CollegeBoard

Physics

# SAT Subject Tests™

## Answer Explanations to Practice Questions

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# SAT® Subject Test in Physics

In this document, you will find detailed answer explanations to all of the physics practice questions from *Getting Ready for the SAT Subject Tests*. By reviewing these answer explanations, you can familiarize yourself with the types of questions on the test and learn your strengths and weaknesses. The estimated difficulty level is based on a scale of 1 to 5, with 1 the easiest and 5 the most difficult.

To find out more about the SAT Subject Tests, visit us at SATSubjectTests.org.

**1. Difficulty:** *3*

The correct answer is choice (A) a convex lens. To produce a tiny spot of light, the optical device must cause the rays to converge and create a real image on the screen. Of the devices shown, only a convex lens can accomplish this.

**2. Difficulty:** *3*

The correct answer is choice (D) an opaque card with a very narrow slit. It provides an obstruction that would yield the single-slit diffraction pattern described.

**3. Difficulty:** *1*

The correct answer is choice (D) point *D* because it is farthest away from the point charge +*Q*. The magnitude of the electric field *E* at any location due to a point charge is inversely proportional to the square of the distance *r* from the location to the charge, $E\mu 1/r^2$, so the greater the distance, the less the magnitude of the electric field.

**4. Difficulty:** *2*

The correct answer is choice (E) point *E*, which is directly below the point charge +*Q*. The electron is negatively charged and since unlike charges attract, it will always experience a force directed straight toward the charge +*Q*, which is fixed in position. The only labeled point where a force toward +*Q* is directed toward the top of the page is point *E*.

**5. Difficulty:** *2*

The correct answer is choice (E) 2 units, 14 units or some value between them. When two vectors are added, the magnitude of the resultant vector depends on the angle between them. The greatest value a resultant vector can have is when both vectors point in the same direction. In this case, the angle is zero, and the magnitudes of the two vectors can be directly added, 6 units + 8 units = 14 units. The least value a resultant vector can have is when the vectors point directly opposite to each other so the angle is 180 degrees. The magnitude of the smaller vector is then subtracted from that of the larger one, 8 units – 6 units = 2 units. For any other angle, the magnitude of the resultant vector is between 2 units and 14 units.

**6. Difficulty:** *1*

The correct answer is choice (C) 50N. The block is in equilibrium so the vector sum of the forces acting on it must be zero. The force exerted by the cord on the block must therefore be opposite in direction and equal in magnitude to the weight of the block, which is the only other force exerted on it. The weight of the block is equal to *m* times *g*, where *m* is the 5-kilogram mass of the block and *g* is the acceleration due to gravity at Earth's surface, which in this test may be approximated as $10\ \text{m}/\text{s}^2$. The product of these two values is 50 newtons, which is also equal to the force exerted by the cord.

**7. Difficulty:** *3*

The correct answer is choice (D) time taken to achieve equilibrium after the copper is dropped into the water. When an amount of heat *Q* is transferred to or from a material, its magnitude is given by $Q = mc\left(T_f - T_i\right)$, where *m* is the mass of the material, *c* is its specific heat and $T_f$ and $T_i$ are its final and initial temperature, respectively. As the copper cools, heat is transferred from it to the water, which gets warmer until both the copper and water are in equilibrium at the same temperature. By conservation of energy, the heat transferred from the copper must be equal to the heat transferred to the water. To determine the specific heat of copper, the experimenter would set the expression for the heat transferred from the copper equal to that for the heat transferred to the water, and solve the equation for the specific heat of copper. Time does not appear in the expression, but the quantities in the other choices do. As long as no heat is lost to the surroundings, it does not matter how long it takes to reach equilibrium. So it is not necessary to know or measure the time taken for the copper to come to equilibrium with the water.

**8. Difficulty:** *2*

The correct answer is choice (B). In classical mechanics, which is appropriate to apply at low speeds, the kinetic energy *K* of a particle is given as a function of its speed $v$ by $K = \left(\frac{1}{2}\right)mv^2$, where *m* is the mass of the particle. So *K* must be zero when $v$ is zero. But according to special relativity, which must be applied when speeds are near the speed of light *c*, the speed of a particle can approach but never reach or exceed *c*. *K* continues to increase as the speed increases, but the curve can only get closer to the line at

$v = c$ and cannot intersect it. Graph (B) is the only one that satisfies both criteria; that is, it is zero when $v$ is zero and it approaches $v = c$ asymptotically.

**9. Difficulty:** *3*

The correct answer is choice (B) It has increased by 4 joules. According to conservation of energy, as expressed by the first law of thermodynamics, adding 12 joules of heat to an ideal gas would increase the internal energy of the gas by 12 joules. However, the internal energy of the gas would decrease by 8 joules if that 8 joules is converted to work done by the gas. So the net change in the internal energy of the gas is 12 joules – 8 joules, which is a net increase of 4 joules.

**10. Difficulty:** *4*

The correct answer is choice (A) $-4\text{kg}\cdot\text{m/s}$. The momentum of an object is given by the product of the mass of the object and its velocity. Before the collision, the disk is moving directly east, so the eastward component of its momentum is $4\text{kg}\cdot 1\text{m/s} = 4\text{kg}\cdot\text{m/s}$. After the collision, the disk is moving directly north so the eastward component of its momentum is zero. Thus, the change in the eastward component of momentum is the final value minus the initial value, or $(0 - 4)\text{kg}\cdot\text{m/s}$, which is equal to $-4\text{kg}\cdot\text{m/s}$.

**11. Difficulty:** *4*

The correct answer is choice (A) 4 eV only. According to the energy level diagram, atoms in the $n = 2$ state have an energy of 4 eV above the ground state ($n = 1$). Atoms can only emit photons spontaneously when they drop to a lower energy level. According to conservation of energy, the energy of the photon will equal the difference in energy of the two atomic states. For atoms in $n = 2$ state, the only lower energy level available is the $n = 1$ ground state. So the only photon energy possible is equal to the difference in energy of these two states, 4 eV − 0 eV, which is equal to 4 eV.

**12. Difficulty:** *4*

The correct answer is choice (E) $mgh = \frac{1}{2}mv^2$. This equation is an application of conservation of mechanical energy. In this situation, the loss of potential energy $mgh$ is equal to the gain of kinetic energy $\frac{1}{2}mv^2$. The other four equations are all kinematics equations that apply only when the acceleration is constant. Since the track is curved, the component of the gravitational force on the box that is tangent to the surface of the track decreases as the box slides. It is this component of the gravitational force that accelerates the box. By Newton's second law, $F = ma$, as the force decreases, the acceleration also decreases. Since the acceleration is not constant, the other four equations are not valid.

**13. Difficulty:** *3*

The correct answer is choice (D) 2I. In this series circuit with just one resistor, the emf across the battery is equal to the voltage $V$ across the resistor, so if the emf is doubled, so is $V$. The current $I$ in the resistor is given by Ohm's law, $I = V/R$, so if $V$ is doubled while the resistance $R$ remains constant, then $I$ is also doubled.

**14. Difficulty:** *5*

The correct answer is choice (E) $4P$. The power $P$ dissipated by a resistor is given by $P = IV$, where $I$ is the current in the resistor and $V$ is the voltage across it. When used in combination with Ohm's law, the power can also be written as $P = V^2/R$, where $R$ is the resistance. If the emf is doubled while $R$ remains the same, $P$ is quadrupled.

**15. Difficulty:** *3*

The correct answer is choice (E) the field lines form circles around the wire. This is a fundamental characteristic of magnetic fields produced by currents.

**16. Difficulty:** *5*

The correct answer is choice (B) 25 kilonewtons. The weight of the satellite on Earth is the same as the gravitational force on it, and the gravitational force F on an object due to Earth is inversely proportional to the square of the distance $r$ of the object from the center of Earth ($F \propto 1/r^2$). In the given orbit, the satellite is twice as far from the center of Earth than when it is on Earth's surface, so the gravitational force on it is one fourth as great. Therefore, the gravitational force on the satellite in orbit is 100 kilonewtons divided by 4, which is equal to 25 kilonewtons.

**17. Difficulty:** *4*

The correct answer is choice (E) quadrupling the length $\ell$ of the pendulum. The period of a pendulum is directly proportional to the square root of its length. Thus, if the length of the pendulum is increased by a factor of 4, its period will be increased by a factor of 2. The period is independent of the mass of the bob, and for small oscillations, it is independent of the amplitude and hence also of the force required to set it in motion.

**18. Difficulty:** *4*

The correct answer is choice (B) positive position, positive velocity and negative acceleration. As the chalk ascends, its position is above the point of release at the hand so it is positive. The chalk is moving upward so its velocity is positive. The gravitational force is downward, so the acceleration of the chalk is also downward and therefore negative.

**19. Difficulty:** *5*

The correct answer is choice (C) positive position, negative velocity and negative acceleration. As the chalk descends, its position is still above the point of release at the hand so it is still positive. The chalk is moving downward so its velocity is now negative. The gravitational force and thus the acceleration are still downward so the acceleration is still negative.