G. C. E (Advanced Level) Examination, August 2014

PHYSICS - I

Two hours

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Instructions :

- *This question paper consists of 50 questions in 10 Pages.*
- *Answer* **all** *the questions.*
- *Write your* ***Index Number*** *in the space provided in the answer sheet.*
- *Read the instructions given on the back of the answer sheet carefully.*
- *In each of the questions 1 to 50, pick one of the alternatives from (1), (2), (3), (4), (5) which is* ***correct or most appropriate and mark your response on the answer sheet with a cross (x) in accordance with the instructions given on the back of the answer sheet***

Use of calculators is not allowed.

($g = 10N\ kg^{-1}$)

01. As far as the units are concerned, which of the following quantities differs from the rest?
(1) Rotational kinetic energy
(2) Mechanical potential energy
(3) Internal energy
(4) Work
(5) Power

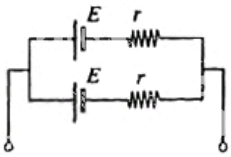
02. Which of the following quantities is / are dimensionless?
(A) Relative velocity
(B) Relative density
(C) Relative humidity
(1) A only. (2) A and B only.
(3) B and C only. (4) A and C only.
(5) All A, B and C.

03. Which of the following propagates in the form of longitudinal waves?
(1) Laser light (2) X-rays
(3) Ultrasonic waves (4) Microwaves
(5) Radio waves

04. When a guitar is played, it will produce
(1) longitudinal progressive waves on the strings and longitudinal progressive waves in air.
(2) transverse progressive waves on the strings and longitudinal progressive waves in air.
(3) longitudinal standing waves on the strings and transverse progressive waves in air.
(4) transverse standing waves on the strings and longitudinal progressive waves in air.
(5) transverse standing waves on the strings and transverse standing waves in air.

05. Which of the following statements is **not** true with regard to a compound microscope?
(1) It has two convex lenses.
(2) Image of the object formed by the objective is real.
(3) Separation of the lenses is much greater than the focal length of the objective or the eyepiece.
(4) Final image formed by the microscope is a virtual image.
(5) The object to be examined should be placed within the focal length of the objective.

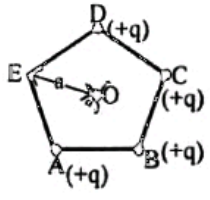
06. Two cells, each having e.m.f. E and internal resistance r, connected as shown in figure are equivalent to a single cell with



(1) e. m.f. E and internal resistance r.
(2) e. m. f. 2E and internal resistance 2r.
(3) e.m.f 2E and internal resistance r.
(4) e.m.f. E and internal resistance r/2
(5) e.m.f. E and internal resistance 2r.

07. Two charged conducting spheres of radii $R_1 = r$ and $R_2 = 2r$ are connected by a thin conducting wire. After being connected, if the respective charges on the two spheres are Q_1 and Q_2 and, the corresponding surface charge densities on the two spheres are Q_1 and Q_2 respectively, then
(1) $\frac{Q_1}{Q_2} = \frac{\sigma_1}{\sigma_2} = \frac{1}{2}$ (2) $\frac{Q_1}{Q_2} = \frac{\sigma_1}{\sigma_2} = 2$
(3) $\frac{Q_1}{Q_2} = \frac{1}{2}, \frac{\sigma_1}{\sigma_2} = 2$ (4) $Q_1 = Q_2,\ \sigma_1 = \sigma_2$
(5) $\frac{Q_1}{Q_2} = 2, \frac{\sigma_1}{\sigma_2} = \frac{1}{2}$

08. Four particles each having a charge of +q are placed on four vertices of a regular pentagon as shown in figure. The distance from the centre O of the pentagon to a vertex is a. The electric fiel intensity at the centre of the pentagon is



(1) $\frac{q}{4\pi\varepsilon_0 a^2}$ in the OE direction
(2) $\frac{q}{4\pi\varepsilon_0 a^2}$ in the EO direction.
(3) $\frac{q}{\pi\varepsilon_0 a^2}$ in the OE direction.
(4) $\frac{q}{\pi\varepsilon_0 a^2}$ in the EO direction.
(5) zero.

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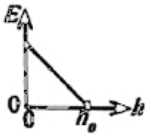
09. A thin ring of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre perpendicular to its plane with a constant angular velocity ω. Now if two small masses, each of mass m, are attached gently to the opposite ends of a diameter of the ring, the new angular velocity of the system is

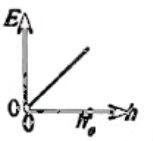
(1) $\frac{\omega M}{M+2m}$ (2) $\frac{\omega(M+2m)}{M}$

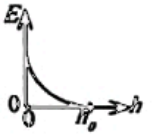
(3) $\frac{\omega M}{M+m}$ (4) $\frac{\omega(M-2m)}{M+2m}$

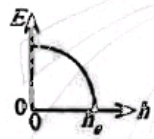
(5) $\frac{\omega(M+m)}{M}$

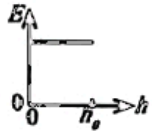
10. A particle of mass m is dropped freely from a location at a height h_0 from the ground. The variation of the kinetic energy (E) of the particle with height h as measured from ground is best represented by

(1) 

(2) 

(3) 

(4) 

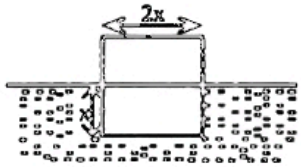
(5) 

11. A solid cube of plastic of mass M and side length 2x floats in water with half the side length submerged as shown in figure. If this cube is now converted into a hollow cube of mass M with external side length 8x, the depth to which it submerges in water will be

(1) $\frac{x}{2}$ (2) $\frac{x}{4}$

(3) $\frac{x}{8}$ (4) $\frac{x}{16}$

(5) $\frac{x}{32}$



12. A Gaussian surface S encloses a metal sphere carrying a charge of $+q$, three n-type semiconductor pieces each having a number of free electrons corresponding to charge of $-q$, and one p-type semiconductor piece having a number of holes corresponding to charge of +q as shown in figure.

Total electric flux through the surface can be made zero by

(A) removing one n-type semiconductor piece.

(B) adding one more p-type semiconductor piece with the same hole concentration.

(C) bringing a metal sphere carrying a charge of $-q$ from outside into the enclosed volume.

Of the above three methods

(1) only A is true.

(2) only C is true.

(3) only A and B are true.

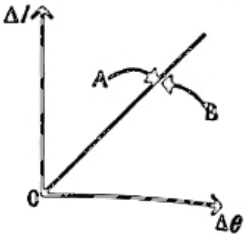
(4) only B and C are true.

(5) All A, B and C are true.



13. When two metal rods A and B at room temperature are heated together and their expansions Δl are plotted with the increase in temperature $\Delta\theta$, the two curves are found to coincide with each other as shown in figure.

This could happen only if



(1) the two rods are made of same material.

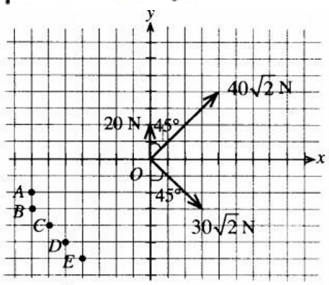
(2) length of A is same as the length of B.

(3) linear expansivity of A is same as that of B.

(4) the product 'linear expansivity x original length' is same for both rods.

(5) the two rods are heated together.

14. If three coplanar forces of 20N, $40\sqrt{2}$ N and $30\sqrt{2}$ N act on a particle situated at the origin O of a x-y coordinate system as shown in figure, the vector that represents the force necessary to keep the particle stationary is



(1) OA (2) OB

(3) OC (4) OD

(5) OE

15. A heavy roller of mass 500kg, moving on a horizontal surface at a constant velocity of 1m s^{-1} as shown in figure is stopped in 0.5s on hitting a smooth vertical wall. The horizontal force exerted by the roller on the wall is



(1) 5 000 N

(2) 3 000 N

(3) 2 000 N

(4) 1 000 N

(5) 500 N

16. A traditional grain grinder consists of two flat stones. The upper stone is rotated on top of the lower stationary stone by applying a horizontal force of magnitude F to the handle H which is fixed at a distance of r from the axis of rotation as shown in figure. If the force is always applied parallel to the direction of motion of the handle, and the period of rotation is T, the power being expended is

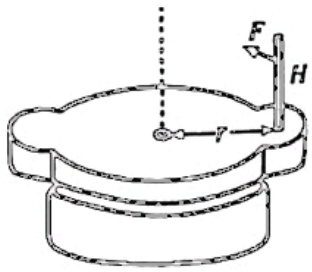
(1) $\frac{\pi rF}{T}$

(2) $\frac{2\pi rF}{T}$

(3) $\frac{rF}{T}$

(4) $\frac{F}{\pi r^2 T}$

(5) $\pi r^2 FT$



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17. A radioactive material has a half life of 60 minutes. The percentage of the fraction of material that has decayed during a period of 3 hours is
(1) 8.75% (2) 12.5%
(3) 66.6 % (4) 78.3%
(5) 87.5%

18. Intensity of the noise generated by a machine is 10^{-2} Wm^{-2}. By employing a noise barrier, the intensity of noise is reduced to 10^{-6} W m^{-2}. What is the reduction in the noise intensity level?
(1) 160 dB (2) 100 dB
(3) 60 dB (4) 40 dB
(5) 25 dB

19. A convex lens is used to obtain a clear image of an object on a screen. The screen is located 30 cm away from the lens, and the object is at 20 cm from the lens. If the lens is now used to focus the image of a distant tree on the screen, the distance between the lens and the image of the tree is
(1) 12 cm (2) 24 cm
(3) 50 cm (4) 60 cm
(5) 90 cm

20. Which of the types of glass prisms shown in figure (2) can be used to bend a ray of light into all the forms given in figure (1)?

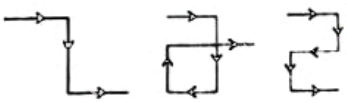


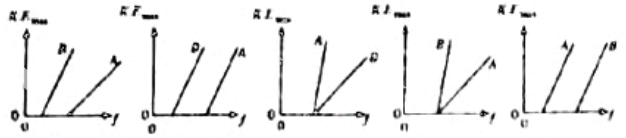
Figure (1)



Figure (2)

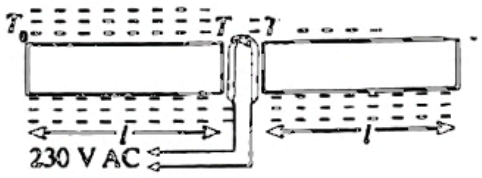
(1) Type A only. (2) Type B only.
(3) Type C only. (4) Types A and C only.
(5) Type B and C only.

21. The work functions corresponding to two metals A and B are W_1 and W_2 respectively, and $W_1 > W_2$. Two surfaces made of *A* and *B* are illuminated separately using a monochromatic beam of light of frequency *f*. Which of the following graphs correctly represents the variation of the maximum kinetic energy ($K.E_{max}$) of the emitted photoelectrons with the frequency (f) of the incident light beam, for the surfaces made of metals *A* and *B*?



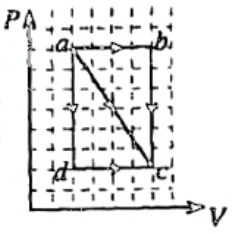
(1) (2) (3) (4) (5)

22. Two ends of two identical metal rods of uniform cross section are placed very close to each other, and those ends are heated using an electric heating element which supplies heat at a constant rate of *P* (Watts), as shown in figure. The rods are thermally well insulated as shown, and at the steady state, the temperature at free ends which are exposed to the surroundings is T_0. Assume that the entire heat energy generated by the element is absorbed equally by the two rods. If *l*, *A* and *k* respectively are the length, cross sectional area and the thermal conductivity of a rod, what is the temperature *T* of the ends close to the heating element at the steady state?



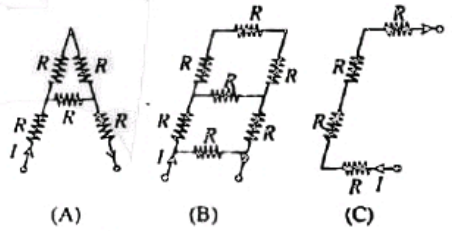
(1) $T = T_0 + \frac{Pl}{kA}$ (2) $T = T_0 + \frac{Pl}{2kA}$
(3) $T = T_0 + \frac{2Pl}{kA}$ (4) $T = 2T_0$
(5) $T = 2\left(T_0 + \frac{Pl}{kA}\right)$

23. An ideal gas can expand from state *a* to state *c* along three thermodynamic paths *adc*, *ac* and *abc* as given in the *P* - *V* diagram. Along which of the above paths would the highest exchange of heat occur?



(1) Path *adc*
(2) Path *ac*
(3) Path *abc*
(4) Path *adc* and ac equally
(5) Path *adc* and *abc* equally

24.

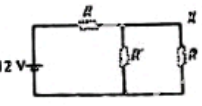


The same current I is sent through resistor networks A, B and C as shown in above figure. If all the resistors in the networks are of equal magnitude, the maximum power is consumed by
(1) the network A.
(2) the network B.
(3) the network C.
(4) the networks A and B equally.
(5) the networks B and C equally.

25. A 5W electronic device having a resistance of 5Ω is operated by receiving power from a 230V main supply through a transformer.

The ratio, $\frac{\text{Number of turns in the primary coil}}{\text{Number of turns in the secondary coil}}$ of the transformer is
(1) 46 (2) 23
(3) $\frac{10}{23}$ (4) $\frac{1}{23}$
(5) $\frac{1}{46}$

26. In the circuit shown, the voltage at X is found to increase by 4 V when R' is removed. The resistance of R' is equal to



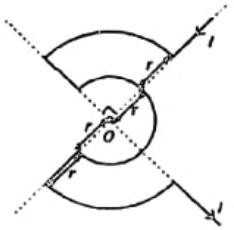
(1) 4R (2) R
(3) $\frac{R}{2}$ (4) $\frac{R}{4}$
(5) $\frac{R}{6}$

27. A piece of wire is bent into the form shown in figure and a current of I is passed in the direction shown. The magnitude of the magnetic flux density at the point O is

(1) $\frac{\mu_0 I}{4r}$ (2) $\frac{\mu_0 I}{8r}$

(3) $\frac{3\mu_0 I}{2r}$ (4) $\frac{\mu_0 I}{2r}$

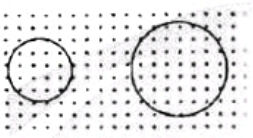
(5) $\frac{3\mu_0 I}{8r}$



28. Two identical strings are separately subjected to a tension T. When plucked at the middle, each string produces waves of frequency f. Now, if the tension of only one string is reduced to 0.81 T and the strings are plucked at the middle simultaneously, five beats can be heard during one second. The value of f is

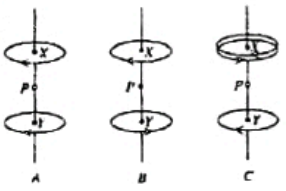
(1) 25 Hz (2) 50 Hz
(3) 75 Hz (4) 90 Hz
(5) 100 Hz

29. An electron and a proton travel with equal speeds around two circular paths shown in the diagram (drawn not to scale) under the influence of a uniform magnetic field. If the direction of magnetic field is perpendicular and into the plane of the paper,



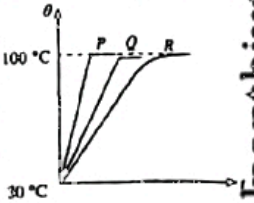
(1) the electron travels clockwise around the small circular path and the proton travels counter - clockwise around the large circular path.
(2) the electron travels counter - clockwise around the small circular path and the proton travels clockwise around the large circular path.
(3) the electron travels clockwise around the large circular path and the proton travels counter-clockwise around the small circular path.
(4) the electron travels counter-clokwise around the large circular path and the proton travels clockwise around the small circular path.
(5) the electron travels counter-clockwise around the small circular path and the proton travels counter-clockwise around the large circular path.

30. Identical loops in the three arrangements A, B and C of circular loops centred around vertical axes, carry equal currents in the directions shown in figure. In the arrangement C there are two separate loops very close to each other with a common centre at X. In all three arrangements the loops are separated by the same distance XY and P is the mid-point of XY. If the magnitudes of the magnetic flux densities at P in the arrangements A, B and C are B_A, B_B and B_C respectively, then



(1) $B_A > B_B > B_C$ (2) $B_A > B_C > B_B$
(3) $B_B > B_C > B_A$ (4) $B_C > B_B > B_A$
(5) $B_C > B_A > B_B$

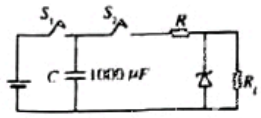
31. Three different types of thermometers, P, Q and R having a temperature range of 0 -110°C, and kept at room temperature of 30°C were simultaneously dipped into a large oil bath maintained at 100°C at time t = 0, and their readings (0) were recorded with time (t). Curves in figure show the variation of 0 with t for three thermometers. Consider the following conclusions made about the thermometers after analyzing the three curves.



(A) P is the most sensitive thermometer.
(B) Thermometers P and R are accurate but not Q.
(C) The scale of thermometer R is not linear.

Of the above conclusions.
(1) Only A is true.
(2) Only B is true.
(3) Only A and B are true.
(4) Only B and C are true.
(5) All A, B and C are ture.

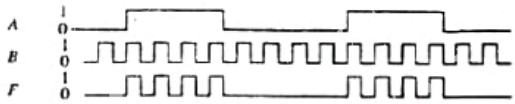
32. Breakdown voltage of the zener diode in the circuit shown is 5V. R_L is a suitable resistor. The capacitor C is first charged to 10V by closing the switch S_1 and opening the switch S_2. Subsequently, S_1 is opened and S_2 is closed. Consider the following statements made about the functioning of the circuit after S_2 is closed.



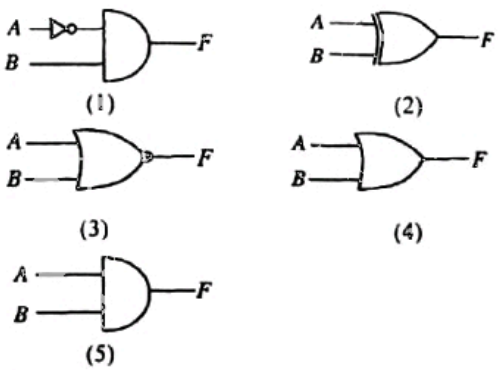
(A) Voltage across R_L will be 5 V so long as the capacitor voltage is adequately above 5 V.
(B) Time period through which the voltage across R_L remains constant does not depend on the value of the capacitance.
(C) Potential drop across R gradually decreases with time.

Of the above statements,
(1) Only A is true. (2) Only C is true.
(3) Only A and B are true. (4) Only A and C are true.
(5) All A, B and C are true.

33. A and B shown below represent the logical inputs applied to circuits (1) to (5) given below, and F represents the expected output from the circuit.



Which of the following circuits, (1) to (5), provides the expected output?



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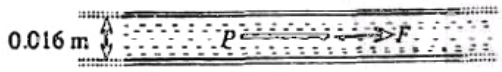
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34. Which of the following is not true regarding an npn transistor and an n-channel junction field effect transistor (JFET)?

npn transistor	*n*-channel JFET
(1) Has two pn junctions.	Has only one pn junction.
(2) Base-emitter junction is forward biased when operating in the active mode.	Gate-source junction is reverse biased during the operation.
(3) An arrow is marked on the emitter of the transistor symbol.	An arrow is marked on the source of the transistor symbol.
(4) Both free electrons and holes participate in the operation of the transistor.	Only free electrons participate in the operation.
(5) Magnitude of the current through the collector depends on the base-emitter voltage.	Magnitude of the current through the channel depends on the gate-source voltage.

35. Figure shows a section of a long horizontal rectangular tube of height 0.016m having a large surface area, and filled with a lubricating oil of viscosity 0.072 Pas. What is the force F required to drag a very thin plate P of area 0.4m^2 with a velocity of 0.02ms^{-1} along the middle plane between the top and bottom surfaces of the tube as shown in figure?

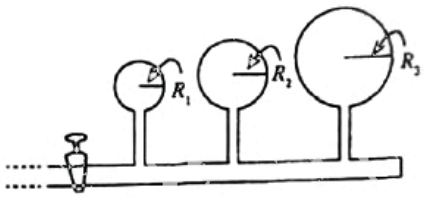
(1) $3.5\pi \times 10^{-3}$N (2) $7.0\pi \times 10^{-3}$N



(3) 3.6×10^{-2} N (4) 7.2×10^{-2} N

(5) 1.44×10^{-1} N

36. Three spherical liquid films of surface tensions T_1, T_2 and T_3 respectively are in equilibrium as shown in figure such that the corresponding radii $R_1 = r$, $R_2 = 2r$ and $R_3 = 3r$ Then.



(1) $T_1 = T_2 = T_3$ (2) $\frac{T_1}{3} = \frac{T_2}{2} = T_3$

(3) $\frac{T_1}{6} = \frac{T_2}{4} = T_3$ (4) $T_1 = \frac{T_2}{2} = \frac{T_3}{4}$

(5) $T_1 = \frac{T_2}{2} = \frac{T_3}{3}$

37. A cylindrical copper block of radius r and length l = 2r radiates energy as a black body at temperature T. If this copper block is cut and separated into N identical disks having the same radius r, the rate of the emission of radiant energy at the above temperature will increase by a factor of

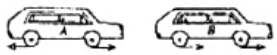
(1) $\frac{(N+3)}{3}$ (2) $\frac{(N+2)}{3}$

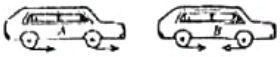
(3) $\frac{(N+1)}{3}$ (4) $\frac{N}{3}$

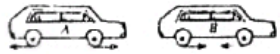
(5) N

38. Consider two motor vehicles, A and B. In motor vehicle A only the front wheels are coupled to the engine and rotated, and in vehicle B only the rear wheels are coupled to the engine and rotated. Which of the following diagrams correctly shows the **directions** of the frictional forces acting on the front and rear wheels of motor vehicles A and B by the ground, when they are travelling in the forward direction?

(1) 

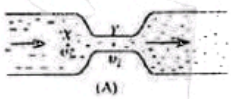
(2) 

(3) 

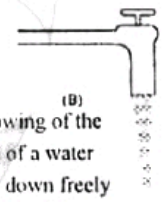
(4) 

(5) 

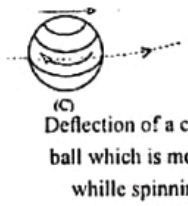
39. Consider the following physical phenomena.



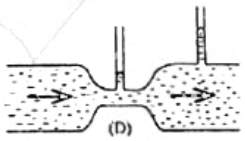
Water flowing through a tube having two different areas of cross-section; speed of water at Y (υ_2) > speed of water at X (υ_1).



Gradual narrowing of the cross section of a water column falling down freely from a tap.



Deflection of a cricket ball which is moving whille spinning.



Existence of a height difference in the liquid columns in vertical tubes.

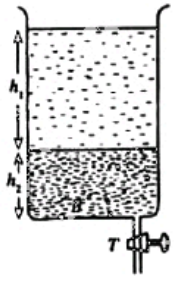
Which of the above phenomena can be explained using the Bernoulli's theorem?

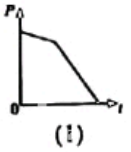
(1) A and D only. (2) B and D only.

(3) C and D only. (4) B, C and D only.

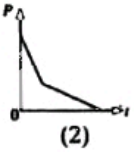
(5) All A, B, C and D.

40. A cylinder contains two immiscible liquids filled to heights h_1 and h_2 as shown in figure. If the tap T at the bottom is opened at time t = 0 and liquids are taken out slowly at a constant volume rate, the variation of pressure (P) due to liquids at the point B at the bottom of the cylinder with time (t) is best represented by

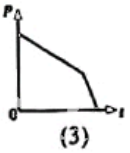




(1)



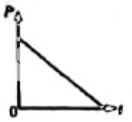
(2)



(3)

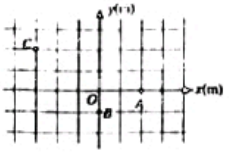
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(4)


(5)

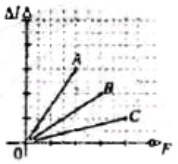
41. A small object is initially at rest at point O, and due to an internal explosion it breaks into three parts and move away. At a certain instant after the explosion, the location of three moving parts are shown by the points A, B and C in figure. If the mass of the part which is at point A is 6 grams, what is the mass of the object (in grams) before explosion?

(1) 6 (2) 9
(3) 12 (4) 15
(5) 18



42. Figure shows the variation of the extensions (Δl) produced by three different metal rods A, B and C with the force when they are subjected to a tensile force F. If E_A, E_B and E_C are the corresponding energies stored in the rods due to extensions, then

(1) $E_A > E_B = E_C$
(2) $E_A = E_B > E_C$
(3) $E_A = E_B = E_C$
(4) $E_A > E_B > E_C$
(5) $E_A < E_B < E_C$



43. A light spiral spring has an unstretched length l and a spring constant k. A small object of mass m is attached to one end of the spring and the system is rotated about a vertical axis that passes through a small light ring attached to the other end of the spring as shown in figure. If the object travels along a circular path of radius R with constant angular speed ω, keeping the spring on a horizontal plane, then

(1) $\omega = \sqrt{\frac{k}{m}\left(\frac{R-l}{R}\right)}$

(2) $\omega = \sqrt{\frac{k}{m}}$

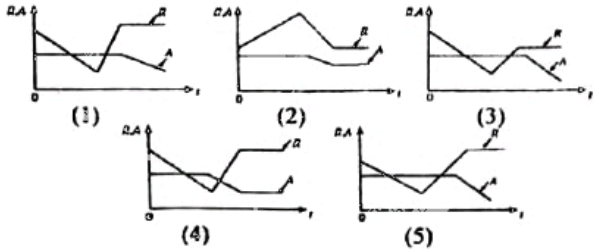
(3) $\omega = \sqrt{\frac{k}{m} \cdot \frac{l}{R}}$

(4) $\omega = \sqrt{\frac{k}{m}\left(1 - \frac{R}{l}\right)}$

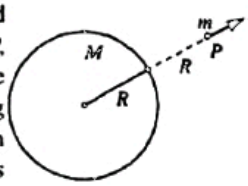
(5) $\omega = \sqrt{\frac{k}{m} \cdot \frac{R}{l}}$



44. A certain volume of air, isolated from the atmosphere at 30°C, is first heated up to 80 °C and then cooled down to 15°C at uniform rates. Both heating and cooling are done at constant pressure. Dew point of the isolated air is 25°C. The variations of relative humidity (R) and absolute humidity (A) of the air volume with time (t) are best represented by


(1) (2) (3) (4) (5)

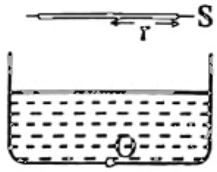
45. A particle of mass m is projected vertically upwards from a point P, which is at a distance of 2R from the centre of a spherical planet having a mass M and radius R as shown in figure. The escape velocity for this projectile is



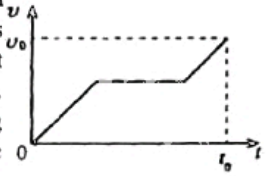
(1) $v = \sqrt{\frac{GM}{R}}$ (2) $v = \sqrt{\frac{2GM}{R}}$
(3) $v = \sqrt{\frac{2Gm}{R}}$ (4) $v = \sqrt{\frac{GM}{2R}}$
(5) $v = 2\sqrt{\frac{GM}{R}}$

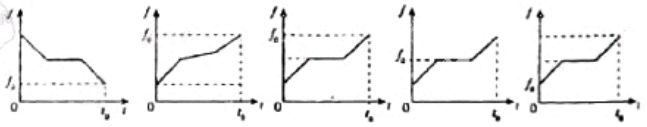
46. A point source of light O situated at the bottom of a water tank produces a circular patch of light of radius r on a horizontal screen S as shown in figure. C is the critical angle for the water-air interface. If the light source is moved vertically up by a distance d, the radius of the light patch will

(1) increase to $r + d \sin C$.
(2) increase to $r + d \tan C$.
(3) remain unchanged.
(4) decrease to $r - d \sin C$.
(5) decrease to $r - d \tan C$.



47. An ambulance which emits a sound of frequency f_0 from its siren is travelling with constant velocity v_0 along a straight road. A car starting from rest is moving behind the ambulance in the same direction, and the velocity-time graph of the car is shown in figure. The car approaches the velocity v_0 of the ambulance at time t_0. The variation of the frequency (f) of the siren sound heard by a passenger in the car with time (t) is best represented by,




(1) (2) (3) (4) (5)

48. When the resistance R_2 in the circuit shown in figure is varied from zero to infinity, the potential at A relative to B will change from

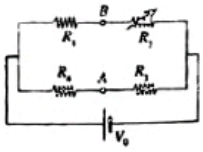
(1) zero to zero

(2) $\frac{R_1}{R_4 + R_1} V_0$ to zero

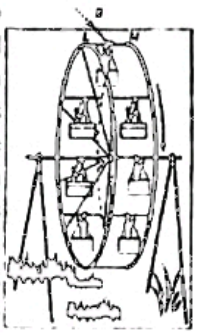
(3) $\frac{R_1}{R_4 + R_1} V_0$ to $\frac{R_1}{R_4 + R_1} V_0 - V_0$

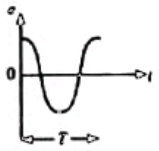
(4) $\frac{R_3}{R_4 + R_3} V_0$ to $\frac{R_3}{R_4 + R_3} V_0 - V_0$

(5) $\frac{R_3}{R_4 + R_3} V_0$ to $\frac{R_4}{R_4 + R_3} V_0 - V_0$

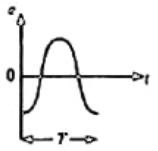


49. A Ferris wheel which consists of two parallel large wooden wheels joined together with metal cross bars as shown in figure, is erected so that the planes of wheels are in the north-south direction, and the cross bars are perpendicular to the direction of the earth's magnetic field B which is horizontal at this location. The Ferris wheel rotates around the horizontal axis passing through the centres of the two wheels at a constant period of rotation T in the direction shown. LM is a metal cross bar which is at the highest position as shown when time t = 0. Variation of the induced electromotive force (e) at the end L of the cross bar with respect to the end M with time (t) is best represented by

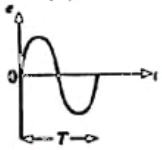




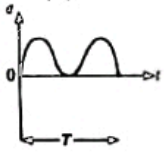
(1)



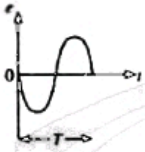
(2)



(3)



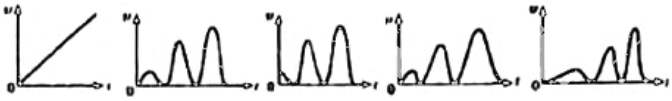
(4)



(5)

50. A wheel, starting from rest, is allowed to roll down without slipping, along an inclined plane as shown in figure. Which of the following graphs best represents the variation of the magnitude (υ) of the velocity of a point P, locate on the perimeter of the wheel, relative to the earth with time (*t*)? (The point *P* touches the inclined plane at t = 0.)





(1) (2) (3) (4) (5)

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