AP Physics I Mock Test

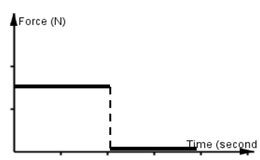
Section 1 (Multiple-Choice)

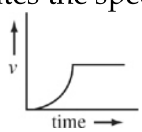
Directions: The multiple-choice section consists of 50 questions to be answered in 90 minutes. You may write scratch work in the test booklet itself, but only the answers on the answer sheet will be scored. You may use a calculator, the equation sheet, and the table of information.

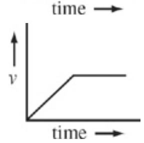
<u>Questions 1--45: Single-Choice Items</u>

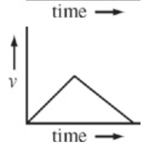
Directions: Choose the single best answer from the four choices provided and grid the answer with a pencil on the answer sheet.

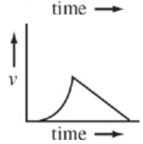
1. A traveling wave has a frequency of 10.0 Hz, amplitude of 0.1 m, and a wavelength of 0.4 m. What is its wave speed?
   a) 4 m/s
   b) 2.0 m/s
   c) 2.4 m/s
   d) 3.0 m/s



2. A block, initially at rest on a frictionless, horizontal surface, is pulled by a constant force **F** from time $t = 0$ to time $t = T$. From time $t = T$ on the force is zero as shown above. Which of the following graphs best illustrates the speed, v, of the block?
   a) 

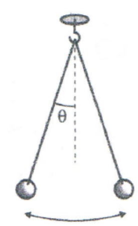
   b) 

   c) 

   d) 

3. A 500-kg car is moving at 28 m/s. The driver sees a barrier ahead. If the car takes 95 meters to come to rest, what is the magnitude of the minimum average net force necessary to stop?
   a) 47.5 N
   b) 1400 N
   c) 2000 N
   d) 19600 N

Questions 4 – 5 refer to the following:



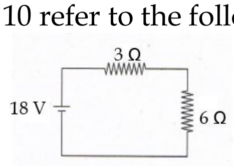
4. A simple pendulum, composed of a bob of mass m connected to the end of a massless rod, executes simple harmonic motion as it swings through small angles of oscillation. Frictional effects are negligible and can be ignored, which one of the following statements is true?
   a) At $\theta = 0$, the tangential acceleration is 0.
   b) At maximum θ, the tangential acceleration is 0.
   c) At $\theta = 0$, the speed is 0.
   d) At $\theta = 0$, the restoring force is maximized.

5. Knowing which one of the following would enable you to calculate the period of the pendulum?
    a) The mass of the bob
    b) The length of the string
    c) The tangential acceleration at $\theta = 0$
    d) The maximum speed of the bob

6. If the unit for force is F, the unit for velocity V, and the unit for time T, then the unit for energy is:
    a) FVT
    b) $\frac{F}{T}$
    c) $\frac{FV}{T}$
    d) $\frac{F}{T^2}$

7. 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. The speed of the 1.0 kg mass at the equilibrium position is
    a) 2 m/s
    b) 4 m/s
    c) 20 m/s
    d) 40 m/s

Questions 8 – 10 refer to the following:

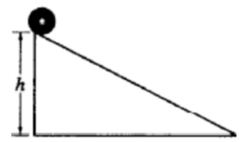


8. Which of the following statements is true?
    a) The voltage drop across the 6 Ω resistor will be more than that across the 3 Ω resistor.
    b) The 6 Ω will get more current than the 3 Ω resistor since it has more resistance.
    c) The voltage drop across the 3 Ω and 6 Ω resistors will be the same.
    d) The voltage drop across the 3 Ω resistor will be more than that across the 6 Ω resistor.

9. What is the voltage across the 6 Ω resistor?
    a) 6V
    b) 8V
    c) 12V
    d) 15V

10. What is the power across the 3 Ω resistor?
    a) 36 Watts
    b) 24 Watts
    c) 18 Watts
    d) 12 Watts

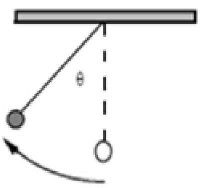
Questions 11-12 refer to the following:



A sphere of mass M, radius r, and rotational inertia I is released from rest at the top of an inclined plane of height h as shown above.

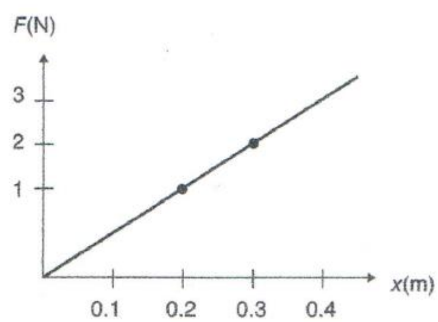
11. If the plane is frictionless, what is the speed v_{cm}, of the center of mass of the sphere at the bottom of the incline?
    a) $\sqrt{2gh}$
    b) $\sqrt{\frac{2Mghr^2}{I}}$
    c)) $\sqrt{\frac{Mghr^2}{I}}$
    d)) $\sqrt{\frac{2Mghr^2}{I+Mr^2}}$

12. If the plane has friction so that the sphere rolls without slipping, what is the speed v_{cm} of the center of mass at the bottom of the incline?
    a) $\sqrt{2gh}$
    b) $\sqrt{\frac{2Mghr^2}{I}}$
    c)) $\sqrt{\frac{Mghr^2}{I}}$
    d)) $\sqrt{\frac{2Mghr^2}{I+Mr^2}}$



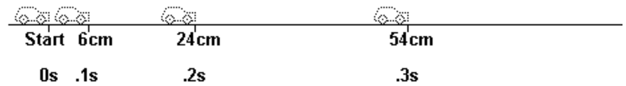
13. A pendulum bob of mass m on a cord of length L is pulled sideways until the cord makes an angle θ with the vertical as shown in the figure to the right. The change in potential energy of the bob during the displacement is:
    a) $mgL\ (1 - \cos\theta)$
    b) $mgL\ (1 - \sin\theta)$
    c) $mgL\ \sin\theta$
    d) $mgL\ \cos\theta$

14. A 3 kg block with initial speed 4 m/s slides across a rough horizontal floor before coming to rest. The frictional force acting on the block is 3 N. How far does the block slide before coming to rest?
    a) 1.0 m
    b) 2.0 m
    c) 4.0 m
    d) 8.0 m



15. Consider the force vs. displacement graph shown for an ideal spring. The work done in stretching the spring from 0 m to 0.3 m is
    a) 1 J
    b) 0.5 J
    c) 0.4 J
    d) 0.3 J

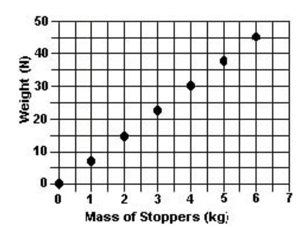
Questions 16 – 18 refer to the following:
The diagram below represents a toy car starting from rest and uniformly accelerating across the floor. The time and distance traveled from the start are shown in the diagram.



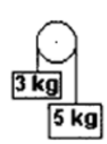
16. What was the average speed of the cart between 0.1 seconds and 0.3 seconds?
    a) 0.6 m/s
    b) 1.9 m/s
    c) 2.4 m/s
    d) 4.8 m/s

17. What was the acceleration of the cart during the first 0.4 seconds?
    a) 6.0 m/s2
    b) 25 m/s2
    c) 9.8 m/s2
    d) 12 m/s2

18. What was the instantaneous velocity of the cart at 96 centimeters from the start?
    a) 0.6 m/s
    b) 4.8 m/s
    c) 1.9 m/s
    d) 6.0 m/s



19. The graph at above shows the relationship between the mass of a number of rubber stoppers and their resulting weight on some far-off planet. The slope of the graph is a representation of the:
    a) mass of a stopper
    b) density of a stopper
    c) volume of a stopper
    d) acceleration due to gravity



20. Two masses are connected by a light cord which is looped over a light frictionless

pulley. If one mass is 3.0 kg and the second mass is 5.0 kg, what is the downward acceleration of the heavier mass? Assume air resistance is negligible.

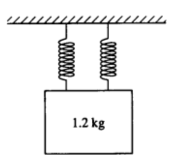
a) 2.5 m/s^2
b) 5.0 m/s^2
c) 6.5 m/s^2
d) 9.8 m/s^2

21. A species of hummingbird beats its wings 3,300 times per minute. What frequencies of sound will a nearby person hears when the hummingbird flies by?

a) .003 Hz
b) 18Hz
c) 6Hz
d) 55Hz

22. A bowling ball of mass M and radius R, whose moment of inertia about its center is $\frac{2}{5}MR^2$, rolls without slipping along a level surface at speed v. The maximum vertical height to which it can roll if it ascends an incline is

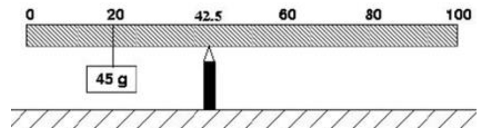
a) $\frac{v^2}{5g}$
b) $\frac{2v^2}{5g}$
c) $\frac{v^2}{2g}$
d) $\frac{7v^2}{10g}$



23. Two identical massless springs are hung from a horizontal support. A block of mass 1.2 kilograms is suspended from the pair of springs, as shown above. When the block is in equilibrium, each spring is stretched an additional 0.15 meter. The force constant of each spring is most nearly

a) 40 N/m
b) 48 N/m
c) 60 N/m
d) 80 N/m

24. A uniform meter stick has a 45.0 g mass placed at the 20 cm mark as shown in the figure below. If a pivot is placed at the 42.5 cm mark and the meter stick remains horizontal in static equilibrium, what is the mass of the meter stick?



a) 120.0 g
b) 135.0 g
c) 72.0 g
d) 18.0 g

25. A 50 kg crate rests on the floor. The coefficient of static friction is 0.3. The force parallel to the floor needed to move the crate is most nearly:

a) 30 N
b) 50 N
c) 150 N
d) 250 N

26. A ball is dropped 1.0 m to the floor. If the speed of the ball as it rebounds from the floor is 75% of the speed at which it struck the floor, how high will the ball rise?

a) 0.28 m
b) 0.35 m
c) 0.56 m
d) 0.75 m

Questions 27 – 28 refer to the following:
The frequency of a wave is 4 cycles per second and its speed is .08 meters per second.

27. What is the period of one of the waves?

a) 0.25 seconds
b) 0.55 seconds
c) 0.125 seconds
d) 0.02 seconds

28. What is the wavelength of one of the waves?

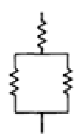
a) .02 m
b) .25 m

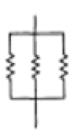
c) 0.32 m
d) 0.8 m

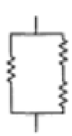
29. Two arrows are launched at the same time with the same speed. Arrow A at an angle greater than 45 degrees, and arrow B at an angle less than 45 degrees. Both land at the same spot on the ground. Which arrow arrives first?
    a) arrow A arrives first
    b) arrow B arrives first
    c) they both arrive together
    d) it depends on the elevation where the arrows are launched

30. A car travels forward with constant velocity. It goes over a small stone, which gets stuck in the groove of a tire. The initial acceleration of the stone, as it leaves the surface of the road, is
    a) vertically upward
    b) horizontally forward
    c) horizontally backward
    d) zero

31. Which of the following combinations of 4Ω resistors would dissipate 24 W when connected to a 12 Volt battery?

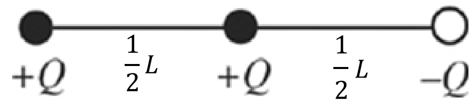

a)


b)

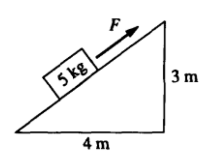

c)


d)

32. A rocket is in a circular orbit with speed v and orbital radius R around a heavy stationary mass. An external impulse is quickly applied to the rocket directly opposite to the velocity and the rocket's speed is slowed to $\frac{v}{2}$, putting the rocket into an elliptical orbit. In terms of R, the size of the semi-major axis a of this new elliptical orbit is
    a) $\frac{4}{7}R$
    b) $\frac{1}{4}R$
    c) $\frac{1}{7}R$
    d) $\frac{1}{2}R$

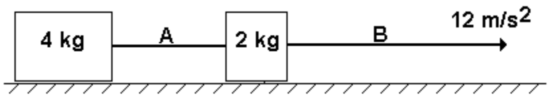


33. Three point charges are arranged along a straight line. If k denotes Coulomb's constant, what is the strength of the electrostatic force felt by the positive charge at the center?
    a) $\frac{KQ^2}{L^2}$
    b) $\frac{2KQ^2}{L^2}$
    c) $\frac{4KQ^2}{L^2}$
    d) $\frac{6KQ^2}{L^2}$



34. A block of mass 5 kilograms lies on an inclined plane, as shown above. The horizontal and vertical supports for the plane have lengths of 4 meters and 3 meters, respectively. The coefficient of friction between the plane and the block is 0.3. The magnitude of the force F necessary to pull the block up the plane with constant speed is most nearly
    a) 30 N
    b) 42 N
    c) 49 N
    d)50 N

Questions 35 – 37 refer to the following:
A 2 kg mass and a 4 kg mass on a horizontal frictionless surface are connected by a massless string A. They are
pulled horizontally across the surface by a second string B with a constant acceleration of 12 m/s2.



35. What is the magnitude of the force of string B on the 2 kg mass?
    a) 72 N
    b) 48 N
    c) 24 N
    d) 6 N

36. What is the magnitude of the force of string A on the 4 kg mass?
    a) 72 N
    b) 48 N
    c) 24 N
    d) 6 N

37. What is the magnitude of the net force on the 2 kg mass?
    a) 72 N
    b) 48 N
    c) 24 N
    d) 6 N

38. A frictionless pendulum of length 3 m swings with an amplitude of 10°. At its maximum displacement, the potential energy of the pendulum is 10 J. What is the kinetic energy of the pendulum when its potential energy is 5 J ?
    a) 3.3 J
    b) 5 J
    c) 6.7 J
    d) 10 J

39. An object with a mass of m moving at a velocity of v collides with another object with a mass of M. If the two objects stick together, what is their velocity?
    a) $\frac{m}{M+m}v$
    b) $\frac{M}{M+m}v$
    c) $\frac{m}{M}v$
    d) $\frac{M+m}{M}v$

40. Two metal spheres of equal size are charged and mounted on insulated stands. One sphere has a charge of $-5\ \mu$C and the second sphere has a charge of +13 C. The two spheres are touched together and then separated. The charge on the second sphere will now be
    a) $+4\ \mu$C
    b) $+8\ \mu$C
    c) $-8\ \mu$C
    d) $-4\ \mu$C

41. A projectile is fired from the surface of the Earth with a speed of 200 meters per second at an angle of 30° above the horizontal. If the ground is level, what is the maximum height reached by the projectile?
    a) 5m
    b) 10 m
    c) 500 m
    d) 1,000 m

Questions 42 – 43 refer to the following:
The planet Mercury's radius is about 0.4 times than the Earth's, 0.4 times distance from the Sun then Earth from the sun and the mass of Mercury is 0.5 times the mass of the earth.

42. What is the Mercury's gravitational constant close to?(Earth's g = 10 m/s^2)
    a) 2 m/s^2
    b) 2.5 m/s^2
    c) 3 m/s^2
    d) 4 m/s^2

43. What is the approximate ratio of the gravitational force between Mercury to the Sun and Earth to the Sun

a) 1
b) 0.5
c) 0.4
d) 0.3

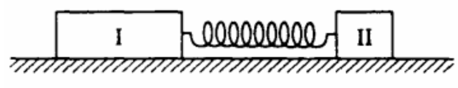
44. A ball is tied to a string that passes through a glass tube and is attached to a hanging mass. The tube is held vertically as the ball is swung in a horizontal disk with a radius r, at a speed of v. If the string is pulled through the tube by hanging a larger mass on the string so that the radius becomes $\frac{1}{2}r$, what will the speed of the ball become?
a) $\frac{1}{\sqrt{2}}v$
b) $\sqrt{2}\,v$
c) $2\,v$
d) ½ v

45. A child has a toy tied to the end of a string and whirls the toy at constant speed in a horizontal circular path of radius R. The toy completes each revolution of its motion in a time period T. What is the magnitude of the acceleration of the toy?
a) 0
b) $\frac{4\pi^2 R}{T^2}$
c) $\frac{2\pi R}{T^2}$
d) g

Directions: For each of questions 46-50 below, **two** of the suggested answers will be correct. Select the two answers that are best in each case, and then fill in both of the corresponding circles on the answer sheet.

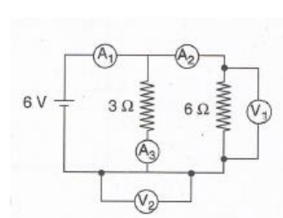
46. A person rotates with extended aims on a turntable. Assume dissipative forces are negligible. The person's aims are then folded and held close to his chest. Which of the following correctly describes the result of such an actions?
a) The person's angular velocity increases.
b) The person increases his rotational inertia.
c) The person's rotational inertia is unchanged.
d) The person's angular momentum is unchanged.

47. Two pucks are firmly attached by a stretched spring and are initially held at rest on a frictionless surface, as shown above. The pucks are then released simultaneously. If puck I has three times the mass of puck II, which of the following quantities is the same for both pucks as the spring pulls the two pucks toward each other?



a) Magnitude of momentum
b) The magnitude of the forces from the spring.
c) Acceleration
d) Kinetic energy

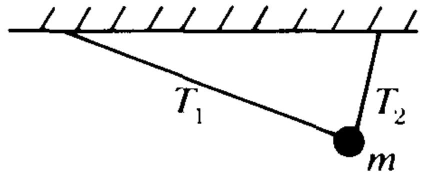
48. A whiffle ball is tossed straight up, reaches a highest point, and falls back down. Air resistance is not negligible. Which of the following statements are true?
a) The ball's speed is zero at the highest point.
b) The ball's acceleration is zero at the highest point.
c) The ball takes a shorter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



49. Two resistors of 3Ω and 6 Ω are placed in parallel with a 6 V battery. Three ammeters and two voltmeters are placed in the circuit

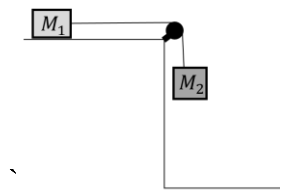
as shown above. Which of the following statements is true of the voltmeters?

a) Ammeter 1 will read 2 A.
b) Voltmeter 1 will read 6 V.
c) Ammeter 2 will read 2 A.
d) Voltmeter 2 will read 0 V



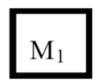
50. A ball of mass m is suspended from two strings of unequal length as shown above. The magnitudes of the tensions T_1 and T_2 in the strings must satisfy which of the following relations?
    a) $T_l < T_2$
    b) $T_l > T_2$
    c) $T_l + T_2 < mg$
    d) $T_l + T_2 > mg$

Section 2(Free-Response) 5 Questions Time—90 minutes



1. In the system shown above, the block of mass M_1 is on a rough horizontal table. The string that attaches it to the block of mass M_2 passes over a frictionless pulley of negligible mass. The coefficient of kinetic friction μ_k between M_1 and the table is less than the coefficient of static friction μ_s

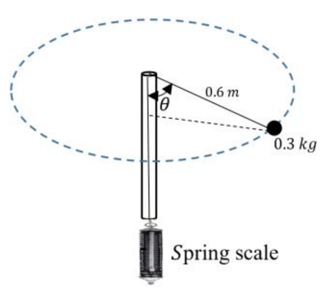
   a. On the diagram below, draw and identify all the forces acting on the block of mass M_1.



   b. In terms of M_1 and M_2 determine the minimum value of μ_s that will prevent the blocks from moving. The blocks are set in motion by giving M_2 a momentary downward push. In terms of M_1, M_2, μ_k, and g, determine each of the following:

   c. The magnitude of the acceleration of M_1

   d. The tension in the string.



2. To study circular motion, two students use the hand-held device shown above, which consists of a rod on which a spring scale is attached. A polished glass tube attached at the top serves as a guide for a light cord attached the spring scale. A ball of mass 0.300 kg is attached to the other end of the cord. One student swings the teal around at constant speed in a horizontal circle with a radius of 0.600 m. Assume friction and air resistance are negligible.

   a. Explain how the students, by using a timer and the information given above, can determine the speed of the ball as it is revolving.

   b. The speed of the ball is determined to be 3.6 m/s. Calculate the expected tension in the cord.

c. The actual tension in the cord as measured by the spring scale is 7.1 N. What is the percent difference between this measured value of the tension and the value calculated in part b?

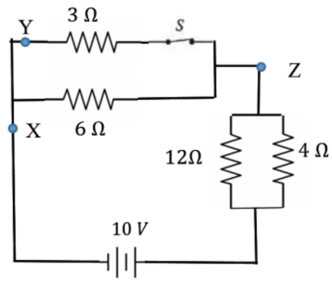
The students find that, despite their best efforts, they cannot swing the ball so that the cord remains exactly horizontal.

d.

i. On the picture of the ball below, draw vectors to represent the forces acting on the ball and identify the force that each vector represents.

ii. Explain why it is not possible for the ball to swing so that the cord remains exactly horizontal.

iii. Calculate the angle that the cord makes with the horizontal.



3. Four resistors are connected in a circuit with a 10 V battery as shown above.

(a) Calculate the equivalent resistance of the circuit.

(b)

i. Calculate the magnitude of the current through point Y.

ii. Indicate on the diagram the direction of the current through point Y.

(c)

i. Determine the average potential energy change of an electron as it moves from point Z to point X.

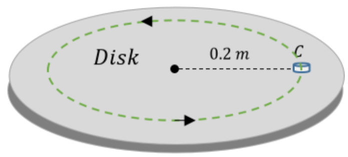
ii. Indicate whether the electron gains or loses potential energy as it moves from point Z to point X.

____ Gains energy ____ Loses energy

(d) Calculate the energy dissipated in the 12 Ω bulb in 5 s.

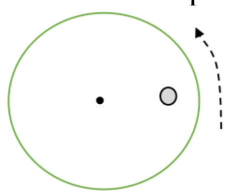
(e) Rank the resistors in order of hottest, with 1 being the hottest. If any bulbs have the same temperature, give them the same ranking.

___ 3Ω ___ 4Ω ___ 6Ω ___ 12Ω



4. A coin C of mass 0.02 kg is placed on a horizontal disk at a distance of 0.2 m from the center, as shown above. The disk rotates at a constant rate in a counterclockwise direction as seen from above. The coin does not slip, and the time it takes for the coin to make a complete revolution is 2.5 s.

   a. The figure below shows the disk and coin as viewed from above. Draw and label vectors on the figure below to show the instantaneous acceleration and linear velocity vectors for the coin when it is at the position shown.

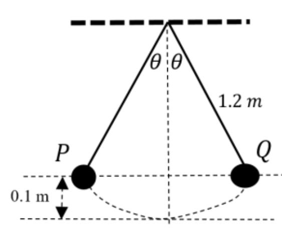


   b. Determine the linear speed of the coin.

   c. The rate of rotation of the disk is gradually increased. The coefficient of static friction between the coin and the disk is 0.60. Determine the linear speed of the coin when it just begins to slip.

   d. If the experiment in part (c) were repeated with a second, identical coin glued to the top of the first coin, how would this affect the answer to part (c)? Explain your reasoning.

5. A simple pendulum consists of a bob of mass 0.1 kg attached to a string of length 1.2 m. The pendulum is raised to point Q, which is 0.1 m above its lowest position, and released so that it oscillates with small amplitude θ between the points P and Q as shown below.



   (a) On the figures below, draw free-body diagrams showing and labeling the forces acting on the bob in each of the situations described.

i. When it is at point P
ii. When it is in motion at its lowest position

(b) Calculate the speed v of the bob at its lowest position.

(c) Calculate the tension in the string when the bob is passing through its lowest position.

(d) Describe one modification that could be made to double the period of oscillation.