SAT Physics Subject Mock Test

Part A

Each set of lettered choices below refers to the numbered questions immediately following it. Select the one lettered choice that best answers each question and then fill in the corresponding oval on the answer sheet. A choice may be used once, more than once, or not at all in each set.

Questions 1 – 3 refer to the following information:

a) Heat conduction
b) Heat radiation
c) Heat convection
d) Latent heat
e) Specific heat

1. Which property involves the transfer of energy by electromagnetic waves'?

2. Which term describes the transfer of heat by successive molecular collisions?

3. Which term represents the amount of heat added or released during the phase change of a pure substance?

Questions 4 – 6 refer to the following information:

An object is placed in front of an optical device, and an image is obtained. Select the device that would produce the types of images described below

a) Concave mirror
b) Convex mirror
c) Concave lens
d) Convex lens
e) Flat mirror

4. The image produced is erect, virtual, and the same size as the object.

5. The image produced is inverted, real, and on the same side of the device.

6. The image produced is inverted, real, and on the opposite side of the device.

Questions 7 – 9 refer to the following information:

Atomic nuclei are typically written in the form ${}^{A}_{B}X$. Select the choice that provides the best match to each of the questions below.

I. A
II. B
III. X

7. Which letter(s) can determines the chemical properties of an element and its place in the periodic table?

a) I only
b) II only
c) III only
d) I and III only
e) II and III only

8. Which letter(s) represents the protons plus neutrons in the nucleus?

a) I only
b) II only
c) III only
d) I plus II only
e) I plus III only

9. Which letter(s) represents the number of electrons in the neutral state of the element?

a) I only
b) II only
c) III only
d) I plus II only
e) I plus III only

Questions 10 – 12 refer to the following properties of waves:

I. Speed
II. Wavelength
III. Frequency

10. Which of the properties change(s) when a wave is refracted?
    a) I only
    b) II only
    c) I and II only
    d) II and III only
    e) I, II, and III

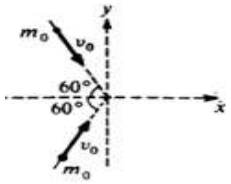
11. The energy of a photon varies directly to which of the properties?
    a) I only
    b) II only
    c) III only
    d) II and III only
    e) I, II, and III

12. Which of the properties is increasing within the following electromagnetic waves:
    x-Ray, Ultra violet, Visible light, Radio waves
    a) I only
    b) II only
    c) III only
    d) II and III only
    e) I, II, and III

Part B

Each of the questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then fill in the corresponding oval on the answer sheet.

13. Of the following phenomena, which provides the best evidence that light can have particle properties?
    a) Interference of light in thin films
    b) Electromagnetic radiation
    c) Photoelectric effect
    d) Electron diffraction
    e) X-ray diffraction

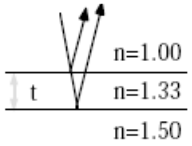


14. Two particles with equal mass m_o, moving at equal speeds of v_o along paths inclined at 60° to the x-axis as shown above, collide and stick together. Their velocity after the collision has magnitude of
    a) $\frac{v_o}{4}$.
    b) $\frac{v_o}{2}$.
    c) $\frac{v_o}{\sqrt{2}}$.
    d) $\frac{\sqrt{3}v_o}{2}$.
    e) v_o.

15. Which of the following statements about the speed of waves on a string is/are true?
    I. The speed depends on the tension in the string.
    II. The speed depends on the frequency.
    III. The speed depends on the mass per unit length of the string.
    a) II only
    b) I and II only
    c) I and III only
    d) II and III only
    e) I, II and III

16. The electron-volt (eV) is a unit of
    a) power.
    b) voltage.
    c) current.
    d) potential.
    e) energy.

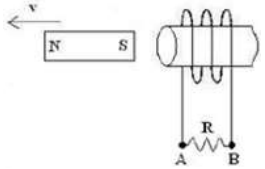
17. A thin film of thickness t and index of refraction 1.33 coats a glass with index of refraction 1.50 as shown below. Which of the following thicknesses t will not reflect light with wavelength 640 nm in air?



    a) 200 nm
    b) 240 nm
    c) 320 nm
    d) 480 nm
    e) 640 nm

18. The "reaction" force does not cancel the "action" force because
    a) the action force is greater than the reaction force.
    b) the action force is less than the reaction force.
    c) they act on different bodies.
    d) they are in the same direction.
    e) the reaction exists only after the action force is removed.

19. A strong bar magnet is held very close to the opening of a solenoid as shown in the diagram below. As the magnet is moved away from the solenoid at a constant speed, what is the direction of conventional current through the resistor and what is the direction of the force on the magnet because of the induced current?



	Current	Force on Magnet
a)	From A to B	To the left

b)	From B to A	To the left
c)	From A to B	To the right
d)	From B to A	To the right
e)	No current	To the right

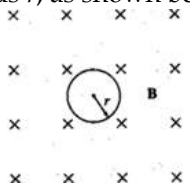
20. Two separate 10-L containers, each contains a different gas. One gas is at a temperature of 400 K; the other gas is at a temperature of 200 K. When both gases are added to the same 10-L container, which of the statements is/are correct?
    I. The hotter gas loses heat to the cooler gas.
    II. The hotter gas increases in temperature when the two are squeezed together.
    III. The cooler gas decreases in temperature when placed into the second container.
    a) I only
    b) II only
    c) I and III only
    d) II and III only
    e) I, II, and III

21. If M represents units of mass, L represents units of length, and T represents units of time, what would be the dimensions of power?
    a) $\frac{ML}{T^2}$
    b) $\frac{ML^2}{T^2}$
    c) $\frac{ML^2}{T^3}$
    d) $\frac{ML}{T}$
    e) $\frac{ML^2}{T}$

22. Correct statements about the binding energy of a nucleus include which of the following?
    I. It is the energy needed to separate the nucleus into its individual protons and neutrons.
    II. It is the energy liberated when the nucleus is formed from the original nucleons.
    III. It is the energy equivalent of the apparent loss of mass of its nucleon constituents.
    a) I only
    b) III only
    c) I and II only
    d) II and III only
    e) I, II, and III

Questions 23 – 24 refer to the following information:

A particle of charge $+e$ and mass m moves from the left to the right of the page at a speed of v perpendicular to a uniform magnetic field B directed into the page. The path of the particle is a circle of radius r, as shown below:

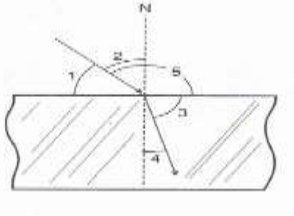


23. Which of the following correctly gives the direction of motion and the equation related to v and r?

	Direction	Equation
a)	Clockwise	$eBr = mv$
b)	Clockwise	$eBr = mv^2$
c)	Counter clockwise	$eBr = mv$
d)	Counter clockwise	$eBr = mv^2$
e)	Counter clockwise	$eBr^2 = mv^2$

24. The period of the particle is
    a) $\frac{mr}{eB}$
    b) $\frac{2\pi m}{eB}$
    c) $\sqrt{\frac{m}{eB}}$
    d) $2\pi\sqrt{\frac{m}{eB}}$
    e) $2\pi\sqrt{\frac{mr}{eB}}$

25. A beam of light passes from the air through a thick piece of glass as shown below. Which of the following angles is the angle of refraction?



    a) 1
    b) 2
    c) 3
    d) 4
    e) 5

26. A place of zero displacement on a standing wave is called
    a) an antinode.
    b) a node.

c) the amplitude.
d) the wavenumber.
e) the harmonic.

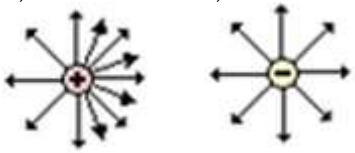
27. A positive electric charge is moved at a constant speed between two locations in an electric field, with no work done by or against the field at any time during the motion. This situation can occur only if the
    a) charge is moved in the direction of the field.
    b) charge is moved opposite to the direction of the field.
    c) charge is moved perpendicular to an equipotential line.
    d) charge is moved along an equipotential line.
    e) electric field is uniform.

28. When Johannes Kepler developed his laws for the movement of planetary bodies, one of the laws stated that the orbits of the planets about the sun are
    a) circular.
    b) elliptical.
    c) parabolic.
    d) sinusoidal.
    e) straight lines.

29. Which of the following diagrams best represents the electric field around a proton?

a) b) c)

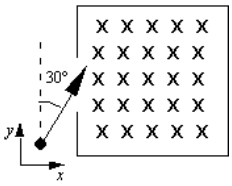
d) e)



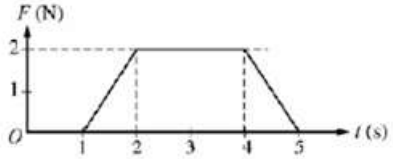
30. The principle underlying fiber optics is
    a) diffraction.
    b) dispersion.
    c) interference.
    d) polarization.
    e) total internal reflection.

31. You are given three 1.0 Ω resistors. Which of the following equivalent resistances *CANNOT* be produced using all three resistors?
    a) $\frac{1}{3}\ \Omega$
    b) $\frac{2}{3}\ \Omega$
    c) $1.0\ \Omega$
    d) $1.5\ \Omega$
    e) $3.0\ \Omega$

32. An electron enters a region that contains a magnetic field directed into the page as shown below. The velocity vector of the electron makes an angle of 30° with the $+y$ axis. What is the direction of the magnetic force on the electron when it enters the field?



    a) Up, out of the page
    b) At an angle of 30° below the positive x axis
    c) At an angle of 30° above the positive x axis
    d) At an angle of 60° below the positive x axis
    e) At an angle of 60° above the positive x axis



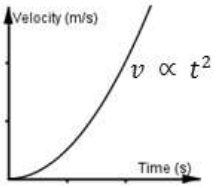
33. A 2-kg object initially moving at a constant velocity is subjected to a force of magnitude F in the direction of motion. A graph of F as a function of time t is shown in the diagram above. What is the increase, if any, in the velocity of the object during the time force is applied?
    a) 0 m/s
    b) 2.0 m/s
    c) 3.0 m/s
    d) 4.0 m/s
    e) 6.0 m/s

34. The critical angle of a material is the angle of incidence. Which of the following is the angle of refraction?
    a) 0°
    b) 30°

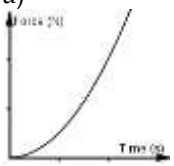
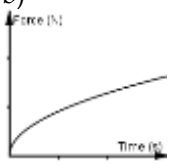
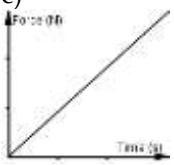
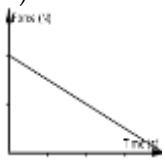
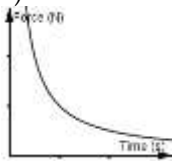
c) 45°
d) 90°
e) 180°

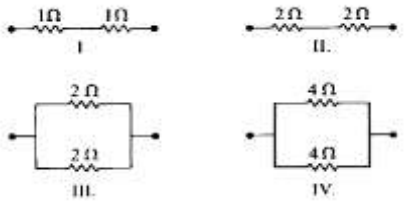
35. A 1.0-kg mass is attached to the end of a vertical ideal spring with a force constant of 400 N/m. The mass is set in simple harmonic motion with amplitude of 10 cm. What is the speed of the 1.0-kg mass at the equilibrium position?
    a) 2 m/s
    b) 4 m/s
    c) 20 m/s
    d) 40 m/s
    e) 200 m/s

36. Two iron spheres separated by some distance have a gravitational attraction *F*. If the spheres are moved to one half their original distance, what would be the resulting gravitational force?
    a) 2*F*
    b) 4*F*
    c) 6*F*
    d) 8*F*
    e) 10*F*



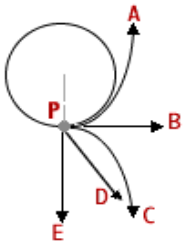
37. The parabola above is a graph of speed *v* as a function of time *t* for an object. Which of the following graphs best represents the magnitude *F* of the net force exerted on the object as a function of time *t*?

a) 
b) 
c) 
d) 
e) 



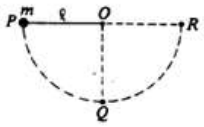
38. Which two arrangements of resistors shown above have the same resistance between the terminals?
    a) I and II
    b) I and IV
    c) II and III
    d) II and IV
    e) III and IV

39. An object on a string is traveling in a circular path as shown below. If the string breaks when the object is at point P, which of the following pathways will the object follow?



    a) Pathway A
    b) Pathway B
    c) Pathway C
    d) Pathway D
    e) Pathway E

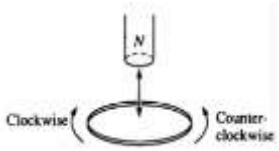
40. A whiffle ball is tossed straight up, reaches a highest point, and falls back down. Air resistance is not negligible. Which of the following statements is/are true?
    I. The ball's speed is zero at the highest point.
    II. The ball's acceleration is zero at the highest point.
    III. The ball takes a longer time to travel up to the highest point than to fall back down.
    a) I only
    b) II only
    c) I and II only
    d) I and III only
    e) I, II, and III



41. A ball with a mass of m is attached to the end of a string of length Q, as shown above. The ball is released from rest from position P. where the string is horizontal. It swings through the position Q, where the string is vertical, and then to the position R. where the string is again horizontal. What are the directions of the acceleration vectors of the ball at the positions Q and R?

	Position Q	Position R
a)	Downward	Downward
b)	Downward	To the right
c)	Upward	Downward
d)	Upward	To the left
e)	To the right	To the left

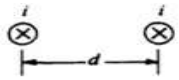
42. In the figure shown below, if the north pole of the magnet is first moved down toward the loop of wire, then withdrawn upward. As viewed from above, the induced current in the loop is



a) always clockwise with increasing magnitude.
b) always clockwise with decreasing magnitude.
c) always counter clockwise with increasing magnitude.
d) always counter clockwise with decreasing magnitude.
e) first counter clockwise, then clockwise.

43. In which one of the following situations is the net force constantly zero on the object?
a) A mass attached to a string and swinging like a pendulum
b) A stone falling freely in a gravitational field
c) An astronaut floating in the International Space Station
d) A snowboarder riding down a steep hill
e) A skydiver who has reached terminal velocity

Questions 44 – 45 refer to the following information:



Two long parallel wires are shown above. Initially the wires are a distance d apart and each has a current i directed into the page. The force per unit length on each wire has magnitude of F.

44. The direction of the force on the right-hand wire due to the current in the left-hand wire is
a) to the right.
b) to the left.
c) upward in the plane of the page.
d) downward in the plane of the page.
e) into the page.

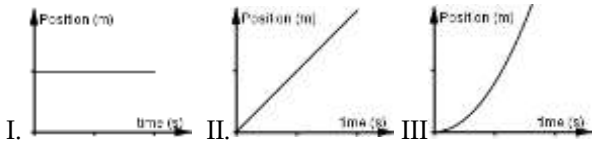
45. The wires are moved apart to a separation $2d$ and the current in each wire is increased to $2i$. What is the new force per unit length on each wire?
a) $\frac{F}{4}$
b) $\frac{F}{2}$
c) F
d) $2F$
e) $4F$

46. An object is thrown upwards at a velocity of $12\ m/s$ near the surface of the earth. After two seconds what would be the direction of the displacement, velocity, and acceleration?

	Displacement	Velocity	Acceleration
a)	up	up	up
b)	up	up	down
c)	up	down	down
d)	up	down	up
e)	down	down	down

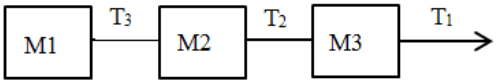
Questions 47 – 48 refer to the following information:

Three objects can only move along a straight level path. The graphs below show the position d of each of the objects plotted as a function of time t.



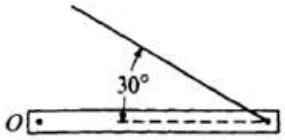
47. The magnitude of the momentum of the object is increasing in which of the cases?
    a) II only
    b) III only
    c) I and II only
    d) II and III only
    e) I, II, and III

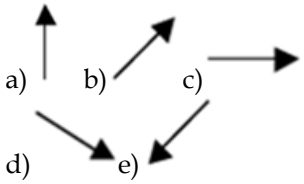
48. In which of the cases, the sum of the forces on the object is zero?
    a) II only
    b) III only
    c) I and II only
    d) I and III only
    e) I, II, and III



49. The three blocks in the diagram above are identical and are pulled at a constant acceleration across a surface that has a frictional coefficient of μ. Which of the following statements about the tensions in the connecting strings is correct?
    a) T_1 is equal to T_2.
    b) T_1 is equal to $2T_2$.
    c) T_1 is equal to $T_2 - T_3$.
    d) T_1 is equal to $2T_3$.
    e) T_1 is equal to $3T_3$.

50. A uniform rigid bar of weight W is supported in a horizontal orientation by a rope that makes a 30° angle with the horizontal, as shown below. The force exerted on the bar at point O, where it is pivoted, is best represented by a vector whose direction is which of the following?





51. A thermos bottle contains 3.0 kg of water and 2.0 kg of ice in thermal equilibrium at 0 °C. How much heat is required to bring the system to thermal equilibrium at 50 °C?
    a) 250 kcal
    b) 310 kcal
    c) 410 kcal
    d) 540 kcal
    e) 2,700 kcal

52. A box slides to the right across a horizontal floor at a constant velocity. A force T_R exerts to the right on the box and another force T_L exerts to the left, which is half as large as the force T_R. Given that there is friction f_r, which of the following statements is true?
    a) $f_r < T_L = \frac{1}{2} T_R$
    b) $f_r = T_L = \frac{1}{2} T_R$
    c) $T_L = \frac{1}{2} T_R < f_r$
    d) $f_r < T_L < T_R$
    e) It cannot be determined.

53. Torque is the rotational analogue of
    a) kinetic energy.
    b) linear momentum.
    c) acceleration.
    d) force.
    e) mass.

54. The beat frequency heard when two tuning forks are vibrating is 3.0 Hz. One of the forks is known to vibrate at 588.0 Hz. What are the possible vibration frequencies of the second tuning fork?
    a) 585.0 or 591.0 Hz
    b) 580.3 or 596.7 Hz
    c) 587.7 or 588.3 Hz
    d) 86.0 or 592.0 Hz
    e) 584.5 or 591.5 Hz

55. Which of the following is true for a system consisting of a mass oscillating on the end of an ideal spring?

a) The kinetic and potential energies are equal to each other at all times.
b) The kinetic and potential energies are both constant.
c) The maximum potential energy is achieved when the mass passes through its equilibrium position.
d) The maximum kinetic energy and maximum potential energy are equal, but occur at different times.
e) The maximum kinetic energy occurs at maximum displacement of the mass from its equilibrium position.

56. A pilot of a spaceship traveling at 90% the speed of light (0.9 c) turns on its laser headlights just as it passes a stationary observer. Which of the following statements is true?
    a) The pilot will measure the speed of the light coming out of the headlights as c, and the observer will measure the speed of the light as 0.9 c.
    b) The pilot will measure the speed of the light coming out of the headlights as c and the observer will measure the speed of the light as 1.9 c.
    c) The pilot will measure the speed of the light coming out of the headlights as 0.9 c, and the observer will measure the speed of the light as 1.9 c.
    d) The pilot will measure the speed of the light coming out of the headlights as 1.9 c, and the observer will measure the speed of the light as 0.9 c.
    e) The pilot will measure the speed of the light coming out of the headlights as c, and the observer will measure the speed of the light as c.

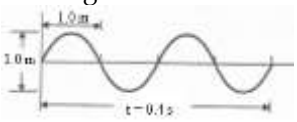
57. Two canoes are 2 m apart on a lake. Each bobs up and down with a period of 1.0 second. When one canoe is at its highest point, the other canoe is at its lowest point. Both canoes are always within a single cycle of the wave. Determine the speed of the wave.
    a) 2.0 m/s
    b) 3.0 m/s
    c) 4.0 m/s
    d) 5.0 m/s
    e) 6.0 m/s

58. Which one of the following temperatures is approximately equal to "room temperature?"
    a) 0 K
    b) 0 °C
    c) 100 °C
    d) 100 K
    e) 293 K

59. Which of the following is true about the net force on an uncharged conducting sphere in a uniform electric field?
    a) It is zero.
    b) It is in the direction of the field.
    c) It is in the direction opposite to the field.
    d) It produces a torque on the sphere about the direction of the field.
    e) It causes the sphere to oscillate about an equilibrium position.

60. Which would cause a more serious burn, 30 g of steam or 30 g of liquid water, both at 100 °C? And why?
    a) Water, because it is denser than steam.
    b) Steam, because of its specific heat capacity
    c) Steam, because of its latent heat of vaporization
    d) Water, because its specific heat is greater than that of steam.
    e) Either one would cause a burn of the same severity since they are both at the same temperature.

Questions 61 – 63 refer to the following information and diagram:



61. What is the wave length?
    a) 0.5 m
    b) 1.0 m
    c) 2.0 m
    d) 4.0 m
    e) 6.0 m

62. What is the amplitude of the wave?
    a) 0.5 m
    b) 1.0 m
    c) 2.0 m
    d)4.0 m
    e) 6.0 m

63. What is the frequency of the wave?
    a) 2 Hz
    b) 4 Hz
    c) 5 Hz
    d) 0.4 Hz
    e) 0.2 Hz

64. In Rutherford famous gold foil scattering experiment, he found that most alpha particles would pass through the foil un-deflected. Which of the following nuclear properties can be inferred from this observation?
    a) The nucleus must have a positive charge.
    b) Most of the mass of an atom is in the nucleus.
    c) The nucleus contains both protons and neutrons.
    d) The diameter of the nucleus is small compared to the diameter of the atom.
    e) None of the above

65. A charged particle traveling at a velocity of v in an electric field E experiences a force F that must be
    a) parallel to v.
    b) perpendicular to v.
    c) perpendicular to v and E.
    d) parallel to E.
    e) perpendicular to E.

66. A carbon atom decays into a nitrogen atom in the equation below. Which of the quantities correctly finishes the equation?

$$^{14}_{6}C \rightarrow {}^{14}_{7}N + ?$$

    a) Alpha
    b) Beta
    c) Gamma
    d) Neutron
    e) Electron

67. A uniform meter stick with a mass of 0.20 kg is pivoted at the 40-cm mark. Where should one hang a mass of 0.50 kg to balance the stick?
    a) 16 cm
    b) 36 cm
    c) 44 cm
    d) 46 cm
    e) 54 cm

68. The S.I. unit of force is named the newton in honor of Sir Isaac Newton's contributions to physics. Which of the following combination of units is the equivalent of a newton?
    a) Kg
    b) $\frac{kgm}{s}$
    c) $\frac{kgm^2}{s}$
    d) $\frac{kgm}{s^2}$
    e) $\frac{kgm^2}{s^2}$

Questions 69 – 74 refer to the following information:

For each question, choose the letter that corresponds to the correct scientist.
    a) Galileo
    b) Halley
    c) Kepler
    d) Hubble
    e) Newton

69. He predicted the periodic return of comets due to the force of gravity.

70. He first used a refracting telescope in 1610 to see the craters on the Moon.

71. He discovered the law of universal gravitation.

72. He discovered the law of falling bodies.

73. He discovers the universe is expanding.

74. He stated as one of his three laws that planets sweep out equal areas in equal time.

75. A force F at an angle θ above the horizontal is used to pull a heavy suitcase of weight mg for a distance d along a level floor at a constant velocity. The coefficient of friction between the floor and the suitcase is μ. How much work does the frictional force do?
    a) $-Fd\ cos\ (\theta)$
    b) $mgh - Fd\ cos\ (\theta)$
    c) $-\mu\ Fd\ cos\ (\theta)$
    d) $-\mu mgd$
    e) $-\mu\ mgd \cos(\theta)$