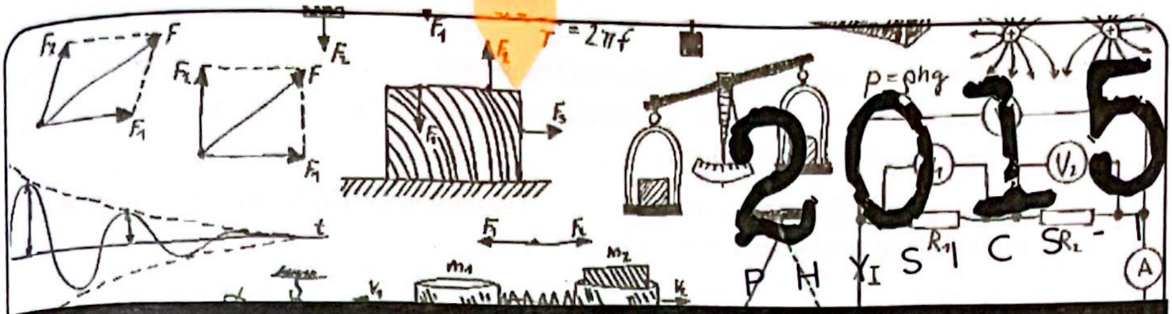
SCIENCE

@ALSCIENCESTUDENT
SDISCUSSIONGROUP




General Certificate of Education (Adv. Level) Examination

1. **Electron volt (eV) is a unit of (l) charge.**

| | | | | | |
|---|---|---|---|---|---|
| **(l)** | **charge.** | **(2)** | **potential.** | **(3)** | **capacitance.** |
| **(4)** | **energy.** | **(5)** | **electric field intensity.** | | |

*Unit and Dimention* **01**

Electron Volt (eV) is a unit of energy. This has been asked in the previous years.

$1eV = 1.6 \times 10^{-19}$ C

The answer is (4).

2. **The following measurements A, B and C have been taken using correctly selected measuring instruments.**

**A = 3.1 cm** **B = 4.23 cm** **C = 0.354 cm**

**Instruments used for the measurements A, B and C are**

| | A | B | C |
|---|---|---|---|
| (1) | Vernier calliper | Vernier calliper | Micrometer screw gauge |
| (2) | Metre ruler | Metre ruler | Vernier calliper |
| (3) | Metre ruler | Micrometer screw gauge | Travelling microscope |
| (4) | Metre ruler | Vernier calliper | Micrometer screw gauge |
| (5) | Vernier calliper | Metre ruler | Travelling microscope |

*Measuring Instruments* **01**

Each measurement is taken from the equipment with the following least count.

A → 0.1 cm/1 mm; B → 0.01 cm/0.1 mm; C → 0.001 cm/0.01 mm. The answer is (4). As the measurement of A less than 10 cm, when it is measured with the meter ruler, its accuracy is less. But if we consider the decimal places of the given value, the least count of the measuring equipment is 1mm. But by considering the percentage error, some argue that (1) is the answer. The examiners should decide whether to accept it as an answer. This is a question that should be subjected for the discussion. It should not be used for insulting purposes.

3. Radii of capillary tubes of two mercury-in-glass thermometers A and B having equal volumes of mercury inside their bulbs are r and 'j" respectively. When the temperatures of the bulbs are increased by 1 °C, the ratio Change in length of mercury column in A .

$$\frac{\text{change in length of mercury column in A}}{\text{change in length of mercury column in B}}$$ is approximately (Neglect the expansion of glass)

(1) $\frac{1}{9}$ (2) $\frac{1}{3}$ (3) 1 (4) 3 (5) 9

*Thermometry* 01

As there are equal volumes, both bulbs get expanded and the rising volumes of Mercury get equal. The change in length ∝ 1/ cross- sectional area. The cross-sectional area of B is 1/9 times of A. The increment of B is 9 times of A. The answer is (1).

4. By what factor does the sound intensity increase if the sound intensity level increases by 1 dB?

(1) 1 (2) 10°·1 (3) 101 (4) 1010 (5) 1012

*Intensity of Sound* 03

It is increased by 1 dB. It is 0.1 in Bel. The factor that the intensities change is $10^{0.1}$. The answer is (2). Even it has been asked in paper 2014.

5. Consider the following statements made regarding three optical instruments.

(A) Simple microscope has a single convex lens, and when in normal adjustment, the microscope produces a virtual image at the least distance of distinct vision.

(B) Compound microscope has two convex lenses, and when in normal adjustment, the microscope produces a virtual magnified image at infinity.

(C) Astronomical telescope has two convex lenses, and when in normal adjustment, the telescope produces a real magnified image at infinity.

Of the above statements,

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

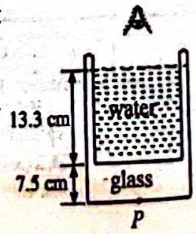
*Optical Instruments* 03

(A) is correct. It is a magnifying lens. In the normal adjustment of the microscope, the image is created at the least distance of distinct vision. Finally, an unreal image is formed.

(B) is wrong.

(C) From the telescope also, an unreal image will be formed. (C) is wrong. The answer is (1).

6. A cylindrical glass vessel with a 7.5 cm thick bottom, is filled with water up to a height of 13.3 cm as shown in the figure. Refractive indices of glass and water are 1.5 and 1.33 respectively. The apparent depth of a mark located at point P of the bottom of the vessel when observed from above the water surface is




(1) 5.8 cm (2) 10.9 cm
(3) 11.6 cm (4) 11.9cm
(5) 15.0cm

*Refraction* 03

Here the net apparent depth is equal to the total of apparent depths when water and glass are separately kept in water. Truth depth/ apparent depth = n

For water 1.33 = 13.3/x1; $x_1$ =10 cm

For glass 1.5 = 7.5/$x_2$; x2= 5 cm

Apparent depth = (10 + 5) cm =15 cm

The answer is (5).

7. **A bull fastened to a strong tree with a rope attempting to eat a nearby coconut plant is shown in figure (a). The free-body diagram for the bull is correctly represented by**

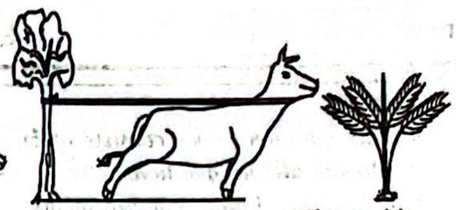
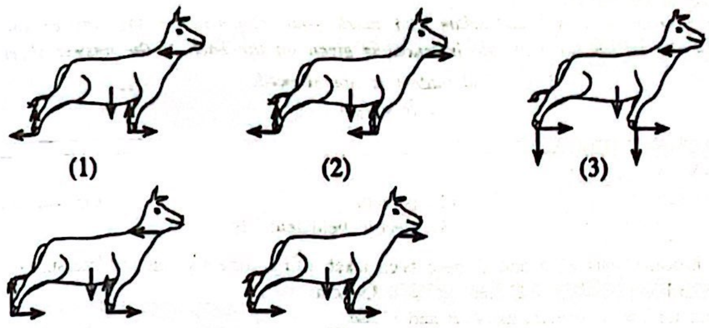


Figure (a)

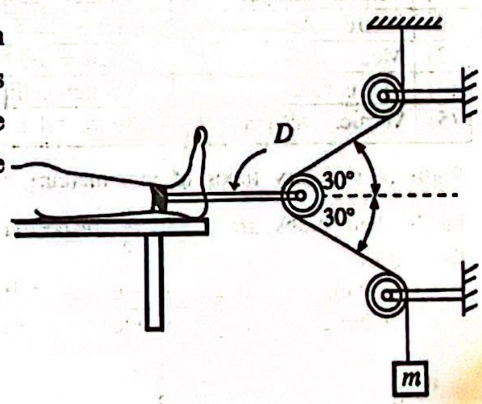


(1) (2) (3) (4) (5)



The actual forces that are acted on the object is represented in a free force diagram. The forces that are applied by the object is not relevant. Here the bull tries his best to reach to the coconut tree. That means opposite to the force on the string, a maximum force is applied to the right. Here we need to argue that the frictional forces on four legs are to the right side. But practically as we do not have an idea about the placement of feet by the bull, there can be changes of frictional forces applying on the rear legs too. The answer is (4).

8. **The pulley arrangement shown in the figure exerts a force on a leg of a patient connected to a traction device D. The pulleys are frictionless and the system is at equilibrium. If the horizontal force acting on the leg by D is 80 N, then the value of the hanging mass m will be $\left(\cos 30^\circ = \frac{\sqrt{3}}{2}\right)$**



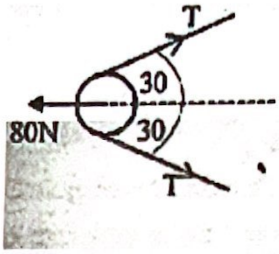

(1) $\frac{4}{\sqrt{3}}$ kg (2) 4 kg

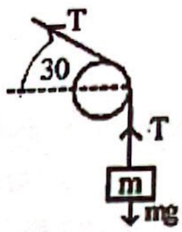
(3) $\frac{8}{\sqrt{3}}$ kg (4) 8 kg

(5) $8\sqrt{2}$ kg

Equilibrium of Forces 02

When you consider the equilibrium, The tension of the string should be equal to the weight of m, mg. T =mg




$\leftarrow 80 = T\cos 30^0 \times 2$

$80 = mg\cos 30^0 \times 2$

$m = \frac{8}{\sqrt{3}} kg$

The answer is (3).

9. If a 1 F air-filled parallel plate capacitor is made by using two metal sheets, each of area A separated by 0.9 cm, the area A would be (Take $\varepsilon_0$ as $9 \times 10^{-12}$ F m')

(1) 1 $cm^2$ (2) 100 $cm^2$ (3) 1 000 $m^2$ (4) 100 $km^2$ (5) 1,000 $km^2$

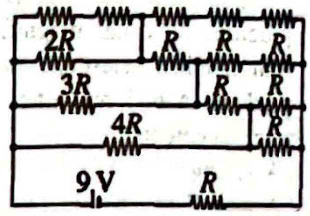
Capacitance and Capcitors 06

$C = A\varepsilon_0/d$

$1 = (A \times 9 \times 10^{-12}) / 0.9 \times 10^{-2}$; $A = 10^9 m^2 = 1000 km^2$

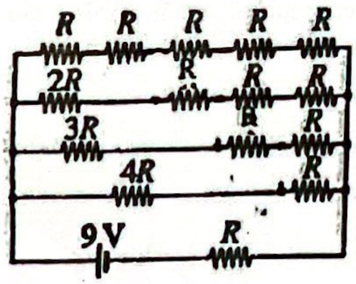
The answer is (5).

10. **Current (in Amperes) drawn from the battery in the given circuit is**




**(1) $\frac{1}{R}$ (2) $\frac{2}{R}$ (3) $\frac{3}{R}$**

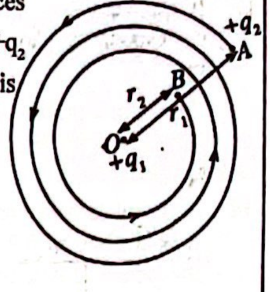
Ohm's Law combinations of Resistance 08




Consider each row by removing the connecting vertical conductor parts. Then as the potential difference of each row is equal, there is an equal potential difference across each resistor R. So, the potential difference of point pairs which are being connected to each conductor part is zero. That means there is no current flow once they are being connected. There is no change to the circuit. Now the circuit is balanced as below.

The resistance in each row is 5R where the equivalent is 5R/4. It is in series with R. The answer is (4).

11. A point charge of $+q_1$, is held at a point 0. The points A and B are located at distances $r_1$ and $r_2$ from O respectively. The work done in bringing another point charge of $+q_2$ from the point A to point B along a spiral path of length l as shown in the figure is




(1) $\frac{q_1 q_2}{4\pi\varepsilon_0}\left(\frac{1}{r_2}-\frac{1}{r_1}\right)$

(2) $\frac{q_1 q_2}{4\pi\varepsilon_0}\left(\frac{1}{r_1^2}-\frac{1}{r_2^2}\right)l$

(3) $\frac{q_1}{4\pi\varepsilon_0}\left(\frac{q_1-q_2}{r_2^2-r_1^2}\right)l$

(4) $\frac{q_1 q_2}{4\pi\varepsilon_0}\left(\frac{1}{r_2}+\frac{1}{r_1}\right)$

(5) $\frac{q_1}{4\pi\varepsilon_0}\left(\frac{q_1}{r_2^2}-\frac{q_2}{r_1^2}\right)l$

*Electrostatic Potential* **06**

The work here is the change of electric potential energy of $q_2$ at A and B. The work done at a conservative force field does not depend on the path that the object is being carried.

$$\text{Energy at A} = \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_1}\right)q_2$$

$$\text{Energy at B} = \left(\frac{1}{4\pi\varepsilon_0}\frac{q_1}{r_2}\right)q_2$$

The answer is (1).

12. Variation of the displacement (x) with time (t) for a particle executing a simple harmonic motion over a period (T) is shown in figure (a). The variation of the kinetic energy (K) of the particle with time (t) over the period is best O represented by

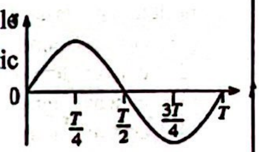
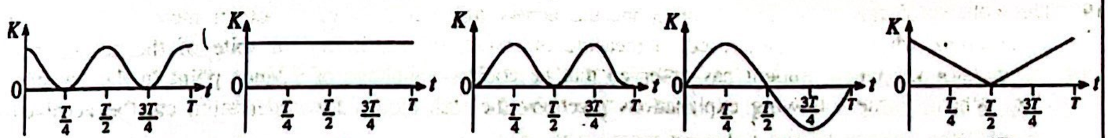



Figure (a)




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

*Simple Harmonic Motion* **03**

The kinetic energy cannot be negative. When the displacement is maximum, the speed is zero. The kinetic energy is zero. The answer is (1).

13. A ball is dropped from a height of 1.8 m onto a rigid surface. The collision between the ball and the surface is perfectly elastic. If the ball continues to bounce on the surface, the motion of the ball is

(1) simple harmonic with a period of 1.2 s.
(2) not simple harmonic but periodic with a period of 0.6 s.
(3) not simpie harmonic but periodic with a period of 1.2 s.
(4) simple harmonic with a period of 0.6 s.
(5) simple harmonic with a period of 2.4 s.

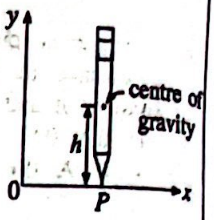
*Linear Motion* **02**

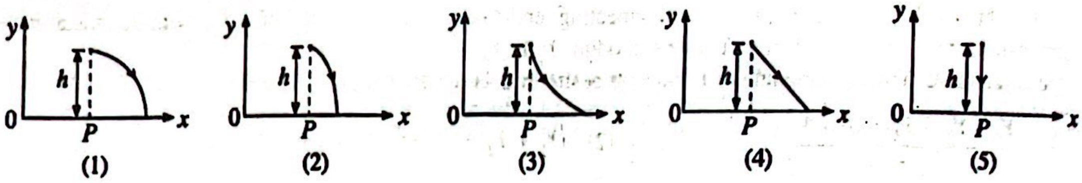
Time is t for the time taken to reach the ground. $\downarrow s = ut + \frac{1}{2}at^2$

$1.8 = 0 + ½ (10) t^2$; $t = 0.6$ s

Time for a period of coming upwards from the infinity again is 1.2 s. The answer is (3).

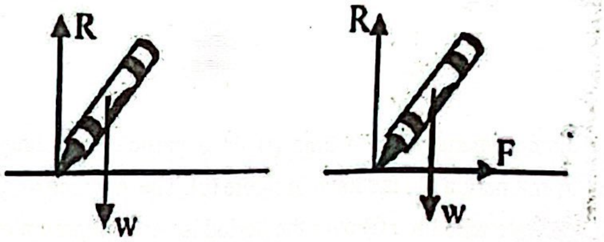
**14. A pencil is held vertical on its tip on a frictionless table as shown in the figure. When it is allowed to fall freely towards the +x-direction, the path of the centre of gravity of the pencil is best represented by.**




*Centre of Gravity*

When the centre of gravity comes out of the vertical line that goes across tip of the pencil (P), it starts to roll. Then the horizontal velocity does not belong to the centre of gravity. Also, as there is no horizontal force (frictional force) acted upon P, the horizontal velocity remains in the zero value. According to this, the centre of gravity moves only downwards.



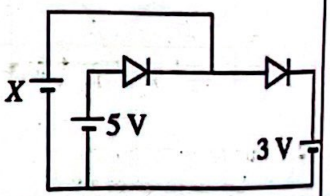

smooth surface rough surface

The answer is (5).

**15. In the circuit shown, each of the rectifier diodes requires a voltage of 1 V across it to make it forward biased. In order to make both diodes forward biased, the voltage of the battery *X* should be**

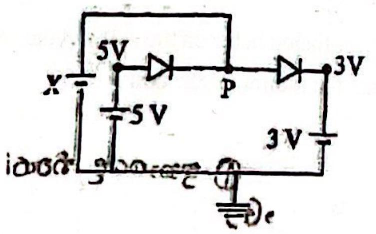
**(1) 1 V (2) 2 V (3) 3 V**

**(4) 4 V (5) 5 V**




*Semi Conductor Diodes*

The potential of P should be 4 V. The answer is (4).



16. $A$, $B$ and $C$ are three metals with threshold wavelengths $\lambda_A = 0.30$ µm, $\lambda_B = 0.28$ µm and $\lambda_C = 0.20$ µm respectively for photoelectric emission. Photons of frequency $1.2 \times 10^{15}$ Hz are incident on each of the metals. Photoelectrons are emitted (The speed of light in vacuum is $3 \times 10^8$ m s$^{-1}$.)
(1) only from $A$.
(2) only from $B$.
(3) only from $C$.
(4) only from $A$ and $B$.
(5) from all $A$, $B$ and $C$.

*Photoelectric Effects* **11**

If $\lambda$ is the wavelength relevant to the given photon, then $c = f\lambda$;

$\lambda = c/f = 3 \times 10^8/1.2 \times 10^{15} = 2.5 \times 10^{-7}$ m $= 0.25 \times 10^{-6}$ m $= 0.25$ µm

Photoelectric effect will occur if the threshold wavelength is greater than 0.25 µm. (A) and (B) only. The answer is (4)

17. If the velocity ($v$) of an object varies with time ($t$) as shown in figure (a), the corresponding variation of the displacement ($x$) with time ($t$) is best represented by

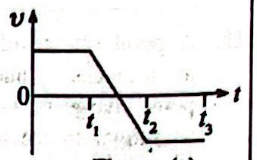
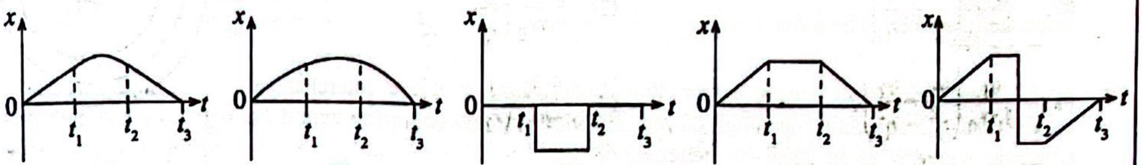


Figure (a)



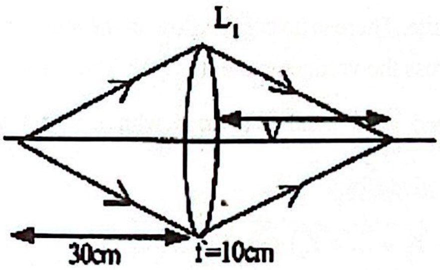
(1) (2) (3) (4) (5)

*Refraction Through Lenses* **03**

Uniform velocity is there from $t = t_1$. There should be a constant positive gradient in the displacement (x) – time (t) graph. From $t_1$ to $t_2$ the velocity is reduced. The positive gradient should be reduced, get zero and increased negatively. From $t_2$ to $t_3$ there should be a constant negative gradient. The answer is (1).

18. When a small object is placed 30 cm in front of a thin lens $L_1$ of focal length 10 cm, an image is formed behin the lens. When another thin lens $L_2$ is placed in contact with $L_1$, the image is formed at infinity. $L_2$ is a
(1) concave lens of focal length 15 cm.
(2) convex lens of focal length 15 cm.
(3) concave lens of focal length 20 cm.
(4) concave lens of focal length 10 cm.
(5) convex lens of focal length 20 cm.

*Refraction Through Lenses* **03**




If the image distance is V, then $1/V - 1/u = 1/f$; $1/V - 1/(-30) = 1/(-10)$; $V = 15$ cm.

When $L_2$ is touched with $L_1$, the focal length of $L_2$ is also equal to V to travel these rays parallelly. $L_2$ should be a concave lens. Then for the concave lens, an unreal object is there with the object distance of V. The answer is (1).

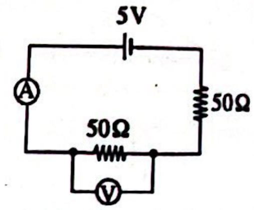
19. The voltage of the 2V–accumulator connected across the two ends of a potentiometer wire is found to be dropping while it is being used to measure the e.m.f. of a cell (X). In spite of the reduction of the accumulator voltage, a student has observed that he could obtain a fixed balance point in the potentiometer wire. Which of the following explanations given by the student for this observation can be accepted?

(1) Balance length does not depend on the voltage of the accumulator.
(2) Differences in the errors associated with the two ends of the potentiometer wire could be the reason for achieving a fixed balance point.
(3) Though the voltage of the accumulator was reducing, the cell (X) had maintained a constant potential gradient across the wire.
(4) The increase of the temperature of the wire has nullified the effect of the reduction of the voltage of the accumulator.
(5) The voltage of the cell (X) too may have been dropping while conducting the experiment.

Potentiometer 08

For the balanced length, the constant of potentiometer is relevant. That means the voltage difference across a unit length. If the voltage of the cell of 2 V is reduced, then the potentiometer constant also gets reduced. The e. m. f of X cell is E is considered as E = kl. If k gets reduced while l is constant, then proportionally E should be reduced. The answer is (5).

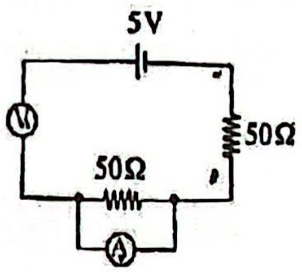
20. In the given circuit, if the voltmeter $V$ and the ammeter $A$ are interchanged by mistake, the respective readings of the ammeter and the voltmeter would be (Assume $A$ and $V$ to be ideal instruments.)




(1) 0 A, 0 V (2) 0 A, 5 V (3) 0 A, 2.5 V
(4) 0.1 A, 0 V (5) 0.05 A, 2.5 V

Moving Coil Meters 08

Then the circuit will be as follows.




As the voltmeter is ideal, the resistance of the circuit is infinite. There is no current flow in the ammeter. The reading of the ammeter is zero. The e. m. f of the cell is across the voltmeter and it is 5 V. The answer is (2)

21. A straight composite rod is made by connecting end-to-end an $n$ number of rods with identical physical dimensions but having different Young's moduli $Y_1, Y_2, Y_3, \ldots, Y_n$.
The equivalent Young's modulus of the composite rod is given by

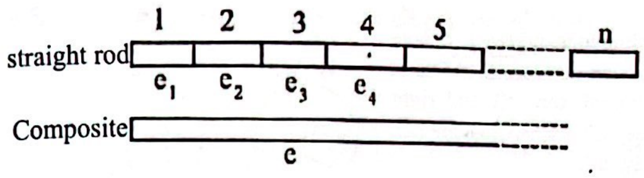
(1) $\frac{Y_1 + Y_2 + Y_3 + \cdots + Y_n}{n}$ (2) $(Y_1 + Y_2 + Y_3 + \ldots + Y_n)n$

(3) $\frac{1}{\frac{1}{Y_1} + \frac{1}{Y_2} + \frac{1}{Y_3} + \cdots + \frac{1}{Y_n}}$ (4) $\frac{n}{\frac{1}{Y_1} + \frac{1}{Y_2} + \frac{1}{Y_3} + \cdots + \frac{1}{Y_n}}$ (5) $(Y_1 Y_2 Y_3 \cdots Y_n)^{\frac{1}{n}}$

Elasticity 10

$$Y = \frac{F/A}{e/l} = \frac{Fl}{Ae}$$

$$e = \frac{Fl}{AY}$$




The extensions of each section in the straight rod should be equal to the extension of the compound. The lengths of each section should be equal to the length of the compound.

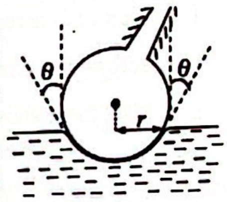
$e = e_1 + e_2 + e_3 + \ldots\ldots + e_n$

If the same force is applied, $\frac{Fln}{AY} = \frac{Fl}{AY_1} + \frac{Fl}{AY_2} + \frac{Fl}{AY_3} + \cdots + \frac{Fl}{AY_n}$

$$\frac{n}{Y} = \frac{1}{Y_1} + \frac{1}{Y_2} + \frac{1}{Y_3} + \cdots + \frac{1}{Y_n}$$

The answer is (4).

**22.** Due to surface tension ($0.07\ \mathrm{N\,m^{-1}}$) of water, certain small insects are able to walk on water surfaces by pushing down the water surface. The feet of insects can be considered to be approximately spherical as shown in the figure. When an insect is stationary on a water surface, the position of a leg is shown in the figure. Radius of the circular cross-section of the spherical foot at the water level is $r$. The mass of the insect is $5.0 \times 10^{-6}$ kg, and $r = 2.5 \times 10^{-5}$ m. If the weight of the insect is supported by its 6 legs, the value of $\cos\theta$ (see figure) is approximately (Take $\pi$ as 3.)




(1) 0.1 (2) 0.2 (3) 0.4 (4) 0.6 (5) 0.8

*Surface Tension* **10**

The vertical component of the surface tension of one leg = $2\pi r T \cos\theta$

If we consider the equilibrium of the insect $(2\pi r T \cos\theta) \times 6 = 5 \times 10^{-6}\,g$

$2 \times 3 \times 2.5 \times 10^{-5} \times 0.07 \cos\theta \times 6 = 5 \times 10^{-6} \times 10$

$\cos\theta = 1/1.26 = 0.8$

The answer is (5).

**23.** Paths of three charges moving separately in three uniform fields are shown in figures (A), (B) and (C). Which of the following responses correctly indicates the static electric field or magnetic field necessary to produce the paths shown?

| | (A) | (B) | (C) |
|---|---|---|---|
| (1) | Electric field | Electric field | Electric field |
| (2) | Magnetic field | Magnetic field | Magnetic field |
| (3) | Electric field | Electric field | Magnetic field |
| (4) | Magnetic field | Magnetic field | Electric field |
| (5) | Magnetic field | Electric field | Electric field |

*Force on a Moving Charge in Magnetic Field* **07**

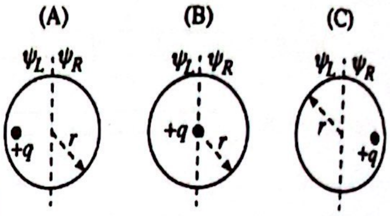
A) To travel in a spiral way, the charge should be projected at an inclined angle in a magnetic field.

B) If needed to go on a straight line, the charge should be projected parallelly in the electric filed.

C) The motion can happen like this if the charge is projected perpendicularly to the electric field.

The answer is (5).

**24.** **Figures (A), (B) and (C) show three situations where a charge of $+q$ is surrounded by a spherical Gaussian surface of radius $r$. If $\psi_L$ and $\psi_R$ are the electric fluxes through the left and right hemispherical sections of the Gaussian surface respectively, which of the following is true regarding $\psi_L$ and $\psi_R$?**




| | (A) | (B) | (C) |
|---|---|---|---|
| (1) | $\psi_L = \psi_R = \frac{q}{2\varepsilon_0}$ | $\psi_L = \psi_R = \frac{q}{2\varepsilon_0}$ | $\psi_L = \psi_R = \frac{q}{2\varepsilon_0}$ |
| (2) | $\psi_L > \frac{q}{2\varepsilon_0} > \psi_R$ | $\psi_L = \psi_R = \frac{q}{2\varepsilon_0}$ | $\psi_L < \frac{q}{2\varepsilon_0} < \psi_R$ |
| (3) | $\psi_L > \frac{q}{\varepsilon_0} > \psi_R$ | $\psi_L = \psi_R = \frac{q}{\varepsilon_0}$ | $\psi_L < \frac{q}{\varepsilon_0} < \psi_R$ |
| (4) | $\psi_L = \psi_R = \frac{q}{\varepsilon_0}$ | $\psi_L = \psi_R = \frac{q}{\varepsilon_0}$ | $\psi_L = \psi_R = \frac{q}{\varepsilon_0}$ |
| (5) | $\psi_L < \frac{q}{2\varepsilon_0} < \psi_R$ | $\psi_L = \psi_R = \frac{q}{2\varepsilon_0}$ | $\psi_L > \frac{q}{2\varepsilon_0} > \psi_R$ |

*Gauss Theorem*

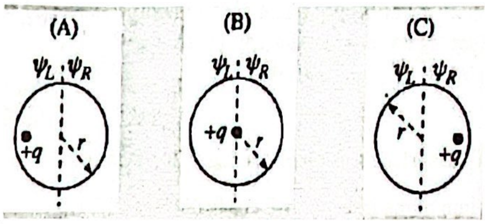
In figure (B), equal fluxes are there across the semi-spherical surfaces.

Total flux of B across the whole sphere = $q/\varepsilon_o$

Flux across the semi-sphere = $q/2\varepsilon_o$

Likewise, there should be a greater flux than $q/2\varepsilon_o$ in the left half of (A) and right half of (C).

The answer is (2).

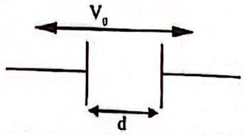



**25.** **An air-filled parallel plate capacitor of plate separation $d$ is fully charged using a battery of voltage $V_0$. Then the battery is removed and the space between the plates of the capacitor is filled with a material of dielectric constant $k$. If the energy stored in the capacitor when it is filled with air is $U_0$, and the electric field intensity across the capacitor, and energy stored in the capacitor when it is filled with the dielectric material are $E$ and $U$ respectively, then**

(1) $E = \frac{V_0}{d},\ U = kU_0$ (2) $E = \frac{V_0}{kd},\ U = \frac{U_0}{k}$ (3) $E = \frac{V_0}{kd},\ U = U_0$

(4) $E = \frac{V_0}{kd},\ U = kU_0$ (5) $E = \frac{V_0}{d},\ U = \frac{U_0}{k}$

*Capacitance and Capacitors*




When the battery is removed, the charge of the capacitor remains constant even if modifications were done.

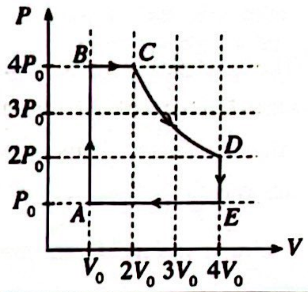
Initial capacitance = $C_1 = A\varepsilon_0/d$; New capacitance = $C_2 = Ak\varepsilon_0/d$

The factor of increment of the capacitance is k. Now let us consider Q = CV. As Q is constant, the factor of reduction in V is 1/k; new voltage difference = $V_0/k$

According to electric field intensity E = V/d, $E = V_0/dk$

Let us consider the initial energy of the capacitor as ½ QV. As the factor of reduction in V is 1/k, the new energy is $U_0/k$. The answer is (2).

**26.** **A fixed mass of an ideal gas undergoes a cyclic process as shown in the *P–V* diagram. If the temperatures of the points *A, B, C, D* and *E* are $T_A$, $T_B$, $T_C$, $T_D$ and $T_E$ respectively, then,**

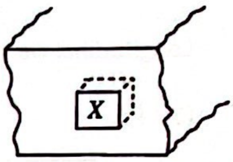



(1) $T_A > T_B > T_C > T_D > T_E$
(2) $T_A = T_B < T_C < T_D = T_E$
(3) $T_C = T_D > T_B = T_E > T_A$
(4) $T_A = T_B > T_C > T_D = T_E$
(5) $T_D = T_C > T_B > T_A = T_E$

*Thermodynamics* **04**

Let us consider PV = nRT. R is a constant. As it is the same sample of air, n is a constant.. $PV \propto T$. The multiple of PV is minimum at point A. The multiple of PV is equal for B and E. It is maximum and equal for C and E. The answer is (3).

**27.** **Figure shows a part of an outdoor brick-structure with a cubical-shrine (X) carved in as shown. The shrine is lime plastered and the front is sealed with a sheet of glass. It has been seen very often that water vapour condenses on the inner surface of the glass sheet, and it is found to happen mostly during the evenings. Which of the following deductions made by a student about this situation is most unlikely?**




(1) Although the shrine is sealed from the front side, water vapour can enter the shrine from the bulk of the brick structure.
(2) Relative humidity at the vicinity of the inner surface of glass sheet varies during the course of the day.
(3) Atmospheric temperature has no effect on the condensation of water vapour.
(4) The bricks of the structure may have absorbed water during rainy seasons.
(5) Condensation of water vapour can be reduced, if the walls of the shrine are water proofed and front sealed during a dry season.

*Hygrometry* **04**

This happens in the evening when the environmental temperature is reduced as well as at the sacred place and by reaching the relative humidity up to 100%. That means there is an effect from the environmental temperature. The answer is (3).

**28.** **A gymnastic player of mass 50 kg lands on the ground vertically with a velocity of 6 $m\,s^{-1}$ and with his body straight. As his feet touches the ground he bends his knees while keeping rest of the body vertical, and brings his body to a complete stop in 0.2 s. The average value of the force exerted on the player by the ground during the period of 0.2 s is**

(1) 30 N (2) 300 N (3) 1 500 N (4) 1 800 N (5) 3 000 N

*Newton's Laws and Momentum* **02**

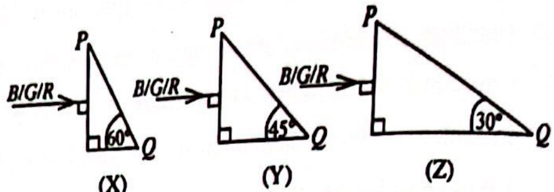
Initial momentum at 0.2 s = 50 X 6

Final momentum = 0

Force = rate of change of momentum = (50 X 6) - 0 / 0.2 = 1500 N

1500 N means the average resultant force that applies on the man here. When considering the force from the ground, the weight of the person also should be added to the above value. That means 2000 N. The correct answer is not here. Considering the resultant force 1500 N has been given as the answer. The correct answer is (3).

**29.** Narrow beams of light consisting of a mixture of three primary colours, blue ($B$), green ($G$) and red ($R$), are incident normally as shown in figures (X), (Y) and (Z) on different glass prisms made from the same material. The critical angles of the material of the prism for blue, green and red are 43°, 44° and 46° respectively. When viewed through the faces $PQ$, only red colour can be seen in




(1) X only. (2) Y only. (3) X and Y only. (4) X and Z only. (5) all X, Y and Z.

*Refraction Through Prism* 03

The incident angle of each figure on PQ is 30°, 45° and 60° respectively. To have red colour to be visible when looked from the surface of PQ, then both blue and green should be subjected to total internal reflection. All of the three colours come out in (X). Only red colour comes out in (Y). In (Z), nothing comes out. The answer is (2).

**30.** A wire of radius 1.0 mm made of a material of Young's modulus $4 \times 10^{11}$ N m$^{-2}$ is subjected to a tension of 30 N. The magnitude of the ratio $\frac{v_L}{v_T}$ of the longitudinal wave velocity ($v_L$) to transverse wave velocity ($v_T$) along the wire is (Take $\pi$ to be 3.)

(1) 100 (2) 150 (3) 200 (4) 250 (5) 300

*Longitudinal Waves* 11

Transverse wave speed = $V_T = \sqrt{\frac{T}{m}} = \sqrt{\frac{T}{A\rho}} = \sqrt{\frac{T}{\pi r^2 \rho}}$ ..... (1)

Longitudinal wave speed = $V_2 = \sqrt{\frac{E}{\rho}}$ ..... (2)

(2)/ (1)

$$V_2/V_T = \sqrt{\frac{E/\rho}{T/\pi r^2 \rho}} = \sqrt{\frac{E\pi r^2}{T}} = \sqrt{\frac{4\times10^{11}\times3\times(1\times10^{-3})^2}{30}} = 200$$

The answer is (3).

**31.** The following table shows the binding energies of some nuclei.

| Nucleus | $^{4}_{2}He$ | $^{20}_{10}Ne$ | $^{40}_{20}Ca$ | $^{60}_{28}Ni$ | $^{238}_{92}U$ |
|---|---|---|---|---|---|
| Binding energy (MeV) | 28.3 | 160.6 | 342.1 | 526.8 | 1802.0 |

Which one of the above nuclei is the most stable nucleus?

(1) $^{4}_{2}He$ (2) $^{20}_{10}Ne$ (3) $^{40}_{20}Ca$ (4) $^{60}_{28}Ni$ (5) $^{238}_{92}U$

*Radioactivity* 11

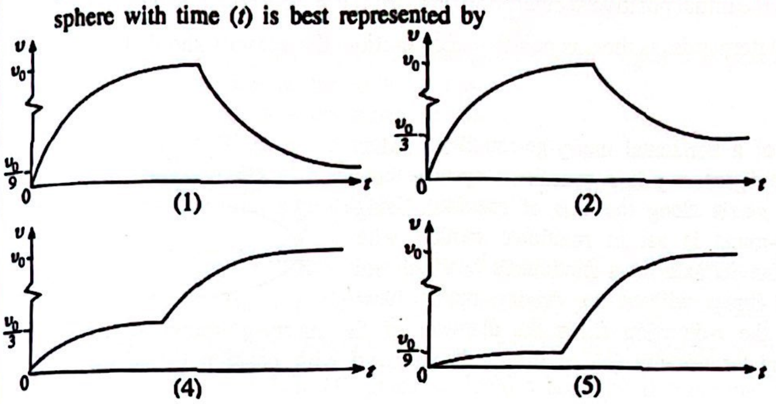
The mass of a stable nucleus is always less than the sum of its total masses of protons and neutrons. That means nucleons (n and p) are added and when making nuclei with lesser mass than the total mass, there should be energy emission corresponding to the reduction of mass (according to the equation $\Delta E = \Delta mc^2$). This mass difference which occurs relative to its energy difference is known as the binding energy of the nucleus. On the other hand, the minimum energy needed to break the nucleus by the constituent nucleons can be called as the binding energy. For an example, if the mass of a $^{4}_{2}He$ nucleus is exactly equal to the masses of its two protons and two neutrons, then without any waste of energy, $^{4}_{2}He$ nucleus will be broken down. If so, $^{4}_{2}He$ nucleus is not stable. Therefore, to be stable, the mass of a nucleus should be lesser than its constituent masses of protons and neutrons. So, the mass of a stable nucleus is lesser than the total mass of its constituent nucleons. Therefore, when an unstable nucleus with more mass becomes a stable nucleus with lesser mass, the energy releases relevant to the difference in the mass.

Here the nucleus with the highest binding energy to the nucleons will be more stable. The binding energy for a nucleon = the binding energy/ mass number

$^{4}_{2}He \rightarrow 28.3/4$ $^{40}_{20}Ca \rightarrow 342.1/40$ $^{238}_{92}U \rightarrow 1082/238$ $^{20}_{10}Ne \rightarrow 160.6/20$ $^{60}_{28}Ni \rightarrow 526.8/60$

The answer is (4).

**32. Seven identical metal spheres each of radius $R$ and mass $m$ are packed inside a hollow spherical container of mass $20m$ and radius $3R$. When this container is released from rest from the water surface of a calm, deep sea, it moves vertically towards the bottom of the sea. Once the container has reached its terminal velocity $v_0$, it is opened and the metal spheres are allowed to continue their motion vertically and independently towards the bottom of the sea without any influence from the container. The variation of the velocity ($v$) of a metal sphere with time ($t$) is best represented by**




Viscosity 10

As the terminal velocity acquired by the 7 spheres and the system is $V_0$,

$(20m + 7m)\, g = 6\pi\eta\, (3R)\, V_0 + 4/3\, \pi\, (3R)^3 \rho g$ .... (1)

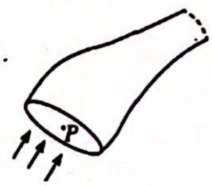
If $V_0$' is the terminal velocity of a small cell, then $mg = 6\pi\eta R V_0' + 4/3\, \pi R^3 \rho g$

$6\pi\eta R V_0' = mg - 4/3\, \pi R^3 \rho g$ .... (2)

(2)/ (1) $V_0' = V_0/9$

The answer is (1).

**33. Figure shows a flow tube corresponding to a streamline motion of a non-viscous and incompressible fluid. Which of the following statements is not true with regard to the fluid flow in such a tube?**




**(1) All particles entering at point $P$ move along the same path in the tube.**
**(2) Flow velocity at a given point in the tube may vary with time.**
**(3) Particles moving along a given streamline may have different velocities at different points in the flow tube.**
**(4) Tangent drawn at any point of a streamline gives the direction of flow velocity at that point.**
**(5) Mass of fluid in the flow tube is always constant.**

Bernouli Equation 02

(1) is correct. The path is a streamline.

(2) The rate of the fluid flow does not change. Therefore, the fluid speed of a certain point also does not change.

(3) When the cross-sectional area changes, the speed changes in each point.

(4) It is correct.

(5) As the rate is not changed, the fluid volume as well as the weight change in the tube.

The answer is (2).

**34.** The variation of the angular acceleration ($\alpha$) of a wheel of a motor vehicle starting from rest with time ($t$) is shown in figure (a). Variation of the angular velocity ($\omega$) of the wheel with time ($t$) is best represented by

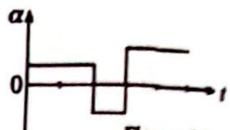
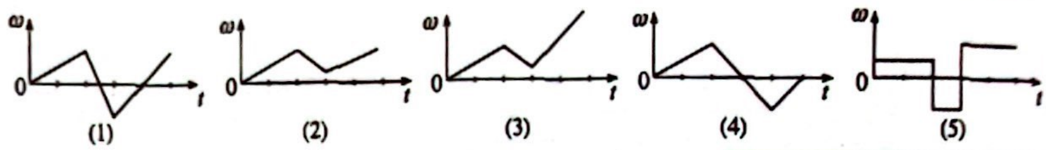


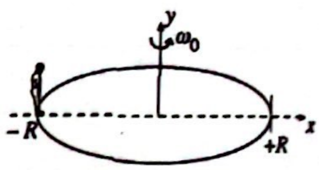
Figure (a)

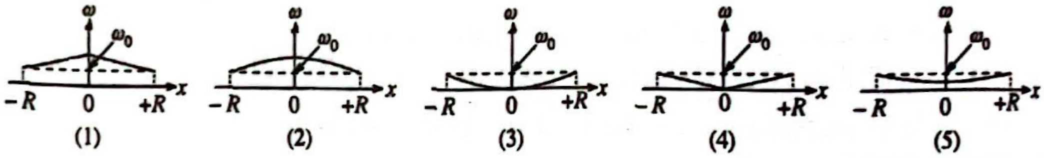



*Rotational Motion*

The increment of the velocity in the initial positive acceleration part (till t) is nearly equal to the decrement of the negative acceleration part. Afterwards, as there is positive acceleration, the velocity should be increased positively. The answer is (3).

**35.** A child is standing at $x = -R$ of a horizontal merry-go-round of radius $R$ in a carnival as shown in the figure. $x$–$y$ is a coordinate system fixed to the merry-go-round with its $y$-axis along the axis of rotation. Using a driving motor, the merry-go-round is set in rotational motion with constant angular velocity $\omega_0$ about its axis on a frictionless bearing, and subsequently allowed to **rotate freely** without the driving motor. Now if the child starts to move in the $x$-direction along the diameter of the merry-go-round to the location $x = +R$, the variation of the angular velocity ($\omega$) of the merry-go-round with position ($x$) of the child is best represented by

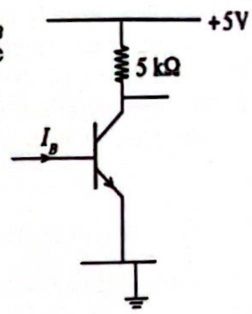



*Rotational Motion*

When x goes from x = -R to x = + R, at a given point the moment of inertia is $mr^2$. Here m is the mass of the child and r is the distance to the child from the axis. From x = - R to the axis, $mr^2$ is reduced. Again, till x = + R, $mr^2$ is increased. As the angular momentum of the system is constant (as Iω is constant), when I is decreased ω is increased. When I is increased, ω is decreased. There is no linear relationship. The answer is (2).

**36.** In the circuit shown, the current gain of the transistor is 100. When different $I_B$ values are applied to the base, which of the following is true regarding the mode of operation of the transistor?




| | $I_B$ value applied in μA | Mode of operation of the transistor |
|---|---|---|
| (1) | 0 | Saturation mode |
| (2) | 5 | Cut off mode |
| (3) | 12 | Active mode |
| (4) | 15 | Cut off mode |
| (5) | 20 | Saturation mode |

*Transistors*

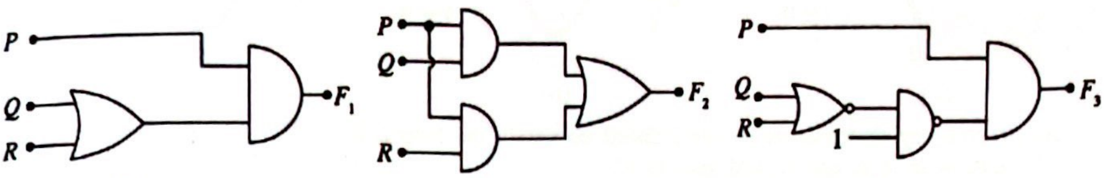
When $I_B = 0$, then $I_C = 0$. $I_CR_C = 0$. $V_C = 5V$. It is the cut off situation.

When it is saturated, $V_C = 0$, $I_CR_C = 5$. Then $I_C \times 5 \times 10^3 = 5$; $I_C = 10^{-3}$ A

Then $I_B = I_C/100 = 10^{-3}/100 = 10^{-5}$ A $= 10\ \mu$ A

The answer is (5).

**37.** ***P*, *Q* and *R* represent the binary input variables applied to the given circuits (A), (B) and (C).**




**(A) (B) (C)**

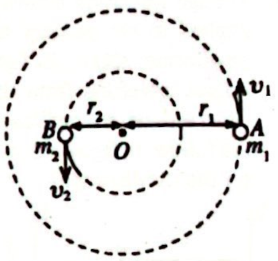
**When outputs $F_1$, $F_2$ and $F_3$ of the circuits for given input combinations are considered**

**(1) only A and B give the same output.**
**(2) only B and C give the same output.**
**(3) only A and C give the same output.**
**(4) all three circuits give the same output.**
**(5) all three circuits give different outputs.**

***Logic Gates*** **09**

Only under P = 1 condition, the output is 1 in all the three circuits as at (A) and (C), P is directly connected to the AND gate and as at (B), OR gets one input or '1' when P=1 only. Either one from Q or R gets 1 then the rest of the inputs in AND gates at (A) and (C) get 1. At (B), when either one from Q or R get 1 then either one of the inputs in OR gates get 1. So, when P=1, if either one of Q and R is 1, then the output is 1. When P=1, if Q and R both are zero, then the output is zero. When P=0, then always the output is zero. The function is identical. The answer is (4).

**38.** **Two stars *A* and *B* of masses $m_1$ and $m_2$ respectively are in circular motions due to their mutual gravitational attraction, about the point *O* for which $m_1r_1 = m_2r_2$ so that *AOB* is always co-linear as shown in the figure. If the speeds of $m_1$ and $m_2$ are $v_1$ and $v_2$ respectively, the ratio $\frac{v_1}{v_2}$ is**




**(1)** $\frac{m_2}{m_1}$ **(2)** $\frac{m_1}{m_2}$ **(3)** $\frac{m_2}{m_1 + m_2}$

**(4)** $\frac{m_1}{m_1 + m_2}$ **(5)** $\frac{m_1 + m_2}{m_2}$

***Gravitational Force Fields*** **05**

Equal gravitational forces are acted on A and B. So, the centripetal force on each is same.

Therefore, $m_1v_1^2/r_1 = m_2v_2^2/r_2$ .... (1)

For each object the period of revolution is same. The angular velocities should be equal. .

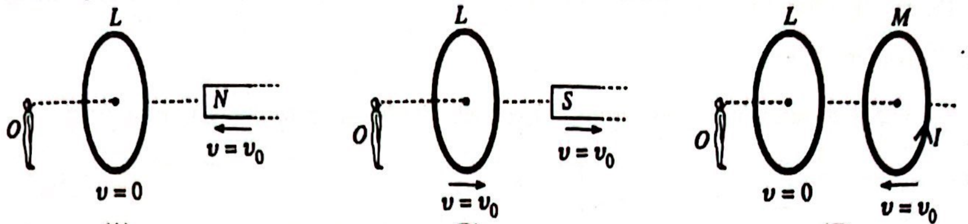
As $V = r\omega$, $v_1/r_1 = v_2/r_2$ ... (2)

(2)/ (1) $m_1v_1 = m_2v_2$

$v_1/v_2 = m_2/m_1$

The answer is (1).

**39.** A bar magnet and/or conducting loop/s are arranged separately as shown in figures (A), (B) and (C). As observed by the observer $O$, the magnet and the loop/s move with the velocities $v$ as indicated. Loop $M$ in the figure (C) carries a current $I$ in the counter-clockwise direction.




(A) (B) (C)

As observed by the observer $O$, the induced current in the loop $L$ is

(1) clockwise in A and B, and zero in C.
(2) clockwise in A and C, and zero in B.
(3) clockwise in A and C, and counter-clockwise in B.
(4) counter-clockwise in A and B, and zero in C.
(5) counter-clockwise in A and C, and zero in B.

*Electro Magnetic Induction* 03

(A) When N pole is moved, the left side flux across the loop is increased. Opposite to that, to build the flux across the right side, the e. m. f should be induced by flowing the current in clockwise direction.

(B) There is no relative motion among the two objects. The flux does not change across the loop. E. m. f is zero. Current is zero.

(C) According to figure (A), the flux across the loop gets increased towards the person. Like (A), the current is induced in L.

The answer is (2).

**40.** Voltage waveform shown in figure (a) is applied to the primary of a step down transformer shown in figure (b) and the output waveform from the secondary is observed on an oscilloscope. Which of the following figures shows the waveform on the oscilloscope?

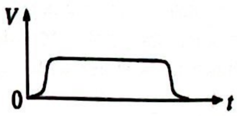



Figure (a)

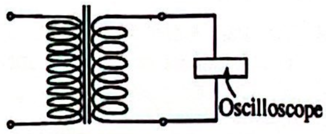
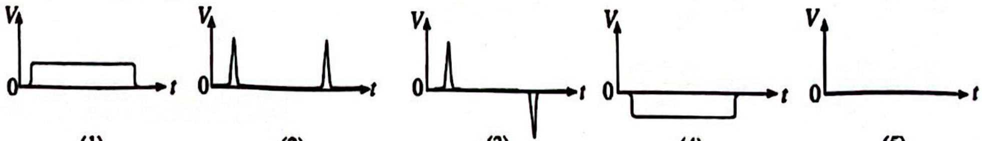



Figure (b)




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

*Mutual Induction* 08

The current in the primary gets increased at the increment starting stage of V. The flux that is building up in the primary is increased. The flux across the secondary is increased. To build up an opposite flux, during that interval the secondary voltage occurs by flowing a current in the secondary. When there is a constant V, the secondary voltage is zero. At the latter stage, V gets reduced and the current in the primary is reduced. Hence when the built-up flux is reduced in the primary, the flux across the secondary gets decreased. To build up the opposite flux to the initial direction (opposite to the initial flux change), the current and the voltage difference should be opposite in the secondary. The answer is (3).

41. Two ideal diatomic gases $A$ and $B$ of volumes $V_A$ and $V_B$ respectively with different densities at the same temperature and pressure are mixed together. The mixture is maintained at the above temperature and it can be considered as an ideal diatomic gas. If $u_A$ and $u_B$ are speeds of sound in gas $A$ and gas $B$ respectively at the above temperature and pressure, then the speed of sound in the mixture will be given by

(1) $u_A u_B\sqrt{\dfrac{V_A+V_B}{V_A u_A^2+V_B u_B^2}}$ (2) $u_A u_B\sqrt{\dfrac{V_A+V_B}{V_A u_B^2+V_B u_A^2}}$ (3) $\sqrt{\dfrac{V_A u_A^2+V_B u_B^2}{V_A+V_B}}$

(4) $\sqrt{\dfrac{V_A u_B^2+V_B u_A^2}{V_A+V_B}}$ (5) $\sqrt{u_A u_B}$

Velocity of Sounds 03

When we consider PV = nRT, as P and T are constant for the two gases and the mixture,

The volume of the mixture $V = V_A + V_B$

Sound speed $u = \sqrt{\dfrac{\gamma P}{\rho}}$

$u^2 \propto \frac{1}{\rho}$ where density ρ = mass (m)/volume (V)

$$u^2 \propto \frac{1}{m/V}$$

$$u^2 \propto \frac{V}{m}$$

$$u_A^{\,2} \propto \frac{V_A}{m_A} \;.....(1)$$

$$u_B^{\,2} \propto \frac{V_B}{m_B} \;.....(2)$$

If the new sound speed is u, then

$u^2 \propto \frac{V_A+V_B}{m_A+m_B}$ ..... (3)

From (1), (2) and (3), $u^2 \propto \dfrac{V_A+V_B}{\frac{V_A}{u_A^2}+\frac{V_B}{u_B^2}}$

The answer is (2).

42. A sonometer wire having mass per unit length of 1.0 g $m^{-1}$ and tension of 40 N is simultaneously sounded with a tuning fork of frequency 320 Hz while varying its vibration length starting from a small value. In this process, if beats of frequency 5 $s^{-1}$ can be observed on an oscilloscope, the corresponding vibration lengths (in m) of the sonometer wire are

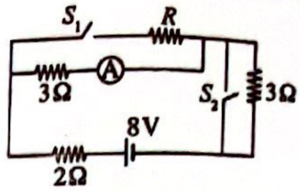
(1) $\frac{2}{13}, \frac{10}{63}$ (2) $\frac{4}{13}, \frac{5}{8}$ (3) $\frac{4}{13}, \frac{20}{63}$ (4) $\frac{5}{8}, \frac{20}{63}$ (5) $\frac{10}{13}, \frac{4}{13}$

Transverse Waves 03

The wave speed of the wire $V = \sqrt{\frac{T}{m}} = \sqrt{\frac{40}{1\times10^{-3}}}$ = 200 $ms^{-1}$

Including the five beats, the funadamental frequency of the tunning fork should be 315 Hz and 325 Hz. According to f = V/2d, find the length of each instance for 315 Hz and 325 Hz. The answer is (3).

**43.** In the given circuit, the reading of the ammeter $A$ indicates the same value when the switches $S_1$ and $S_2$ are both closed or both open. If $A$ is an ideal ammeter, the value of the resistor $R$ is




(1) 1 Ω (2) 2 Ω (3) 3 Ω
(4) 4 Ω (5) 6 Ω

*Korchoff's Law - Combination of Cells* **08**

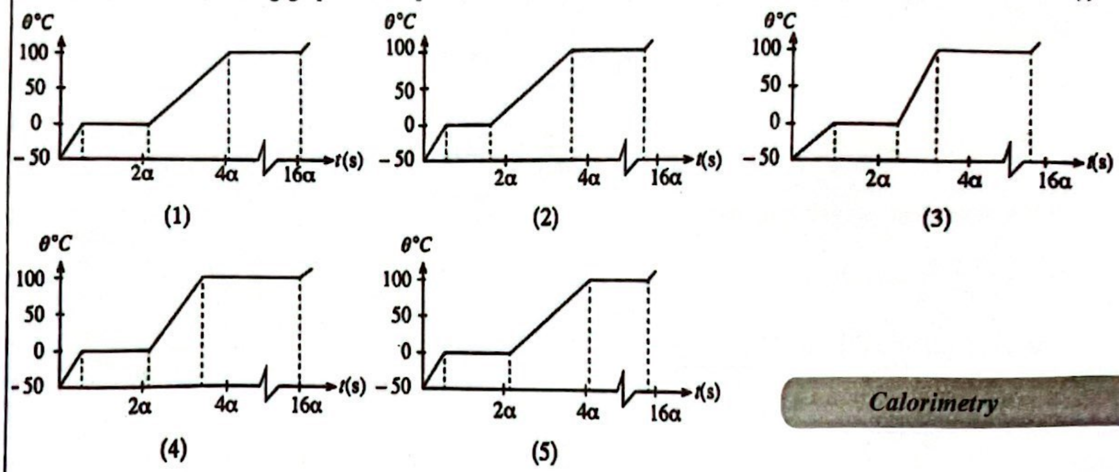
When $S_1$ and $S_2$ are opened, the resistors 2 Ω, 3 Ω and 3 Ω are in series. The voltage difference across them are 2 V, 3 V and 3 V. When $S_1$ and $S_2$ are closed, there is no current flow across 3 Ω at right side. At this moment, as the current across the other 3 Ω takes the previous value, the voltage difference across it should be 3 V. Therefore, the voltage difference across 2 Ω should be 5 V. The equivalent resistance of R and 3 Ω is 3R/ (3 + R) and the resistance ratio between 2 Ω should be 3 : 5. $\frac{3R/(3+R)}{2} = \frac{3}{5}$; R = 2 Ω

The answer is (2).

**44.** A piece of ice of mass 0.1 kg at –50 °C is heated uniformly by providing heat energy at a constant rate of 10 W. If the specific heat capacity of ice is $\alpha$, in SI units, the values of the other relevant quantities in terms of $\alpha$ can be given approximately as follows.

Specific heat capacity of water = $2\alpha$
Latent heat of fusion of ice = $160\alpha$
Latent heat of vaporization of water = $1200\alpha$

Which of the following graphs best represents the variation of the temperature ($\theta$) of the system with time ($t$)?




*Calorimetry* **04**

Let us consider the time taken to transform -50°C ice into 0°C ice.

Q = mcθ

Q/t = mcθ/t

10 = 0.1 α X 50/$t_1$; $t_1$ = ½ α

Now let us consider the time taken to transform 0°C ice into 0°C water.

Q = m L

Q/t = mL/t

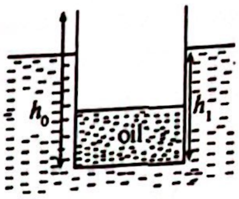
10 = 0.1 X 160α/ $t_2$; $t_2$ = 1.6 α

According to this time taken by 0°C water to transform 100°C water. $t_2$ = $t_1$ X 2X 2 = ½ α X 2 X 2 = 2α (The specific heat capacity has become double as well as the temperature increment)

Time taken by 100°C water to transform into 100°C vapour = (1.6α/ 160α) X 1200α = 12α

As these values are compared, the correct answer is (1).

45. A vessel of uniform rectangular cross-section with height $h_0$ and mass $M$ contains a certain amount of oil having mass $m$ and density $\rho_{oil}$ as shown in the figure. The vessel floats vertically in water of density $\rho_\omega$ ($> \rho_{oil}$) with height $h_1$ under water. A certain volume of oil is now replaced by an **equal** volume of water. If the maximum volume of oil that can be replaced while keeping the vessel floating is $V$ and the initial volume of oil is $V_0$, then the ratio $\frac{V}{V_0}$ is given by (Assume that at the end of the process there is a certain amount of oil left in the vessel.)




(1) $\frac{(h_0 - h_1)(M + m)\rho_{oil}}{h_1 m(\rho_\omega - \rho_{oil})}$ (2) $\frac{h_0(M - m)\rho_{oil}}{h_1 m(\rho_\omega - \rho_{oil})}$ (3) $\frac{h_1}{h_o} \cdot \frac{\rho_\omega}{\rho_{oil}}$

(4) $\frac{(h_0 - h_1)(M - m)\rho_{oil}}{h_0 m(\rho_\omega + \rho_{oil})}$ (5) $\frac{h_0(M + m)\rho_{oil}}{M(h_0 + h_1)(\rho_\omega + \rho_{oil})}$

*Hydrostatics* **02**

If we consider the initial equilibrium with the cross-sectional area of the container as A, then

$(M + m)\, g = A\, h_1 \rho_w g$ ... (1)

As the displaced volume is V, then the weight of the removed oil = $V\rho_{oil}g$

The weight of the inserted water = $V\rho_w g$

According to the given situation, the container should sink up to the height $h_0$. Then when we consider the equilibrium, the increment of the liquid weight should be equal to the increment of the upthrust.

$V\rho_w g - V\rho_{oil}g = A\,(h_o - h_1)\,\rho_w g$ ... (2)

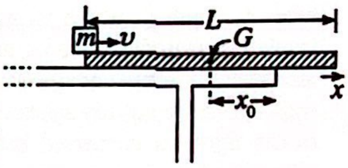
(1)/ (2) $\frac{M+m}{V\rho_w - V\rho_{oil}} = \frac{h_1}{h_0 - h_1}$

$$V = \frac{(M+m)(h_0 - h_1)}{h_1(\rho_w - \rho_{oil})}$$

But $V_0 = m/\rho_{oil}$

$$\frac{V}{V_0} = \frac{(M+m)(h_0 - h_1)\rho_{oil}}{h_1 m(\rho_w - \rho_{oil})}$$

46. A uniform rectangular wooden strip of length $L$ and mass $M$ is placed on a table along the $x$ direction and parallel to one of its edges so that a part of the strip is extended out as shown in the figure. Distance from the centre of gravity $G$ of the strip to edge of the table is $x_0$. Now a small block of mass $m$ is placed at the left edge of the strip, and an initial speed of $v$ is given to it along the strip in the $x$ direction. If the coefficient of kinetic friction between the strip and the block is $\mu$, the minimum speed that can be given to the block to topple the strip is

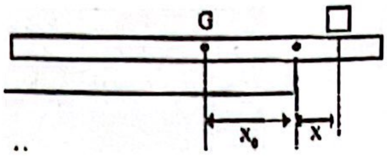


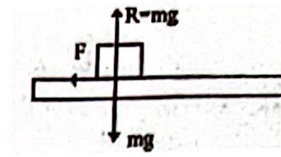

(1) $\sqrt{2\mu g\left(x_0 + \frac{L}{2} + \frac{Mx_0}{m}\right)}$ (2) $\sqrt{\mu g\left(\frac{L}{4} + \frac{Mx_0}{m}\right)}$

(3) $\sqrt{2\mu g\left(x_0 + \frac{L}{2} + \frac{mx_0}{M}\right)}$ (4) $\sqrt{\frac{\mu g M x_0 L}{\left(\frac{L}{2} + x_0\right)}}$ (5) $\sqrt{2\mu g\left(\frac{x_0}{2} + \frac{ML}{m}\right)}$

*Newton's Laws and Momentum* **02**

The centre of gravity of the system of wooden belt and m should reach towards the end of the table if the belt is needed to fall. Then we will consider the position of m at that moment.




$Mgx_0 = mgx$; $x = M x_0/m$

If F is the frictional force on m, then F = μmg

Then the work done by the frictional force should be equal to the initially supplied kinetic energy. If V is the minimum speed that should be given, then

$\frac{1}{2} mV^2 = F (x_0 + x + L/2)$

$\frac{1}{2} m V^2 = \mu mg (x_0 + Mx_0/m + L/2)$

$$V = \sqrt{2\mu g(x_0 + \frac{L}{2} + \frac{Mx_0}{m})}$$

The answer is (1).

**47.** During a Tsunami warning, a stationary siren emits sound waves of frequency 1 600 Hz while a wind is blowing at a uniform speed of 60 m s$^{-1}$ from the shore towards the land. A person hearing the sound of the siren is driving his car away from the shore towards the land at 30 m s$^{-1}$. If the wind blows in the direction of motion of the car and if the speed of sound in still air is 340 m s$^{-1}$, the frequency of the sound of the siren heard by the driver is

(1) 1 400 Hz (2) 1 480 Hz (3) 1 600 Hz (4) 1 740 Hz (5) 1 880 Hz

*Doppler Effects* 03

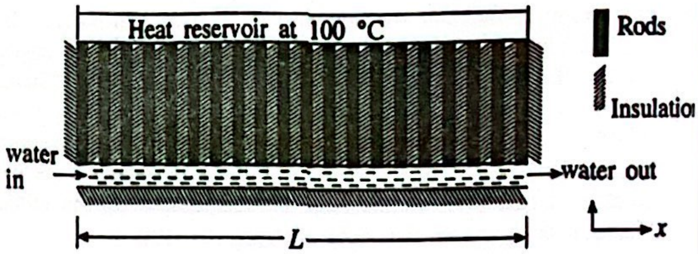
The sound speed of air relative to the person = V = (340 +60) ms$^{-1}$ =400 ms$^{-1}$

$$f' = \frac{V - V_0}{V}.f_0$$

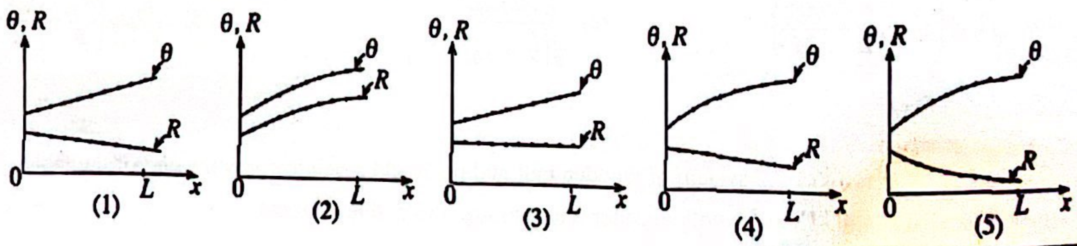
$$f' = \frac{(400 - 30)}{400} \times 1600 = 1480\ Hz$$

The answer is (2).

**48.** Water flows at a uniform rate through a tube of length $L$, which is made of an insulating material. A large number of identical, uniform and insulated metal rods which are equally spaced as shown in the figure is connected between the tube and a large heat reservoir maintained at 100 °C to transfer heat from the reservoir to the water in the tube.



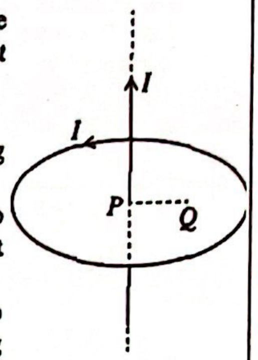

If the inlet temperature of water is equal to the room temperature, which of the following graphs best represents the variation of the rate of flow of heat ($R$) through the rods and temperature ($\theta$) of water along the length ($x$) of the tube at the steady state?




*Conductivity*

The distance x, should be increased with θ. If θ is increased proportionally to the distance, then heat should be conducted at the same rate across each rod. But when the temperature is increased with the distance, the bottom end temperature of the rods also gets increased. That means the rate of heat conductivity of the rods gets reduced with the distance. The rate of temperature increment is reduced. The answer is (5).

**49.** **A long straight wire carrying a current *I* is held along the axis passing through the centre *P* and perpendicular to the plane of another circular loop carrying a current *I* as shown in the figure.**




**Consider the following statements.**

**(A) The net force and the net torque on the loop due to the current carrying straight wire are zero.**

**(B) When the current carrying straight wire is moved to point *Q* parallel to the axis of the loop, there is a net torque on the loop due to the current carrying straight wire.**

**(C) When the current carrying straight wire is moved to point *Q* parallel to the axis of the loop, the net force on the loop due to the current carrying straight wire is not zero.**

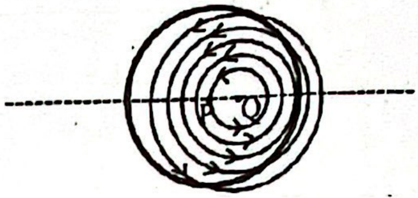
**Of the above statements,**

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

*Magnetic Effects of Electric Currents* **07**

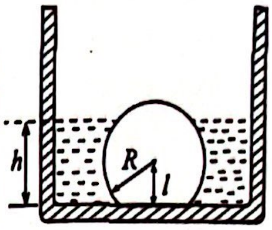
Due to current I, the magnetic field is built up on the plane of the loop and the magnetic flux lines are parallel to the loop. That means the force on the loop is zero. (A) is correct.

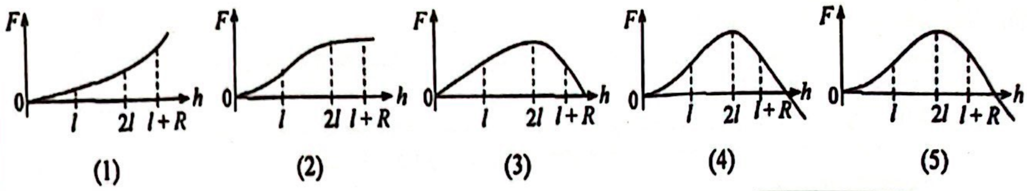
When the wire is taken to Q and look from above, the loop and the flux lines are as below.




The force is applied into the paper from the top part of the dashed line and the force is applied out of the paper in the bottom part of the dashed line. As they are equal in magnitude, the resultant force is zero. As they are in opposite directions and they are not in the same action line, the torque does not get zero. The answer is (4).

50. An object in the shape of a truncated solid sphere of radius $R$ is kept at the bottom of a tank as shown in the figure. The distance from the centre of the sphere to the bottom of the tank is $l$. The tank is now slowly filled with water. Assume that the truncated sphere is fixed to the bottom of the tank, so that its bottom surface does not get wet. The variation of the vertical upward force $F$, exerted on the object by the water, with the height $h$ of water is best represented by

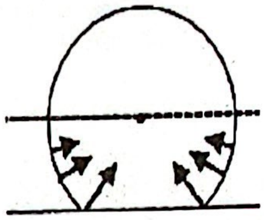


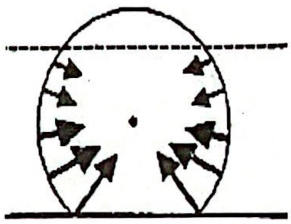

Hydrostatistic

02

When the water is filled up to a height of l, we will consider how forces are applied. The resultant of these forces is acting vertically upwards. The horizontal resultant is zero.



We will consider the force when the water is filled up to a height of 2l. This time also the resultant is in upward direction. Even there is a downward resultant from the upper section above the centre, when the water is filled (figure 1) the force that is applied from the bottom section gets increased more. That means the resultant is still upwards.



We will consider the force when the water is filled till l + R. Now the filling R-l part applies force downwards. The resultant of figure 2 is unchanged. According to this, when more water is filled, the force applied on R-l part is increased proportional to the height. That means if the water is filling to a certain height, the resultant gets zero and the downwards resultant force is increased uniformly with h. The answer is (4).