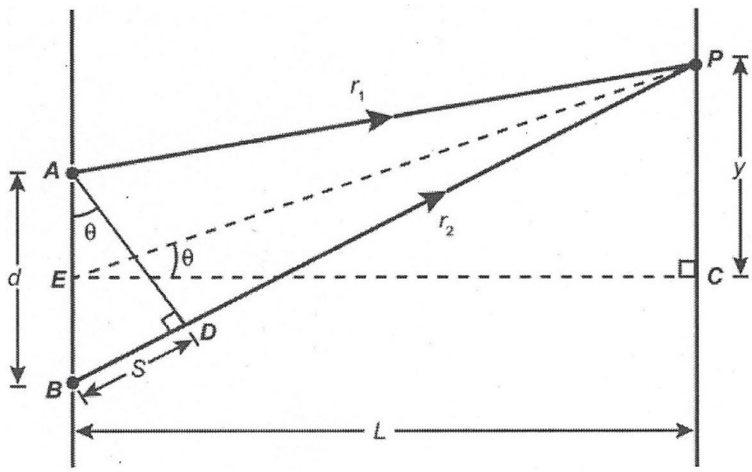


not to scale

in at 5 m

out at 10 m edge

Question #18 (Score Point 3 Response)



Using the small angle approximation:

$$\sin\theta = \theta = \frac{S}{d}$$

And:

$$\tan\theta = \theta = \frac{y}{L}$$

Which means:

$$\frac{S}{d} = \frac{y}{L}$$

Let's assume that $S = 1$

$$\frac{1}{d} = \frac{y}{L}$$

The resulting expression for path length difference is: $y = \frac{L}{d}$

There is a direct proportionality relationship between the path length difference and the wavelength of light. Points of maximum light intensity (bright spots) are directly in phase with the original wave, while points of minimum light intensity (dark spots) are out of phase by half a cycle.

For the distance of the first order maximum from the central maximum:

$$y = \frac{L\lambda}{d} = \frac{(1.3m) \times (560 \times 10^{-9}m)}{(2.9 \times 10^{-6}m)} = 0.251\ meters$$

Scoring Information for CSET: Science Subtest II: Physics

Responses to the multiple-choice questions are scored electronically. Scores are based on the number of questions answered correctly. There is no penalty for guessing.

There are three constructed-response questions in Subtest II: Physics of CSET: Science. Each of these constructed-response questions is designed so that a response can be completed within a short amount of time—approximately 10–15 minutes. Responses to constructed-response questions are scored by qualified California educators using focused holistic scoring. Scorers will judge the overall effectiveness of your responses while focusing on the performance characteristics that have been identified as important for this subtest (see below). Each response will be assigned a score based on an approved scoring scale (see page 27).

Your performance on the subtest will be evaluated against a standard determined by the Commission on Teacher Credentialing based on professional judgments and recommendations of California educators.

Performance Characteristics for CSET: Science Subtest II: Physics

The following performance characteristics will guide the scoring of responses to the constructed-response questions on CSET: Science Subtest II: Physics.

PURPOSE	The extent to which the response addresses the constructed-response assignment's charge in relation to relevant CSET subject matter requirements.
SUBJECT MATTER KNOWLEDGE	The application of accurate subject matter knowledge as described in the relevant CSET subject matter requirements.
SUPPORT	The appropriateness and quality of the supporting evidence in relation to relevant CSET subject matter requirements.

Scoring Scale for CSET: Science Subtest II: Physics

Scores will be assigned to each response to the constructed-response questions on CSET: Science Subtest II: Physics according to the following scoring scale.

SCORE POINT	SCORE POINT DESCRIPTION
3	**The "3" response reflects a command of the relevant knowledge and skills as defined in the subject matter requirements for CSET: Science.** • The purpose of the assignment is fully achieved. • There is an accurate application of relevant subject matter knowledge. • There is appropriate and specific relevant supporting evidence.
2	**The "2" response reflects a general command of the relevant knowledge and skills as defined in the subject matter requirements for CSET: Science.** • The purpose of the assignment is largely achieved. • There is a largely accurate application of relevant subject matter knowledge. • There is acceptable relevant supporting evidence.
1	**The "1" response reflects a limited or no command of the relevant knowledge and skills as defined in subject matter requirements for CSET: Science.** • The purpose of the assignment is only partially or not achieved. • There is limited or no application of relevant subject matter knowledge. • There is little or no relevant supporting evidence.
U	**The "U" (Unscorable) is assigned to a response that is unrelated to the assignment, illegible, primarily in a language other than English, or does not contain a sufficient amount of original work to score.**
B	**The "B" (Blank) is assigned to a response that is blank.**