SRI LANKAN PHYSICS OLYMPIAD - 2005

MULTIPLE CHOICE TEST

30 QUESTIONS – ONE HOUR AND 15 MINUTES

INSTRUCTIONS

This test contains 30 multiple choice questions. Your answer to each question must be marked on the answer sheet that accompanies the test. Only the circles preceded by numbers 1 through 30 are to be used on the answer sheet.
Select the single answer that provides the best response to each question. Please be sure to use a pencil and completely fill the circle corresponding to your choice. If you change an answer, the previous mark must be completely erased.
Your score on this multiple choice test will be your number of correct answers. There is no penalty for guessing. It is to your advantage to answer every question.

Calculators are not allowed to use.

$g = 10 \text{ m s}^{-2}$

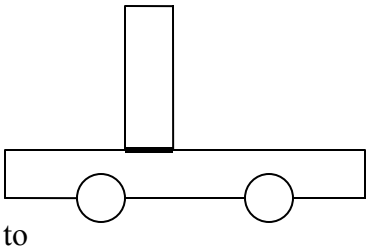
1. A driver travels three-fourth distance of his journey at a velocity (v) and completes rest of the journey at one half of his original velocity ($\frac{1}{2}v$). What was his average speed for the trip?

[1] $0.85v$ [2] $0.80v$ [3] $0.75v$ [4] $0.70v$ [5] $0.65v$

2. Sunil and Ramesh push a 1200 kg block horizontally in the same direction. Sunil pushes with a force of 500 N and Ramesh pushes with a force of 300 N. If a frictional force provides 200 N of resistance, what is the acceleration of the block?

[1] 1.3 m s^{-2} [2] 1.0 m s^{-2} [3] 0.87 m s^{-2} [4] 0.75 m s^{-2} [5] 0.5 m s^{-2}

3. A uniform 2 kg cylinder rests on a laboratory trolley as shown. The coefficient of static friction between the cylinder and the trolley is 0.5. If the cylinder is 4 cm in diameter and 10 cm in height, which of the following is closest to the minimum acceleration of the trolley needed to cause the cylinder to tip over?



[1] 2 m s^{-2} [2] 4 m s^{-2} [3] 5 m s^{-2} [4] 6 m s^{-2}

[5]The cylinder would tip over at all of these accelerations.

4. A ball is thrown upward near the surface of the earth with a velocity of 50 m s^{-1}. After 5 s later its velocity becomes zero momentarily. If the ball were thrown up with the same velocity on Planet X, after 5 s it would still be moving upwards at 31 m s^{-1}. (Neglect air resistance)

The ratio of

$$\frac{\text{The magnitude of the gravitational field intensity near the surface of planet X}}{\text{The magnitude of the gravitational field intensity near the surface of the earth}}$$

is equal to

[1] 0.16 [2] 0.38 [3] 0.53 [4] 0.63 [5] 1.59

5. Two light plastic bags of negligible mass are placed 2 meters apart. Each bag contains 15 mangoes. If 10 mangoes were moved from one bag to the other, the gravitational force between the two bags would

[1] increase to 3/2 the original value.

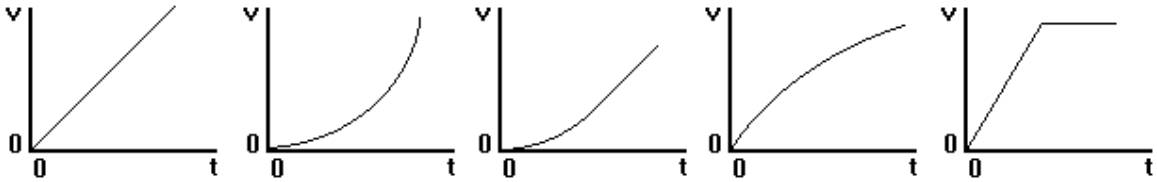
[2] decrease to 2/5 the original value.

[3] increase to 5/3 the original value.

[4] decrease to 5/9 the original value.

[5] not change.

6. A large balloon filled with air is dropped from the ceiling of a school lab to the floor about 10 m below. Which of the following graphs would best represent the variation of its velocity (v) with time (t) if the balloon comes down vertically?



[1] [2] [3] [4] [5]

7. A driver in a 1500 kg car wishes to pass a slow moving bus on a two lane road. What is the average power in watts required to accelerate the car from 20 m s^{-1} to 40 ms^{-1} in 3 s?

[1] 10,000 [2] 20,000 [3] 100,000 [4] 300,000 [5] 400,000

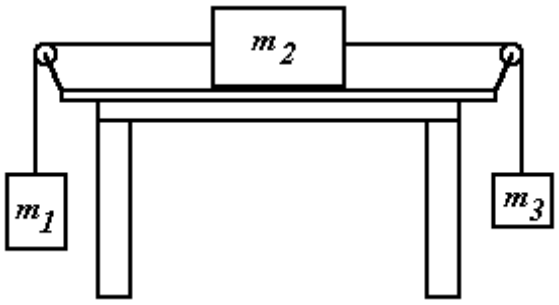
8. A 40 kg mass is attached to a horizontal light spring with a spring constant of 500 N m^{-1}. If the mass rests on a frictionless horizontal surface, what is the total energy of this system when the mass set into simple harmonic motion by an original displacement of 0.2 m?

[1] 10 J [2] 20 J [3] 50 J [4] 4000 J [5] 100,000 J

9. Two skaters on a frictionless icy surface push apart from one another. One skater has a mass *M* much greater than the mass *m* of the second skater. After some time the two skaters are at a distance *d* apart. How far has the lighter skater moved from her original position?

[1] d [2] $d\frac{M}{m}$ [3] $d\frac{m}{M}$ [4] $d\frac{m}{M+m}$ [5] $d\frac{M}{M+m}$

10.

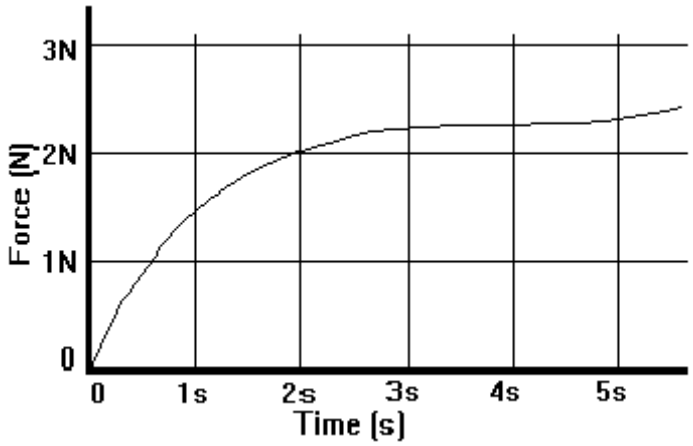


Given three masses are connected as shown in the diagram. If the coefficient of kinetic friction between the large mass (m_2) and the table is μ, what would be the upward acceleration of the small mass (m_3)? The mass and friction of the cords and pulleys are small enough to produce a negligible effect on the system.

[1] $\frac{m_1 g}{m_1+m_2+m_3}$ [2] $\frac{g(m_1+m_2\mu)}{m_1+m_2+m_3}$ [3] $\frac{g\mu(m_1+m_2+m_3)}{m_1-m_2-m_3}$

[4] $\frac{g\mu(m_1-m_2-m_3)}{m_1+m_2+m_3}$ [5] $\frac{g(m_1-m_2\mu-m_3)}{m_1+m_2+m_3}$

11.



An object with a mass of 2 kg is accelerated from rest. The graph above shows the variation of the magnitude of the net force with time. At t = 4 s the object's speed would have been closest to which of the following:

[1] 2.2 m s^{-1} [2] 3.5 m s^{-1} [3] 5.8 m s^{-1} [4] 7.0 m s^{-1} [5] 11.5 m s^{-1}

12. A thin ring of mass *m* and radius *r* rolls across the floor with a velocity *v*. Which of the following expression would be the best estimate of the ring's total kinetic energy as it rolls across the floor?

[1] mv^2 [2] $\frac{1}{2}mv^2$ [3] $\frac{1}{4}mv^2$ [4] $\frac{1}{2}mv^2 + \frac{mv^2}{r}$

[5] $\frac{1}{2}mv^2 - \frac{mv^2}{r}$

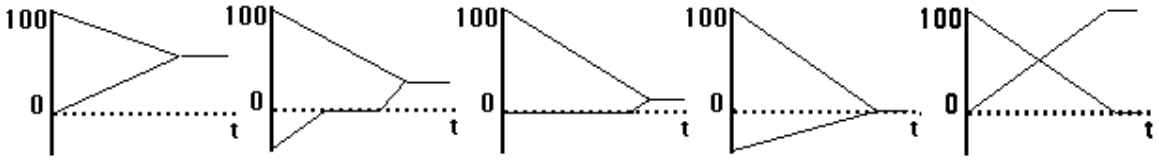
13. A 4.0 kg mass is attached to one end of a rope of 2 m long. If the mass is swung in a vertical circle from the free end of the rope, what is the tension in the rope when the mass is at its highest point if it is moving with a speed of 5 m s^{-1}?

[1] 5.4 N [2] 10.0 N [3] 21.6 N [4] 50 N [5] 90.0 N

14. A mole of an ideal gas at STP is heated in an insulated container of constant volume until the average speed of its molecules doubled. Its pressure would therefore increase by a factor of

[1] 0.5 [2] 1 [3] 2 [4] 4 [5] 8

15. If 100 g of ice at 0 ^{0}C is mixed with 100 g of boiling water at 100 ^{0}C, which of the following graphs would best represent the variation of temperature vs time (t) of the two components of the mixture?



[1] [2] [3] [4] [5]

16. A wave produced by a simple harmonic oscillator whose displacement in meters is given by the equation: $y = 0.3 \sin(3\pi x + 24\pi t)$, what is the frequency?

[1] 3 Hz [2] 7.2 Hz [3] 8 Hz [4] 12 Hz [5] 24 Hz

17. Which of the following wave properties cannot be demonstrated by all kinds of waves?

[1] Polarization [2] Diffraction [3] Superposition [4] Refraction

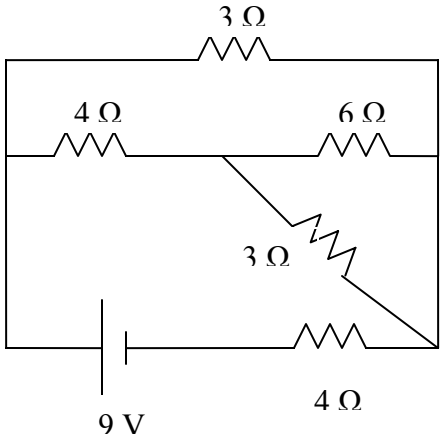
[5] Reflection

18. A source when at rest in a medium produces waves to the right with a velocity v and a wavelength of λ. If the source is set in motion to the left with a velocity v_S ($v_S < v$), what would be the magnitude of the wavelengths produced directly in front of the source?

[1] $\lambda\left[1 - \frac{v_S}{v}\right]$ [2] $\lambda\left[1 + \frac{v_S}{v}\right]$ [3] $\lambda\left[1 - \frac{v}{v_S}\right]$ [4] $\frac{\lambda - v}{v - v_S}$

[5] $\frac{\lambda v}{v + v_S}$

19. What would be the total current being supplied by the battery of negligible internal resistance in the circuit shown?



[1] 3.0 A [2] 2.25 A [3] 2.0 A [4] 1.5 A [5] 1.0 A

20. Consider a simple circuit containing a battery of negligible internal resistance and three identical light bulbs. Bulb A is wired in parallel with bulb B and this combination is wired in series with bulb C. What would happen to the brightness of the other two bulbs if bulb A were to burn out?

[1] only bulb B would get brighter.

[2] both would get brighter.

[3] bulb B would get brighter and bulb C would get dimmer.

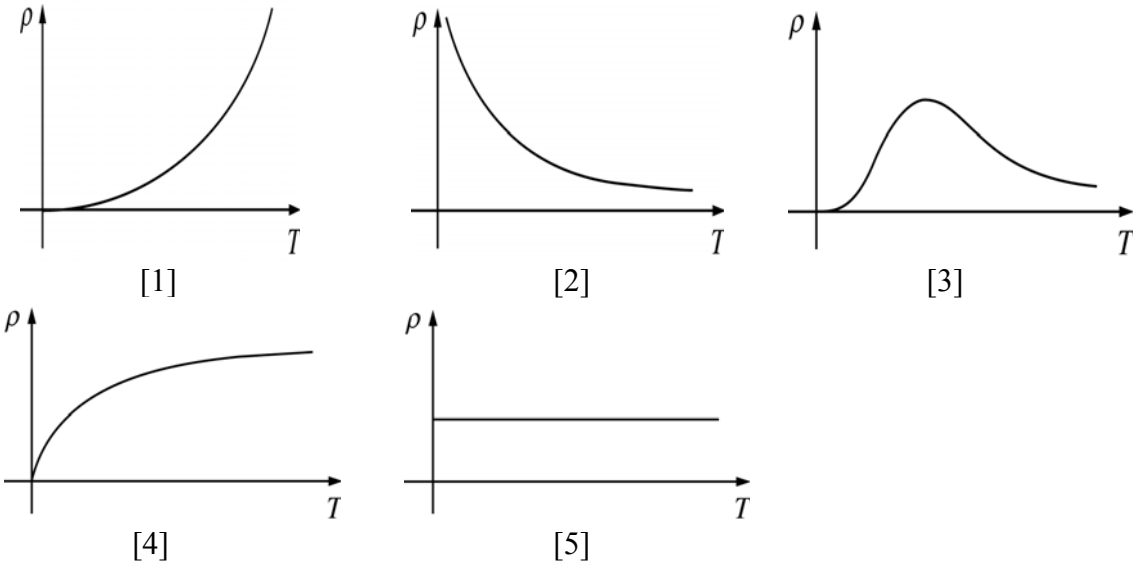
[4] bulb B would get dimmer and bulb C would get brighter.

[5] There would be no change in the brightness of either bulb B or bulb C.

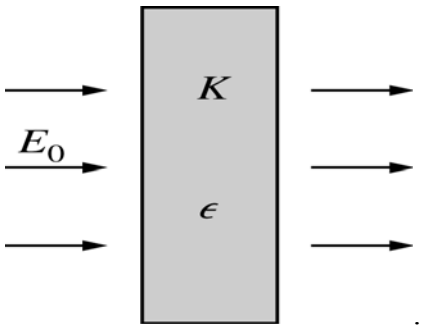
21. A circular coil of wire is moved vertically at a constant velocity through a horizontal magnetic field. The plane of the coil is perpendicular to the magnetic field. Which of the following graphs would best represent the electric current (I) induced in the coil with time (t), if it started somewhat above the magnetic field and ended equally as far below the magnetic field?

[1] [2] [3] [4] [5]

22. Which of the following graphs best represents the temperature (*T*) dependence of the resistivity (ρ) of an undoped semiconductor?



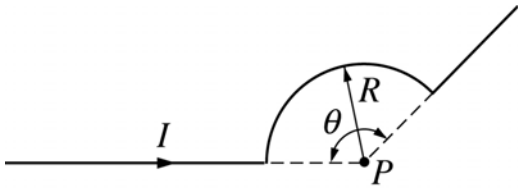
23.



An infinite slab of dielectric material with dielectric constant K and permittivity $\varepsilon(=K\varepsilon_0)$ is placed in a uniform electric field of magnitude E_0. The field is perpendicular to the surface of the slab, as shown in the figure above. The electric field intensity inside the slab is

[1] $\frac{E_0}{K}$ [2] $\frac{E_0}{K\varepsilon_0}$ [3] E_0 [4] $K\varepsilon_0 E_0$ [5] KE_0

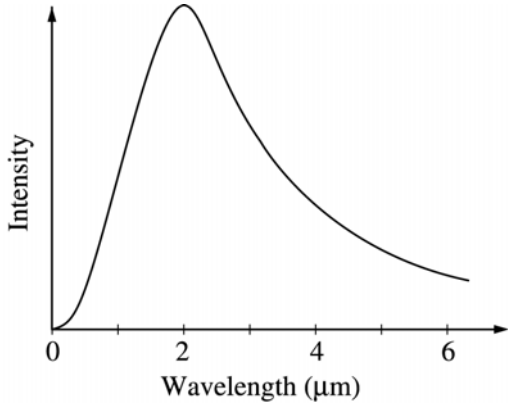
24.



A wire is bent into an arc of radius R and subtended angle θ, as shown in the figure above. Point P is at the centre of the circular segment. The wire carries current I. The magnitude of the magnetic flux density at the point P is

[1] 0 [2] $\frac{\mu_0 I\theta}{(2\pi)^2 R}$ [3] $\frac{\mu_0 I\theta}{4\pi R}$ [4] $\frac{\mu_0 I\theta}{4\pi R^2}$ [5] $\frac{\mu_0 I}{2\theta R^2}$

25.



The distribution of relative intensity [$I(\lambda)$] of blackbody radiation emitted from a solid object versus the wavelength (λ) is shown in the figure above. If the Wien displacement constant is 2.9×10^{-3} m K, what is the approximate temperature of the object?

[1] 10 K [2] 50 K [3] 250 K [4] 1500 K [5] 6250 K

26. A satellite of mass m orbits a planet of mass M in a circular orbit of radius R. The time required for one revolution is

[1] independent of M

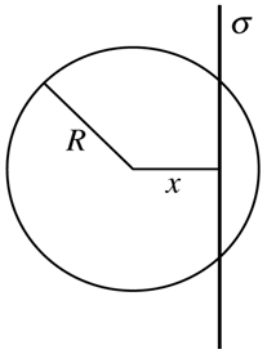
[2] proportional to m

[3] proportional to R

[4] proportional to $R^{3/2}$

[5] proportional to R^2

27.



An infinite, uniformly charged sheet with surface charge density σ cuts through a spherical Gaussian surface of radius R at a distance x from its centre, as shown in the figure above. The flux of the electric field intensity Φ through the Gaussian surface is

[1] $\frac{\pi R^2 \sigma}{\varepsilon_0}$ [2] $\frac{4\pi R^2 \sigma}{\varepsilon_0}$ [3] $\frac{\pi (R-x)^2 \sigma}{\varepsilon_0}$ [4] $\frac{\pi (R^2 - x^2) \sigma}{\varepsilon_0}$

[5] 0

28.

Before Collision After Collision

A particle of mass m moving along the x-axis with speed v collides with a particle of mass $2m$ initially at rest. After the collision, the first particle has come to rest, and the second particle has split into two equal-mass pieces that move at equal angle θ with the x-axis, as shown in the figure above. Which of the following statements correctly describes the speeds of the two pieces?

[1] Both pieces move with speed v.

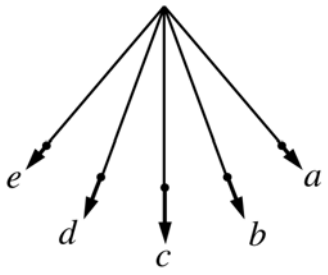
[2] One of the pieces moves with speed v, the other moves with speed less than v.

[3] Both pieces move with speed $v/2$.

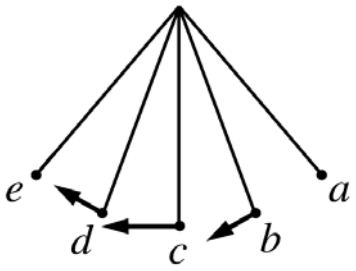
[4] One of the pieces moves with speed $v/2$, the other moves with speed greater than $v/2$.

[5] Both pieces move with speed greater than $v/2$.

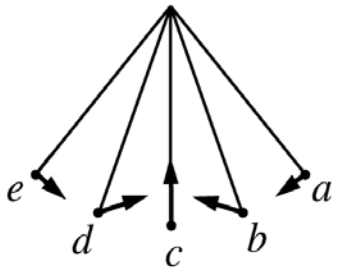
29. Which of the following best illustrates the acceleration of a simple pendulum bob at points *a* through *e*?



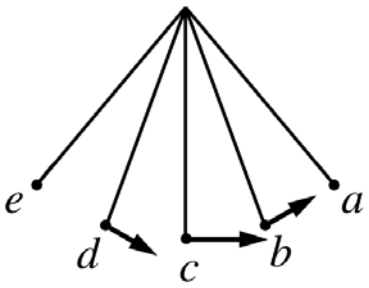
[1]



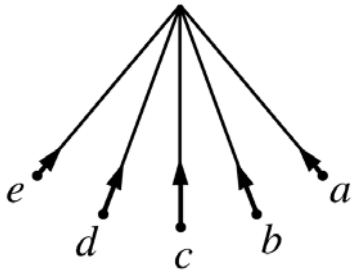
[2]



[3]

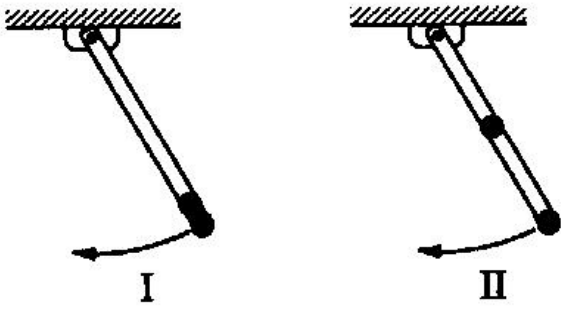


[4]



[5]

30.



A straight and light rod pivots about one end in a vertical plane. In configuration I, two small identical masses are attached to the free end and in configuration II, one mass is moved to the centre of the rod as shown in the above figure. The ratio of

$$\frac{\text{The frequency of small oscillations of configuration II}}{\text{The frequency of small oscillations of configuration I}}$$

is equal to

[1] $\frac{\sqrt{3}}{2}$ [2] $\sqrt{\frac{5}{6}}$ [3] $\sqrt{\frac{6}{5}}$ [4] $\frac{2}{\sqrt{3}}$ [5] $\frac{3}{2}$