General Certificate of Education (Adv. Level) Examination

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

1. In the following expression I and V represent current and voltage respectively. C is a constant.

$$C \log\left(\frac{I}{I_0} + 1\right) = \frac{qV}{kT}$$

The term $\frac{2T}{q}$ has

(1) no dimensions. (2) dimensions of resistance. (3) dimensions of V^{-1}.

(4) dimensions of I. (5) dimensions of V.

01 **Unit and Dimensions**

As soon as the question was seen, most of the children might have got surprised. I can certify that for most children, it was a jumbled question as there was a logarithmic part that was incorporated with the question. There is a weakness in the question. C has been mentioned as a constant but it has not been mentioned as a dimensionless constant. That is why the question has been considered as a question with 'All' answers. It is not difficult to get the solution if we consider C as a dimensionless constant. Always there cannot be dimensions to an expression that has a logarithmic mathematical function. Here you can see that there is no dimension to (I/I_0) instantly. There cannot be dimensions to log (), ln () and the power (index) of any number. (For example, 10^0, e^0) Here it has been mentioned as 'ln' for the symbol of logarithmic base e. The normal symbol for the logarithmic base 10 is 'log'. There is no need to have the knowledge of ln for this question. If the radioactive equation $N=N_0e^{-\lambda t}$ is taken both sides by the base of e, then it can be written as $\ln N=\ln N_0-\lambda t$. No need to study about these. But you need to know that there is no dimension for an expression with a power of any base. For example, the multiple of λt in the above expression cannot have a dimension.
The expression in the question, C and log parts do not have dimensions. So, there cannot be dimensions to the right side. Therefore, q/KT should have the dimensions of the reciprocal of voltage. That means KT/q should have the dimensions of V. If C is given as a dimensionless constant, the correct answer is (5).

2. Consider the following statements made regarding plane electromagnetic waves propagating in a vacuum.

(A) Electronagnetic waves are transverse waves.

(B) The speed of elecreomagnetic waves is independent of the wavelength.

(C) The electric and magnetic fields associated with the wave are always directed along the direction of propagation of the wave.

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

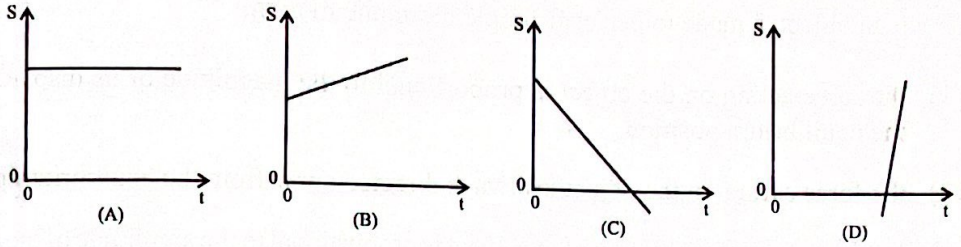
(3) only (A) and (C) are true. (4) only (B) and (C) are true.

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

03 **Properties of Waves**

The statements in this question have been checked many times before. It is a known truth that electromagnetic waves are transverse waves. Statement (A) is true. Then (C) is obviously false if (A) is true. That means it oscillates in a plane that is perpendicular to the direction of propagation of the wave. Statement (B) has been asked in many times. It is true.

3.



Of the given distance (s) – time (t) graphs drawn to same scale, the magnitude of the velocity is

(1) minimum in A and maximum in C.

(2) minimum in C and maximum in D.

(3) minimum in A and maximum in D.

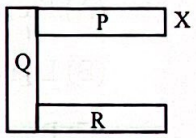
(4) minimum in B and maximum in C.

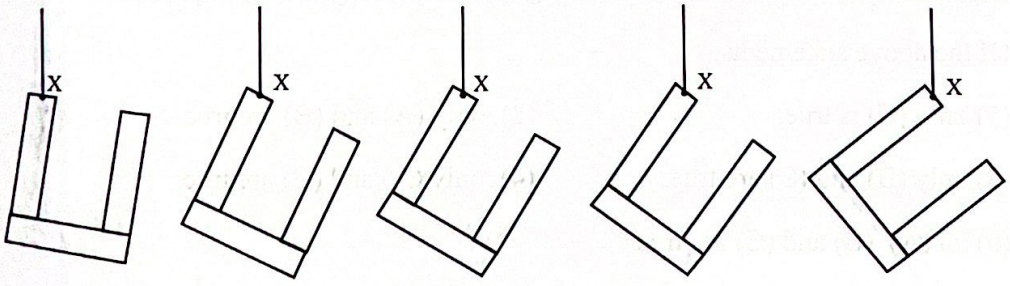
(5) minimum in D and maximum in B.

Graphs of Motion **02**

This question has a little weakness. The displacement should be mentioned instead of distance. We can talk about velocity in association with the displacement. On the other hand, one can build a logic that distance cannot be negative. If S is taken as the displacement, then the correct answer is (3). Only the magnitude of the velocity is being asked. Therefore, no need to consider about + or – sign here. You need to find the instance with the minimum gradient (slope) and the maximum gradient. The gradient of A is zero. Maximum slope is there for the straight line of D. Which graphs show the maximum and minimum velocities?

4. A frame is made by joining three uniform rods P,Q and R having identical geometrical dimensions as shown in the figure. Rods P and R are of the mass, but the rod Q is twice as heavy as P or R. When the frame is suspended freely from the point X, its equilibrium position is most likely to be





Centre of Gravity **02**

This is also a familiar problem. The centre of gravity should be situated along the suspended vertical line. You can estimate the centre of gravity of the frame very easily. The mass of Q rod should be considered as a double value of the mass of P or R rod. Even when I also read initially, neglected this fact. The centre of gravity of P and R rods lie in the middle of the joining line of their mid points. As mass of Q is equal to the sum of P and R masses, the combined centre of gravity lies in the middle ofthe line joining the above point and the mid-point of Q.

The answer can be found easily if the vertical line across X can be drawn downwards in the figures. Choice (1) and (5) can be removed directly. There is no clear difference in (3) and (4) according to the drawn figures. The correct answer is (2). If the mass of the rods is equal, it is unavoidable to pick (3).

5. When an object is made to perform simple harmonic motion,

(1) the force acting on the object is proportional to the magnitude of its displacement from the equilibrium position.

(2) the force acting on the object is always directed away from the equilibrium position.

(3) the frequency of oscillation of the object is proportional to the amplitude of the oscillations.

(4) the total energy of the object does not depend on the amplitude of the oscillations.

(5) the potential energy of the object is always constant.

03 **Simple harmonic Motion**

The theory that you should know for a simple harmonic motion is mentioned here. You should understand that all statements are wrong excluding (1). (1) is correct. The spring is harder to pull when it is stretched more due to this reason. The force is always directed towards the equilibrium position. When a spring is released after pulling or compressing, it likes to come back to its initial equilibrium stage. There is no relationship between the oscillatory frequency and the amplitude. If it is not exceeding the proportionality limit, then the oscillatory frequency does not change even the spring is pulled more less. The simple pendulum also behaves like that. Total energy is proportional to the square of the amplitude. Total energy is varied more and less between the potential and the kinetic energies. When potential energy decreases, kinetic energy increases. When kinetic energy decreases, potential energy increases.

6. Consider the following statements made about light passing through a prism.

(A) Frequency of light changes when passing through a prism.

(B) Light of different colours travel at different speeds inside a prism.

(C) Blue light deviates more than red light when passing through a prism.

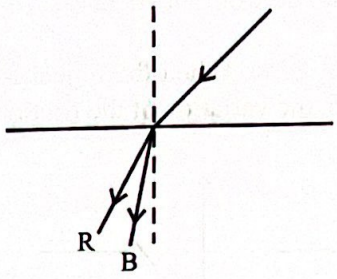
Of the above statements.

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

03 **Optics**

This question consists simple and previously given sentences. Statement (A) is wrong. Frequency is not changed. (B) is correct. That means different colours travel in different speeds inside the prism. The speed of red light is greater than the speed of blue light. Accordingly, the deflection of red light is lesser than blue light. The refractive angle of blue light is lesser than red light.

(Sin i/ Sin r) = (speed of air/ speed of the medium)



$V_R > V_B \rightarrow r_R > r_B$

Statements (B) and (C) are correct.

7. The most appropriate fuse for an electric heater of 1 kW connected to the main house hold electric supply is

(1) 1 A fuse (2) 3 A fuse. (3) 4 A fuse.

(4) 5 A fuse. (5) 15 A fuse.

Electric Energy and Power 08

Even though knowledge about fuse is directly out of A/L syllabus, this is a general knowledge question. A student who learns Physics should be ashamed if he/she does not know about fuse. If the domestic power supply is taken as 250 V, you can get the answer without calculation. The current is 4A if you have 250 V and 1 kW (1000/250). But as normal domestic voltage is 230 V (lesser than 250 V), it is better to put a fuse. The closest answer that is greater than 4 is (5).

8. Total electric power generation capacity of Sri Lanka is approximately 2.1 GW. If this power is to be generated by (Velocity of light = 3×10^8 m s^{-1})

(1) 0.025 mg/s (2) 23 g/s (3) 2.3 kg/s

(4) 6.9 kg/s (5) 47.61 kg/s

This is a question that should be solved using $E = mc^2$.

$2.1 \times 10^9 = m \times 9 \times 10^{16}$ $m \approx 0.23 \times 10^{-7}$ kg/s ≈ 0.023 mg/s

A small calculation is needed. As c^2 is a big value, a massive energy can be generated from a small mass (thinking that it can be destroyed completely). Therefore, you should expect a very small mass per second.

9. A horizontal force of 10 N is applied for a period of 10ms on a body placed on a smooth horizontal table. The change in momentum of the body in SI units will be

(1) 10^{-3} (2) 0.1 (3) 1.0

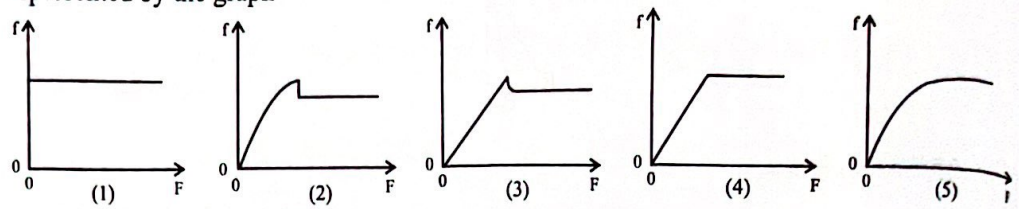
(4) 10^2 (5) 10^3

Newton's Law and Momentum 02

This question also has been asked several times. The resultant force is equal to the rate of

change of momentum. Therefore, change of momentum = 10 X 10 X 10^{-3} = 0.1. There is no need to do calculation. You can do from the memory.

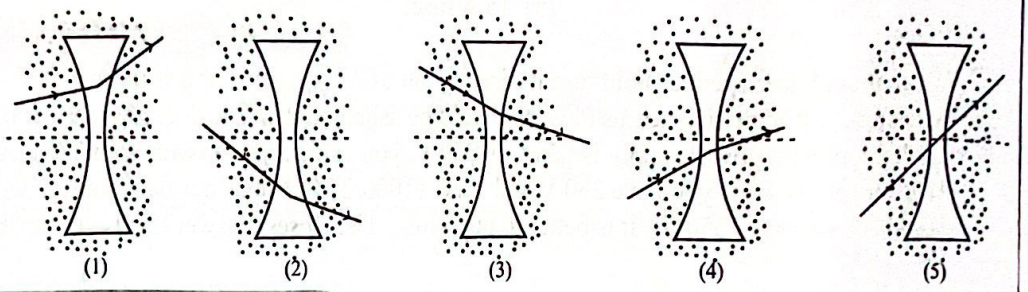
10. An object lies on a horizontal table. When the object is pulled by a horizontal force F that increases uniformly from zero, the variation of the frictional force f acting on the object is best represented by the graph



02 Friction

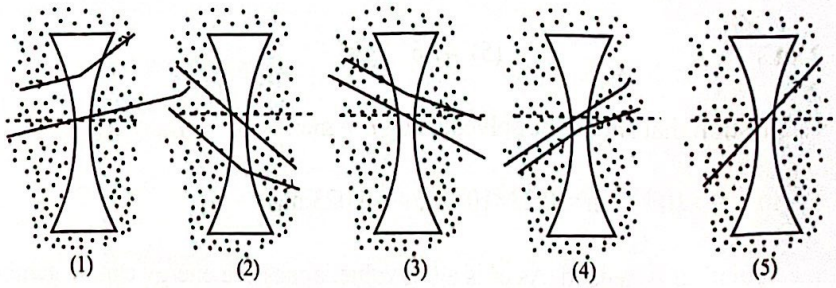
This question also has been asked many times. As long as the object is at rest, the frictional force is equal to the applied force. Once the object starts to move, it is reduced a little (dynamic friction). Such a shape is only represented in graph (3).

11. A thin glass (refractive index= 1.5) lens is immersed in water (refractive index = 1.33). Which of the following ray diagrams is wrong?



03 Refraction through lenses

If you do not find a short method, it is a question that can consume lot of your time. At a glance you can decide that (1) and (5) as correct. By drawing the ray parallel to the incident ray across the optic centre would be the shortest method as I think. Look at the following figure.



From figure (1) to (4), parallel rays are drawn to incident rays across the optical centre. If a parallel light beam (which is not parallel to the main axis) is incident on a concave lens, we know that they should be seen as diverging from a point in the focal plane. Therefore, if the ray diagram is correct, then when the refracted ray is drawn backwards, it should meet somewhere with the ray that goes across the optical centre without any deviation. According to this logic, you can directly see that figure (2) is wrong. In that, the refracted ray which is lengthened backwards is not crossing with the ray which goes across the optical centre. Figure (1), (3) and (4) obeys the law that I mentioned. There are even different ways to solve this (by looking at the convergent/ divergent nature or considering the refraction from each surface). But to me, these methods are bit confusing. The method that I have introduced to solve such problems is100% guaranteed. You can use this method in the same way to the mirrors too.

12. A certain person cannot clearly see objects located beyond 1 m away from the eye. This defect can be corrected by wearing

(1) concave lens of focal length 1 m.

(2) convex lens of focal length 1 m.

(3) concave lens of focal length 0.5 m.

(4) convex lens of focal length 0.5 m.

(5) convex lens of focal length 0.25 m.

Defects of Vision 03

This question has been asked in every question paper. When you are reading the question, it is clear that the answer is (1). The eye should feel that, the rays that are coming from the distance, are coming from a distance of 1 m.

13. Among we following, identify the quantity which increases with temperature.

(1) Resistivity of a copper wire (2) Resistivity of a piece of silicon

(3) Surface tension of water (4) Viscosity of water

(5) Relative humidity of air in a closed room

Thermometry 04

This is an easy question. The resistance/resistivity of a metal is increased with the temperature. Silicon is a semi-conductor. In semi-conductors, the resistance/resistivity is decreased with the increasing temperature. Surface tension and viscosity are entities that are decreased with increasing temperature. Once the temperature is increased, the relative humidity gets reduced in a closed room. The mass of water vapour inside the room is a constant. As the temperature increases, the needed water vapour mass to saturate the room is increased. Therefore, relative humidity is reduced.

14. Which as the following responses contains false information regarding photons and electrons?

	Photons	Electrons
(1)	Cannot travel at different speeds in a vacuum.	Can travel at different speeds in a vacuum.
(2)	Can have different energies.	Can have different energies.
(3)	Can be deflected by electric fields.	Can be deflected by electric and magnetic fields.
(4)	Can behave as particles and waves.	Can behave as particles and waves.
(5)	Can eject electrons from materials.	Can eject photons from materials.

Photoelecric Effect 11

This question is a new type of question. Few questions of this type can be seen in the paper. Once I saw the question, at a glance I felt that these two statements should be false. But one false statement is enough. Photons have the same speed inside a vacuum (speed of light). It is not wrong to consider as electro magnetic waves instead of photons. There can be different speeds to the electrons. Electric fields can accelerate or decelerate the electrons. Depending on the frequency, the energy of the photons differs from each other. If electrons can take different speeds then they can take different energies too. As photons do not have a charge, they cannot be deflected by electric or magnetic fields. Electrons are not like that. Both photons and electrons can behave as waves and particles. Photons can emit electrons from some materials. Photo electric effect is a good example for this. The dissipated energy due to the sudden stopping of electrons can be converted into photons. The generation of X-rays is a good example for this. This question checks lot of facts in the syllabus. If you can see that, electric fields cannot deflect photons, then directly you can get the answer quickly. This has been checked previously.

15. The magnitude of the magnetic force acting on a current carrying straight wires in a uniform magnetic field is determined by

(1) The magnetic flux density, the current, the length of the wire and the angle between the magnetic and wire only.

(2) The magnetic flux density, the current, the length of the wire only.

(3) The magnetic flux density, the current, the length between the magnetic field and the wire only.

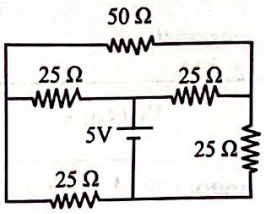
(4) The magnetic flux density and length of the wire only.

(5) The magnetic flux density and the current only.

07 Magnetic Fields I Force having on a Current Carrying Conductor

This is about theory. From $F=ilB\sin\theta$, you can understand that the correct answer is (1). Even though each problem considers the instance of $\theta = 90^0$, you must keep in mind that the force is dependent on θ. If $\theta = 0$, that means when the direction of the magnetic field is parallel to the wire, then the force is zero.

16. In the circuit shown, the current through 50 Ω resistor is

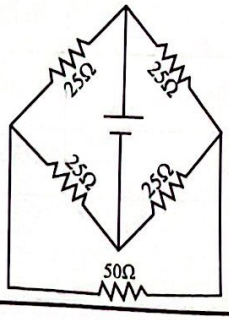


(1) (2) 0.1 A. (3) 0.2 A.

(4) (5) 0.5 A.

08 Wheatstone Bridge and Meter Bridge

Once you recognize that, this is nothing but a Wheatstone bridge circuit, the answer is in your hand. Look at the circuit of the question paper and this one. Is not it the same? It is a known fact that the cell and 50 Ω can be interchanged. This has been asked previously in a paper. The correct answer is (1).



7. Which of the following procedures does not increase the accuracy of the indicated measuring quantity?

	Measuring Quantity	Procedure
(1)	Period of a simple pendulum	Measuring time for several oscillation
(2)	Thickness of a plate of uniform thickness	Measuring thickness with a micrometer gauge instead of a vernier callipers
(3)	Diameter of a wire	Taking several measurement at different position
(4)	Balanced length of the potentiometer wire the	Inserting a high resistance in series with galvanometer
(5)	Current in a circuit	Using an ammeter having a smaller internal resistance

Measurements **01**

Even though there is lot to read, you can clearly see the answer while you are reading. You can directly decide that (1), (2), (3) and (5) are very true. Connection of a big resistance in series with the galvanometer will reduce the accuracy of getting the balanced point. Connection of a big resistance in series is good for the security of the galvanometer.

8. Three wheels A.B and C of the same mass and same external radius are made out of uniform sheet of different materials as shown in the figure. These wheels are released simultaneously from rest from the same height at the top of an inclined plane. The wheels roll down without slipping. The order that they will reach the bottom of the inclined plane as first, second and third respectively is

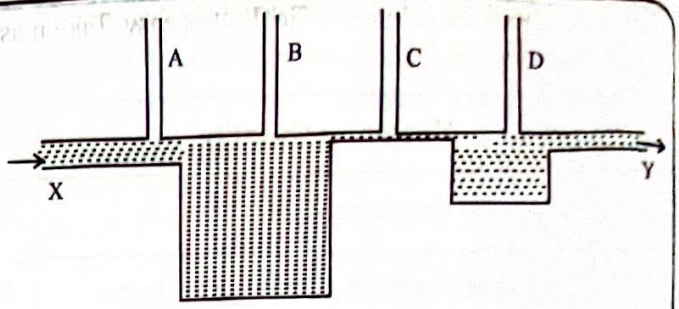
(1) A, B, C (2) B, C, A (3) C, A, B

(4) B, A, C (5) A, C, B

Rotational Motion **02**

Although it is seen as a difficult question, it is very easy. Such a question had been asked previously as well. All you need is to find the wheels with the highest and the lowest moment of inertia. Wheel A has the highest mass distribution which is centred more towards to its corners. Then it is with (C). The material is distributed in the rim of (C) as well to its inside. (B) has the least moment of inertia. Therefore, it comes to the bottom quickly. Then comes (C). Finally comes (A) with the highest moment of inertia.

19. A water-flow system consisting of manometer tubes A,B,C and D is shown in the figure. Water enters the system at X at a constant rate and at a pressure greater than the atmospheric pressure, and leaves at Y. If the heights of the water levels (not indicated in the diagram) in manometer tubes A,B,C and D are H_A, H_B, H_C and H_D respectively, then



(1) $H_A = H_B = H_C = H_D$

(2) $H_C > H_A > H_D > H_B$

(3) $H_B > H_D > H_C > H_A$

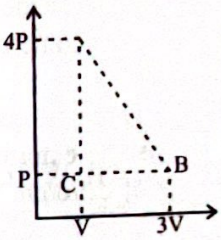
(4) $H_D > H_C > H_A > H_B$

(5) $H_B > H_D > H_A > H_C$

02 Hydrodynamics

This is also very easy. At a glance, you will remember Bernoulli equation. If the cross-sectional area is high, then the speed of water flow is also high. If the speed is high, then the pressure is low. (The bottom end tubes of the pressure meters are at the same horizontal level.) The pressure is higher at the place with the largest area. In the figure, all you need to do is move your eye from the highest are to the lowest area. Then you will realize that the correct answer is (5) automatically.

20. Work done during the cyclic thermodynamic process ABCA indicated in the P-V diagram shown is



(1) PV

(2) 2 PV

(3) 3 PV

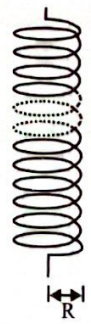
(4) 4 PV

(5) 5 PV

04 Thermodynamics

Very simple. You need to find the area of the triangle ABC. The things that you need to know about P-V curves have been studied in previous years. This can be done from the memory. The lengths have to be taken with care. (1/2 X 2V X 3P = 3PV)

21. A coil of metal wire made of a material of linear expansivity $2 \times 10^{-5}\ K^{-1}$ has turns. When the temperature of the coil is increased by 1°C while keeping its radius R (see figure) constant the number of turns becomes n+1. The value of n is



(1) 2.5×10^9

(2) 10^5

(3) 5×10^4

(4) 2.5×10^4

(5) $\sqrt{5} \times 10^4$

04 Expansion of Solids

Even though it looks difficult, it is easy. Take n as a length. If it is (n+1), then the increment of the length is 1. [(n+1)-n]. Now according to the definition of linear expansivity,

Linear expansivity = increased length/ (initial length X increased temperature)

$2 \times 10^{-5} = 1/(n \times 1)$ $n = 5 \times 10^4$ If you try to find the length of the coil, you will be in trouble.

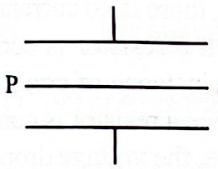
22. When 1 g of each of the gases helium (relative atomic mass =4), neon (relative atomic mass = 20) and argon (relative atomic mass = 40) are separately enclosed in the same container at the same temperature, the ratio of pressures exerted by the gases respectively is

(1) $\frac{1}{4} : \frac{1}{20} : \frac{1}{40}$ (2) $4 : 20 : 40$ (3) $4^2 : 20^2 : 40^2$

(4) $\frac{1}{4^2} : \frac{1}{20^2} : \frac{1}{40^2}$ (5) $\frac{1}{\sqrt{4}} : \frac{1}{\sqrt{20}} : \frac{1}{\sqrt{40}}$

Expansion of Gases 04

It is very simple. The volume is the same. Temperature is the same. Mass is the same. Then is not the pressure proportional to each atomic masses of each gas? $P \propto \frac{1}{M}$. Answer is (1).

23. 

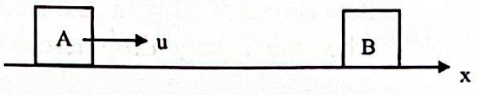
A thin metal plate PQ is inserted between the plates of a parallel plate capacitor of capacitance C. so that it is parallel to the capacitor plates as shown in the diagram. If the area of the plate PQ is same as that of a capacitor plate, the new capacitance of the system will be

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

Electrostatic Potential 06

Same question was given in a previous paper. As the plate is thin, there is no change in the capacity. There is no doubt that you might have proved that when a metal plate of thickness t is inserted into a parallel plate capacitor of plate area A and distance d, the net capacity of the system is $\frac{A\varepsilon_0}{d-t}$. When t = 0, it is clear that, $C = \frac{A\varepsilon_0}{d}$. But such equations are unnecessary. Once you see the figure in the question, the answer is remembered.

24. The object A of mass m and velocity u moving on a smooth horizontal surface along positive x direction makes a perfectly elastic collision with an identical object B which is at rest as shown i the figure. After the collision, the velocities of A and B are,



(1) 0, and u along positive x direction respectively.

(2) u/2 along positivex direction, and u/2 along positive x direction respectively.

(3) u/2 along negative x direction, and u/2 along positive x direction respectively.

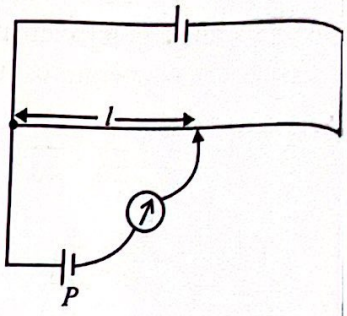
(4) u along positivex direction, and 0 respectively.

(5) 0, and u/2 along positive x direction respectively.

Momentum 02

If you write equations, the work will be a lengthy process. You need to apply conservation momentum and conservation of kinetic energy. If it is an elastic collision with equal masse then the moving mass goes on rest whereas the mass on rest will acquire the speed of t collided mass. No doubt that you might have seen the collision of metal balls in exhibitions. you write equations, you need $U = V_1 + V_2$ and $U^2 = V_1^2 + V_2^2$. As m is equal, it has not bee written in the equations. Once you solve these, you can get the answer. Do the substitution V_1 in the first equation to the second equation.

25. In the potentiometer circuit shown, the indicated balance length lis obtained for a cell P having an internal resistance. When another resistor in connected with P, the value of



(1) *l* increases if the resistor is in parallel with P.

(2) *l* does not change if the resistor is in parallel with P.

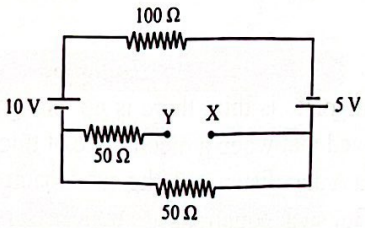
(3) *l* increases if the resistor is in series with P.

(4) *l* decreases if the resistor is inseries with P.

(5) *l* does not change if the resistance is in series with P.

08 **Potentiometer**

It is very simple. No need to do any calculation. At the balanced point, there is no current across the cell, P. So, there will be no change in the balanced length when a resistor is connected in series with P. The correct answer is (5). No need to look into the instance of connecting a resistor in parallel as there cannot be two answers to the question. Once a resistor is connected parallelly with P, there will be a current flow across the cell. Therefore, the voltage drop across P is lesser than of its e. m. f. So, the value of l should be reduced.

26. 

In the circuit shown the internal resistances of the cells are negligible. The voltage across XY is

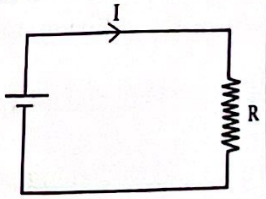
(1) 1.6 V (2) 3.75 V (3) 5 V

(4) 7.5 V (5) 15 V

08 **Kirchhoff's Law Combinations of Cells**

Again, there is no need for a calculation as you can do it from the memory. There is no current flow across 50 Ω with XY. Actually, there is no use from 50 Ω. Therefore, the work is done when the voltage-drop across other 50 Ω was found. According to the way that cells are connected, their e. m. f values get added. So, the needed answer is $\frac{15}{150} \times 50 = 5$.

27. If the internal resistance of the cell in the circuit shown is negligible, current I in the circuit can be increased to 3I by connecting another resistor of value



(1) R in series with R. (2) 2R in series with R.

(3) R in parallel with R. (4) 2R in parallel with R. (5) R/2 in parallel with R.

08 **Ohm's Law Combination of Resistances**

No need to look into the answers of series because the current gets reduced. If you need to multiply the current by three times, then the equivalent resistance should be reduced by three

times. If R should be R/3, then the connecting R should be lesser than R. If it is R, then the equivalent is R/2. Only (5) has the answer with a lesser R value.

28. If the electrical energy costs Rs 5.00 per kilowatt-hour, the cost to operate an electric appliance of resistance 60Ω for 6 minutes on a 240 V supply is

(1) Rs 0.08 (2) Rs 0.48 (3) Rs 0.50

(4) Rs 2.80 (5) Rs 480.00

Heating Effect of Electric Current 08

You need a simple calculation. $\frac{240\times240}{60}\times 6\times\frac{5}{1000\times60}=0.48$. It should be remembered that kilowatt-hour is a unit of energy. 1 kWh = 1000 X 60 W min.

29. The force required to increase the length of an elastic string by a unit length is given by k. Consider the following statements made about k.

(A) The value of k can be increased by increasing the Young's modulus of the material of the string.

(B) The value of k can be increased by increasing the cross-sectional area of the string.

(C) The value of k can be increased by decreasing the length of the string.

Of the above statements

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

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

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

Elasticity 10

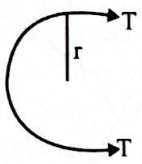
A simple method is that expressing K (force constant) with Young modulus. $E=\frac{FL}{Al}$. Therefore, $K=\frac{EA}{L}$ (as F =Kl) Now the answer is in your hand. E↑ K↑, A↑ K↑, L↓ K↑, all are true.

30. A loop made of a string of length l is kept on a soap film. When the section of the film inside the loop is broken, the tension of the string becomes T. If the length of the string is $2l$ then the tension of the string would be

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

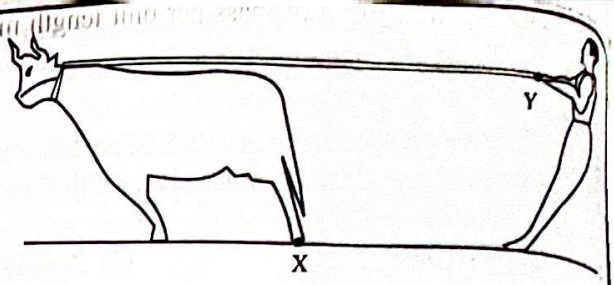
Surface Tension 10

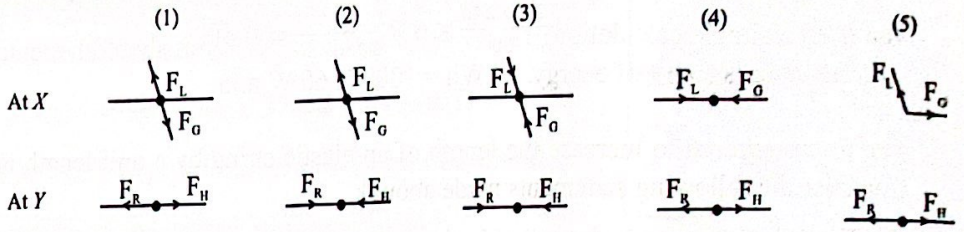
No doubt that you must have done many associated questions like this. You must have realized that T ∝ length of the string (l). So, when $l\rightarrow 2l$, T→2T. Or else do the question one time.



$T\propto r\propto l$

31. Figure shows an attempt made by a man to hold a bull tied to a rope trying to escape. The force at X acting on the bull's leg is F_L and that on the ground is F_G. The force at Y acting on the rope is F_R and that on the and that on the hand of the man is F_H. The forces F_L, F_G, F_R and F_H are correctly represented by





02 Equilibrium of Forces

It is a question about marking the forces of Newton's third law and its associated forces. The bull is pulling the ground from its legs. Therefore, F_G should be into the ground. F_L is the equal and opposite action. The man is pulling the rope. The rope is pulling the man. The correct answer is (2). You must keep in mind that even these forces are drawn at one point, they are not acted on the same object. You do not need to look at all the answers in such a question. First, pick the correct figures according to X. According to that, only (1) and (2) are left out. Then you need to look at the figure according to Y only in (1) and (2).

32. A beam of light that appears to be converging to a point on the axis 10 cm behind a lens is actually converged to a point on the axis 8 cm behind it. The lens is

(1) a convex lens of focal length 40 cm

(2) a concave lens of focal length 40 cm

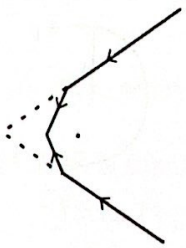
(3) a convex lens of focal length 4.4 cm

(4) a concave lens of focal length 4.4 cm

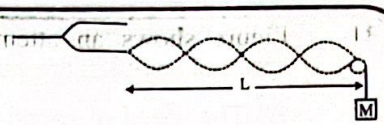
(5) a convex lensof focal length 20 cm

03 Refracfion Through Lenses

A calculation is needed. According to the concept of unreal object real image you can alternate the rays and solve the question. $1/10 - 1/8 = 1/f \rightarrow f = -40$



33. One end of a string of mass per unit length m is connected to a prong of a tuning fork and the other end is connected to a mass M after passing over a frictionless pulley as shown in the figure. When the tuning fork is vibrated, the string vibrates forming a standing wave as shown. The frequency of the tuning fork is



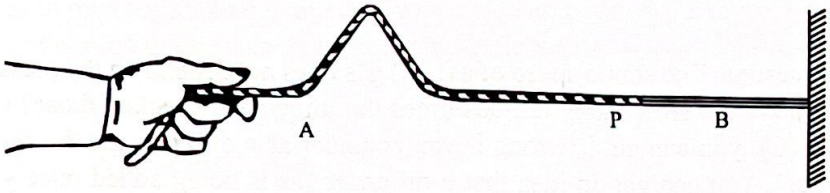
(1) $\frac{2}{L}\sqrt{\frac{Ma}{m}}$ (2) $\frac{2}{L}\sqrt{\frac{M}{m}}$ (3) $\frac{4}{L}\sqrt{\frac{Mg}{m}}$ (4) $\frac{1}{L}\sqrt{\frac{Mg}{m}}$ (5) $\frac{2}{L}\sqrt{\frac{m}{Mg}}$

Transverse Waves **03**

A simple problem. The wavelength of the standing wave is L/2 which can be seen from the figure.

$$\sqrt{\frac{Mg}{m}} = \frac{fL}{2}$$

34.



Two strings, A and B are connected and-to-end at P as shown in the figure and the free end of the lighter string B is attached to a rigid vertical wall. The masses per unit length of A and B are 0.04 kg m^{-1} and 0.01 kg m^{-1}, respectively. The composite string is first pulled by hand to create a tension of 1 N and then a pulse is created at the free end of A. After the pulse has reached the point P

(1) a non-inverted pulse would have travelled along B to the right with speed 10 m s^{-1}.

(2) an inverted pulse would have travelled along B to the right with speed 10 m s^{-1}.

(3) a non-inverted pulse would have travelled to the left along A with speed 10 m s^{-1}.

(4) an inverted pulse would have travelled to the left along A with speed 5 m s^{-1}.

(5) no pulse would have travelled along A to the left.

Wave Properties **03**

A soft reflection and a transmission into B are happening at P. As it is a soft reflection, the pulse that is reflected into A is not getting inverted. From this you can omit the choices (4) and (5). The pulse that is transmitted into B will never be inverted. From this (2) can be removed. Only (1) and (3) are left out. Now, look at the speed values. The pulse speed of string A = $\sqrt{\frac{1}{0.04}} = \sqrt{\frac{100}{4}} = 5$. From this choice (3) is removed. In this question, you need to consider many facts. There are four facts. Such as the inverted and non-inverted nature of the pulses of A and B strings, values of the speed and moving to the right and left. Even though you feel that there are many facts in this question for a MCQ, you need to use 'the choices removing method' by looking at one point only. If you try to consider all, then it will be a difficult task. As each choice is starting with the inverted, non-inverted nature, you can start from there. Then you do not have to look at all the things in each sentence. The speed of the transverse waves is dependent upon T and m only. Reflection or transmission are not affecting the speed. But the amplitude of the pulses gets reduced.

35. A gas is confined to a closed container. Consider the following statements made regarding the speed of sound in the gas.

(A) The speed of sound does not change when the volume of the container is changed at a constant temperature.

(B) The speed of sound changes with temperature.

(C) The speed of sound changes when more gas is added to the container at a constant temperature.

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.

03 **Velocity of Sound**

A simple question. The sound speed of a (real) gas does not depend on the pressure. It depends on the temperature. How many famous times that they have checked those? (A) and (B) are correct. In (C), you can get it wrong if you consider as a different gas for the two words of 'another gas'. You can get an idea that a different gas is being added once you are reading (C). It is better if it was written as 'more added from the same gas'. If a different gas has been added, (C) is correct as the net molecular weights get changed. If it is added from the same gas, then the pressure gets increased. But the speed of the sound is not affected by it.

36. A driver sitting in a parked car, seeing another car moving directly towards his car, sounds his horn. The frequency of the horn of the parked car is 340 Hz and the speed of sound in air is 340 m s^{-1}. If the driver of the moving car detects the frequency of this sound as 348 Hz, the speed of his car is

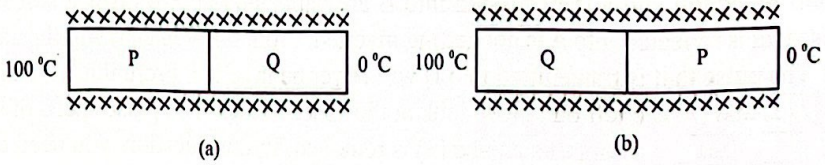
(1) 2.0 m s^{-1} (2) 3.0 m s^{-1} (3) 4.0 m s^{-1}

(4) 6.0 m s^{-1} (5) 8.0 m s^{-1}

03 **Doppler Effect**

It is a simple question which is given every time. The source is still. The observer is moving towards the source. $\frac{340+V}{340} \times 340 = 348 \rightarrow V = 8$. As there are two 340 values, simplification is very easy.

37.



(a) (b)

Temperatures at the two ends of a composite cylindrical rod made of two similar pieces of different metals P and Q are maintained at 100 °C and 0°C in two different situations (a) and (b) as shown in figures. The composite rod is well lagged, and the thermal conductivity of the metal P is twice that of Q. Consider the following statements made regarding the system at the steady state.

(a) The temperature variation along the composite rod from hot end to cold end is the same in both situations (a) and (b).

(b) Temperature at the junction between two metals of the composite rod is higher in the

situation (a) than in (b).

(c) The rates of flow of heat along the composite rod are the same in situation (a) and (b).

Of the above statements

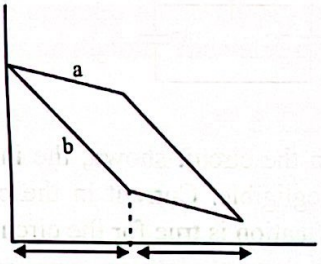
(1) only (C) is true. (2) only (A) and (B) are true.

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

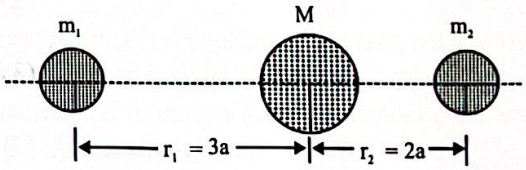
(5) all (A), (B) and (C) are true.

Conductivity **04**

At a glance, you can see that (C) is correct. You do not have to think far to find that (A) is wrong. If I did this question, I would have drawn the temperature distribution of both instances in my rough paper. Now the answer is visible. As the heat conductivity is greater in P, the temperature gradient in that rod should be lesser than of Q. (B) and (C) are true.



38. The figure shows an isolated system of three masses. The mass M is at rest under the influence of the masses m_1 and m_2, which are held in the positions indicated in the diagram. When mass m_1 is doubled, M will remain at rest if r_2 is changed to



(1) $2\sqrt{2}\,a$ (2) $\sqrt{2}\,a$ (3) $2\,a$ (4) $4\,a$ (5) $3\sqrt{2}\,a$

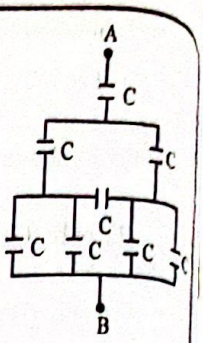
Gravitational Forec Fields **05**

When m_1 is doubled, the force acting on M to the left gets doubled. To balance M, you need to double the gravitational force also on M to the right (due to m_2). To make sure it happens, mass m_2 should move towards M. Only (2) has the answer that r_2 is smaller than 2a. Is not it awesome? No need to calculate. If you want to do calculations, then do like this.

$$F \propto \frac{1}{(2a)^2} \propto \frac{1}{4a^2} \qquad 2F \propto \frac{1}{r^2}$$

When these two expressions are divided, $2 = 4a^2/r^2 \rightarrow r = \sqrt{2}a$

39. The equivalent capacitance between points A and B of the network shown in the diagram is

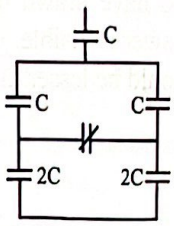


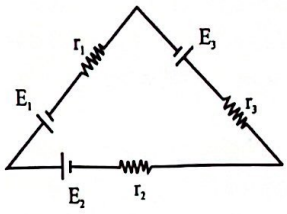
(1) $8C$ (2) $2C$ (3) $\frac{7}{3}C$

(4) $\frac{3}{2}C$ (5) $\frac{4}{7}C$

06 Electrostatic Potential

Left and right side capacitors are parallel to each other. Now there is no need from middle C. Think of a circuit like Wheatstone circuit. Now when C and 2C are in series, the equivalent capacity is 2/3 C. (It should be lesser than C.) When two 2/3 C are in parallel, the equivalent 4/3 C and C are in series becomes 4/7 C. It cannot be 7/4 C.



40. 

In the circuit shown, the internal resistance of all the cells are negligible. Current in the circuit is I. Which of the following equation is true for the circuit?

(1) $E_1+E_2+E_3 = I(r_1+r_2+r_3)$

(2) $E_1+E_2+E_3 = I(-r_1+r_2+r_3)$

(3) $E_1-E_2-E_3 = I(r_1-r_2-r_3)$

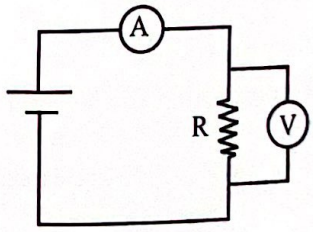
(4) $-E_1+E_2+E_3 = I(r_1+r_2+r_3)$

(5) $-E_1+E_2-E_3 = I(-r_1+r_2-r_3)$

08 Kirchhoff's Law Combinations of Cells

Kirchhoff's second law has been used. First, make the left-hand side. According to the way that the cells are connected, e. m. f cannot be $E_1 + E_2 + E_3$.E_2 and E_3 are on the same side. Therefore, the correct answer should be either (3) or (4). The right-hand side is very easy. What else than the expression $I(r_1+r_2+r_3)$? The correct answer is (4).

41. Consider the following statements made regarding the voltmeter V and the ammeter A in the circuit shown.



(A) Negative terminal of the ammeter and the positive terminal of the voltmeter should be connected together for proper operation.

(B) Internal resistance of the voltmeter should have a value lower than R for proper operation.

(C) If A and V are interchanged by mistake, the ammeter is now expected to read a smaller current than the reading obtained under proper operation.

Of the above statements.

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

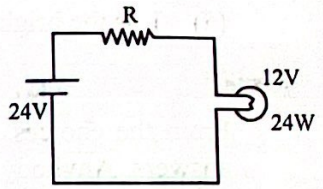
(3) only (B) and (C)are true. (4) only (A) and (C) are true.

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

Moving Coil Meters 08

This is also very easy. Each sentence contains general and simple knowledge. Statement (A) is correct. Marking of positive and negative ends was even there in the structured question of the previous year. Even the statement (B) has been checked many times in MCQ, structured and essay questions. It is wrong. The internal resistance of the voltmeter should be much greater than R. (C) is also a simple sentence. If the ammeter is connected to the same place where the voltmeter was, the ammeter reading should be less as the circuit current goes across R and ammeter. (C) is correct.

42. In the circuit shown, the bulb operates at the given rated value. Internal resistance of the cell is negligible. The value of R is

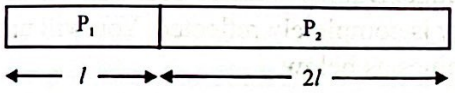


(1) 1 Ω (2) 3 Ω (3) 6 Ω

(4) 12 Ω (5) 18 Ω

Heating Effect of Electric Current 08

It is a O/L calculation. If the bulb is properly lit, then the current that flows across should be 2A (as 24/12). If 12 V is across the bulb, then the rest 12 V should be across R. That means R should be 6 Ω (12/2).

43. 

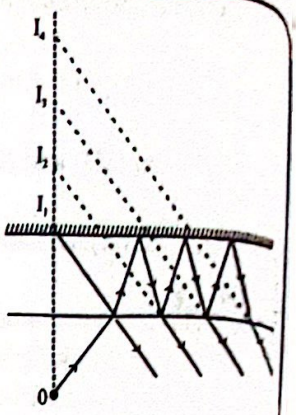
Two wires of equal cross-sectional areas but having lengths l and 2l, and resistivities ρ_1 and ρ_2 respectively, are connected end to end to form a composite wire as shown in the figure. The effective resistivity of the composite wire is

(1) $\frac{\rho_1+\rho_2}{2}$ (2) $\frac{\rho_1-\rho_2}{\rho_1+\rho_2}$ (3) $\rho_1+\rho_2$ (4) $\frac{\rho_1\rho_2}{\rho_1+\rho_2}$ (5) $\frac{\rho_1+2\rho_2}{3}$

Ohm's Law combination of resistances 08

Need to write a simple expression. As the cross-sectional area of both wires are the same, there is no need to write A in the relationship of $R=\frac{\rho l}{A}$ (as it is a MCQ problem). Two resistors are connecting in series. If the equivalent resistivity is ρ, then you can get the expression for ρ from $\rho_1 l + \rho_2 2l = \rho 3l$.

44. When an object O is kept in front of a thick plane mirror formed by silvering one side of a thick glass plate as shown in the figure, a series of images I_1, I_2, I_3,---- can be observed. which of the following statements is correct?



(1) I_1 is the brightest and the intensities of images I_2,I_3, ... decrease gradually.

(2) I_2 is the brightest and the intensities of images I_3,I_4, ... decrease gradually.

(3) I_2 is the brightest and the intensities of images I_3,I_4, ... are the same.

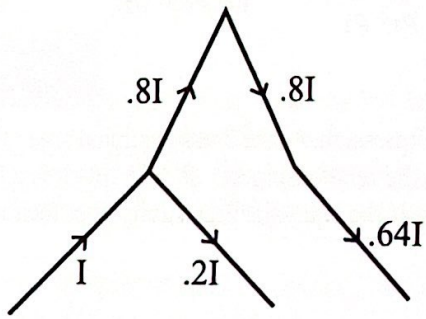
(4) I_3 is the brightest and the intensities of images I_2,I_4, ... are the same.

(5) I_1 is the brightest and the intensities of images I_2,I_3, ... are the same.

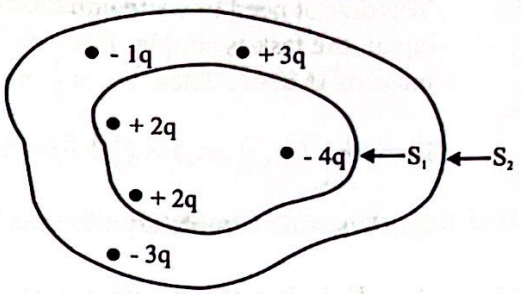
03 **Refraction**

From the choices, you can omit as soon as you see (3), (4) and (5). They are just useless answers. Anybody can understand that the intensities of the images cannot be equal when you go far and far away. The competition is between (1) and (2). From the reflection of the normal glass surface I1 is generated. Majority of light is refracted from the incident light when a light ray is travelling from air is incident on the surface of a normal glass. Normally, 80% is refracted where as the rest of 20% is reflected. Even though you do not need to know these values exactly, you will take the answer as (1) if you did not think that the percentage of refraction is higher from your general knowledge. But (2) is the correct answer. As silver is coated on the second surface, the incident energy is completely reflected. You will understand easily when you compare the rough intensity values as below.

$0.8\ I \times (80/100) = 0.64\ I$ $\qquad$ $0.64 > 0.2$



45. Consider the following statements made regarding the charge distribution shown.



(A) No electric field lines cross the closed surface S_1.

(B) Total electric flux due to the charge +3q does not depend on the rest of the charges present.

(C) Net electric flux through the closed surface S_2 is not zero.

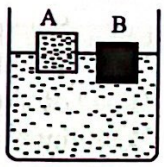
Of the above statements

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

Gauss Theorem 06

Similar questions can be seen in the past papers of recent past. In this question, statement (A) can get wrong most of the time. The net charge is zero inside the surface of S_1 (-4+2+2). Therefore, it true that the net flux is zero across the surface of S_1. But it does not imply that electric force lines are not going across the surface. Actually, due to the charges that are inside, the electric force lines are going away from the surface of S_1. Due to the negative charges, the electric force lines are going into the surface of S_1. As the net charge inside is zero, the number of force lines that are coming inside is equal to the force lines that are going outside. Therefore, the net flux is zero. Due to the charges located outside (from S_1), there are force lines which travel across the surface of S_1. But all the entering force lines are exited again. Therefore, (A) is wrong. I heard that, this is the question that went wrong in a student who got 59 out of 60. It is very clear that (B) and (C) are correct. The flux due to any charge is dependent on its charge only. The net charge inside the surface of S_2 is not zero. It is -1 q. Therefore, (C) is correct. The net flux across surface S_2 is towards to the surface.

46. Two cubes A and B of the same geometrical dimensions float in water as shown in the figure. Cube A has half of its volume above the water level whereas B has only 1/4 of its volume above the water level. If the cube B is carefully placed on cube A, which of the following responses indicates the correct positions of the cubes A and B ?



	Cube A	Cube B
(1)	3/4Of the volume is under water	Completely above the water level
(2)	Completely submerged	Completely above the water level
(3)	Completely submerged	1/4 Of the volume is under water
(4)	Completely submerged	1/2 Of the volume is under water
(5)	Completely submerged	3/4 Of the volume is under water

Hydrostatics 02

You do not need to write equations traditionally. As the cross-sectional areas of the cubes are equal, the task is simple. Both are in the same liquid (in water). Take the mass of A as m_1 and mass of B as m_2. Then, $m_1 \propto \frac{1}{2}$ $m_2 \propto \frac{3}{4}$

Therefore, $(m_1 + m_2) \propto (\frac{1}{2} + \frac{3}{4}) \propto 1\frac{1}{4}$

So, A is sunk completely whereas ¼ of B is in water.

47. A particle P moving with a uniform velocity of 4 m s^{-1} along x-axis passes the origin O at time t=0. A second particle Q moving along the same direction with a uniform velocity of 5 m s^{-1} passes origin O at t=1 s. Particle Q will reach the particle P when they have travelled a distance of

(1) 10 m from the origin (2) 16 m from the origin

(3) 20 m from the origin (4) 25 m from the origin

(5) 30 m from the origin

02 **Linear Motion**

Little calculation is needed. If the travel time of P is t when the particles are met, then the travel time of Q by that instance is (t-1). 4t = 5(t -1) t= 5 (4 X 5 =5 X 4) The meeting distance is 20 m.

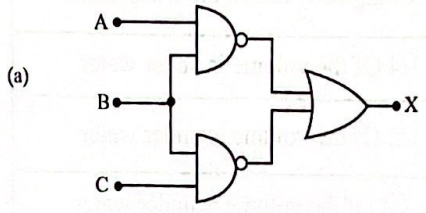
48. The intensity of sound emitted from a point source is inversely proportional to the square of the distance from the source. If the intensity level of sound at a distance of 1.0 m from a point source of sound is 50 dB, the sound intensity level at a distance of 10.0 m from the source will be

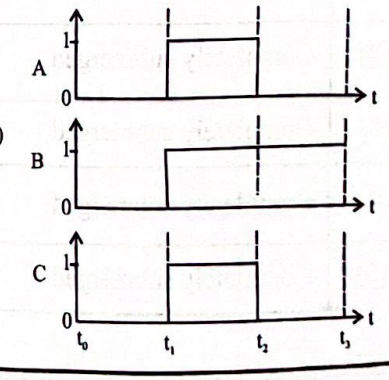
(1) 0.5 dB. (2) 3 dB. (3) 5 dB.

(4) 30 dB. (5) 70 dB.

Sound intensity is proportional to $1/r^2$. Even this is general knowledge, it has mentioned in the question as it is not in the syllabus. The intensity of 100 m distance is 1/100 of an intensity of 1 m distance. If the intensity is reduced by 100 times, the respective difference of the intensity level (reduction) is 20 dB. So, the intensity level at 100 m is 30 dB. (50-20) If you use equations, then $\beta_1 - \beta_2 = 10 \log (I_2/I_1)$ $I_2 = 10^{-2} I_1.\beta_2 - 50 = -20 \rightarrow \beta_2 = 30$.

49. Figure (a) shows a digital circuit. The variation of the logic value of its inputs A,B and C with (t) are shown in figure (b).





09 **Logic Gates**

The output X will be 0 during the time interval / intervals

(1) from t_0 to t_1 (2) from t_1 to t_2 (3) from t_2 to t_3

(4) from t_1 to t_3 (5) from t_0 to t_1, and t_2 to t_3

This can be solved in two methods. One method is by writing Boolean expressions with A, B, C for each instance for X. $X = \overline{AB} + \overline{BC}$

t_0 -t_1 A = B = C =0 $\overline{AB} = 1\,\overline{BC} = 1\,X = 1$

t_1 -t_2 A = B = C =1 $\overline{AB} = 0\,\overline{BC} = 0X = 0$

t_2 -t_3 A = 0, B = 1, C = 0 $\overline{AB} = 1\,\overline{BC} = 1X = 1$

Even though it is written in a lengthy way, a child needs to write only $X = \overline{AB} + \overline{BC}$. The other method is to take values of A, B, C in three instances that go with the circuit from memory and write the final output in the rough paper or question paper.

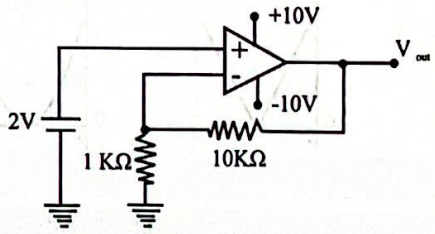
0, 0 is 1. 0, 0 is 1. 1, 1 is 1.

1, 1 is 0. 1, 1 is 0. 0, 0 is 0.

0, 1 is 1. 1, 0 is 1. 1, 1 is 1.

Here it is written the way that the mind reads.

50. The operational amplifier circuit shown operates with +10V and –10V power supplies. What would be the approximate output voltage (V_{out}) of the circuit?

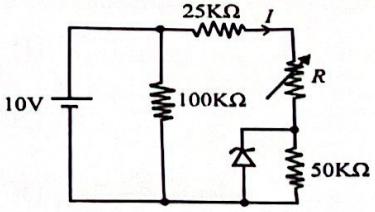


(1) +22 V (2) –22 V (3) +20 V

(4) +10 V (5) –10 V

This is a reversible operational amplifier (Op-Amps). First, if we find the voltage gain in the normal way, then it is (10+1)/1 = 11. So, V_{out} should be 22 V. You will quickly colour (1) definitely. Wait for a while. Vout cannot be more than 10 V which is the supplying voltage. If so, the energy can be created. Therefore, the correct answer is (4). On the other hand, in a question to amplify voltage of 2 V, there is normally no point in using Op-Amps. The inputs of such amplifying circuits are in μV, mV range. The near value of Vout is asked because it is really lesser than 10 V.

51. The breakdown voltage of the zener diode of the circuit shown is 5 V. The internal resistance of the cell is negligible. when the value of R is changed from 25 Ω to 0, the current I in the circuit will change from



(1) 0.10 A to 0.13 A. (2) 0.20 A to 0.40 A. (3) 0.13 A to 0.20 A.

(4) 0.10 A to 0.20 A. (5) 0.20 A to 0.27 A.

Normally, 10 V should be divided in between 25 Ω, R and 50 Ω as the e. m. f of the cell 10 V. But as a Zener diode is connected across 50 Ω in a reverse biased way, the voltage difference is 5 Vacross 50 Ω. This is the usage of a Zener diode. When R = 25 Ω, the rest of 5 V in the cell is dropped in between (25+25). Then I = 0.1(5/50). When R = 0 the rest of 5 is completely across 25 Ω. Then I = 0.2 (5/25). There is no need for rough work. You can do from the memory.

52. A metal sphere of radius r carrying a charge +q is connected by a conducting wire to another metal sphere of radius 2r carrying a change +q. After the connection, the amount of change in the sphere of radius r is (Assume that the amount of change residing in the connecting wire is negligible.)

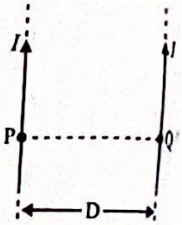
(1) 0 (2) $+\frac{q}{3}$ (3) $+\frac{q}{2}$ (4) $+\frac{2}{3}q$ (5) $+\frac{3}{2}q$

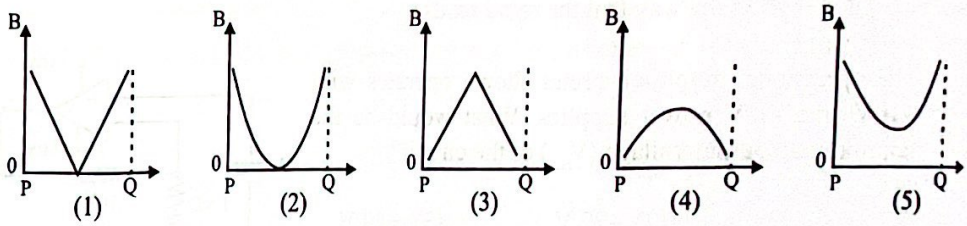
06 Electrostatic Potential

This is a very common and a famous question. After the connection, if the charge of the small sphere is q', then the charge that should be in the other is (2q – q') (conservation of charge). As the potential should be equal after connection,

$$\frac{q'}{r}=\frac{2q-q'}{2r} \quad 2q'=2q-q' \quad \rightarrow q'=\frac{2}{3}q$$

53. Two long, parallel, thin wires placed at a distance D apart as shown in the figure. carry equal currents I in the same direction. Variation of the magnitude of the resultant magnetic flux density B along the line PQ from Pto Q, is best represented by

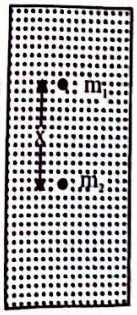




09 Magnetic Effect of Electric Currents

The current flows to the same direction in the wires. Therefore, there should be a null point (B = 0) in the middle of the wires. In other places, it should be $B \propto \frac{1}{r^2}$. Both of these points are being satisfied only in the graph of (2). You can remove (3), (4) and (5) from the logic of the existence of B = 0 point. B cannot vary in a linear way. From that (1) is omitted.

54. Two spheres each of radius a but of different masses m_1 and m_2, ($m_1 > m_2$) move down at their terminal velocities in a liquid of viscosity η. At the instant shown in the figure, the separation x between the two spheres is being



(1) increased at a rate of $\frac{m_1 m_2}{6\pi a\eta}$ g per second.

(2) decreased at a rate of $\frac{6\pi a\eta}{m_1-m_2}$ per second.

(3) increased at a rate of $\frac{(m_1-m_2)g}{6\pi a\eta}$ per second.

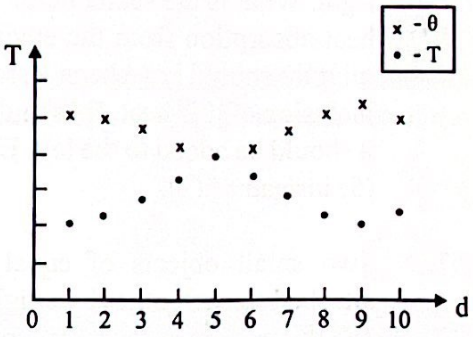
(4) decreased at a rate of $\frac{(m_1+m_2)g}{6\pi a\eta}$ per second.

10 Viscosity

(5) decreased at a rate of $\frac{(m_1-m_2)g}{6\pi a\eta}$ per second.

At a glance, it seems like a hard question but it is not. As the density of the liquid is not given, there is no need to consider about the upthrust here. You can calculate the terminal speed instantly. The rate of increment or decrement of the distances between the two spheres is the difference of the terminal speeds. Speed is the distance in a second (unit time). Therefore, the rate of separation between the spheres is $V_1 - V_2$. Sphere of m1 has a greater terminal speed (as $m_1 > m_2$ even with the same radius). In the figure, m_1 is drawn above m_2. It indicates that m_2 is released before m_1. If they are released simultaneously, m_1 should travel lower than m_2. As, m_1 is above of m_2 and the speed of m_1 is greater than m_2, their separation should get lesser and lesser. The correct answer is (5). $m_1 g = 6\pi\eta a V_1$

55. The mean temperature (θ) and the dew point (T) of the atmosphere between 6.00 a.m. and 8.00 a.m. in 10 consecutive days (d), 1-10, are shown in the figure.



Consider the following statements made about the atmosphere.

(A) Relative humidity is maximum on day 9.

(B) Day 6 has more water vapourin the atmosphere than on day 8.

(C) Mist is possible in none of the days.

Of the above statements

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

Hygrometry **04**

The atmospheric temperature and the dew point have become equal on the 5th day. If the atmospheric temperature and the dewpoint are equal, then the atmospheric relative humidity is 100%. The atmospheric temperature is higher in every other day compared to the dew point. Therefore, the relative humidity is lesser than 100% on each day except on the 5th day. So, (A) is wrong. (B) is correct. The atmospheric temperature of the 6th day is near to the dew point compared to the 8th day. There can be mist on the 5th day. So, only (B) is correct.

56. A mass m_1 of ice at 0 °C is added to a mass m_w of water at the room temperature of 30 °C, and the mixture is stirred until the ice is completely dissolved in water. If the minimum temperature of the mixture is found to be 10 °C, the amount of heat absorbed by the mixture from the container and the environment is

(Specific heat capacity of water $= S_w$, Latent heat of fusion of ice = L)

(1) $\frac{m_1(L+10\,S_w)}{20\,m_w S_w}$
(2) $m_1\,(L + 10\,S_w) - 20\,m_w S_w$
(3) $10 m_w S_w + m_1(L + 10\,S_w)$
(4) $m_1\,(L + 10\,S_w) - 10\,m_w S_w$
(5) $20 m_w S_w - m_1(L + 10\,S_w)$

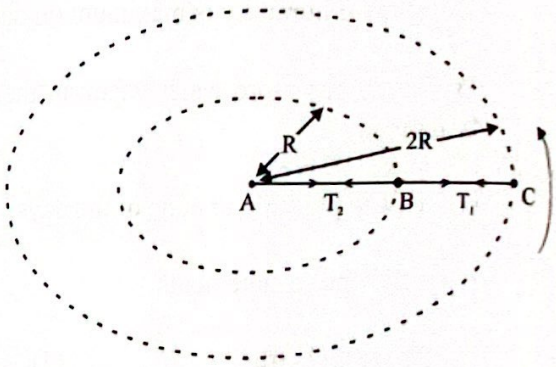
Calorimetry **04**

Normal relationships of heat transfer should be written. Normally when writing such expressions, we assume that, there is no heat transfer to the environment nor heat absorption from the environment. If the amount of heat absorbed is h,

$$m_w s_w 20 + h = m_l L + m_l s_w 10$$

You can realize that the correct expression is (2). You need to write 'h' to the correct side of the expression. It must be done carefully. The heat is removed from water. Ice and the ice that turned into water (in 0^0C) absorb heat. Therefore, most of the time we tend to add 'h' to the right side of the expression. It can be thought as logical as the absorbed heat is written on the right. What is the secret here? The final temperature of the mixture is measured including the heat absorption from the environment. If this does not happen, the final temperature of the mixture should have been lesser than 10^0C. As the temperature of 10^0C has obtained with the inclusion of this heat, 'h' should be removed from the right when writing the equality. Or else it should be added to the left. Even though the question is easy, most of the time you may mark (5) instead of (2).

57. Two small objects of equal masses are attached to each other by a light string BC, and this system is connected to a fixed point A with another light string AB as shown in the figure. The masses are then made to move in horizontal circular paths of radii R and 2R (see figure) with the same angular speed to that points A,B and C are always in a straight line. If T_1 and T_2 are the tensions of the strings BC and AB respectively, then



(1) $T_2 = \frac{1}{2}T_1$ (2) $T_2 = \frac{2}{3}T_1$ (3) $T_2 = T_1$ (4) $T_2 = \frac{3}{2}T_1$ (5) $T_2 = 2T_1$

You need to write two equations for the motion of the two masses. There is no need to write the symbols of m, ω, R unnecessary as the the relationship of T_1 and T_2 is being asked with equal angualr speeds. For the mass of B,

$$T_1 - T_2 \propto 1 \quad (T_1 - T_2 = mR\omega^2)$$

For the mass of C,

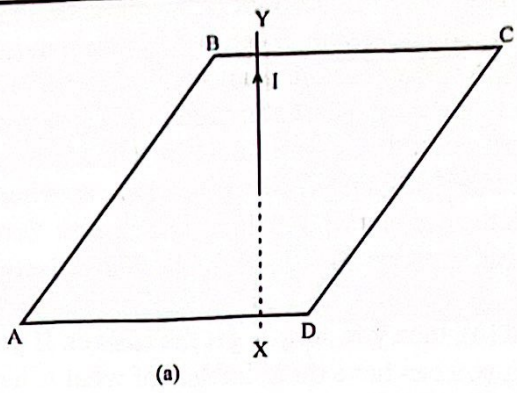
$$T_1 \propto 2 \quad (T_1 = m2R\omega^2)$$

$$\frac{T_2 - T_1}{T_1} = \frac{1}{2}$$

If the denominator is added to the numerator of both sides,

$$\frac{T_2}{T_1} = \frac{3}{2} \rightarrow T_2 = \frac{3}{2}\ T_1$$

58. XY is a long vertical wire carrying a current I in the upward direction as sown in figure. (a) ABCD is a horizontal plane perpendicular to the wire. The directions of the magnet of a compass kept at positions P_1, P_2, P_3, P_4 and P_5 on the plane ABCD near the wire are shown in figure (b). The position at which the direction indicated by the magnet of the compass is the same as the direction of the horizontal component of the earth's magnetic field is

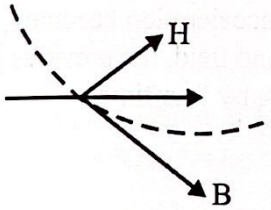


(1) P_1 (2) P_2 (3) P_3

(4) P_4 (5) P_5

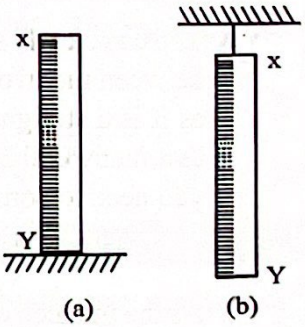
Magnetic Effect of Electric Currents 07

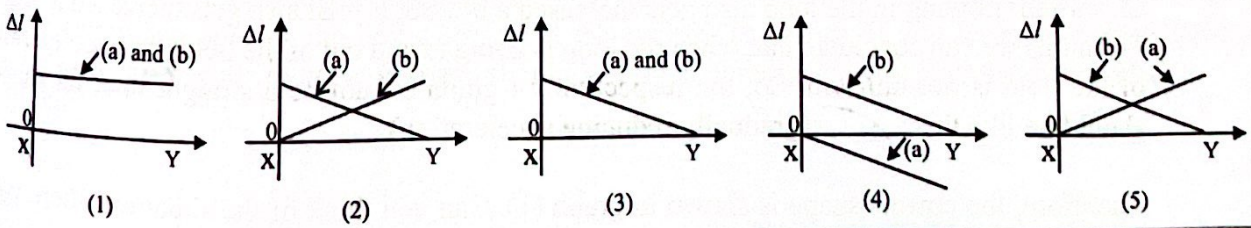
If there is no earth's magnetic field or any other mangentic field, the direction of the magnetic field due to current I is located on the direction of the tangent of the dashed lined circle. If there is a magnetic field on the horizontal plane, then the compass is directed towards the direction of the resultant magnetic field. As the magnetic field due to current I is towards the tangent of the circle, if the compass is also directed towards the direction of the tangentat a particular place, then the other magnetic field's direction should also be in that direction. Such a drawing is only in (3).



In any other location, the compass is directed inclined to the direction of the tangent. For an example, at P_1 the magnetic field due to curernt (B), the horizontal component of the earth's magnetic field (H) and the direction of the resultant is shown in the figure.

59. A 1 m long cylindrical copper rod XY of mass M is accurately calibrated in (standard) millimeters when it is in horizontal position. In two separate occasions, this rod is kept in vertical position by placing on a horizontal platform [see figure (a)], and by hanging from a ceiling [see figure(b)]. If ' the distance between two consecutive milimetre marks' – length of a standard millimeter = Δl,then the variation of Δl along the rod in the occasions (a) and (b) is best represented by

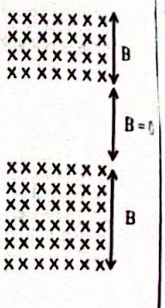


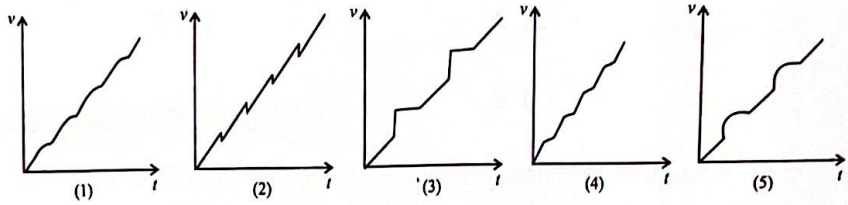


Elasticity 10

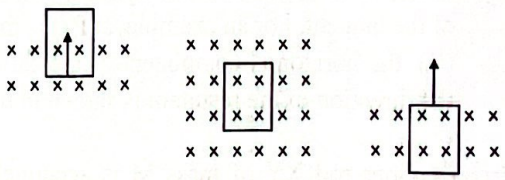
At the instance (a), the rod is compresssed downwards due to its weight. At the instance (b), the rod is stretched due to its weight. When we go down in (a), the distance between the two marks is reduced due to compression. That means Δl gets a negative value and its value is gradually increasing negatively. The bottom end of Y gets more compressed. At (b), the end of X is stretched more and the distance between the marks gets increased than the standard millimeter. That means Δl gets a positive value where as when it comes to the end of Y, Δl is gradually reduced as the amount of streching gets lesser. You can decide the correct answer as the only graph with negative Δl values is (4). This question contains general knowledge than Physics. If you can decide that the rod is compressed downwards at (a) and the rod is stretching upwards at (b), then you simply get the answer. If you can think about heavy rubber cylindrical rods, then you can have mind images of what is happening.

60. A closed rectangular wire loop (W) falls vertically through two uniform magnetic field regions of flux density B as shown in the figure. If viscous and upthrust forces on the loop are negligible, the velocity (v) - time(t) graph of the loop is best represented by





When the loop that is falling under the gravitational accleration enters into the magnetic field, the flowing current due to the induced e. m. f applies an upwards froce on the horizontal hand (ilB). This has been checked in different occasions. Due to the upward force, the acceleration of the loop gets reduced. Once it has come completely into the field, ilB is zero as the induced e. m. f gets zero. Then again the loop falls under the gravitational accleration. When the loop is going out of the field, this process happens again. Then, the acceleration becomes g as the loop is falling to a place without a field. When it enters the second field, the previous process happens again. So, the acceleration of the loop gets lesser than g by four times.



You can clearly see that the answer is either (1) or (4) from the v-t graphs. What is the difference between the two graphs? The place that shows less acceleration is a curve in graph (1) where as it is a straight line in (4). You need to have an eagle's eye to find this. There is no doubt that many children will select (4). As the loop is falling vertically, there is another point that you need to consider. The speed of the loop (v) is not constant when it is falling down. It gets increased. Therefore, the induced e. m. f of the loop, vlB is not constant.

As the induced e. m. f is not constant (increases) when the loop is going in and out of the field, the current flowing in the loop also gets increased a bit. So, F =iBl also gets increased a little. From this we can conclude that, when the loop is going in and out of the field, the acceleration of the field is not uniform. So, the respective v-t graph cannot be a straight line. Its shape should be like this. (gradually reducing acceleration)

Therefore, the correct shape is shown in graph (1). Can you think of the situation where you can get graph (4)?