අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2018 අගෝස්තු
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2018 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2018

10.08.2018 / 0830 – 1030

භෞතික විද්‍යාව I பௌதிகவியல் I **Physics I**	**01 E I**	පැය දෙකයි இரண்டு மணித்தியாலம் ***Two hours***

Instructions:

- ✻ *This question paper consists of* **50** *questions in* **12** *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*** (×) ***in accordance with the instructions given on the back of the answer sheet.***

Use of calculators is not allowed.

(Acceleration due to gravity, $g = 10\,\text{N kg}^{-1}$)

1. Unit of pressure is

(1) kg m s^{-2} (2) $\text{kg m}^2\text{s}^{-2}$ (3) $\text{kg m}^{-1}\text{s}^{-2}$ (4) $\text{kg m}^2\text{s}^{-3}$ (5) $\text{kg m}^{-2}\text{s}^{-2}\,\text{A}^{-1}$

2. X, Y and Z represent three physical quantities with **different** dimensions. They can be combined to form another physical quantity P of the form,

$$P = AX + BY + CZ$$

Which of the following expressions has different dimensions from the rest?

(1) AX (2) $AX - CZ$ (3) $\frac{(AX)(CZ)}{BY}$ (4) $\frac{(BY)^2}{P}$ (5) $(BY)(CZ)$

3. Which of the following statements is **not** true?

(1) LASER light consists of transverse waves.
(2) Gamma rays are transverse waves.
(3) Primary waves (P-waves) travelling through the crust of the Earth are longitudinal waves.
(4) Ultrasound waves are longitudinal waves.
(5) FM waves are longitudinal waves.

4. Consider the following statements made regarding the speed of sound v in an ideal gas.

(A) v is directly proportional to the absolute temperature of the gas.
(B) v is inversely proportional to the molar mass of the gas.
(C) v depends on the ratio of the molar heat capacities γ for the gas.

Of the above statements,

(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.

5. Which of the following statements made regarding optical instruments under normal adjustment is **not** true?

(1) In a simple microscope, the image of the object is virtual.
(2) When reading small letters using a simple microscope, a short-sighted person has an advantage over a long-sighted person.
(3) In a compound microscope, the eyepiece acts as a simple microscope.
(4) In a compound microscope, the final image is inverted.
(5) In an astronomical telescope, the object distance and the image distance are both considered to be very large.

[*See page two*

6. In a certain thermodynamic process in which an ideal gas is used, the increase of the internal energy of the gas is equal to the heat supplied to the gas. This process is
(1) a cyclic process. (2) an adiabatic process.
(3) a constant pressure process. (4) a constant volume process.
(5) an isothermal process.

7. When the temperature of a metal rod is increased by 100 °C, its fractional change in length is 2.4×10^{-5}. The linear expansivity of the material of the rod is
(1) 2.4×10^{-3} °C^{-1} (2) 2.4×10^{-4} °C^{-1} (3) 2.4×10^{-5} °C^{-1}
(4) 2.4×10^{-6} °C^{-1} (5) 2.4×10^{-7} °C^{-1}

8. A certain transformer has 900 turns in the primary coil and 30 turns in the secondary coil. When 240 V alternating voltage is applied across the primary coil, the voltage across the secondary coil is
(1) 0 V (2) 8 V (3) 12 V (4) 72 V (5) 7.2 kV

9. Which of the following is **not** a source of e.m.f.?
(1) Electrochemical cell (2) Photodiode (3) Piezoelectric crystal
(4) Thermocouple (5) Charged capacitor

10. The logic circuit shown in figure (a) is equivalent to

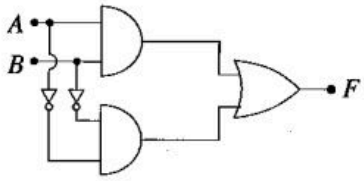
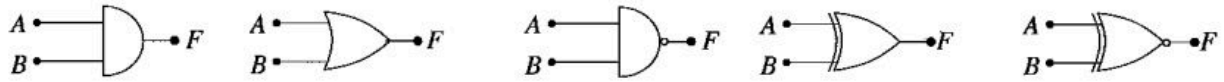


Figure (a)



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

11. The accelerations due to gravity on the surfaces of a uniform spherical planet A of radius R_A and a uniform spherical planet B of radius R_B are equal. If the mass of A is twice the mass of B,
(1) $R_A = \sqrt{2}R_B$ (2) $R_A = 2R_B$ (3) $R_A = \frac{R_B}{\sqrt{2}}$ (4) $R_A = \frac{R_B}{2}$ (5) $R_A = R_B$

12. A, B, C, D and E are five coplanar forces of equal magnitudes acting on a body as shown in figure (a). Which of the following diagrams best represents the direction of the resultant of these forces?

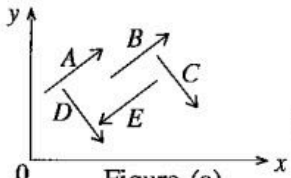
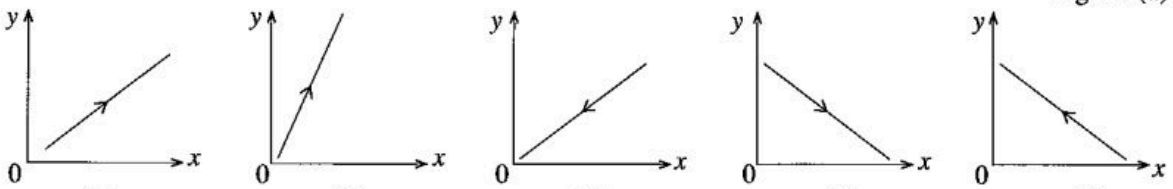
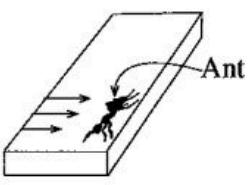


Figure (a)



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

13. An ant of mass 2×10^{-6} kg (2 milligrams), which is stationary at the edge of a horizontal smooth strip is removed in 0.2 s by blowing with mouth. The direction of blowing is horizontal as shown by the arrows in the figure. If the ant is thrown out in the direction of the blowing with a horizontal velocity of 0.5 m s^{-1}, the average force exerted on the ant by the blow is



(1) 5×10^{-6} N (2) 1×10^{-5} N (3) 2×10^{-5} N (4) 1×10^{-3} N (5) 5×10^{-3} N

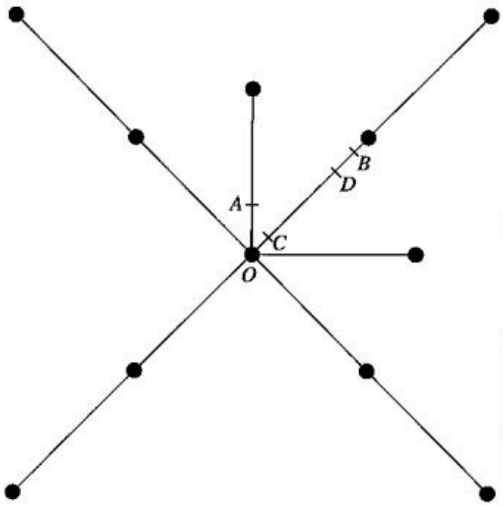
[See page three

14. A small object of mass m placed on the horizontal surface of a frozen pond is given a kick imparting an initial speed v_0 along the horizontal direction. The object moves on the surface in a horizontal straight line without rotation. The coefficient of kinetic friction between the object and the surface is μ. If the air resistance can be neglected, the distance that the object moves before coming to rest is

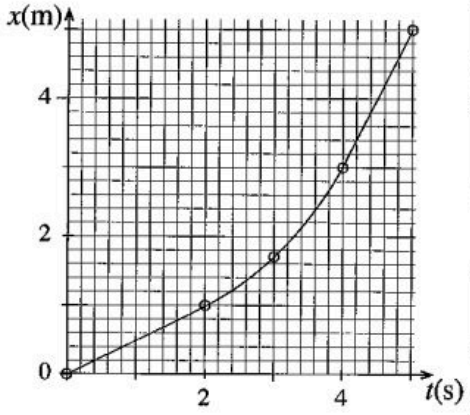
(1) $\frac{v_0^2}{2\mu g}$ (2) $\frac{v_0^2}{\mu g}$ (3) $\frac{2v_0^2}{\mu g}$ (4) $\frac{v_0^2}{2g}$ (5) $\frac{2v_0^2}{g}$

15. A coplanar structure is made by connecting eleven identical spheres each of mass m using ten identical light rods as shown in the figure. The centre of gravity of the structure is most likely to be at the point,

(1) O
(2) A
(3) B
(4) C
(5) D

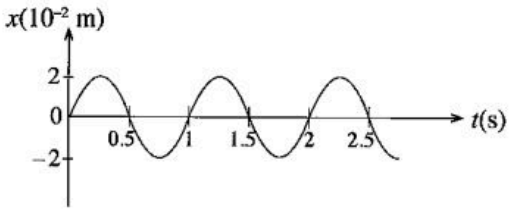


16. A block of mass 2 kg is pushed along a horizontal surface. The variation of the displacement x, of the block with time t, is shown in the figure. The values of the resultant force F acting on the block along the direction of motion during each of the time intervals $0 < t < 2$, $2 < t < 4$ and $4 < t < 5$ do not change. Which of the following correctly represents the magnitude of F in each of the time intervals?



	F(N) $(0 < t < 2)$	F(N) $(2 < t < 4)$	F(N) $(4 < t < 5)$
(1)	0	0	0
(2)	0	1.5	0
(3)	0	2	0
(4)	1	0	0
(5)	2	1.5	1

17. Figure shows a displacement (x) – time (t) curve for an object executing simple harmonic motion. For this motion, magnitudes of the period T, the frequency f, the angular speed ω, the maximum speed v_{max} and the maximum acceleration a_{max} are given by,



	T (s)	f (Hz)	ω (s^{-1})	$v_{max} \times 10^{-2}$ (m s^{-1})	$a_{max} \times 10^{-2}$ (m s^{-2})
(1)	0.5	2	4π	4	16
(2)	1	1	2π	4π	$8\pi^2$
(3)	1	2π	2	4π	8
(4)	1	1	2π	8π	$16\pi^2$
(5)	1	1	4π	8	16

[See page four

18. An elephant at rest is observed by a person 1 km away from his location. The sound intensity of trumpet of the elephant heard by the person is 10^{-10} W m^{-2}. Assume that the sound comes from a point source. If the threshold of hearing of the person is 10^{-12} W m^{-2}, what is the maximum distance from which he can hear this trumpet?

(1) 1 km (2) 2 km (3) 4.5 km (4) 10 km (5) 20 km

19. Two mercury-in-glass thermometers P and Q are to be constructed with P having a larger bulb of mercury than that of Q, and both calibrated in the range 0 °C – 100 °C. Assume that walls of both bulbs have the same thickness. Consider the following statements.

Using capillary tubes with appropriate uniform bore radii, the two thermometers can be constructed to have

(A) the same capillary length between 0 °C and 100 °C markings.

(B) the same response time for rapid changes in the measuring temperature.

(C) a higher sensitivity in thermometer P than the sensitivity of Q thermometer.

Of the above statements,

(1) only A is true. (2) only B is true.

(3) only B and C are true. (4) only A and C are true.

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

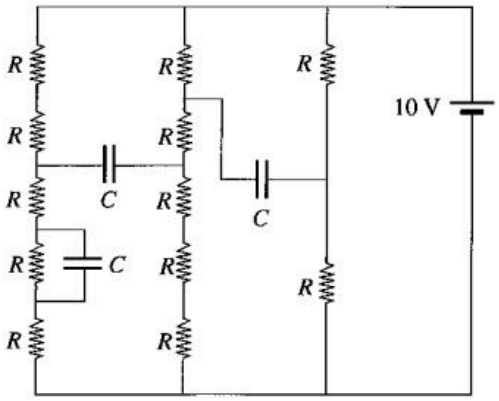
20. Water at 0 °C is continuously fed into a fully insulated boiler fixed with an immersion heater at a constant rate of 1×10^{-2} kg s^{-1}. The specific heat capacity and the specific latent heat of vaporization of water are 4.2×10^3 J kg^{-1} °C^{-1} and 2.25×10^6 J kg^{-1} respectively. If the steam at 100 °C is to be produced at the same rate as that of supply of water, the power of the immersion heater should be

(1) 4.2 kW (2) 22.5 kW (3) 26.7 kW (4) 42.0 kW (5) 267.0 kW

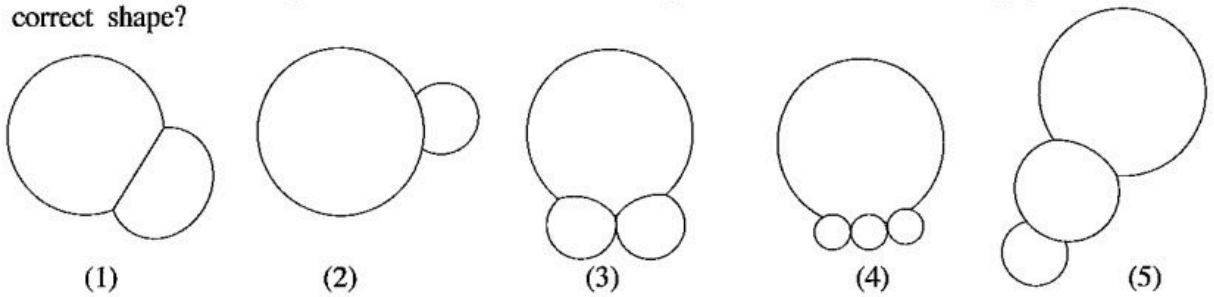
21. In the circuit shown, value of each capacitor is 1 μF. When the capacitors are fully charged, the total charge stored in capacitors is

(1) 2 μC (2) 4 μC (3) 5 μC

(4) 8 μC (5) 10 μC

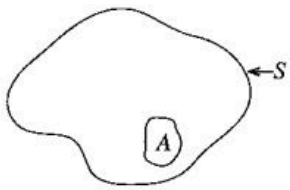


22. Figures show five clusters of soap bubbles in air, as drawn by a student. If centres of the bubbles in each cluster are coplanar, which of the following shows the cluster with physically possible correct shape?



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

23. A Gaussian surface S is drawn enclosing a charge distribution of net positive charge as shown in the figure. If the electric flux through the portion of the surface marked as A is $-\psi$ ($\psi > 0$), which of the following is true regarding the electric flux ψ_R through the rest of the Gaussian surface?

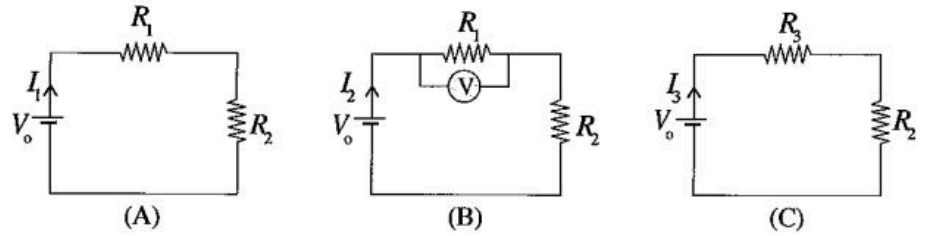


(1) $\psi_R = -\psi$ (2) $\psi_R = +\psi$ (3) $\psi_R < -\psi$

(4) $\psi_R < +\psi$ (5) $\psi_R > +\psi$

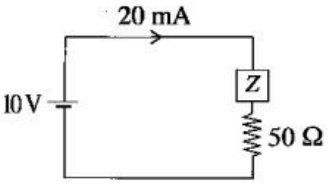
[See page five

24. The three identical voltage sources in the circuits (A), (B) and (C), have a negligible internal resistance. In circuit (B), Ⓥ represents a voltmeter having internal resistance r. If $R_3 = \frac{R_1 r}{R_1 + r}$, which of the following is true regarding I_1, I_2 and I_3 shown in the circuits?



(1) $I_1 = I_2 = I_3$ (2) $I_1 > I_2 > I_3$ (3) $I_1 > I_2 = I_3$
(4) $I_2 = I_3 > I_1$ (5) $I_3 > I_2 > I_1$

25. In the figure shown, Z represents a network consisting of resistors of unknown values. If the internal resistance of the voltage source is negligible, the power dissipated by the network is

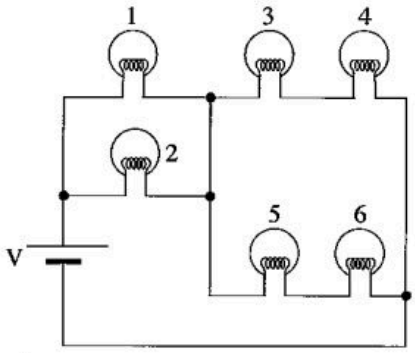


(1) 60 mW (2) 90 mW (3) 120 mW
(4) 150 mW (5) 180 mW

26. In the figure shown 1, 2, 3, 4, 5 and 6 represent six identical electric bulbs. Consider the operation of the circuit under conditions (A), (B) and (C) given below.

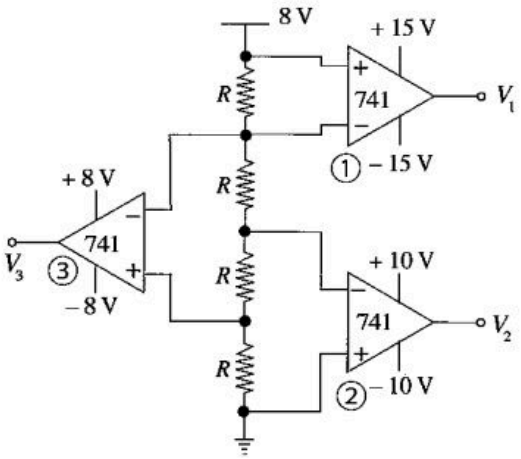
(A) When bulb 2 is burnt.
(B) When bulbs 2 and 5 are burnt.
(C) When **none** of the bulbs are burnt.

Unburnt bulbs in the circuit can be seen glowing at the same brightness in,



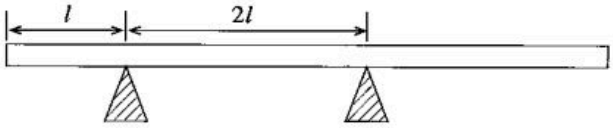
(1) B only. (2) C only.
(3) A and C only. (4) B and C only.
(5) all A, B and C.

27. In the given circuit, the three 741 operational amplifiers ①, ② and ③ are operated by power supplies of ±15 V, ±10 V, and ±8 V, respectively. The approximate values of the output voltages V_1, V_2 and V_3 are respectively given by,



(1) +2 V, −4 V, −4 V
(2) +15 V, −10 V, −8 V
(3) +2 V, +4 V, −4 V
(4) −15 V, +10 V, +8 V
(5) +15 V, +10 V, +8 V

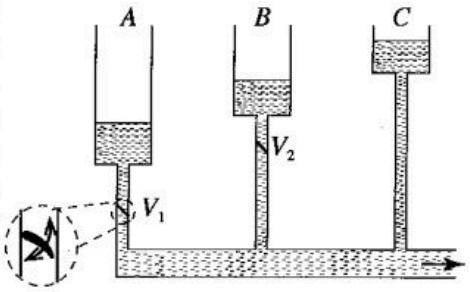
28. A uniform straight heavy plank of length $5l$ and mass $5m$ is kept horizontal on two supports separated by a distance $2l$ as shown in the figure. A painter of mass m needs to walk along the entire length of the plank carrying his bucket of paint. What is the maximum mass of the bucket of paint that can be carried by the painter without toppling the plank?



(1) $\frac{15m}{2}$ (2) $\frac{13m}{2}$ (3) $\frac{5m}{4}$ (4) m (5) $\frac{m}{4}$

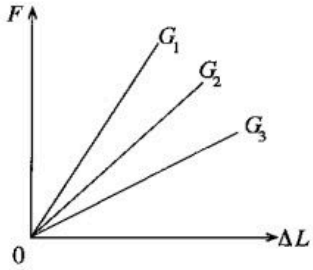
[See page six

29. Three tanks A, B, and C open at the top are initially filled with water to levels as shown in figure. They provide water at very slow speed to an outlet where static conditions could be applied. The two valves V_1 and V_2 allow water to flow only downwards when the pressure above the valve is greater than the pressure below the valve. When the system is put into operation with the initial conditions shown in the figure, which of the following statements best describes subsequent operation of the system?



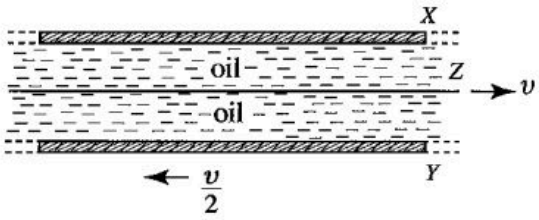
(1) Only C will contribute to the flow at the outlet.
(2) Initially, C starts to contribute to the flow at the outlet followed by B and then A in succession.
(3) Initially, A starts to contribute to the flow at the outlet followed by B and then C in succession.
(4) The three tanks will never contribute to the flow at the outlet simultaneously.
(5) Initially, all three tanks contribute to the flow at the outlet with major contribution from C.

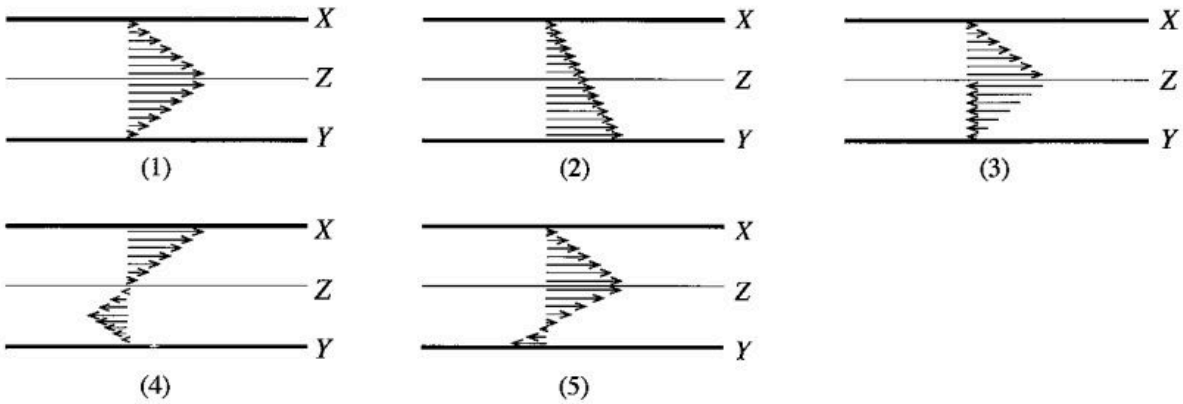
30. In an experiment to find Young's modulus, three different wires W_1, W_2 and W_3 of the same material have been used and obtained three curves G_1, G_2 and G_3 respectively for the graph of applied tensile force F with extension ΔL as shown in the figure. Which of the following statements, made for the reason of obtaining different graphs, is true?



(1) The wire W_1 may have a larger length and a smaller area of cross-section than W_2.
(2) The wire W_1 may have the same length as W_2 but a smaller area of cross-section than W_2.
(3) The wire W_3 may have the same area of cross-section as W_1 but a length larger than W_1.
(4) The wire W_2 may have a smaller area of cross-section, but a larger length than W_3.
(5) The wire W_3 may have a larger value for the ratio, $\frac{\text{Area of cross-section}}{\text{Length}}$ than that of W_1.

31. A thin flat plate Z is placed midway between two large horizontal plates X and Y, and the space is filled with a viscous oil as shown in the figure. Now, consider a situation that the plate Z is pulled horizontally to the right with constant speed v and plate Y is pulled horizontally to the left with constant speed $\frac{v}{2}$ while keeping X stationary. The velocity vectors of thin oil layers between plates X and Y are best represented in,



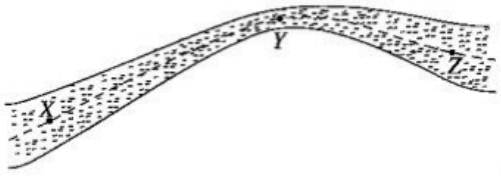


32. Radioactive element ${}^{A}_{Z}X$ transforms to stable ${}^{206}_{82}Pb$ after emitting eight α particles and six β^- particles in successive decays. The numbers of protons and neutrons in the element X respectively are

(1) 92, 130 (2) 92, 146 (3) 92, 238 (4) 104, 148 (5) 146, 92

[See page seven

33. Consider a non-viscous and incompressible fluid moving with steady streamline flow through a tube of non-uniform cross-sectional area in a vertical plane. Figure shows the vertical cross-section of the tube. X, Y and Z represent three positions of a streamline. Area of cross-section of the tube at X is same as that at Z. Consider the following inequalities for the relative magnitudes of the kinetic energies per unit volume (KE_X, KE_Y, KE_Z), potential energies per unit volume (PE_X, PE_Y, PE_Z) and the fluid pressures (P_X, P_Y, P_Z) at the positions X, Y and Z respectively.

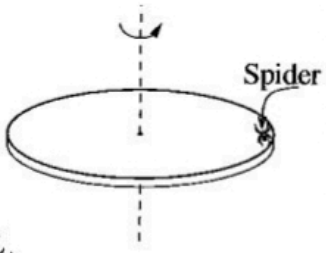


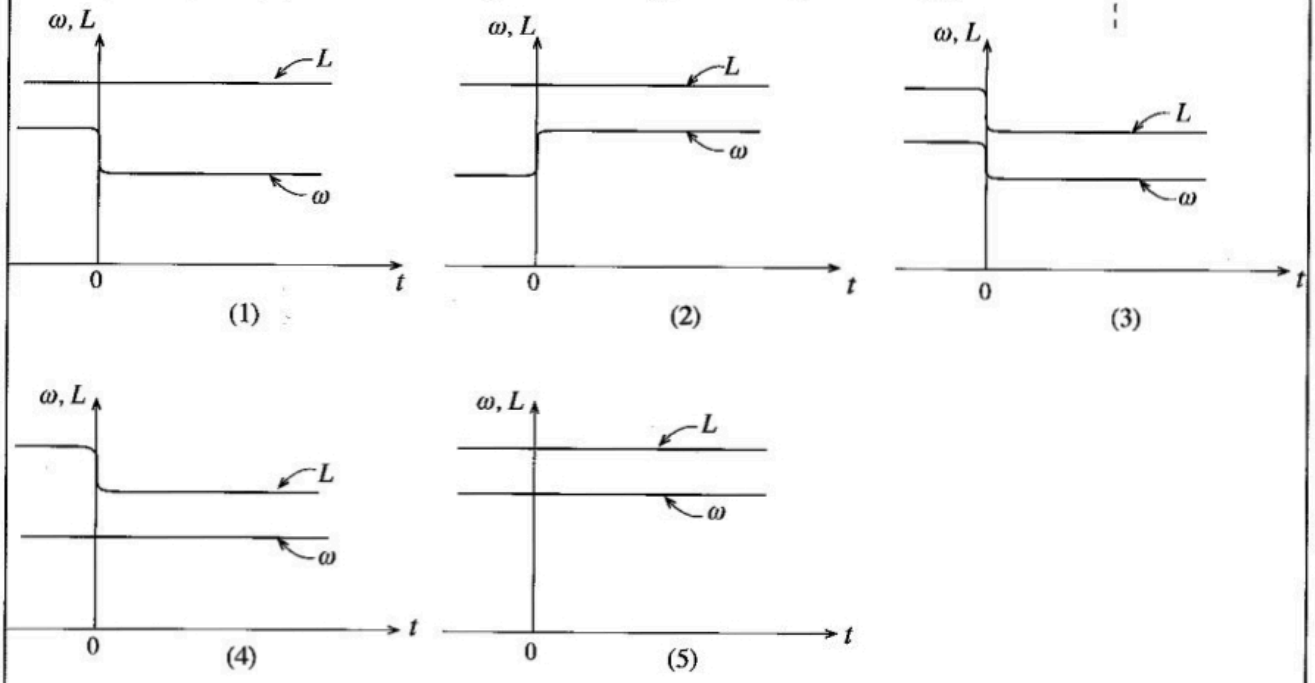
(A) $KE_Z < KE_X < KE_Y$ (B) $PE_X < PE_Z < PE_Y$ (C) $P_Y < P_Z < P_X$

Of the above inequalities,

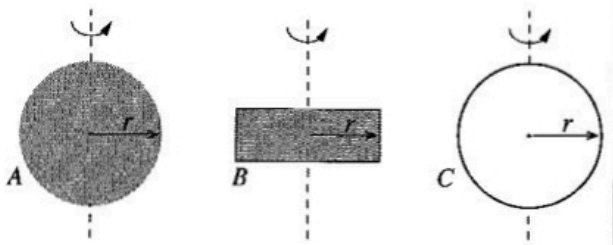
(1) only A is true. (2) only B is true.
(3) only A and B are true. (4) only B and C are true,
(5) all A, B and C are true.

34. A disc freely rotates without friction at a certain angular speed, about a fixed vertical axis normal to the plane of the disc and passing through its centre. At time $t = 0$, a spider vertically lowers itself with negligible speed onto the rim of the rotating disc as shown in figure, and becomes rest. Variation of the magnitudes of the angular momentum (L) and the angular speed (ω) of the **disc only** with time (t) is best represented by,





35. Figure shows vertical cross-sections of three uniform bodies A, B and C of identical masses. A is a solid sphere of radius r. C is a hollow sphere of radius r and having **thin walls**. The spheres can be rotated about vertical axes passing through respective centres. B is a disc of radius r which can be rotated about an axis normal to the plane of the disc passing through its centre. All figures are drawn to **same scale**. If KE_A, KE_B and KE_C respectively are the rotational kinetic energies to be provided for the bodies A, B and C to attain equal angular speeds, which of the following expressions is true?



(1) $KE_A < KE_B < KE_C$ (2) $KE_C < KE_A < KE_B$ (3) $KE_C < KE_B < KE_A$
(4) $KE_A < KE_C < KE_B$ (5) $KE_A = KE_B = KE_C$

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36. A whistle that is used to train a dog produces a frequency of 22 kHz which is more than the thereshold of hearing of the human. The trainer of the dog wants to make sure that the whistle is working. While the trainer stands by the side of a long straight road, he asks a friend to blow this whistle from a car moving along the same road. The required speed of the car and the direction of motion of the car for the trainer to hear the whistle at his threshold of hearing of 20 kHz is (Speed of sound in air is 340 $m\,s^{-1}$)

(1) 31 $m\,s^{-1}$, away from the trainer. (2) 32 $m\,s^{-1}$, away from the trainer.
(3) 34 $m\,s^{-1}$, away from the trainer. (4) 32 $m\,s^{-1}$, towards the trainer.
(5) 34 $m\,s^{-1}$, towards the trainer.

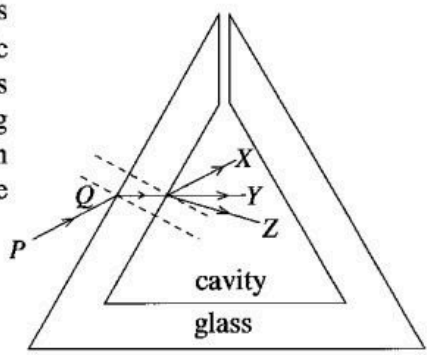
37. Number ೩೨ is written on a piece of paper placed on the flat horizontal surface of a table. A thin convex lens is held just above the number and then it is slowly taken vertically upward while looking at the image of the number through it, and keeping its optical axis vertical. Which of the following best represents the variation of the size and shape of the image as the lens is gradually moved up from the number ೩೨?

(1) ೩೨.೩೨.....೭೮.೭೮... (2) ೩೨.೩೨.....೫೯.೫೯...

(3) ೩೨.೩೨.....೫೯.೫೯... (4) ೩೨.೩೨.....೭೫.೭೫...

(5) ೭೫.೭೫.....೭೫.೭೫...

38. The hollow glass prism with thick walls as shown in figure, is made of a material of refractive index μ_g. A ray of monochromatic light PQ travelling in air is incident on the glass surface as shown in figure. In order to make the emergent ray travel along X, Y and Z directions respectively, the cavity of the hollow prism should be **separately** filled with transparent fluids of refractive index μ, where

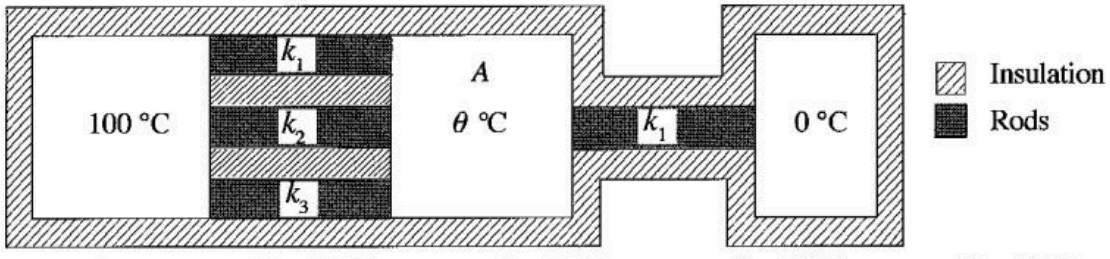


(1) $\mu < \mu_g$, $\mu = \mu_g$, and $\mu > \mu_g$ respectively.
(2) $\mu > \mu_g$, $\mu < \mu_g$, and $\mu = 1$ respectively.
(3) $\mu = 1$, $\mu = \mu_g$, and $\mu < \mu_g$ respectively.
(4) $\mu = 1$, $\mu < \mu_g$, and $\mu > \mu_g$ respectively.
(5) $\mu = \mu_g$, $\mu = 1$, and $\mu = \mu_g$ respectively.

39. Biscuits of a freshly opened packet of biscuits were placed inside a container, and it was tightly closed with a lid, so that air cannot enter or leave the container. The initial relative humidity inside the container was also found to be 80%. After a few days, it was found that the relative humidity inside the container, had decreased to 30% and the mass of the biscuits had increased by m. If the temperature inside the container remained constant throughout, the mass of water vapour initially present inside the container was

(1) $\frac{5m}{8}$ (2) $\frac{11m}{8}$ (3) $\frac{8m}{5}$ (4) $\frac{5m}{3}$ (5) $\frac{8m}{3}$

40. Figure shows how four thermally insulated heat conducting rods of equal lengths and equal cross-sectional areas are connected between two heat reservoirs maintained at temperatures 100 °C and 0 °C. A is a thermally insulated heat reservoir which always remains at constant temperature θ. The thermal conductivities k_1, k_2 and k_3 of the rods are 10, 30 and 50 $W\,m^{-1}\,K^{-1}$ respectively. At the steady state, the temperature θ of the reservoir A is



(1) 90 °C (2) 85 °C (3) 80 °C (4) 75 °C (5) 65 °C

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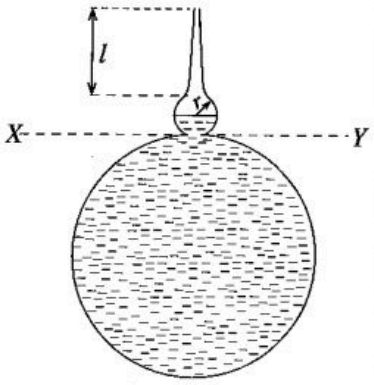
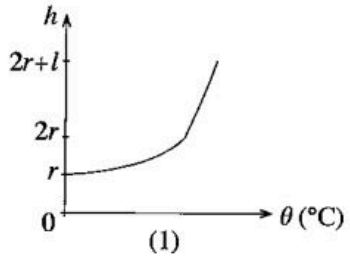
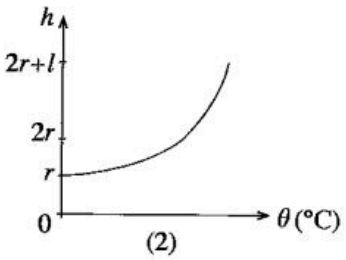
41. A glass bottle of special shape, a vertical cross-section of which is shown in figure consists of a large cavity, a small spherical cavity of radius r and a narrow tapered tube of length l. The total volume of the large cavity and the half of the volume of the small cavity are initially filled with water at 0 °C as shown. If the expansion of the bottle is **negligible**, the variation of height (h) of the water surface measured from the level XY, with the temperature of the water (θ) is best represented by

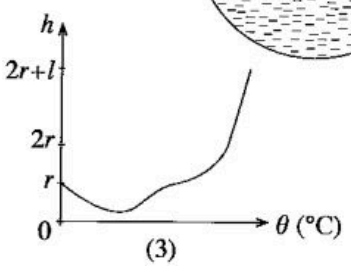




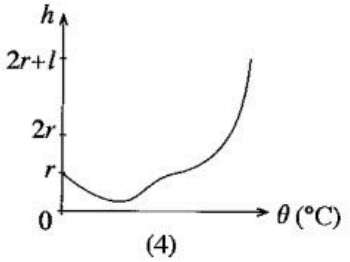
(1)



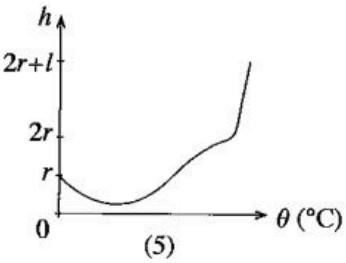
(2)



(3)



(4)



(5)

42. In the circuit shown in figure (a), the box with broken lines contains a resistor network. The 2 V battery has a negligible internal resistance. An ideal voltmeter connected across ab gives a reading of 1 V. When the voltmeter is replaced by an ideal ammeter it indicates 2 mA. The resistor network inside the box with broken lines is

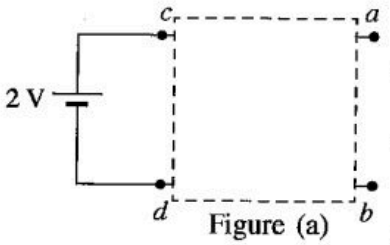
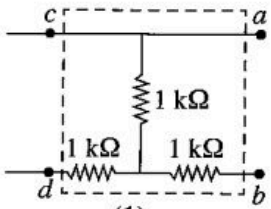
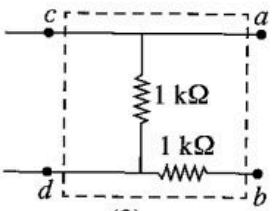


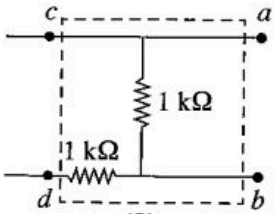
Figure (a)



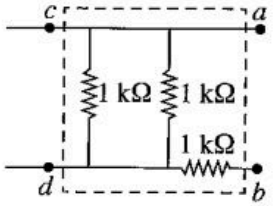
(1)



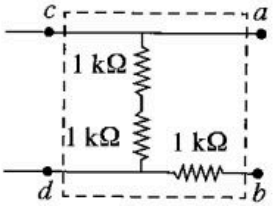
(2)



(3)



(4)



(5)

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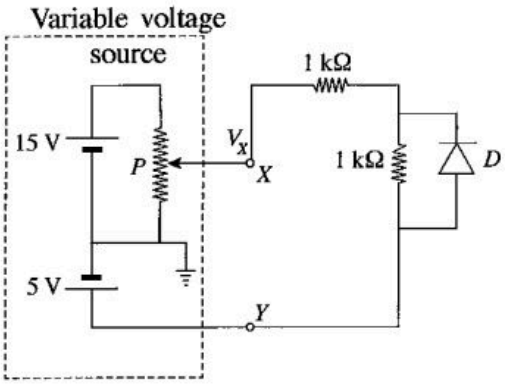
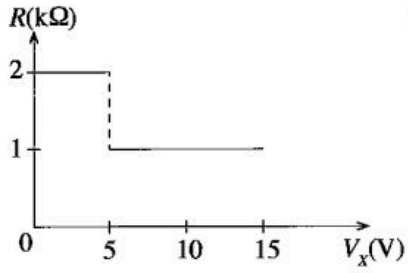
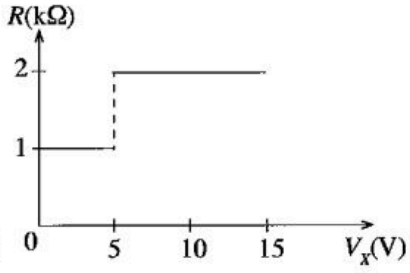
43. In the circuit shown, X and Y represent the terminals of a variable voltage source situated in the box with broken lines. P is a variable resistor. D is an ideal diode. As the value of the voltage V_X at point X is gradually increased from 0 to 15 V, which of the following graphs correctly represents the variation of the overall resistance R of the section of the circuit to the right of XY?

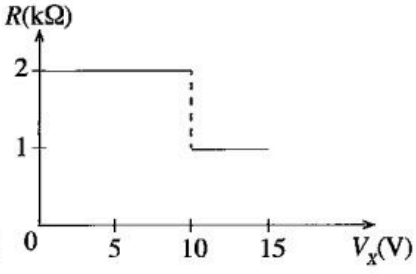




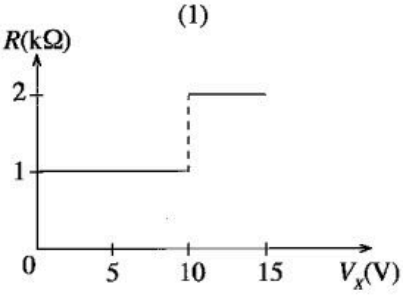
(1)



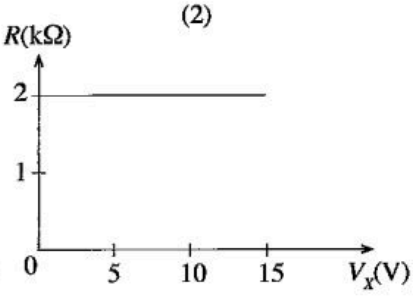
(2)



(3)



(4)



(5)

44. When a long capillary tube of uniform bore radius is dipped vertically in a beaker of water of density d_w, the water column in the capillary tube rises to a height h_0 as shown in figure (a). Now, an oil of density d_0 ($< d_w$) is poured onto the surface of the water in the beaker slowly **without** disturbing the water as shown in figure (b). Assume that the oil and water are immiscible liquids. The variation of height H of the water column inside the capillary tube, measured from the water surface, with the height h of the oil layer is best represented in

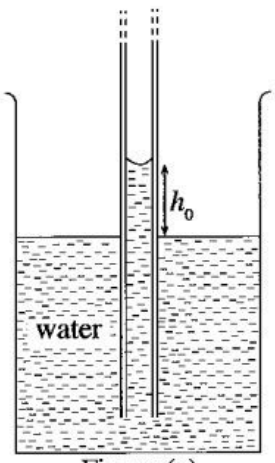


Figure (a)

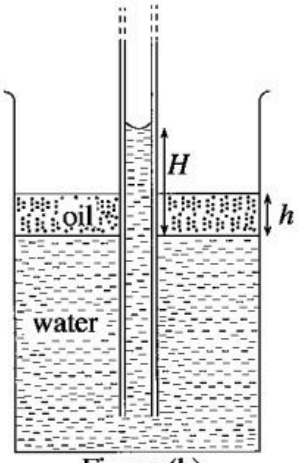
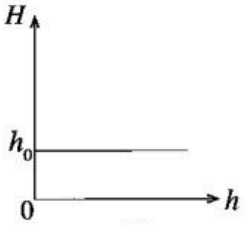
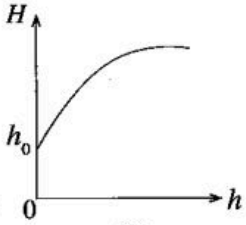


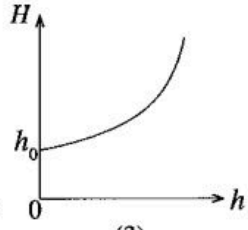
Figure (b)



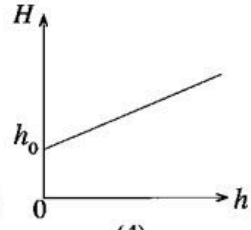
(1)



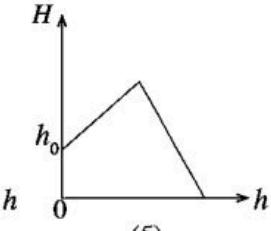
(2)



(3)



(4)



(5)

45. Charges in an isolated distribution of three $+q$ point charges are located at distances 2 cm, 3 cm and 6 cm from a point O. Another charge can be brought from infinity to the point O without doing any work once a point charge of $-q$ is placed at a distance r from the point O. The value of r is

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

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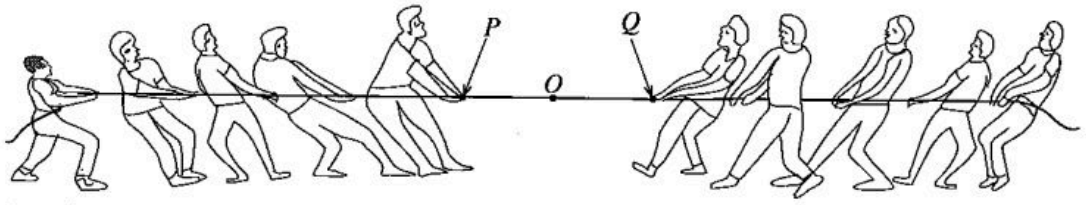
46. Two teams start to play tug-of-war using a rope of uniform strength on a hard flat horizontal surface as shown in the figure. Both teams apply equal forces and as a result, the point O on the rope does **not move**. Consider the following statements made about this situation.



(A) If each of the members of the two groups applies the same force on the rope, the magnitude of the tension throughout the rope is the same.

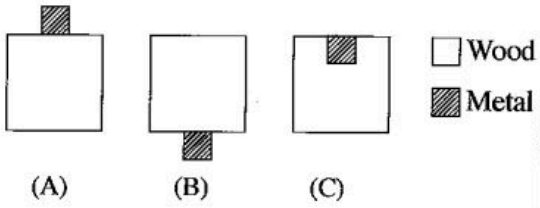
(B) If the magnitude of tension on the rope exceeds its breaking tension, the rope will break only at a point between P and Q.

(C) The magnitude of the maximum force that can be applied by an individual on the rope depends on the coefficient of static friction between feet of the individual and the surface.

Of the above statements,

(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 true.

47. Figure shows three objects (A), (B) and (C) which are made using three uniform wooden cubes of identical dimensions made out of the same material, and three identical uniform metal cubes. In (A) and (B) the metal cubes are glued onto the top and the bottom of the wooden cubes respectively. In (C), the metal cube is embedded in the wooden cube, as shown in the figure.

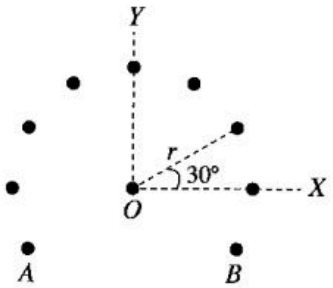


The three objects (A), (B) and (C) are now slowly lowered without changing their orientation and made to float vertically in a pool of water. If the depths to which the **wooden cubes** are immersed in water are H_A, H_B and H_C respectively, which of the following relationships is true?

(1) $H_A > H_B > H_C$
(2) $H_A = H_B > H_C$
(3) $H_A = H_B = H_C$
(4) $H_C > H_B > H_A$
(5) $H_A > H_C > H_B$

48. An infinitely long thin straight wire held perpendicular to the plane of the paper at point O carries a current I into the paper as shown in the figure. Nine other similar infinitely long wires, parallel to the above wire, and held on the circumference of a circle of radius r with centre at point O, each carries a current I into the paper. Except for wires A and B, the angular separation between any two consecutive wires is 30° as shown. The magnitude and the direction of the magnetic force per unit length on the wire held at the centre O due to other wires are, (Take $\cos 30° = \frac{\sqrt{3}}{2}$.)

(1) $\frac{\mu_0 I^2}{2\pi r}\left(1+\sqrt{3}\right)$ in the direction of YO.
(2) $\frac{\mu_0 I^2}{2\pi r}\left(1+\sqrt{3}\right)$ in the direction of OY.
(3) $\frac{\mu_0 I^2}{\pi r}\left(1+\sqrt{3}\right)$ in the direction of OY.
(4) $\frac{\mu_0 I^2}{2r}\left(1+\sqrt{3}\right)$ in the direction of OX.
(5) $\frac{3\mu_0 I^2}{2\pi r}$ in the direction of YO.



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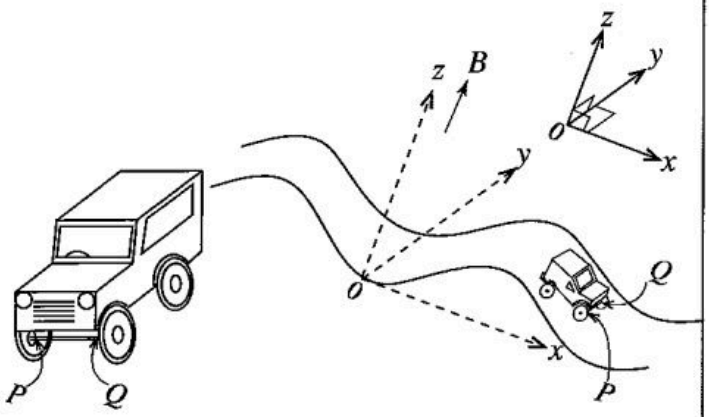
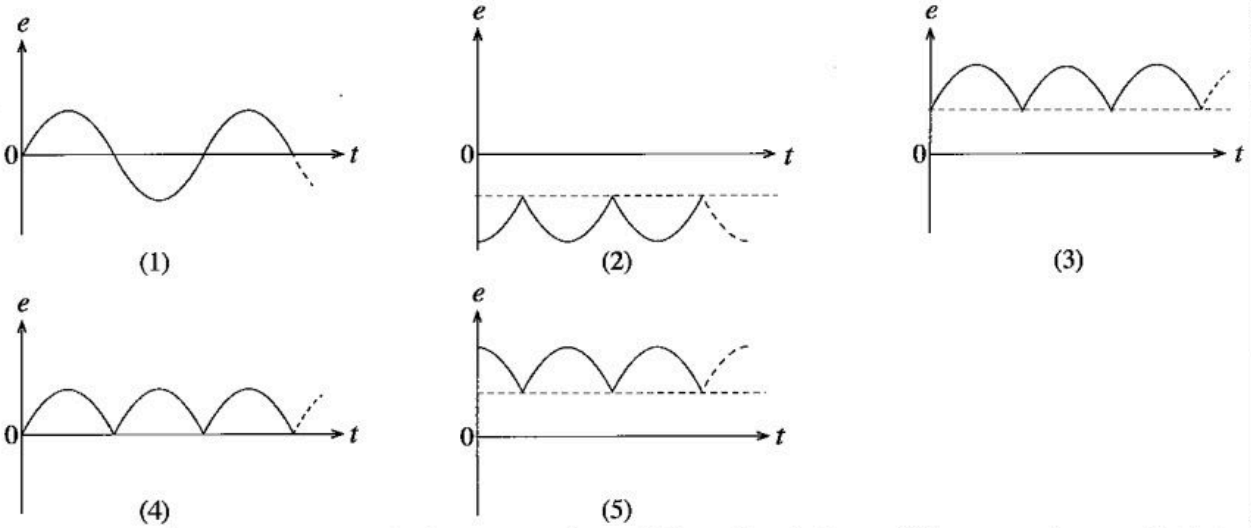
49. A toy car shown in figure (a) having an isolated metal axle PQ, travels with a constant speed v along a sinusoidal path whose vertical cross-section is in zx plane as shown in figure (b). At time $t = 0$, the axle PQ coincides with the y axis. If a uniform magnetic field of flux density B exists throughout the region in the $+z$ direction and normal to the xy plane, the variation of the induced e.m.f.(e) at end P of the axle with respect to end Q, with time (t) is best represented by, (Neglect the effect of the Earth magnetic field.)





50. A, B, C and D represent vertical cross sections of four identical parallel rectangular metal plates placed normal to the plane of the paper. Each of the plates B, C, and D has a small hole at its centre. The three plates are arranged so that their holes are coaxially placed as shown in figure (a). Plate A is grounded and the entire system is in a vacuum. A stationary electron is created at time $t = 0$, at the position O on the axis through the holes as shown. Which of the voltages V_B, V_C and V_D should be applied to the plates to obtain the velocity (v) – time (t) curve shown in figure (b) for the electron? (Assume that the given voltages are suitable for practical use and that the edge effects and gravitational effects can be neglected.)

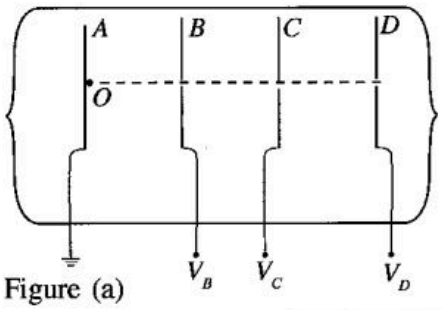


Figure (a)

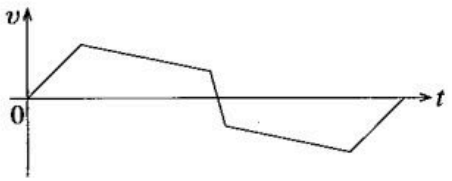


Figure (b)

	V_B	V_C	V_D
(1)	– 3 kV	+ 2.6 kV	0 V
(2)	+ 2.5 kV	– 2.6 kV	+ 3 kV
(3)	+ 2.5 kV	+ 2.4 kV	+ 200 V
(4)	+ 3 kV	+ 2.6 kV	– 2.8 kV
(5)	+ 3 kV	+ 3.2 kV	– 2.2 kV

***