2003 PHYSICS - I

General Certificate of Education (Adv. Level) Examination

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

1. The unit of intensity level of a sound wave is

(1) Hz (2) W (3) $J\ m^{-2}$ (4) $W\ m^{-2}$ (5) dB

03 **Intensity of Sound**

At a glance you can understand that the answer is dB.

2. Which of the following quantities must be known in order to calculate the energy consumed by an electrical appliance?

(1) Supply voltage and current (2) Current and time of operation

(3) Current and resistance (4) Power consumed and time of operation

(5) Power consumed and supply voltage

08 **Heating Effect of Electric Current**

I doubt this question got jumbled to the children. The calculation of consumed energy is being asked in this question. You get the power from the multiplication of voltage and current. To get the energy, power should be multiplied by time. If there was a multiplication of voltage, current and time, then it is correct. The correct answer is (4).

3. Of the elements given below, power (VI) can be amplified only with

(1) resistors. (2) diodes. (3) capacitors.

(4) transformers. (5) transistors.

09 **Transistors**

This is very easy. Power can be developed by only transistors. On the other hand, from the given sources of equipment, transistors only provide a power. Does not the 11^{th} question of paper 1998 contain the given information of this question?

4. A cricket ball is hit for a six. It leaves the bat at an upward angle of 45° to the horizontal with kinetic energy k. Kinetic energy of the ball at the top of its flight is (neglect air resistance)

(1) 0 (2) $\frac{k}{4}$ (3) $\frac{k}{2}$ (4) $\frac{k}{\sqrt{2}}$ (5) k

09 **Transistors**

This is the 33^{rd} question of paper 1981. It consumes time if you try to solve as a normal question. It can be done from the memory if you think a bit. The kinetic energy of the highest point is being asked. Only the horizontal component of the velocity is there at the highest point. As the air resistance is neglected, the horizontal component of the velocity as well as the kinetic energy do not change. Initially, as the velocity makes an angle of 45^0 with the horizontal, the horizontal kinetic energy is half of the initial kinetic energy. Therefore, the

kinetic energy at the top is also half of the initial kinetic energy.

If it is done from a simple calculation, then the horizontal component of velocity is V cos45^0 =V/$\sqrt{2}$ when the initial velocity is considered as V. As the kinetic energy is proportional to the square of velocity, when V/$\sqrt{2}$ is squared, you will get $V^2/2$. That means half of the initial kinetic energy.

33rd question of paper 1981: When a cricket ball of mass M is hit, it leaves the bat with an angle of 45^0 with the horizontal. The kinetic energy is E at the highest point of the path of the ball. If the air resistance is neglected, what is the velocity of the ball which goes away from the bat?

It is funny how intelligent children who study Physics say that this is not the question of 2003. The only difference is that the question is being asked from the other way around.

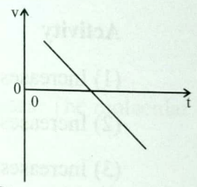
5. A golf ball of mass 0.05 kg leaves with a velocity of 70 m s^{-1} after being struck by a golf club. If the time of contact of the ball with the golf club is 5 x 10^{-4} s, the mean force applied by the golf club on the ball is

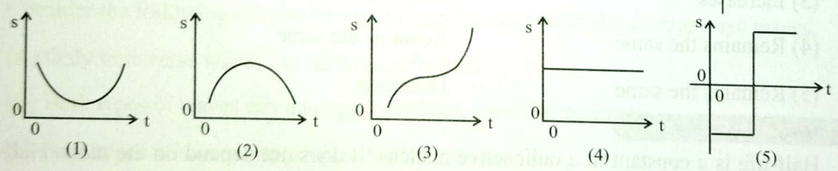
(1) 5.0 x 10^5 N (2) 2.5 x 10^5 N (3) 7.0 x 10^3 N

(4) 1.4 x 10^3 N (5) 1.2 x 10^3 N

Such questions can be found in many question papers. There are plenty of questions of ball hitting or water hitting on the wall in past papers. All you need is a simple calculation. Force is equal to the rate of change of momentum $\frac{0.05\times70}{5\times10^{-4}}$ Cannot you solve from the memory? Why on earth have 0.05 and 5 are given? Your D or A pass for mathematics in O/L should be thrown away if you cannot solve this from memory. It is useless. When 0.05 is divided from 5, it is 0.01. That is 10^{-2}. When 10^{-2} is divided by 10^{-4} you will get 10^2. Therefore, the answer is 7 X 10^3.

6. The graph shown in the figure represents the velocity (v) - time (t) curve for an object. The corresponding displacement (s) - time (t) curve is best represented by





This is closer to the 38th question of 2002. There is only a small change. In 2002, the direction of the velocity is not being changed.

In this question, the direction of the velocity was changed when the velocity was zero. As initially the velocity takes a positive value, the gradient should be positive in the respective displacement-time curve. Only (1) and (2) choices are correct if you look at that point. Next, the gradient of the s-t curve should be negative.Therefore, the correct answer is (2). The gradient of the s-t curve should be positively reduced and then negatively increased as the velocity gradually reduced positively and then gradually increased negatively.

7. In an adiabatic process always

(1) no heat enters or leaves the system.

(2) no work is done on the system or by the system.

(3) the temperature of the system remain constant.

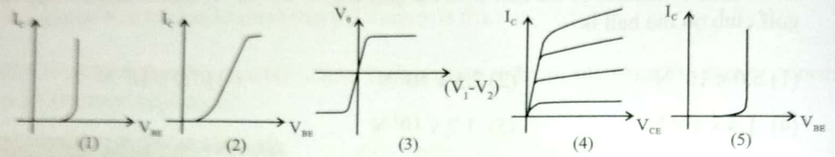
(4) the pressure of the system remains constant.

(5) the volume of the system remains constant.

04 Thermodynamics

You can find the correct choice as (1) when you are reading. The main characteristics of an adiabatic process is mentioned from (1). Adiabatic implies that there is a constant amount of heat. That means there cannot be an exchange of heat.

8. Which of the curves shown in figure represents the output characteristic of an npn transistor?



09 Transistors

This has been asked in 5(b) essay question of paper 2002. You should know the output characteristic of a transistor. It has been asked to draw in 2002. It has been given for multiple choice question in 2003. Why cannot you do these? The correct answer is (4).

9. If the mass of a radioactive sample is doubled, which of the following is correct, regarding its activity and its half-life.

	Activity	Half-life
(1)	Increases	Increases
(2)	Increases	Decreases
(3)	Increases	Remains the same
(4)	Remains the same	Remains the same
(5)	Remains the same	Decreases

11 Radioactivity

Half-life is a constant in a radioactive nucleus. It does not depend on the mass. Half-life or decay constant is not dependent on physical states such as pressure, temperature etc. Activity is the amount of emitted radiation in a unit time. Therefore, the activity should get increased as the number of radioactive nuclei increased. The correct answer is (3). This is a very easy question if you know the very basics of radioactivity.

10. A metal plate is illuminated with a beam of light of a certain frequency. Which of the following determines whether the electrons are emitted or not from the metal surface?

(1) The intensity of the light.
(2) The length of the time of exposure to the light.
(3) The surface area of the plate.
(4) The type of the metal.
(5) The speed of the incident photons.

This is also has been checked by many times. Have a look at 37th question of paper 2000 and 54th question of paper 2001. Electron emission is decided only by the frequency of the incident light, type of metal (work function) and the nature of the surface.

As the frequency is mentioned in the question, the correct answer is (4). If the photo electric effect is occurring, then the intensity is dependent upon the number of emitting electrons. (photo current) If the frequency of the incident light does not exceed the threshold frequency, then there will be no electron emission irrespective of the time of light exposure.

11. Consider the following statements made regarding the speed of sound in air.

(A) Speed increases with the increase of pressure when the temperature is kept constant.

(B) Speed increases with the increase of temperature and humidity.

(C) Speed decreases with the increase of density when the temperature is kept constant.

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.

How many times has this been asked in past papers? Look at 10th question in 1988, 32nd question in 1998 and 3rd question in 2002. In a given gas, the speed of sound is dependent only on the temperature and humidity. When both temperature and humidity are increased, the speed of sound gets increased.

$$V = \sqrt{\frac{\gamma RT}{M}}$$

When the humidity increases, the net molecular weight of the air decreases. The molecular weights of N_2, O_2 and water are 28, 32 and 18 respectively.

12. Consider the following statements made regarding longitudinal and transverse waves.

(A) Only transverse waves can undergo refraction.

(B) Both types of waves can undergo interference and diffraction.

(C) Both types of waves can produce beats.

Of the above statements.

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

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

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

(A) is wrong. Any wave can undergo reflection, refraction, interference and diffraction. Therefore, (B) is correct. Statement (C) is also correct. Any wave can generate beats. Yet,

beats can be heard only in sound waves. Beats occur when any two waves of transverse or longitudinal with nearly equal frequencies undergo the superposition. Superposition is a valid process for any wave. Therefore, beats are occurred as a result of superposition.

It is true that we talk about the beats of only sound waves (longitudinal). That is because we hear only sound waves. But beats of the waves can be discovered by a sensitive equipment. For an example, when a moving body is studied using ultrasonic waves, the frequency difference of incident and reflected waves (f_1-f_2) can create beats. That beat frequency can be monitored by a detector that is sensitive to ultrasonic waves. If the statement (C) was written like this, then it is wrong. "Beats can be heard from both of the waves." Look at the 14th question of paper 1993. Therefore, both of the statements (B) and (C) are correct.

13. A broad beam of parallel light is to be converted to a narrow beam of parallel light. This can be achieved with

(A) two convex lenses. (B) two convex lenses. (C) a convex lens and a concave lens.

Of the above statements.

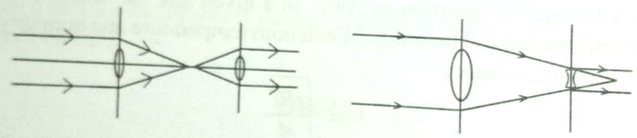
(1) only (A) is true. (2) only (C) is true.

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

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

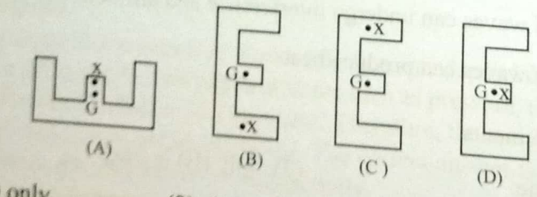
03 **Refraction Through Lenses**

This has also been asked several times by different methods. Look at the 22nd question of paper 1994.



It can be clearly concluded that, you can get this by using two convex lenses with suitable focal lengths or with one convex and one concave lens. Such ray diagrams can be seen in previous past papers too.

14. Identical laminae cut into the form of the letter E are pivoted vertically at X. If G is the centre of gravity of the laminae, which of the states shown in the figure are at stable equilibrium positions?



(1) (A) and (C) only. (2) (A) and (B) only.(3) (C) and (D) only.

(4) (B), (C) and (D) only. (5) (A), (C) and (D) only.

02 **Centre of Gravity**

To be in the stable equilibrium, the point of suspension should be above the centre of gravity. That is seen in figure (A) and (C) only. If the point of suspension is above the centre of gravity, then laminas will come back to their equilibrium position after swinging when you give a

small displacement. If the lamina of (B) is given a pull, then it will not come to its initial position.

It is doubtful whether figure (D) was confusing to the students. Even though it is seen as it is in stable equilibrium, such a position is known as a neutral equilibrium. The reason for that is,at any given position of the lamina, there can be a stable equilibrium. As the point of suspension and the point of gravity overlap with each other, the lamina can exist in any position conveniently. The weight never will not create a moment around the point of suspension. Is not the "Fortune Cycle" that has been used in some competitions like this? The stopping probability is same for any position. Otherwise, the competition will get complex.

Even though the 25th question of paper 2002 is not the same, it has the same meaning of this. Look at the review of it.

15. Which of the following statements is correct with regard to the angle of deviation (d) of a monochromatic ray of light, produced by a glass prism.

(1) d is independent of the angle of incidence.

(2) d always increases with the angle of incidence.

(3) d always decreases with the angle of incidence.

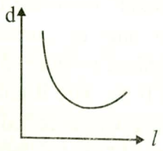
(4) d has aminimum value and it is independent of the angle of prism.

(5) d has aminimum value which is dependent on the angle of prism.

Optics 03

This is a small theory question. You should instantly remember that, how the angle of deviation (d) varies with angle of incidence (i).

If you have this image created in your mind, then you can see that (1), (2) and (3) are wrong.



Understand the reason why the word 'always' has been bold. It is true that there is a minimum value for d. But it is dependent on the angle of the prism. If you can recall the equation for minimum deviation, then this point will be clear to you instantly.

16 Which of the following images cannot be formed by a concave mirror of focal length f?

(1) Real inverted image larger than the object.

(2) Virtual erect image larger than the object.

(3) Inverted image larger than the object, and formed at a distance more than 2f.

(4) Inverted image having same size as the object.

(5) Inverted image smaller than the object, and formed at a distance more than 2f.

Reflection 03

This is a question of Ordinary Level. You need to find the wrong one by reading each choice, one by one properly. A real and inverted image larger than the object can be created. That is when the object is in between f and 2f. Choice number (3) also mentions this. A large, non-real and non-inverted image can be created when the object is in between the pole and f. You can get (4) on 2f. Then only (5) remains. If (3) is correct, then you could not get (5).

17. A calcular hole is made in a steel sheet of linear expansivity $1.2 \times 10^{-5}\ ^0C^{-1}$. When the temperature of the sheet is raised by 100 ^{0}C the area of the hole

(1) is increased by a fraction of 2.4×10^{-3} (2) is decreased by a fraction of 2.4×10^{-3}

(3) is increased by a fraction of 1.2×10^{-3} (4) is decreased by a fraction of 1.2×10^{-3}

(5) remains unchanged.

04 **Expansion of Solids**

This is a question that has been given many times. Look at the 41st question of paper 1987 and the 10th question of paper 1998. All answers have fractions. It means the fraction of (increased area/initial area). Therefore, the question can be done from the memory. You do not have to run around by writing equations. The answer is achieved by $2\alpha\Delta\theta$. The temperature increment is 100 (10^2). Therefore, when 1.2 is multiplied by 2, it is 2.4. When 10^{-5} is multiplied by 10^2, it is 10^{-3}. Why do you need rough papers? It is a work of going to hell if you have not practiced these methods as such questions have been asked before.

18. Three identical straight metal wires are subjected to the following changes separately

(A) the length is increased by stretching. (B) the temperature is increased.

(C) the wire is coiled into a solenoid.

Which of the above will cause an increase in the resistance of the wire?

(1) (A) only. (2) (B) only. (3) (C) only.

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

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

What is the difficulty in this question? Once the length and the temperature are increased, is not there an increase in the resistance of a metal wire? Do you need equations to decide this? In semi-conductors, the resistance is reduced when the temperature is increased. Look at the 19th question in paper 1999. If the wire is coiled like a solenoid, there is no such effect on its (ohmic) resistance. But once a wire is coiled as asolenoid, its inductive resistance gets increased. Yet, this is not in Advanced Level syllabus.

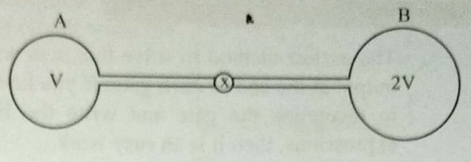
19. An electric water heater has to supply hot water at 40^{0}C at a constant rate of 1 kg s^{-1} from water at 30 ^{0}C. If the heat loss to surroundings is neglected, the minimum power of the heating element of the heater should be (specific heat capacity of water is 4200 J $kg^{-1}\ ^0C^{-1}$)

(1) 4.2×10^4 W (2) 4.2×10^3 W. (3) 1.2×10^4W. (4) 1.8×10^4 W (5) 1.8×10^3 W.

04 **Calorimetry**

This is also a question that has been given many times. Look at the 19th question of 2001. Is not this the same question? Can't you do it from memory? The temperature difference is 10. It has been given to ease the calculation. The rate of water is 1 kgs^{-1}. So, don't you get the answer by multiplying 4200 by 10? Writing equation to this is a crime which is unbearable to the Earth. The answer is 4.2×10^4.

20. Two containers A and B of volumes V and 2V respectively, are connected by a narrow tube via a tap as shown in the figure. Initially, the tap is closed and Aand B, each contains n moles of an ideal gas at same temperature. When the tap is opened and the steady state is reached the number of gas moles remaining in A is



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

This is not a totally uncommon or unfamiliar question. But 99% children spent more time on this question is my belief. Can't this be done in a simple way? Do we need to write many equations as in a normal question?

If you think like this is not it easy? The temperature is equal in both of the bulbs and contain same number of gas moles. Therefore, their multiplication of (PV) should be equal. That means the pressure of bulb A should be greater than the pressure of bulb B as the volume of A is less than of B. As the temperature and volumes are unchanged, if we can find the final pressure in terms of initial pressure in bulb A, then the remaining number of moles will be in that same ratio with its final number of moles. Once the tap is opened, is not the total pressure of the system 2/3 of the initial pressure of A? If you need a calculation for this finding, take the initial pressure of A as P and the final pressure as P'. $2PV = P' 3V \rightarrow P' = 2/3\ P$. Then, the remaining number of moles are 2/3 n. This can be done from the memory for a child who thinks like me. Even it is not necessary to write the above equation.

Why cannot for a child who does not see the equality in multiple of (PV)initially, see the initial pressure of B as P/2 when the pressure of A is P? The number of moles and temperature are the same. Then in if P is the pressure in volume V, then in volume 2V is not the pressure P/2? If an equation is written, then $PV + (P/2)\ 2V = P'\ 3V$. There is no wrong in writing this equation (for a child who does not see it from memory). But it is a sin to write more equations than this. No doubt that you may scold the mothers and grandmothers of the paper makers if you do the questions in the following traditional way.

$P_1V = nRT \quad P_2 2V = nRT$

$(P'V/RT) + (P'2V/RT) = 2n$

21 The second input of the gates shown in the diagram are connected to binary 1. Of the gates, performances are identical only in

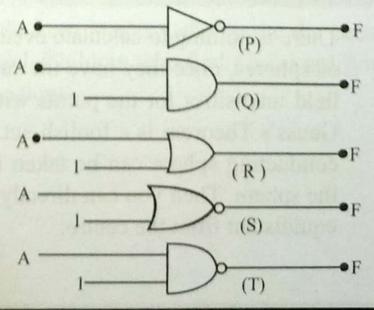
(1) P and Q

(2) Q and R

(3) R and S

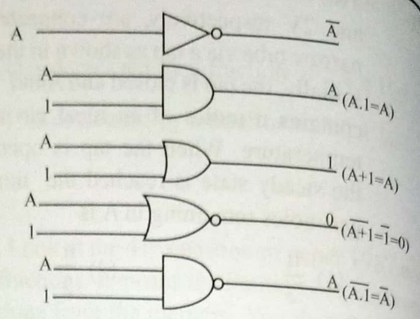
(4) S and T

(5) P and T



The easiest method to solve this is to write the output at the end of each gate. If you know how to recognize the gate and write the Boolean expressions, then it is an easy work.

Therefore, identical functionality is there for P and T. The answer can be obtained even by looking at the gate for a child who has practiced them. As the second input is connected to binary 1, NAND gate is equivalent to a NOT gate.

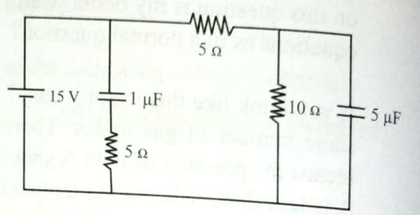


22. In the circuit shown, the charges on the 1 μF and 5 μF capacitor are respectively

(1) 15 μC,75 μC (2) 15 μC,50 μC

(3) 15 μC,25 μC (4) 5 μC,50 μC

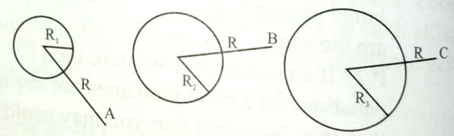
(5) 5 μC,10 μC



06 Electrostatic Potential

This can be done from the memory if you really need.There is no current flow across 5Ω (series with 1 μF) once it has come to a continuous state. Therefore, total 15 V is applied across 1 μF. If so, the charge is 15 μC. Then we need to find the voltage difference across 5 μF. There is a continuous current flow across 5 Ω and 10 Ω. Then do you need to do calculations to find the voltage drop across 10 Ω? Is not it 10 V? Are not you ashamed to do calculations of 15 V that should be divided between5 Ω and 10 Ω (1:2 ratio)? Hence, the charge of 5 μF is 50 μC (5 X10).

23. Figure shows three conducting spheres of radii R_1, R_2 and R_3 ($R_1<R_2<R_3$) each carrying a charge Q. If the electric field intensities at points A,B and C at a distance R from the centre of each sphere are E_A, E_B and E_C respectively, then



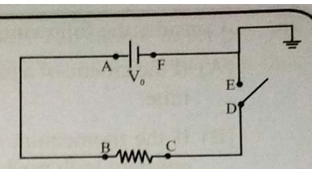
(1) $E_A > E_B > E_C$ (2) $E_A = E_B = E_C$ (3) $E_A < E_B < E_C$

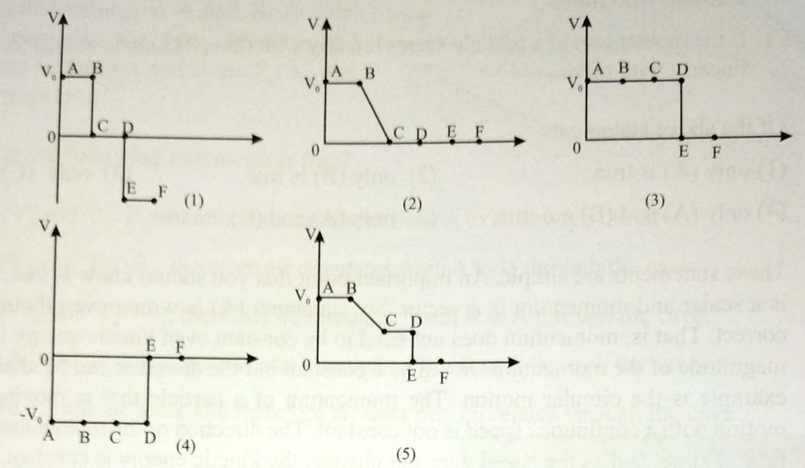
(4) $\frac{E_A}{R_1} = \frac{E_B}{R_2} = \frac{E_C}{R_3}$ (5) $\frac{E_A}{R_1^2} = \frac{E_B}{R_2^2} = \frac{E_C}{R_3^2}$

06 Gauss Theorem

There is nothing to calculate even though it is seen as a big question. Irrespective of the radii of spheres, once they have the same chargers outside the spheres, don't they have the same field intensities for the points with same distance from the centre? Writing equations using Gauss's Theorem is a foolish act. You can think in a simpler way like this. The charge in a conducting sphere can be taken into the centre with relative to apoint that is outside from the sphere. Then you can directly get that, the field intensities are equal of all points that are equidistant from the centre.

24 The battery in the given circuit has negligible internal resistance. The potential variation around the circuit when the switch is open, is best represented by





Potentiometer **08**

This should not be confused. As the switch is opened, there is no current from the circuit. Therefore, there is no voltage drop across the resistor. Then the potentials should be the same in the points of A, B, C and D. As the point E is earthed, point F and itself have zero potential. This has been represented in graph (3). On the other hand, the equal potentials of A, B, C and D has been only drawn in (3). Can you draw the variation once the switch is closed?

25. A defective eye of a person has a near point at 0.5 m. The magnitude of the power of the lens that the person has to use in order to bring the near point to 0.25 m is

(1) 2 diopters. (2) 1 diopters. (3) 0.5 diopters.

(4) 0.75 diopters. (5) 2.5 diopters.

Defects of Vision **03**

Such questions can be seen in any question paper. Look at the 18th question of paper 2001. Cannot you do it from your memory even there is a small calculation? The object that is in 0.5 m should be seen as it is at 0.25m. $\frac{1}{0.25} - \frac{1}{0.5} = \frac{1}{f}$ Even 1/f is asked, not f. All the distances are given in m. So, what else do you need? Do you need to put an effort on this? Is (1/0.25) not 4? Is (1/0.5) not 2? Then the power of the lens is (4-2) 2 Diopters. Is not it? As mentioned above, for a child who has a practice on such questions can do them from memory. 1/0.25 is 4. 1/0.5 is 2. When 4 is subtracted by 2 is 2. If you cannot do from memory, then write the equation and do according to the previously mentioned method. Children who find f by simplifying it more and then finding 1/f again cannot do all 60 questions.

26. Consider the following statements.

(A) If the kinetic of a particleis constant with time, its momentum should also be constant with time.

(B) If the momentum of a particle is constant with time, its kinetic energy should also be constant with time.

C) If the momentum of a particle varies linearly with time, its kinetic energy should also vary linearly with time.

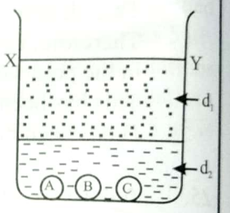
Of the above statements

(1) only (A) is true. (2) only (B) is true. (3) only (C) is true.

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

These statements are simple. An important point that you should know is that, kinetic energy is a scalar and momentum is a vector. So, statement (A) is wrong even though it is seen as correct. That is, momentum does not need to be constant even kinetic energy is constant.The magnitude of the momentum should be a constant but the direction can be changed. A simple example is the circular motion. The momentum of a particle that is moving in a circular motion with a continuous speed is not constant. The direction of the momentum changes from time to time. But as the speed does not change, the kinetic energy is constant. Statement (B) is correct. Statement (C) is wrong. As the kinetic energy is proportional to the square of the momentum, (C) cannot never be correct.

27. A beaker contains two immiscible liquids having densities d_1, and d_2. Three spheres A, B, C made of materials of densities d_A,d_B, and d_C,respectively. are released from the bottom of the beaker. If $d_1 < d_B < d_A < d_2 < d_C$,



(1) sphereC will reach the surface XY and come to rest.

(2) all spheres will reach the surface XY and come to rest.

(3) none of the spheres will move up.

(4) spheres A and B will reach the surface XY and come to rest.

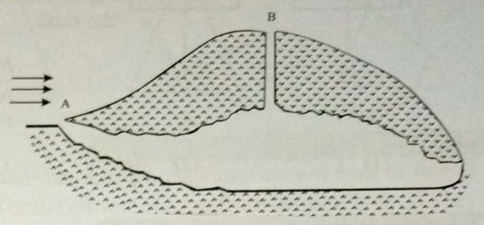
(5) sphereC will stay at the bottom.

Hydrostatics

Even though it is seen as a complex problem, you can get the answer if you think in a simple way. Do not try to write equations for such questions. Solving by writing equations is never expected. If you start to write equations, then it is not a MCQ question. Do not you get it from the first choice? Out of all, the material made of sphere C has the highest density. So, how can it come up? If it is not coming upwards, then it is implying that it is at the bottom. It not it? From that you can find the correct answer as (5). If the choice (1) is wrong, then (2) is automatically wrong. How can other spheres come up if sphere C cannot come up? You can see that obviously (3) is wrong. For example, as $d_A < d_2$, A starts to go upwards. In these choices, the phrase 'goes to XY surface and remains at rest' is mentioned. You cannot simply decide that. Even if a particular sphere has come up, how can you decide whether it reaches the XY surface or not without knowing the height of the liquid levels? Therefore, these phrases might have been included to the choices by the examiners with a purpose to remove the irrelevant choices directly. Then automatically you can decide that, the correct choice is (5). This is an IQ question. You must correctly understand such questions. Otherwise, you will be lost with

confusion. May all gods bless you if you start to write equations! You cannot never provide answers to all 60 questions with the same logic and thinking pattern. This is a question that should be solved with the logic.

28. Figure shows an underground cave with two small openings at A and B. A wind is blowing over the cave. Pressure and velocities of air at A and B are P_A, V_A and P_B, V_B respectively.



Which of the following statements is true?

(1) $V_A > V_B$ and $P_A > P_B$, therefore air circulates from A to B through the cave.

(2) $V_A < V_B$ and $P_A > P_B$, therefore air circulates from A to B through the cave.

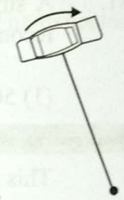
(3) $V_A < V_B$ and $P_A < P_B$, therefore air circulates from B to A through the cave.

(4) $V_A > V_B$ and $P_A > P_B$, therefore air circulates from B to A through the cave.

(5) P_A and P_B, are the same and therefore air does not circulates through the cave.

This is a great application of Bernoulli's Theorem. The velocity of flowing gas at B is greater than A as the flow lines are convergent at B. So, $P_B < P_A$ as $V_B > V_A$. So, air is flowing from A to B inside the cave. The correct choice is (2). This is how some cave living beings like insects get air.

29. A toy car connected to a fixed point by an elastic string as shown in figure, travels in a horizontal circle of radius 2r. The initial unstretched length of the elastic string is r. The period of rotation of the car is T. The car is then speeded up until it is moving in a circle of radius 3r. If the string If the string obeys Hooke's law, and resistive forces are negligible, the new period of rotation of the car will be



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

It will be a lengthy process if you use equations without using the proportionality method. As the string is elastic, the tension of the string is proportional to the increased length. Due to the circular motion, tension is proportional to $r\omega^2$. Ω is proportional to $(1/T)$.

For the first instance, $r \propto 2r.\frac{1}{T^2}$

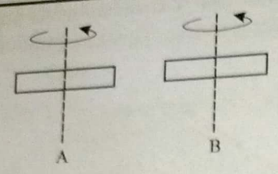
Increased length is r.(2r-r). The radius of the moving circle is 2r. ω^2 is proportional to $(1/T^2)$.

For the second instance, (increase length 3r-r) $2r \propto 3r\frac{1}{T'^2}$

Once you divide the equations, $\frac{1}{2} = \frac{2}{3}\frac{T'^2}{T^2} \rightarrow T' = \frac{\sqrt{3}}{2}T$

More time is consumed if it is not done by the proportionality method.

30. Two uniform rods A and B having same dimensions but made different materials of densities d_A and d_B rotate as shown in the figure. If the rotational kinetic energies of therods are same, then the ratio,



$\frac{\text{Angular momentum of A}}{\text{Angular momentum of B}}$ is given by

(1) 1 (2) $\frac{d_A}{d_B}$ (3) $\left(\frac{d_A}{d_B}\right)^2$ (4) $\left(\frac{d_A}{d_B}\right)^{\frac{1}{2}}$ (5) $\left(\frac{d_A}{d_B}\right)^{\frac{3}{2}}$

02 **Rotational Motion**

You can get the answer conveniently if you can solve this question also using the proportionality method. Rotational kinetic energy is equal to $(L^2/2I)$. L is the angular momentum where as I is the moment if inertia. Translational kinetic energy is equal to $(P^2/2m)$. Linear momentum is displaced by the angular momentum. Mass is cut off from the moment of inertia.

If the rotational kinetic energies are equal, $\frac{L_A}{L_B} = \sqrt{\frac{I_A}{I_B}}$

You do not need to know the expressions for the moment of inertia. We know that, the moment of inertia is dependent on mass and dimensions (length). The dimensions are equal in these rods. Therefore, the moment of inertia is directly proportional to the density. Once the volume of the rod is multiplied by the density, you can get the mass. Therefore, the correct answer is (4). On the other hand, a square root can be only be seen in (4). I think that children might have spent more unnecessary time on the question number 27, 29 and 30.

31. A string is stretched between two fixed supports. It is observed to have two consecutive resonant frequencies at 300 Hz and 400 Hz. The lowest resonant frequency of the string is

(1) 50 Hz. (2) 100 Hz. (3) 150 Hz. (4) 200 Hz. (5) 300 Hz.

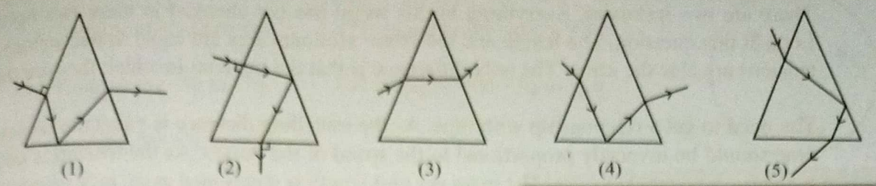
03 **Transverse Waves**

This is like the 56th question of paper 1988. Are not the resonant frequencies lie in 1: 2: 3: 4: 5 ratios in a string with two fixed ends? If the length of the string is L and starts with fundamental tone, then are not the wavelengths in 2L, L, 2L/3, L/2? Therefore, the frequencies lie in $\frac{1}{2}$: 1 : $\frac{3}{2}$: 2 (1: 2: 3: 4). So, the minimum resonant frequency or the fundamental frequency should be 100 Hz.

56th question of 1988: When a string that is plucked from the middle has two overtones of 300 Hz and 500 Hz, what is its fundamental frequency?

Here it has been mentioned that the string is plucked from the middle. Then it cannot have even frequencies. For example, there cannot be values like L or L/2 for wavelengths. Therefore, the frequencies lie in 1: 3: 5 like that. But here the answer is 100 Hz. In the question of 2003, it has not been given that the string is plucked from the middle. In that way, the stupid answer which is 'the question of 2003 is not the question of 1988' is not expected from an intelligent child.

32. Which of the following is a possible path of a ray of light through a glass prism placed in air?



Refraction **03**

This is an Ordinary Level question. On the other hand, such questions are not hard to find in the previous papers. Figure (5) can be decided as the correct answer from the first look. If a ray is entering or exiting a surface perpendicularly to the surface, it cannot go to another direction other than the perpendicular direction in refraction. From that (1) and (2) can be removed. The path of the ray in the second surface is wrong in (3). It should go away from the normal. Likewise, in (4), the ray should bend towards the normal.

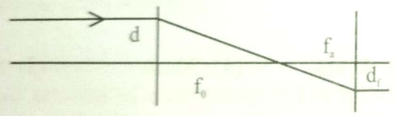
33. An astronomical telescope is in normal adjustment. The diameter of the incident light beam falling on the objective is d. If the angular magnification of the telescope is m the diameter of the emerged beam is

(1) $\frac{d}{m}$ (2) dm (3) $d(m+1)$ (4) $\frac{2d}{m}$ (5) $\frac{d}{2m}$

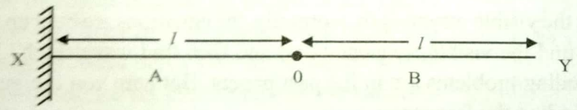
Optical Instrument **03**

This is the 40th question in paper 1992. In that there is a figure. The answer is (1). You can answer from the memory as it is a question that has been asked before. As the focal length of the eye piece is shorter than the focal length of the objective in a telescope, the diameter of the exiting beam clearly should be lesser than the diameter of the incident beam. The expected answer is d/m as the magnification needed to be greater than 1.

If you want to get the answer, just draw the following using a ray.



$$\frac{d}{f_o} = \frac{d_1}{f_e} \rightarrow d_1 = \frac{f_e}{f_o} d = \frac{d}{m}$$



34. Two string (A and B) having equal lengths (l) and equal cross sectional area but different densities (d_A and d_B) are connected together, and the composite string is stretched across fixed walls as shown in the figure. Two pulses simultaneously sent along A and B from the two ends X and Y at t = 0 are found to pass through the centre O of the string at times t_A and t_B. If $d_A = 4d_B$, then

(1) $t_B = \frac{1}{4}t_A$ (2) $t_B = \frac{1}{2}t_A$ (3) $t_B = t_A$ (4) $t_B = 2t_A$ (5) $t_B = 4t_A$

Transverse Waves **03**

For questions like these, you need to use the proportionality method again. You should know this by the hint when it is described as two instances or locations. If you get familiar to the methods that I mention, you will get the experience and the knowledge to solve such problems.

Look at question 29, 30 and this one as they can be solved using the proportionality method. There are two instances. Everything in this world has not changed in these two occasions. Look at this question. The length and the cross- sectional area are equal in two strings. Their tensions are also the same. The only difference is that the material in which they are made.

You need to get a relationship with time. As the travelling distance is equal,the associates of time should be inversely proportional to the speed of the pulses. As the tension is equal, the speed is proportional to $\frac{1}{\sqrt{m}}$. The mass per unit length is mentioned as m. m is proportional to the density of the material (m= Ad where A is same in both).

Start the question like this in the rough paper.

$$t \propto \frac{1}{V} \propto \sqrt{d}$$

$\frac{t_B}{t_A} = \sqrt{\frac{d_B}{d_A}}$ Now the answer is in hand. $t_B = \frac{1}{2} t_A$

Look how easy is the question if you use this method. I think that only very few children initiate the question like this. I know there are children who try to do MCQs according to the methods that I think. Majority is lazy to think like this or they are backward. Some think that he/she should be a genius to solve problems like this. They have the negative attitude that 'we cannot solve like this'. This is a big joke. All of you are intelligent. All you need is to use your brain and guide it. What is the use of unused intelligence? For a child who has mastered this method, can write

$t \propto \sqrt{d}$ directly. Then the answer is evident in front of the eyes. Otherwise, multiples of 4, 9, 16 are given because their roots can be easily obtainable. Therefore, if such a number is given, the square root is associated with the calculation.

35. A train moving along a straight track at a velocity of 30 m s^{-1} emits a sound of frequency 600 Hz. If the speed of sound in air is 330 m s^{-1}, the wavelength of the sound propagated forward along the track will be

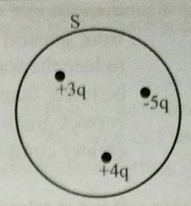
(1) 30 cm. (2) 40 cm. (3) 45 cm. (4) 50 cm. (5) 55 cm.

03 **Doppler Effect**

This question asks the visible wavelength. Normally, the equations are built up for frequencies. Are you going to find the visible frequency first and then find wavelength? It is not wrong. Such frequency finding problems are in the past papers. But here you can get the answer by memory without finding the frequency.

Once you move forward in the path, the propagating wavelength is less as we know that the source is also moving forwards. So, cannot we get the answer if 30 is subtracted from 330 and then divided by 600? Do you need rough papers for that? Answer is 0.5 m when 300 is divided by 600. As the answer is given in cm, 0.5 m is 50 cm. Is not it? True wavelength is (330/600) m. Backward propagating wavelength is (360/600) m. Do you need more equations for these? 330 and 30 are given to get 300 as the difference. Then it can be divided by 600 easily.

36. Net flux through the closed surface S in the diagram can be reversed by



(1) changing the +3q to +4q.
(2) changing the +4q to +3q.
(3) changing the -5q to -7q.
(4) changing the +3q to +1q.
(5) changing the +4q to +1q.

Gauss Theorem 06

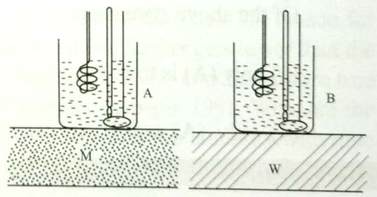
This is not a difficult question. As the net charge inside the closed surface is positive (7q-5q=2q, no need to calculate), you need to find the negative answer from the given choices. The net is positive if $+3_q$, $+4_q$ used. Even the net is still positive if $+4_q$, $+3_q$ used. The net charge gets zero if -5_q, -7_q used. If $+3_q$, $+_q$ used, the net is also zero. The net charge gets negative if $+4_q$, $+_q$ used. Therefore, the correct answer is (5).

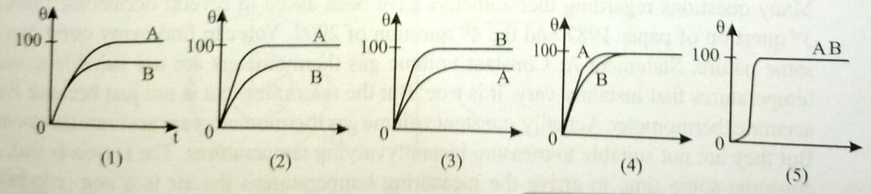
There was a raised question for many people. Now there is a net charge of -q inside S according to (5) even though of initial $+2_q$. There can be no answer according to their logic as the flux get negative (reversed), the magnitude of the flux has been changed numerically. There is a certain validity in their logic too. But flux is not a vector. It is a scalar even though it has a magnitude and a sign. It is more scientific to say that flux has + or – sign rather than saying that flux has a direction (like work). As flux is a scalar, when it is explained to reverse the net flux, the reversing of the flux is only sufficient. It is not necessary to be same in magnitude. For example, reverse a speed means a reverse and that is enough. But reverse a velocity means that we need to consider its magnitude and direction. So, even the above logic is a good one, it is not relevant here.

Even the net charge is negative only in (5). It has been instructed to find the correct or the most suitable answer in the paper. According that view, there is no problem in (5). It does not imply that Physics is wrong in (5). There is no weakness in the question.

Here the adjective 'net' is used to flux because we need to consider positive charges as well as negative charges in flux.

37. Two identical thin metal cans A and B containing equal amounts of water are heated using to identical domestic electrical heaters. As shown in the figure, the cans A and B are kept on a large metal block (M) and a large wooden block (W) respectively. Which of the following curves best represents the variation of temperature (θ) of water in A and B with time (t)?





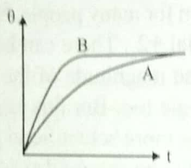
Conductivity 04

You do not have to think a lot. The amount of water is equal. Two heaters and the containers are identical. The only difference is that A is kept on a metal block. You do not need to know Physics to identify that, the rate of heat loss from the container on the metal block is greater

than the rate of heat loss from the container on the wooden block. You can get the experience from general knowledge. It is better to keep the container on a metal block if you need to reduce the warmth of the water very quickly. So, the rate of temperature increment of A should be lower than of B (as A has the highest heat loss). Even from this point you can get (3) as the correct graph. Only one graph is drawn as the rate of temperature increment of B is always greater compared to A.

It is not relevant to the question that the temperature gets constant after some time. As the rate of heat loss is less in B, it arrives to 100. The water of A does not come to 100. That means the rate of heat supply from the heateris equal to the rate of heat loss before it arrives to 100. So, the power of the heater is not capable to take towards 100. Understanding these facts are not relevant to the question. You can get the answer quickly from the gradients of Q-t curves.

If you increased the power of the heater more, curve A will also arrive 100 later. Therefore, there is wrong in the following curves.



But such a curve is not given. If it was given, then you need to have an idea about the power of the heaters to find the correct choice. The question is not given for heaters with high powers. Therefore, the temperature of A becomes continuous before it reaches 100.

38. Consider the following statements **carefully**.

(A) Constant volume gas thermometer is not suitable for measuring rapidly changing temperature becauseit is not an accurate thermometer.

(B) Thermocouple is suitable for measuring rapidly changing temperatures because its heat capacity is large.

(C) Mercury-in-glass thermometer is not suitable for measuring rapidly changing temperatures because its heat capacity is very small.

Of the above statements.

(1) only (A) is true. (2) only (B) is true. (3) only (B) and (C) are true.

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

04 **Thermometry**

Many questions regarding thermometers have been asked in several occasions. Look at the 3rd question of paper 1987 and the 4th question of 2002. You can find many questions of the same nature. Statement A: Constant volume gas thermometers are not suitable to measure temperatures that instantly vary. It is true. But the reason for that is not just because it not an accurate thermometer. Actually, constant volume gas thermometers are accurate thermometers. But they are not suitable to measure instantlyvarying temperatures. The reason is that, it will consume some time to arrive the measuring temperatureas the air is a non- conductor of heat. So, (A) is wrong. Statement B: Thermo electric couple is suitable to measure instantly varying temperatures. It is true but the second part of the statement is wrong. Heat capacity is very small in thermo electric couple (Its joints are good thermal conductors). Therefore, (B) is also wrong. Statement C: There is no problem to use mercury to measure instantly varying

temperatures as it is a good heat conductor. But it does not have very small heat capacity. It does not have a less heat capacity like thermo electric couple.

Therefore, all the three statements are wrong. At the beginning of the question, it has been mentioned to consider carefully as some parts of the statement may be correct whereas the other part may not be correct. Normally, it very uncommon to get all statements as wrong in Physics MCQ paper.

39. Consider the following statements made about the space just above a small block of ice placed in still air at a school laboratory, where room temperature and the relative humidity are 30^0C and 80% respectively.

(A) Absolute humidity of air in the space just above the ice block is higher than the absolute humidity of air away from the block.

(B) Relative humidity of air in the space just above the ice block is higher than the absolute humidity of air away from the block.

(C) Air in the space just above the ice block is drier than the air away from the block.

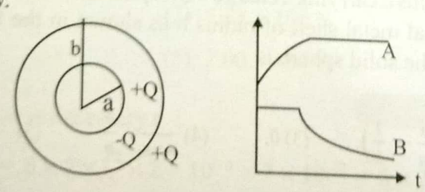
Of the above statements

(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.

There is no room to be difficult in this question. Such questions are also being asked in different modes many times. Look at the 32nd question of paper 1991 and the 51st question of paper 1993. The temperature of the air that is near to an ice block is also nearly 0^0C. Therefore, this temperature is very less than the dew point. The water vapour inside it get condensed. So that, its absolute humidity gets decreased whereas the relative humidity gets 100%. The gas is considered as 'dry' when its absolute humidity is less. Then what is the difficulty in this question?

When ice is put into a glass, water condenses at the outer surface of the glass. The reason for that is, the temperature of the air near to the glass gets reduced and further gets lesser than the dew point. Then the water vapour gets condensed and deposited. These conclusions are true for this air. The correct answer is (3). Look at the 32nd question of paper 1991. What are the graphs that represent relative humidity with time (curve A) and absolute humidity with time (curve B) of a first-time functioning, closed and empty refrigerator in Sri Lanka? The correct graph is as below.



When the temperature gradually decreases, the relative humidity increases. The absolute humidity remains constant until the dew point. That is because the mass of water vapour in a certain volume is constant. But after the dew point, the absolute humidity gradually gets decreased whereas the relative humidity remains 100%. Same knowledge has been checked in the 56th question of paper 2002.

The 51st question of paper 1993: Most of the time, where can we find a possible place of maximum relative humidity and minimum absolute humidity?

1) Little above a boiling water surface

2) Little above an ice block which is kept in still air of 30°C

3) Inside a closed room of dew point temperature

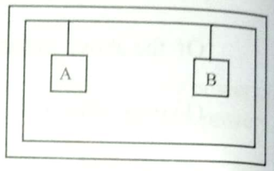
4) Inside a closed deep freezer which is in -10°C

5) Inside a room full of people with less ventilation

The correct answer is (4). That is because the refrigerator is in -10°C. Then (2) has the maximum relative humidity and minimum absolute humidity. It is because the next minimum temperature is above the ice block. Absolute humidity is at a high value inside a room full of people and above the boiling water surface. That is because there is ample water vapour.

So, is the question of 2003 a question for a student who studied this question intelligently?

40. Two blocks A and B initially at 80 °C and room temperature (30 °C) respectively are hung from insulated string in an evacuated and conducting enclosure which is at room temperature. The enclosure is insulated from outside. Which of the following statements is correct prior to the system being reached equilibrium?



(1) Temperature of A, B and the enclosure remain uncharged.

(2) Enclosure remains at room temperature but the temperatures of A and B change.

(3) Temperatures of the enclosure and the block B increase, but that of block A decreases.

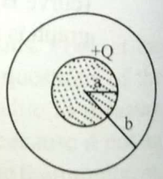
(4) Temperature of the enclosure increases but that of A and B remain uncharged.

(5) Temperatures of A and B decrease but that of enclosure increases.

11 **Radiation**

This is an Ordinary Level question even though it is seen as a big question. Initially if A is at 80 °C and B is at 30 °C with the room in temperature, then the temperature of B should increase an A should decrease before coming to its continuous state. What else can happen children? Even there is no air in the room, the heat loss occurs due to radiation. This is general knowledge. Anyone who does not know the basics of Physics can answer.

41. A solid metal sphere of radius a carrying a charge +Q, is placed concentrically inside an isolated spherical metal shell of radius b as shown in the figure. The electric potential of the solid sphere is



(1) $\frac{1}{4\pi\epsilon_0}\frac{Q}{a}$ (2) $\frac{1}{4\pi\epsilon_0}Q\left(\frac{1}{a}-\frac{1}{b}\right)$. (3) 0. (4) $\frac{1}{4\pi\epsilon_0}\frac{Q}{b}$ (5) $-\frac{1}{4\pi\epsilon_0}\frac{Q}{a}$

06 **Electrostatic potential**

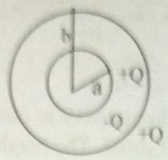
There is an induced charge as -Q in the inside surface and +Q in the outside surface of the outer sphere. The electric potential of the sphere = $\frac{1}{4\pi\varepsilon_0}\left[\frac{Q}{a}-\frac{Q}{b}+\frac{Q}{b}\right]=\frac{1}{4\pi\varepsilon_0}\frac{Q}{a}$

Actually, if you have done more such questions, you can get the answer directly. This has been

discussed in detail in the 3rd essay question of year 2001. If the outer sphere is earthed, the sphere has -Q charge only. If so, the potential of the inner sphere is $\frac{Q}{4\pi\varepsilon_0}\left[\frac{1}{a}-\frac{1}{b}\right]$.

Potential of the outer sphere is $\frac{1}{4\pi\varepsilon_0}\left[\frac{Q}{b}-\frac{Q}{b}\right]=0$.

A question about earthed outer sphere is there in the 47th question of 1987.



42. The mass of mars is 0.1 times that of Earth. The distance between the Sun and Mars is 1.5 times the distance between Sun and Earth. The ratio

$\frac{\text{Gravitational force of attracion between the Sun and Mars}}{\text{Gravitational force of attracion between the Sun and Earth}}$ is

(1) 1 (2) $\frac{0.1}{(1.5)^2}$ (3) $\frac{1}{(1.5)^2}$ (4) $\frac{(1.5)^2}{1}$ (5) $\frac{(1.5)^2}{0.1}$

This can be done by using the proportionality method. As you know the equation for gravitational force, you can directly write it. But there is no need to write G and the mass of the Sun. They will cut off as the ratio is being asked here. You can directly use the data once you are writing the ratio. The needed ratio $=\frac{M_1 R_2^{\,2}}{R_1^{\,2} M_2}$

M_1 = mass of Mars M_2 = mass of Earth

R_1 = the distance between Mars and Sun R_2 = distance between Earth and Sun

You can look at the above expression and write the answer. It is easy as there is no need to simplify. Use the given data and substitute to the above symbols.

$=\frac{0.1}{1.5^2}$ Avoid using unnecessary symbols.

43. A six-legged insect stands on the surface of water. The radius of each circular flat foot is 2×10^{-4} m. The maximum weight of the insect that can be supported by water surface is (surface tension of water is 7×10^{-2} N m^{-1})

(1) 8.80×10^{-5} N (2) 5.28×10^{-4} N (3) 5.28×10^{-8} N

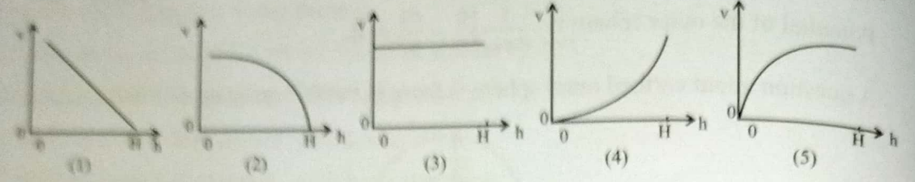
(4) 8.80×10^{-9} N (5) 2.00×10^{-4} N

A simple calculation is necessary.

Maximum weight $= 6\times2\times\frac{22}{7}\times2\times10^{-4}\times7\times10^{-2}=6\times2\pi rT$

Once it is written, you do not have to write unnecessary steps to simplify. 7 is cut off by 7. All you need is to simplify the rest. The correct answer is (2). The logic in this is common to normal surface tension questions. Surface tension forces acted by the surface on the legs should be equal to the weight. Surface tension forces cannot balance a weight more than this value. Do not forget to consider that there are 6 legs.

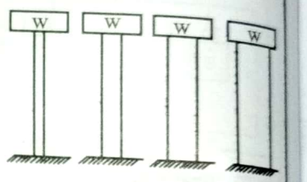
44. A small rain drop releases from a cloud at a height H above the earth surface. The variation of the speed (v) of the rain drop with height h from the earth surface is best represented by

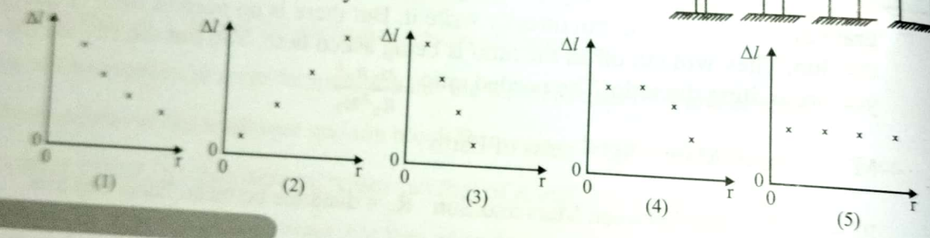


(1) (2) (3) (4) (5)

This is a known question. But you do not have to change the sides. It is a known fact that a small rain drop attains to its terminal speed. The height is measured from the Earth's surface. That means when the rain drop comes down, h gradually reduces. The height h is starting from H. Therefore, in a small value of h, it attains to its terminal speed. So, the correct shape is (2) not (5). There is a tendency to pick (5) instantly. If so, then you are unlucky. If the distance is measured from the rain drop, then the correct choice is (5). If you get it wrong, then it is not due to ignorance.

45. Consider a situation where weights w are placed on vertical rods of radii r,2r,3r and 4r respectively and made of same material as shown in the figure. If the rods have the same length, and not attained the proportional limit, variation of the compression(Δl) with radius (r) is best represented by





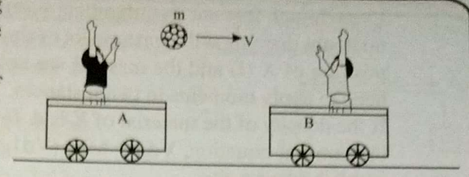
(1) (2) (3) (4) (5)

You do not have to think so far. All the rods are made from the same material. Their initial lengths are the same. Even the loads are also the same. Therefore, is not the compression (Δl) proportional to $1/r^2$?

$$E = \frac{W}{\pi r^2}\frac{L}{\Delta l}$$

The only graph that varies according to $1/r^2$ is (1). You do not need to get scared if it is only marked with points. You need to check the shape of the curve. Actually, the marked points are not the corresponding points according to the respective instances. They are the points that are just marked. If they are the corresponding points, then they should be ¼ of Δl with the corresponding r and Δl should be the corresponding 2r. If this question is just asked (that means to find the variation of r) it is the same. There are four instances to show that, only r does not change continuously. The question has made more practical by drawing for four instances. But whether r is continuous or discrete, it is not affecting to the shape of the curve.

46. Two boys of identical masses are standing on two identical trolleys A and B which are at rest on a frictionless horizontal surface. The boy on trolley A then throws a ball of mass m horizontally with velocity V with respect to the earth and the boy on trolley B catches it. If the mass of a trolley with a boy is M, the respective final velocities of trolleys A and B are



(1) $\frac{-mV}{M}$ and $\frac{-mV}{M+m}$ (2) $\frac{-mV}{M+m}$ and $\frac{mV}{M+m}$

(3) $\frac{-mV}{M}$ and $\frac{mV}{M+m}$ (4) $\frac{-mV}{M-m}$ and $\frac{mV}{M+m}$ (5) -V and V

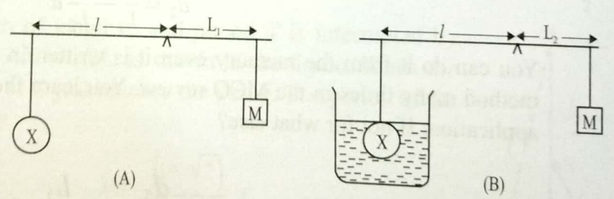
This is also a question that you can get the answer by memory. All you have to use is simple conservation of momentum. Child A is throwing a ball of mass m to the right side horizontally. Then the child in the trolley is recoiled to the left. Velocity to the right is taken as positive. As the mass of child and trolley is M, the velocity to the left is -mV/M. Is not it? Then you can remove the choices (2), (4) and (5).

Once the ball is caught by child B, the trolley and himself are recoiled to the right. Here you can get it wrong by not considering the total mass after the ball is caught by child B as (M+m). Once the child at A is throwing the recoiling mass is M. But once the ball is caught by the child at B, the total mass that is being recoiled is (M+m). Therefore, the velocity of the trolley B is (mV/M+m).

Even this is not being checked here. Once choices (1) and (3) are selected, you can automatically understand that (1) is not correct. Why? Can both A and B trolleys be in the same direction? From the general knowledge we know that trolley A should go to the left whereas trolley B should go to the right. Then A and B cannot have velocities to the same direction. If one is negative, the other should be positive. Choice (1) can be omitted by considering this (about the directions). Then only (2) remains.

A similar question has been given in 1(a) essay question of paper 1996. An ice skater throws away his helmet where another skater catches it. This question is easier than that. But there also you can find conservation of momentum.

47. Fig. A shows the balanced position of a light rod carrying an object X and a mass M. Fig. B shows the balanced position of the same system when X is immersed in water. If the density of water is d, the density of the material made of X is given by



(1) $\frac{L_1}{(L_1-L_2)}d$ (2) $\frac{L_1}{L_2}d$ (3) $\frac{L_1}{(L_1+L_2)}d$ (4) $\frac{(L_1-L_2)}{L_1}d$ (5) $\frac{L_2}{L_1}d$

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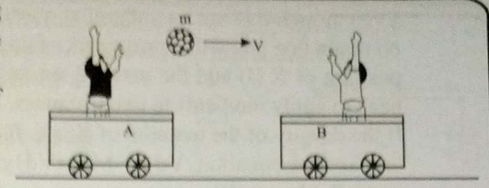

(1) $\frac{-mV}{M}$ and $\frac{-mV}{M+m}$ (2) $\frac{-mV}{M+m}$ and $\frac{mV}{M+m}$

(3) $\frac{-mV}{M}$ and $\frac{mV}{M+m}$ (4) $\frac{-mV}{M-m}$ and $\frac{mV}{M+m}$ (5) -V and V

This is also a question that you can get the answer by memory. All you have to use is simple conservation of momentum. Child A is throwing a ball of mass m to the right side horizontally. Then the child in the trolley is recoiled to the left. Velocity to the right is taken as positive. As the mass of child and trolley is M, the velocity to the left is -mV/M. Is not it? Then you can remove the choices (2), (4) and (5).

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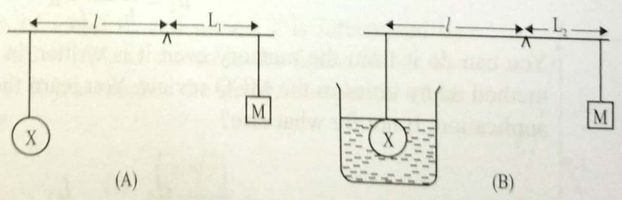


(1) $\frac{L_1}{(L_1-L_2)}d$ (2) $\frac{L_1}{L_2}d$ (3) $\frac{L_1}{(L_1+L_2)}d$ (4) $\frac{(L_1-L_2)}{L_1}d$ (5) $\frac{L_2}{L_1}d$

Even though it is not an unfamiliar question, if you try to solve with the traditional way, then no doubt that you will consume lot of time. You can use the proportionality method again.The position of X (l) and the mass M are not changed. If you are using the normal method, you need to apply moments to two instances. There, you try to balance the moments of both sides. If the density of the material of X is d, for instance A is it wrong to write $d_1 \alpha L_1$? If you write the familiar equation, $Vd_1l = ML_1$ ($Vd1gl = MgL_{1)}$ The bracket shows the equation that very good children write.

V is the volume of X. V, l and M are not changed. Then what is the use of writing them?

If you simply think, the mass of X at instance A is proportional to L_1. There is no sin in such thinking as M and l do not change in the instance B. The mass of X is proportional to its density. You will never get MCQs by changing all of them. If you need a long question, then you can change l and M if you need. On such a case, there is no use in the proportionality method.

Now what is the proportionality statement for the instance? L_2 is proportional to the resultant force that is acting on X there. That is the upthrust. Again, the weight of X is proportional to d_1. The upthrust is proportional to the density of water d (as the volume of X is not changed.) So,$(d_1\text{-}d) \alpha L_2$

Now our good and fair children's equation is, $V(d_1\text{-}d)\, l = ML_2$ [$V(d_1\text{-}d)\, gl = MgL_2$]

Now when the two proportionals are divided with each other, (always divide with one another when there are two terms of proportions)

$$\frac{d_1}{d_1 - d} = \frac{L_1}{L_2}$$

From this point onwards, do not we have a shorter way? Can you think outside the normal way? You can get this equation even if you write the long equations without using the proportional. Even after this do you need to waste the precious time to find d_1?

If the left-hand side only has d_1, is not that the answer? How can you make the left with only d_1? The numerator has d_1. If d_1 from the denominator is removed, then our work is done. Is not it? How can you remove d_1 from the denominator? Subtract numerator from the denominator. Is not d1 removed? Do what is done to the left side, to the right side too.

$$\frac{d_1}{d_1-(d_1-d)} = \frac{L_1}{L_1-L_2}$$

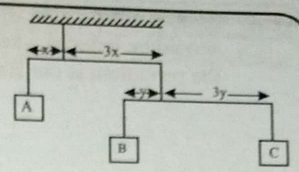
$$d_1 = \frac{L_1}{L_1 - L_2} d$$

You can do it from the memory even it is written in a lengthy way. I have mentioned this method many times in the MCQ review. You learn these to solve more questions with their application. If not for what else?

$$\frac{d_1}{d_1 - d} = \frac{L_1}{L_2}$$

If you cannot get the answer by looking at this expression, you are not a child who has practiced to answer MCQs. I am not telling that you are not intelligent. But you are a lazy person who cannot nail the question according to the situation.

48. Three masses A, B and C are hanging from horizontal crossbars as shown in the figure. Each crossbar has negligible mass. If A has mass 6 kg, the masses of B and C respectively are

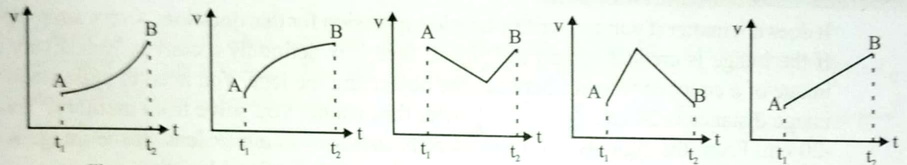


(1) 1.0 kg ; 1.0 kg
(2) 1.5 kg ; 0.5 kg
(3) 3.0 kg ; 1.0 kg
(4) 0.5 kg ; 1.5 kg
(5) 1.5 kg ; 1.0 kg

Equilibrium of Forces 02

Previously this has been given exactly like this. Look at the 21st question of paper 1987. You can solve it from the memory. If not, you should be hung according to the figure in the question as this question has been given before. As A is 6 kg, there should be a corresponding force of 2 kg on the top rod to the right acting down wards (6 X 1 =3 X 2). Now 2 kg should be divided by 3:1 ratio. If you cannot divide 2 kg into 3:1 ratio, then go back to year 5 with your younger sister or brother. I am condemning you for the encouragement and not for rage. The correct answer is (2).

49. In which of velocity (v)– time (t) graphs shown below would the average velocity over the entire period between t_1 and t_2 be equal to the average of the two velocities at the ends A and B of the interval?



Graphs of Motion 02

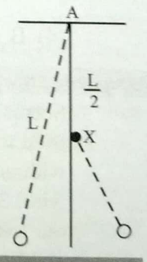
I do not know how far children have thought about this question. If the average of two ends of a quantity is equal to the average of the whole limit, then that variation should be definitely a straight line. This cannot be satisfied in a curve. The answer is (5).

To get the average of a variation, then the corresponding limit should be divided by the area of the curve with X axis.

Average value = $\frac{V_1+V_2}{t_2-t_1} \times \frac{t_2-t_1}{2} = \frac{V_1+V_2}{2}$

$(V_1 + V_2) \times \frac{(t_2-t_1)}{2}$ is the area of the trapeze. For a different shape, this is not equal to $\frac{V_1+V_2}{2}$.

50. Motion of a simple pendulum of length L and period T is interrupted by an object placed at X, where AX = 1/2L as shown in the figure. When the pendulum is at rest the object at X just touches the string. The period of the resultant pendulum is given by



(1) T
(2) $\frac{T}{\sqrt{2}}$
(3) $\frac{\left(1+\sqrt{2}\right)}{2\ 2}$ T
(4) $T + \frac{T}{\sqrt{2}}$
(5) $\frac{T}{2}$

Simple harmonic Motion 03

You can get the answer without going into lengthy equations. Half of the total oscillation happens under T. The relevant time for that half is T/2. The corresponding length is L/2 relative to the other half. As T α $\sqrt{L}$, the oscillatory time should be $\frac{T}{\sqrt{2}}$ to its corresponding L/2.

You do not have to write equations to get this. The other point is that, the oscillatory time should be reduced when L is decreased. Therefore, the oscillatory time can not be $\sqrt{2}T$. Now the pendulum is oscillating with half of T and half of $\frac{T}{\sqrt{2}}$.

$$\frac{T}{2}+\frac{T}{2\sqrt{2}}=\frac{(1+\sqrt{2})}{2\sqrt{2}}T$$

It is clear that the answer is (3), once you write the first part. No need to simplify further. However, the choices (1), (2) and (5) can be directly removed. Then only (3) and (4) remain. Choice (4) has given two times of the oscillatory time. On the other hand, you should know by intuition that the combined oscillatory time cannot be greater than T. T will be there if the initial length was remained until the end. As the length is reduced half of the way, the net oscillating time should be lesser than T.

51. When an object is placed 10 cm from a lens its image is formed 10 cm behind the object. The focal length and the type of the lens respectively are

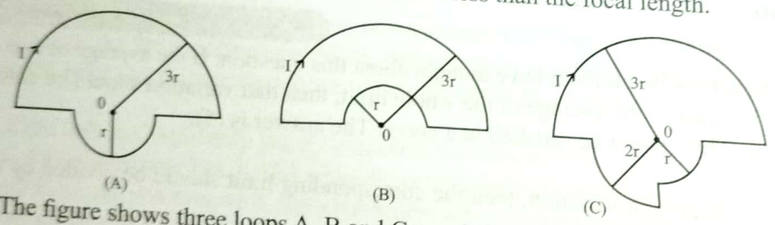
(1) 6.7 cm, concave (2) 6.7 cm, convex (3) 10.0 cm, concave

(4) 10.0 cm, convex (5) 20.0 cm, convex

03 Refraction through Lenses

It does not matter if you can write a simple expression for this question. A very simple problem. If the image is created behind the object, then it is definitely a convex lens. Every time an image of a concave lens lies between the object and the lens. You need to understand that the image distance is 20 cm. $\frac{1}{20}-\frac{1}{10}=\frac{1}{f}$ After this, cannot you solve from memory? You get f = -20 cm. From the sign also you can identify that it is a convex lens. If the image is created behind the object, then the object distance is less than the focal length.

52.



The figure shows three loops A, B and C consisting of concentric circular arcs (either half or quarter-circles of radii r,2r and 3r). The loops carry the same current I. If the magnetic flux densities produced at O by each loop is B_A, B_B and B_C respectively, then

(1) $B_A > B_C > B_B$ (2) $B_A = B_B = B_C$ (3) $B_A > B_B > B_C$

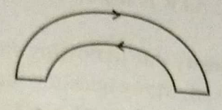
(4) $B_A < B_C < B_B$ (5) $B_A = B_B > B_C$

07 Magnetic Effect of Electric Currents

Seems this question has consumed lot of time. Every child has built up equations and has tried to find big and small from that. If it was done like that, it would have taken 5 minutes without a doubt. 'This time it has given three wires whereas in previous times it was only one wire' Somebody has heard that a teacher was saying like that. It implies that, even some of our teachers are not tuned into MCQ channel. If teachers are like that, needless to talk about children.

You need to identify that such a question is never given to build up equations to get the answer. If that is so, even the people who made the paper cannot do it in 2 minutes. The logic of this question should be built up like this.

In A and C, the current flows clockwise throughout the wire. Only at B, there is a semi-circle with radius r that is bent inwards. Therefore, the current flows in that part in anti-clockwise way.

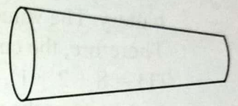


So, the minimum magnetic flux density at O should be in B. In other two, magnetic flux density adds together due toall of the parts. Even if you try to find the magnetic flux density at B, you get that the magnetic flux from 3r should be reduced by the magnetic flux from r. This has been previously asked in another paper.

Out of A and C, which has the least magnetic flux density? You can build a simple logic for that too. The only difference of the two parts is that half of the r semi-circular part is far away in C (as the radius of 2r). Both A and C are the same in other ways. Then who has less? Is not that C? Everything is reduced as long as it is going far away. Is not it? So, the highest is at A and then it is at C. Finally, it is at B. The correct answer is (1).

It is a puzzle why children do not think like this way. This is not due to anything. It is the lack of working alone, thinking and experience.

53. The diameter of a current carrying wire decreases as shown in figure, and the current flows through the wire from left to right. Consider the following statements.



(A) Current decreases along the wire.

(B) Potential drop per unit length increases along the wire.

(C) Magnetic flux density on the surface of the wire due to the current decreases along the wire.

Of the above statements

(1) only (A) is true. (2) only (B) is true. (3) only (C) is true.

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

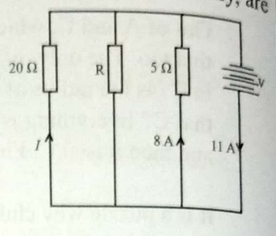
This went wrong for most of the children. Especially the statement (A). Most of us think that, the current gradually reduces when it is getting thinner. This is a wrong conclusion. Consider water that is flowing in a tube. Can the water volume be changed per unit time? AV is always a constant. But when A (cross- sectional area) gets decreased, V (speed) gets increased. Don't we use this in many instances? Same thing happens to the current as well. Current is the total number of charges that flow in a unit time. What will happen if it gets reduced when the wire is thinned? If so, can it get reduced and reduced and finally reduced until it has nothing?

Some argues that when A is reduced, *i* also gets reduced according to the equation, $i=neAV_d$. But when A is decreased V_d gets increased. Therefore, *i* is kept at a constant. But the value of (i/A) is increased when the wire gets thinner. This is the current that flows across a unit area. When a tube gets thinner, the flowing water volume increases across a unit area. But the water volume that flows in a unit time is a constant.

As the current is constant in (B), once the wire gets thinner, the voltage drop per unit length is increased. Why? The resistance per unit length is increased once the wire gets thinner.($R = \frac{\rho l}{A}$) The reason is the reduction of A. As R is increased, the multiple iR gets increased.

In wire (C), the magnetic flux density due to flowing current is dependent upon 1/r. So, when r is decreased, B should be increased. Many question that, does B has a value on the surface of the wire. There is a value for B on the wire too. Most of the time, problems are solved to find B for a point that is away from the wire. But there is a value for B on the surface of the wire. This has been discussed under the 26th question of paper 2001.

54. The battery in the circuit has no internal resistance. The values of V,I and R respectively, are



(1) 20 V, 1 A and 10 Ω (2) 20 V, 1 A and 20 Ω

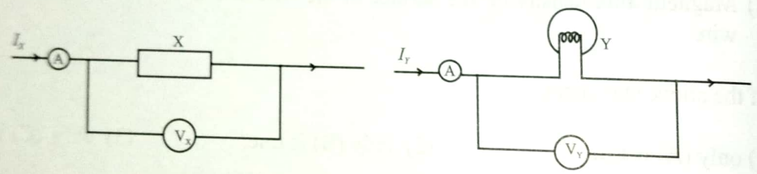
(3) 40 V, 1 A and 20 Ω (4) 40 V, 2 A and 20 Ω

(5) 40 V, 2 A and 40 Ω

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

This can be done from the memory. First get V. The voltage drop across every resistor is V. Resistors are connected parallelly to the battery. Also, there is no internal resistance in the battery. The value of V is directly 40 V (8 x 5). The drop of voltage across 20 Ω is also 40 V. Therefore, the current should be 2 A (40/20). When I value is 2 A, the current across R is 1 A. (11 = 8 + 2 + 1). Then R is 40 Ω. The correct answer is (5). If the relevant values are written in the paper, the task is very easy. It should be reminded again that, writing equations to solve is a stupid act as well as a time-consuming activity. If 4 hours are given to the paper, you can solve like that.

55.



In figure shown, X is a resistor and Y is a torch bulb. When $I_X = I_Y = 2$ mA, $V_X = V_Y = 0.3$ V. When $V_X = I_Y = 40$ mA the filament of the bulb glows. Then the possible voltmeter readings are

(1) V_X=6.0 V and V_Y= 3.0 V (2) V_X= 6.0 V and V_Y= 6.0 V

(3) V_X= 6.0 V and V_Y= 9.0 V (4) V_X= 3.0 V and V_Y= 9.0 V

(5) V_X= 3.0 V and V_Y= 6.0 V

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

This is a question which had lot of problems. If you do not get into the correct tract, you cannot do it in 5 years.

There is no problem in the first circuit. When current I is increased by 20 times, according to V= IR, V_X should be increased by 20 times. That means V_X should be 6V. From that, (4) and (5) can be removed.

The problem was raised in the other circuit. It has been mentioned that the bulb is on when I_Y

= 40 mA. You know that when there is a lit bulb, its resistance is not constant. This has been checked by many times in MCQs.

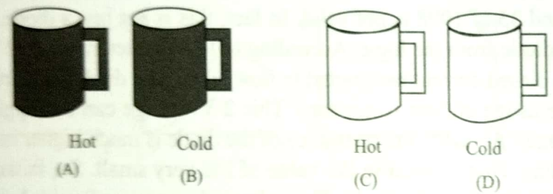
Here the question for most of the people was, what is the correct R to find to get V_Y. Here V_Y actually cannot be calculated. Initially this is the issue that I meant, that you cannot do it for five years. You only have to guess the value of V_Y. Even in the question it has been mentioned with a phrase which is 'the readings can be'. You must decide that V_Y should be higher than V_X. That is when the bulb is lit, V is not linearly increased with I. The only choice that V_Y is higher than 6 V is (3). In (1) V_Y= 3V.V_Y cannot be lesser than 6 V and cannot be 6 V too. If there is a choice of 12 V for V_Y, you cannot find the answer. There is only one choice that is with a higher value than 6 V forV_Y

Many got into trouble by trying to calculate the exact value for V_Y. The real beauty and the curiosity are created by due to this. (I know you will not think like that. It is fair.)

You cannot think every question in the same manner. For one question you need to apply the proportionality method. For another question, it is a calculation. Another should be solved using logic. Even the emission method of choicesone-by-one should be applied on another question.

You cannot find solutions to the questions in life in the same manner. Logic, intelligence, knowledge, experience, mind image creation etc. should be used in life. Even life is beautiful because it is not monotonous.

56.



A,B,C and D are four cups of same size. A and B have rough black surfaces and C and D have smooth shining surfaces.

A and C are filled with hot tea at 50 ^{0}C and B and D are filled with cold tea at 10 ^{0}C. If the room temperature is 30 ^{0}C which of the following is true?

(1) A cools faster than C, and B warms faster than D

(2) A cools slower than C, and B warms faster than D

(3) Aand C cool at the same rate, and B warms faster than D

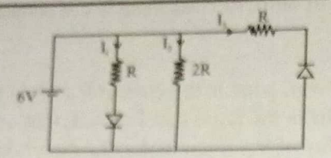
(4) A cools slower than C, and B warms slower than D

(5) A cools faster than C, and B warms slower than D

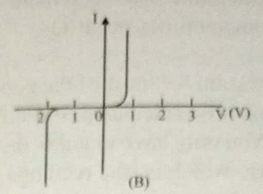
Even though it looked like it has been jumbled here and there, the logic is in the level of Ordinary Level. Black, rough surfaces are good heat emitters as well as good heat absorbers. Smooth polished surfaces are weak heat radiators and heat absorbers.

Always it has been compared with A and C along with B and D. That means among the two hot ones and two cold ones. So, A should be quickly cool down compared to C whereas B getsquickly warmed up than D. This is not a hard question.

57.



(A)



(B)

I .V characteristic of the silicon diodes shown in circuit (A) is given in figure (B). 6 V cell has negligible internal resistance. Of I_1, I_2 and I_3, the maximum and the minimum currents respectively, are

(1) I_2 and I_1 (2) I_3 and I_2 (3) I_1 and I_2 (4) I_3 and I_1 (5) I_1 and I_3

This is a tricky question. Even though it can be solved by thinking in same old logic, it does not tally with the correct answer.

The problem is created for I_3. At a glance, one can argue that I_3 can be zero. That is by thinking that the related diode with I_3 is being backward biased. The questions that applied this logic are: the 50th question in paper 2001 and the 35th question in paper 1998. But in those questions, I-V characteristic is not given as in this question. In such a situation, there is no alternative other than thinking that the diode is in backward biased. But in this question, the examiners have given I-V characteristic because it should be taken into consideration. So, the logic applied to solve 50 of 2001 and 35 of 1998 is not valid. In fact, this is not just a diode. You need to identify it as a Zener diode from the logic. According to I-V characteristic, in 2 V (backward bias), a big backward biased current has started to flow across the diode. The drop of voltage across it is 2 V where as the current is not zero. This 2 V voltage can be supplied from the source (with 6 V voltage). Actually, the resistance of the diode is much higher initially (in the backward bias situation). That is because the value of I is very small. So, initially there is a voltage difference like 6 V across the diode. The voltage drop across R with I_3 is very less at the beginning. But after a moment, there is a 2 V voltage drop across the diode and the rest 4 V is dropped across R. So $I_3 = (4/R)$.

Directly I_2 is $I_2 = (6/2R) = 3/R$ $I_1 = (6 - 0.7)/R = 5.3/R$

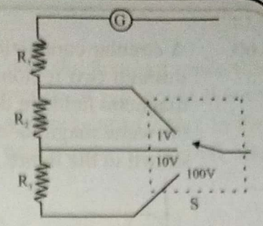
The diode with I_1 is in forward bias. Therefore, the voltage drop across it is 0.7 V (as it is Silicon). This value is not affecting to solve the question. If it is treated as 1 V, then the voltage drop across R is 5 V.

$I_1 = 5.3/R$ (5/R), $I_2 = 3/R$ and $I_3 = 4/R$

Now you can decide the minimum and maximum values. I_1 has the maximum where as I_2 has the minimum. The correct answer is (3) not (5). The famous answer was (5).

Actually, a Zener diode is given in this question. Some criticize that its symbol or name is not mentioned here. It is true but I suppose if it is given by the examiners,they cannot create a 'feeling' to this question. (This is the 57th question.)If the given I-V characteristic is identified as the Zener diode's characteristic, then this question can be easily solved. Normally, the breakdown voltage of a Silicon diode is about 75 V. Therefore, the applied logic is correct in 50 of 2001 and 35 of 1998. The cells on those cannot give 75 V. There is a cell of 6 V. Therefore, once you saw the I-V characteristic, you need to identify as a Zener diode's characteristic. By properly doping Silicon junction diodes, Zener diodes can be manufactured with a Zener voltage from 2 V to 200 V.

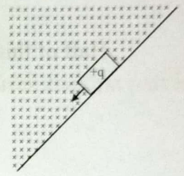
58. A multi-scale voltmeter arrangement giving full-scale reading of 1 V, 10 V and 100 V for the three settings of the switch S is shown in the figure. The galvanometer G given a full-scale deflection for a current of 1 mA and has a negligible resistance. The values of R_1 , R_2 and R_3 respectively are



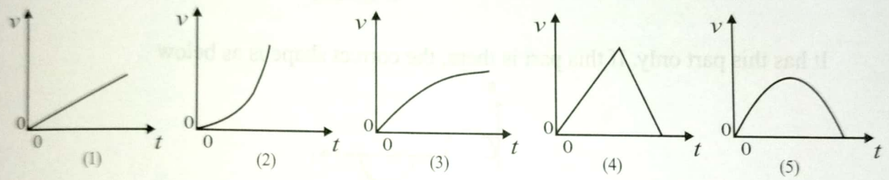
(1) 1 kΩ, 1 kΩ, 1 kΩ
(2) 1 kΩ, 10 kΩ, 100 kΩ
(3) 1 kΩ, 9 kΩ, 99 kΩ
(4) 1 kΩ, 9 kΩ, 90 kΩ
(5) 1 kΩ, 100 kΩ, 1000 kΩ

There is a simple ratio taking here. There should be 1 V across R_1. 10 V across R_1+R_2. 100 V across $R_1+R_2+R_3$. In every choice, R_1 is given as 1 kΩ. So, R_2 should be 9 kΩ and R_3 should be 90 kΩ. However, to get a current of 1 mA,R_1 must be 1 kΩ. $(1/10^{-3})$ As R_1 is given as 1 kΩ in every choice, the date of 1 mA is not necessary. All you need is taking simple ratios. No need to write any equation.

59. An object carrying a positive charge slides down a long inclined rough plane from rest. A uniform magnetic field is acting as shown in the figure.



The variation of the velocity v of the object with time t is best represented by



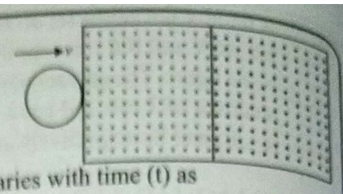
We need to find out the direction of qVB force that has occurred due to the moving charge.

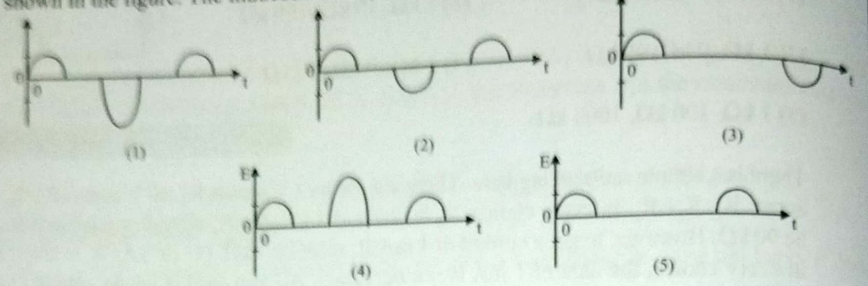
Its direction is perpendicular and into to the plane. That means the object is pushed more to the plane. You can treat it as the increment of perpendicular reaction. Therefore, the upward frictional force (μR) that is parallel to the plane is gradually getting increased. So, at an instance, mgSinθ can be equal to μR. Initially, mgSinθ is greater than μR. The question has mentioned that the object started to move downwards.

Once mgSinθ is equal to μR, the acceleration gets zero. That means V gets constant. The answer is (3). We cannot really decide whether the object attains to its terminal speed. But only the graph (3) shows a decrease in the rate of speed increment. You can easily decide the correct choice even if you do not think anything else. It is essential to know the direction of qVB force here. Once you know that the object is being pushed into the plane, then the answer is in your hand.

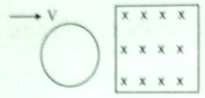
If the direction of B is directed perpendicularly to upwards, what is the shape of the v-t graph?

60. A circular conducting loop moves at a constant velocity through two regions consisting of magnetic fields. The magnetic fields in the two regions are uniform and have the same magnitude but acting in opposite directions as shown in the figure. The induced e.m.f. (E) in the loop varies with time (t) as

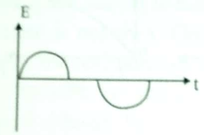




Half of this is given as the 60th question of paper 1996.

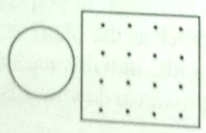


It has this part only. If this part is there, the correct shape is as below

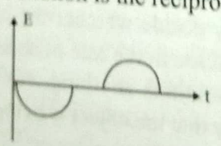


The logic on how to get this has been described in the 60th question of paper 1996. If the loop is divided into the stripes with same width, its area is gradually increasing until the half circle part. On the other half (in the next half circle), the areas get reduced in the respective stripes. Once the loop is exiting the same thing is happening to the other side.

The easiest way is to consider the parts of the flux density in opposite directions and use the superposition of those results (by adding each other).



If this section is only there, the variation is the reciprocal of the previously drawn figure.



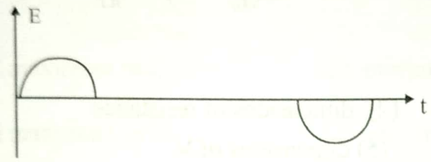
It is according to this figure. Now the graph of (1) shows the required E-t curve if these parts are kept one after the other. As the loop is coming to the second part by exiting from the first part, the middle of the graph gets a double resultant by adding them together. This can be

obtained by the simple superposition principle.

The other logic that you can get the shape is like this. If there is only the first part, once the loop is exiting, the flux gradually gets reduced. Change in the direction of E happens due to this. The gradual disappearance of inward flux is equivalent to an increment of a flux in the opposite direction. Therefore, when the loop is going from the first part to the second, the induced e. m. f gets doubled.

When one quantity is reduced in left side, it is balanced by as an increment in right side. Therefore, when the loop goes from the first part to the second, now the induced e. m. f does not get zero. It doubles. The second part provides the encouragement more and more to the process of disappearance.

If both parts had an inward flux, then actually it is one flux. Then the corresponding E-t curve is as below.



If two parts are being considered separately at this instance, what is lost from the first part is provided from the second part. The resultant is zero.