Introduction - Physics

The following released test questions are taken from the Physics Standards Test. This test is one of the California Standards Tests administered as part of the Standardized Testing and Reporting (STAR) Program under policies set by the State Board of Education.

All questions on the California Standards Tests are evaluated by committees of content experts, including teachers and administrators, to ensure their appropriateness for measuring the California academic content standards in Physics. In addition to content, all items are reviewed and approved to ensure their adherence to the principles of fairness and to ensure no bias exists with respect to characteristics such as gender, ethnicity, and language.

This document contains released test questions from the California Standards Test forms in 2003 and 2004. First on the pages that follow are lists of the standards assessed on the Physics Test. Next are released test questions. Following the questions is a table that gives the correct answer for each question, the content standard that each question is measuring, and the year each question last appeared on the test. Reference sheets, provided for students taking the test, are also included as they are necessary in answering some of the questions. It should be noted that asterisked (*) standards found in the *Science Content Standards for California Public Schools, Kindergarten through Grade 12*, are not assessed on the California Standards Tests in Science and, therefore, are not represented in these released test questions.

The following table lists each reporting cluster, the number of items that appear on the exam, and the number of released test questions that appear in this document. The released test questions for Biology, Chemistry, Earth Science, and Physics are the same test questions found in different combinations on the Integrated Science 1, 2, 3, and 4 tests.

Physics — Released Test Questions

REPORTING CLUSTER	NUMBER OF QUESTIONS ON EXAM	NUMBER OF RELEASED TEST QUESTIONS
Investigation and Experimentation (Standards: PHIE1. a-n)	6	3
Motion and Forces (Standards: PH1. a-g)	12	7
Conservation of Energy and Momentum (Standards: PH2. a-g)	12	6
Heat and Thermodynamics (Standards: PH3. a-e)	9	5
Waves (Standards: PH4. a-f)	10	5
Electric and Magnetic Phenomena (Standards: PH5. a-i)	11	4
TOTAL	60	30

In selecting test questions for release, three criteria are used: (1) the questions adequately cover a selection of the academic content standards assessed on the Physics Test; (2) the questions demonstrate a range of difficulty; and (3) the questions present a variety of ways standards can be assessed. These released test questions do not reflect all of the ways the standards may be assessed. Released test questions will not appear on future tests.

For more information about the California Standards Tests, visit the California Department of Education's Web site at http://www.cde.ca.gov/ta/tg/sr/resources.asp.

THE INVESTIGATION AND EXPERIMENTATION REPORTING CLUSTER

The following 14 California content standards are included in the Investigation and Experimentation reporting cluster and are represented in this booklet by three test questions. These questions represent only some ways in which these standards may be assessed on the California Physics Standards Test.

CALIFORNIA CONTENT STANDARDS IN THIS REPORTING CLUSTER

Investigation and Experimentation	
PHIE1.	**Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other five reporting clusters, students should develop their own questions and perform investigations. Students will:**
PHIE1. a.	Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
PHIE1. b.	Identify and communicate sources of unavoidable experimental error.
PHIE1. c.	Identify possible reasons for inconsistent results, such as sources of error or uncontrolled conditions.
PHIE1. d.	Formulate explanations by using logic and evidence.
PHIE1. e.	Solve scientific problems by using quadratic equations and simple trigonometric, exponential, and logarithmic functions.
PHIE1. f.	Distinguish between hypothesis and theory as scientific terms.
PHIE1. g.	Recognize the usefulness and limitations of models and theories as scientific representations of reality.
PHIE1. h.	Read and interpret topographic and geologic maps.
PHIE1. i.	Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena (e.g., relative ages of rocks, locations of planets over time, and succession of species in an ecosystem).
PHIE1. j.	Recognize the issues of statistical variability and the need for controlled tests.
PHIE1. k.	Recognize the cumulative nature of scientific evidence.
PHIE1. l.	Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
PHIE1. m.	Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.
PHIE1. n.	Know that when an observation does not agree with an accepted scientific theory, the observation is sometimes mistaken or fraudulent (e.g., the Piltdown Man fossil or unidentified flying objects) and that the theory is sometimes wrong (e.g., the Ptolemaic model of the movement of the Sun, Moon, and planets).

THE MOTION AND FORCES REPORTING CLUSTER

The following seven California content standards are included in the Motion and Forces reporting cluster and are represented in this booklet by seven test questions. These questions represent only some ways in which these standards may be assessed on the California Physics Standards Test.

CALIFORNIA CONTENT STANDARDS IN THIS REPORTING CLUSTER

Motion and Forces	
PH1.	**Newton's laws predict the motion of most objects. As a basis for understanding this concept:**
PH1. a.	*Students know* how to solve problems that involve constant speed and average speed.
PH1. b.	*Students know* that when forces are balanced, no acceleration occurs; thus an object continues to move at a constant speed or stays at rest (Newton's first law).
PH1. c.	*Students know* how to apply the law $F = ma$ to solve one-dimensional motion problems that involve constant forces (Newton's second law).
PH1. d.	*Students know* that when one object exerts a force on a second object, the second object always exerts a force of equal magnitude and in the opposite direction (Newton's third law).
PH1. e.	*Students know* the relationship between the universal law of gravitation and the effect of gravity on an object at the surface of Earth.
PH1. f.	*Students know* applying a force to an object perpendicular to the direction of its motion causes the object to change direction but not speed (e.g., Earth's gravitational force causes a satellite in a circular orbit to change direction but not speed).
PH1. g.	*Students know* circular motion requires the application of a constant force directed toward the center of the circle.

THE CONSERVATION OF ENERGY AND MOMENTUM REPORTING CLUSTER

The following seven California content standards are included in the Conservation of Energy and Momentum reporting cluster and are represented in this booklet by six test questions. These questions represent only some ways in which these standards may be assessed on the California Physics Standards Test.

CALIFORNIA CONTENT STANDARDS IN THIS REPORTING CLUSTER

Conservation of Energy and Momentum	
PH2.	**The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. As a basis for understanding this concept:**
PH2. a.	*Students know* how to calculate kinetic energy by using the formula $E = (1/2)mv^2$.
PH2. b.	*Students know* how to calculate changes in gravitational potential energy near Earth by using the formula (change in potential energy) = mgh (h is the change in the elevation).
PH2. c.	*Students know* how to solve problems involving conservation of energy in simple systems, such as falling objects.
PH2. d.	*Students know* how to calculate momentum as the product mv.
PH2. e.	*Students know* momentum is a separately conserved quantity different from energy.
PH2. f.	*Students know* an unbalanced force on an object produces a change in its momentum.
PH2. g.	*Students know* how to solve problems involving elastic and inelastic collisions in one dimension by using the principles of conservation of momentum and energy.

THE HEAT AND THERMODYNAMICS REPORTING CLUSTER

The following five California content standards are included in the Heat and Thermodynamics reporting cluster and are represented in this booklet by five test questions. These questions represent only some ways in which these standards may be assessed on the California Physics Standards Test.

CALIFORNIA CONTENT STANDARDS IN THIS REPORTING CLUSTER

Heat and Thermodynamics	
PH3.	**Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:**
PH3. a.	*Students know* heat flow and work are two forms of energy transfer between systems.
PH3. b.	*Students know* that the work done by a heat engine that is working in a cycle is the difference between the heat flow into the engine at high temperature and the heat flow out at a lower temperature (first law of thermodynamics) and that this is an example of the law of conservation of energy.
PH3. c.	*Students know* the internal energy of an object includes the energy of random motion of the object's atoms and molecules, often referred to as *thermal energy*. The greater the temperature of the object, the greater the energy of motion of the atoms and molecules that make up the object.
PH3. d.	*Students know* that most processes tend to decrease the order of a system over time and that energy levels are eventually distributed uniformly.
PH3. e.	*Students know* that entropy is a quantity that measures the order or disorder of a system and that this quantity is larger for a more disordered system.

THE WAVES REPORTING CLUSTER

The following six California content standards are included in the Waves reporting cluster and are represented in this booklet by five test questions. These questions represent only some ways in which these standards may be assessed on the California Physics Standards Test.

CALIFORNIA CONTENT STANDARDS IN THIS REPORTING CLUSTER

Waves	
PH4.	**Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:**
PH4. a.	*Students know* waves carry energy from one place to another.
PH4. b.	*Students know* how to identify transverse and longitudinal waves in mechanical media, such as springs and ropes, and on the earth (seismic waves).
PH4. c.	*Students know* how to solve problems involving wavelength, frequency, and wave speed.
PH4. d.	*Students know* sound is a longitudinal wave whose speed depends on the properties of the medium in which it propagates.
PH4. e.	*Students know* radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3×10^8 m/s (186,000 miles/second).
PH4. f.	*Students know* how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

THE ELECTRIC AND MAGNETIC PHENOMENA REPORTING CLUSTER

The following nine California content standards are included in the Electric and Magnetic Phenomena reporting cluster and are represented in this booklet by four test questions. These questions represent only some ways in which these standards may be assessed on the California Physics Standards Test.

CALIFORNIA CONTENT STANDARDS IN THIS REPORTING CLUSTER

Electric and Magnetic Phenomena	
PH5.	**Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept:**
PH5. a.	*Students know* how to predict the voltage or current in simple direct current (DC) electric circuits constructed from batteries, wires, resistors, and capacitors.
PH5. b.	*Students know* how to solve problems involving Ohm's law.
PH5. c.	*Students know* any resistive element in a DC circuit dissipates energy, which heats the resistor. Students can calculate the power (rate of energy dissipation) in any resistive circuit element by using the formula Power = IR (potential difference) $\times$ I (current) = I^2R.
PH5. d.	*Students know* the properties of transistors and the role of transistors in electric circuits.
PH5. e.	*Students know* charged particles are sources of electric fields and are subject to the forces of the electric fields from other charges.
PH5. f.	*Students know* magnetic materials and electric currents (moving electric charges) are sources of magnetic fields and are subject to forces arising from the magnetic fields of other sources.
PH5. g.	*Students know* how to determine the direction of a magnetic field produced by a current flowing in a straight wire or in a coil.
PH5. h.	*Students know* changing magnetic fields produce electric fields, thereby inducing currents in nearby conductors.
PH5. i.	*Students know* plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.

1 **A student does an experiment to measure the acceleration of a falling object, which is 9.8 $\frac{m}{s^2}$. The student obtains an experimental value of 14.6 $\frac{m}{s^2}$. The reason for this variation is *most* likely due to**

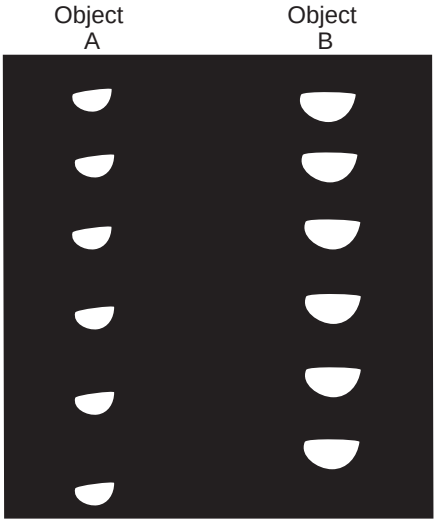
A human error.

B air resistance.

C local fluctuations in gravity.

D the mass of the object.

2



The picture shows two objects that were dropped and recorded with a stroboscopic camera. The *best* explanation for the results is that object A

A has less air resistance.

B was dropped from a greater height.

C has a greater mass.

D accelerated more slowly.

3 **A student wires a series circuit that includes a block of rubber and a light bulb. She states that she does not expect the light bulb to light up when current is applied to the circuit. Which of the following *best* describes her statement?**

A It is a conclusion based on observed data about electrical phenomena.

B It is a hypothesis based on knowledge of the theory of electrical phenomena.

C It is a procedure based on her hypothesis about electrical phenomena.

D It is a theory based on her observations of electrical phenomena.

4 **How much time will it take for a person to walk the length of a football field (100 yards) at a constant speed of 5 $\frac{ft}{s}$?**

A 20 seconds

B 33 seconds

C 60 seconds

D 166 seconds

5 **A 10-newton force and a 15-newton force are acting from a single point in opposite directions. What additional force must be added to produce equilibrium?**

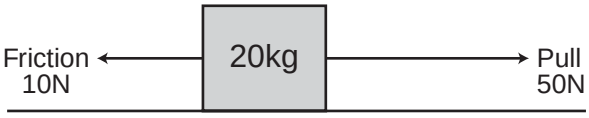
A 5 N acting in the same direction as the 10-N force

B 5 N acting in the same direction as the 15-N force

C 10 N acting in the same direction as the 10-N force

D 25 N acting in the same direction as the 15-N force

6



The figure shows a block that is being pulled along the floor. According to the figure, what is the acceleration of the block?

A 2 $\frac{m}{s^2}$

B 3 $\frac{m}{s^2}$

C 4 $\frac{m}{s^2}$

D 6 $\frac{m}{s^2}$

7 **A soccer player kicks a 0.5-kilogram stationary ball with a force of 50 newtons. What is the force on the player's foot?**

A 0 N

B 25 N

C 50 N

D 100 N

8 **A ball is thrown straight up and then falls straight back down. When it attains maximum height, the ball's velocity is**

A equal to its displacement.

B equal to its displacement divided by the time.

C at its maximum.

D at its minimum.

9 **A communication satellite is in a circular orbit around Earth. If the speed of the satellite is constant, the force acting on the satellite**

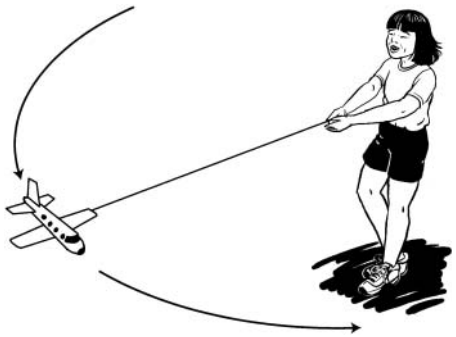
A is zero.

B is decreasing.

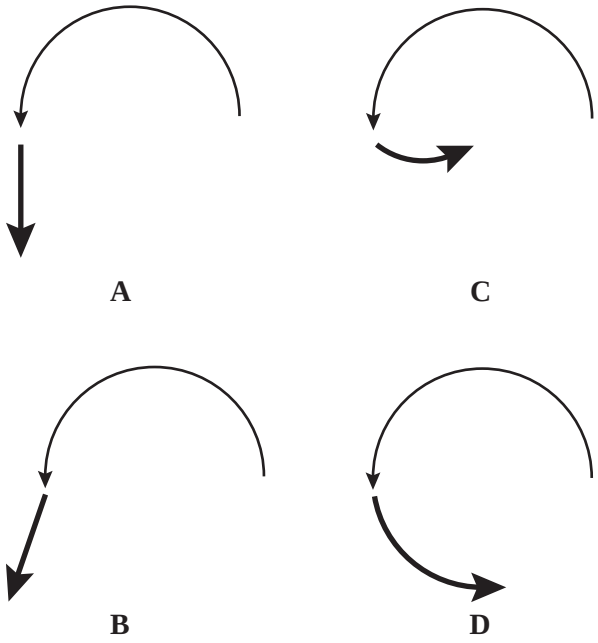
C points toward the center of Earth at all times.

D points in the direction that the satellite is moving.

10



The picture shows the circular path of a toy plane being swung around on a string. What path would the toy take if the string broke?



11 **A 2.0-kilogram mass is moving with a speed of 3.0 $\frac{\text{m}}{\text{s}}$. What is the kinetic energy of the mass?**

A 1.5 J

B 6.0 J

C 9.0 J

D 12.0 J

12 **A 50-kilogram firefighter is on a ladder 10 meters above the ground. When the firefighter descends to 5 meters above the ground, the firefighter's gravitational potential energy will decrease by**

A 0.194 joules.

B 5.10 joules.

C 490 joules.

D 2450 joules.

13 **A high diver steps off a diving platform that is 10 meters above the water. If no air resistance is present, during the fall there will be a decrease in the diver's**

A gravitational potential energy.

B total mechanical energy.

C kinetic energy.

D momentum.

14 **A child is on a sled moving down a hill at 20 $\frac{\text{meters}}{\text{second}}$. The combined mass of the sled and child is 100 kilograms. The momentum of the child and sled is**

A 5 kilogram • $\frac{\text{m}}{\text{s}}$.

B 20 kilogram • $\frac{\text{m}}{\text{s}}$.

C 1000 kilogram • $\frac{\text{m}}{\text{s}}$.

D 2000 kilogram • $\frac{\text{m}}{\text{s}}$.

15 **When is linear momentum conserved?**

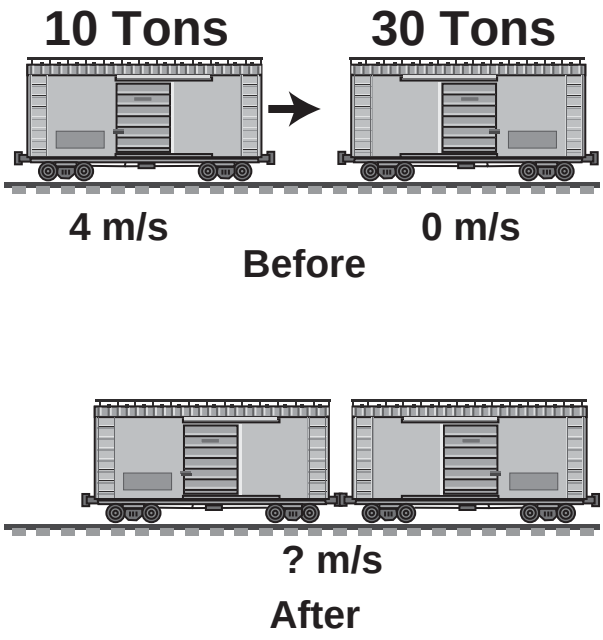
A when only nonlinear forces are present

B when more linear than nonlinear forces are in the system

C when internal forces exceed external forces

D when the net force on the system is zero

16



When these two freight cars of different mass collide and couple, what will be their resultant velocity?

A $1 \frac{m}{s}$

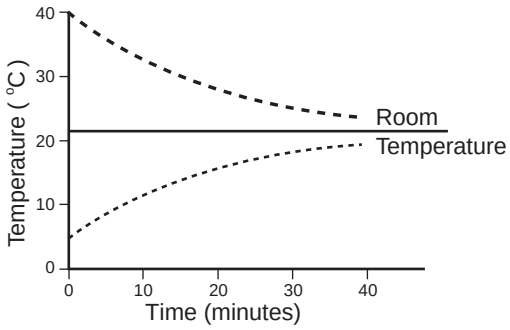
B $2 \frac{m}{s}$

C $4 \frac{m}{s}$

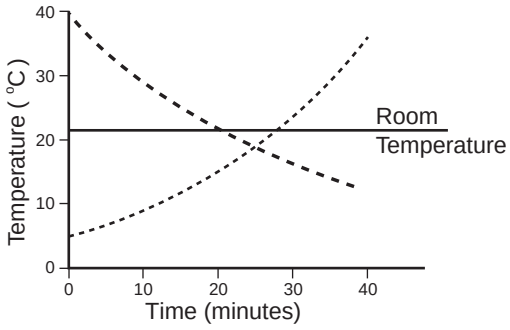
D $8 \frac{m}{s}$

17 **A cup of water at 40 °C and a cup of water at 5 °C are left on a table. Which graph correctly shows the temperature of the two cups of water as time passes?**

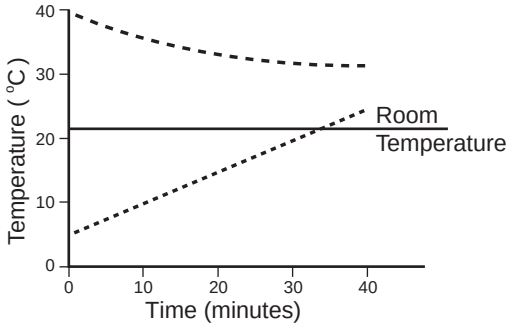
A



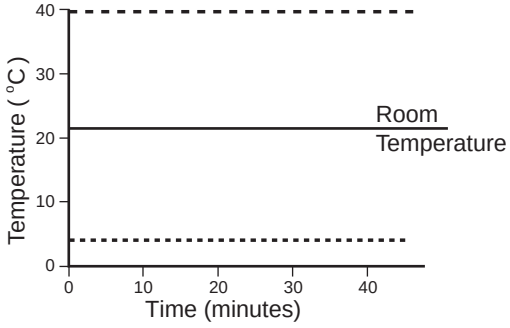
B



C



D



18 **The pressure of a gas inside a closed, rigid container will increase when the gas temperature increases. The pressure of the gas increases because the**

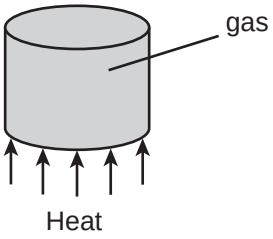
A density of the gas decreases.

B rate of collisions of gas molecules with the surface increases.

C container expands in size when heated.

D gas molecules bond together to form more massive molecules.

19 **A gas in a sealed cylinder is heated.**



Which of the following does *not* increase as the gas is heated?

A the average number of gas molecules hitting the cylinder walls per second

B the average kinetic energy of the gas molecules

C the average speed of the gas molecules

D the average distance between the gas molecules

20 **When a gas is heated in a closed container, the internal pressure increases. Which *best* describes the reason for the increase in pressure?**

A The average kinetic energy of the gas molecules decreases.

B The potential energy of the gas increases.

C The average kinetic energy of the gas molecules increases.

D The potential energy of the gas decreases.

21 **In which of the following processes is the order of the system increasing?**

A shaking a jar containing separate layers of salt and pepper

B smashing a coffee cup with a hammer

C adding cold milk to a cup of hot coffee

D forming crystals in a solution

22 **A radio station transmits to a receiving antenna. The radio wave sent is a**

A sound wave.

B torsional wave.

C longitudinal wave.

D transverse wave.

23 **A sound wave traveling through a solid material has a frequency of 500 hertz. The wavelength of the sound wave is 2 meters. What is the speed of sound in the material?**

A $250 \frac{m}{s}$

B $500 \frac{m}{s}$

C $1000 \frac{m}{s}$

D $250{,}000 \frac{m}{s}$

24 **Astronauts on the Moon would *not* be able to hear a landslide because**

A the lunar dust deadens sounds.

B intensive sunlight destroys sound waves.

C the magnetic field of the Moon is too weak to carry sound.

D air molecules on the Moon are too far apart to carry sound.

25 **Objects appear different in size and shape in a container of water due to**

A refraction of the light waves.

B interference of the water and light waves.

C polarization of the light waves.

D diffraction of the light waves.

26 **An engineer in a moving train blows the train's horn. The train is moving away from a person standing on the ground. Compared to the frequency of the sound that the engineer hears, the person standing on the ground hears a sound with**

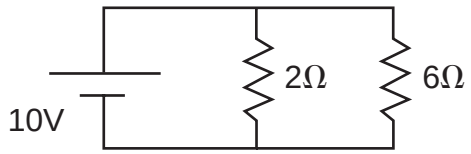
A the same wavelength.

B more variation in tone.

C greater amplitude.

D a lower frequency.

27



In this circuit, what is the current through the 2-ohm resistor?

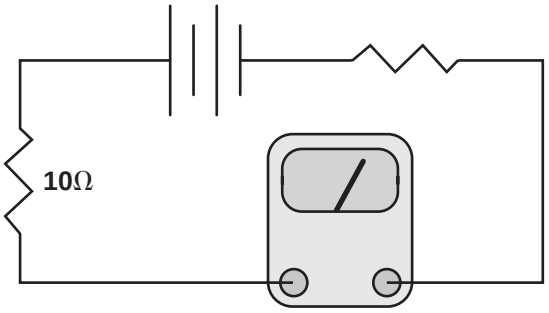
A 0.2 A

B 0.8 A

C 5.0 A

D 8.0 A

28



In the circuit shown above, the meter registers 1.5 amperes. The voltage across the 10.0-ohm resistor is about

A 1.5 V.

B 6.7 V.

C 8.5 V.

D 15.0 V.

29 **A metal bar magnet has a magnetic field in the region of space around it. The magnetic field is due to**

A magnetic monopoles embedded in the metal.

B a hidden voltage source in the metal.

C the motion of charged particles in the metal.

D an electric current that runs along the length of the magnet.

30 **In order to turn neon gas into neon plasma,**

A energy must be removed from the neon gas.

B energy must be supplied to the neon gas.

C the neon gas must be ignited with a flame.

D the neon gas must become a superconductor.

Question Number	Correct Answer	Standard	Year of Test
1	*A*	PHIE1.B	2003
2	*A*	PHIE1.C	2003
3	*B*	PHIE1.F	2004
4	*C*	PH1.A	2003
5	*A*	PH1.B	2004
6	*A*	PH1.C	2003
7	*C*	PH1.D	2003
8	*D*	PH1.E	2003
9	*C*	PH1.F	2004
10	*A*	PH1.G	2004
11	*C*	PH2.A	2003
12	*D*	PH2.B	2003
13	*A*	PH2.C	2004
14	*D*	PH2.D	2004
15	*D*	PH2.E	2004
16	*A*	PH2.G	2004
17	*A*	PH3.A	2004
18	*B*	PH3.C	2003
19	*D*	PH3.C	2003
20	*C*	PH3.C	2004
21	*D*	PH3.D	2004
22	*D*	PH4.B	2003
23	*C*	PH4.C	2003
24	*D*	PH4.D	2004
25	*A*	PH4.F	2003
26	*D*	PH4.F	2004
27	*C*	PH5.A	2003
28	*D*	PH5.B	2003
29	*C*	PH5.F	2004
30	*B*	PH5.I	2004

Physics Reference Sheet

Formulas

Average Speed: $v = \frac{\Delta x}{\Delta t}$

Uniformly Accelerated Motion: $v = v_o + at$

$$x = x_o + v_o t + \frac{1}{2} at^2$$

Newton's Second Law: $F = ma$

Centripetal Force: $F = \frac{mv^2}{r}$

Law of Universal Gravitation: $F = \frac{Gm_1m_2}{r^2}$

Force Due to Gravity: $F = w = mg$

Work: $W = Fd$

Kinetic Energy: $E = \frac{1}{2} mv^2$

Gravitational Potential Energy: $E = mgh$

Momentum: $p = mv$

Collision in One Dimension: $[m_1v_1 + m_2v_2]_{initial} = [m_1v_1 + m_2v_2]_{final}$

Heat Energy: $Q = mc\Delta T$

First Law of Thermodynamics: $\Delta U = Q + W_{(on\ the\ system)}$

$$\Delta U = Q - W_{(by\ the\ system)}$$

Work by a Heat Engine: $W = Q_H - Q_L$

Change in Entropy: $\Delta S = \frac{Q}{T}$

Wave Speed: $v = f\lambda$

Current: $I = \frac{q}{t}$

Ohm's Law: $V = IR$

Power Dissipated in a DC Circuit: $P = IV$

Power Dissipated in a Resistor: $P = I^2R$

Units

Force: $1\ \text{N} = 1\ \frac{\text{kg m}}{\text{s}^2}$

Energy: $1\ \text{J} = 1\ \text{N m}$

Power: $1\ \text{W} = 1\ \frac{\text{J}}{\text{s}}$

Constants

Gravitational Constant: $G = 6.67 \times 10^{-11}\ \frac{\text{N m}^2}{\text{kg}^2}$

Acceleration Due to Gravity: $g = 9.8\ \frac{\text{m}}{\text{s}^2}$

Speed of Light in a Vacuum: $c = 3.00 \times 10^8\ \frac{\text{m}}{\text{s}}$