2002

PHYSICS - I

General Certificate of Education (Adv. Level) Examination

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

1. Dimensions frequency is

(1) LT^{-1} 2) Hz (3) L^{-1} (4) T^{-1} (5) ML^{-1}

Unit and Dimensions 01

You can select the answer at a glance. The limits of per second is T^{-1}.

2. Which of the following phenomenon could **not** be explained by the wave theory of light?

(1) Interference (2) Diffraction (3) Refraction (4) Reflection (5)Photo emission

Velocity of Sound 03

Interference and diffraction are common phenomena only associated with waves. Refraction and reflection can be explained from wave phenomena as well as from the particle model. Photo emission can be completely explained only by particle (photon) theory.

3. Which of the following could influence the speed of sound in air?

(A) Frequency of the sound wave (B) Temperature of air (C) Humidity of air

(1) (A) only (2) B) only (3) (C) only (4) (B) and (C) only

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

Waves in the air 03

This question has been checked by many times. The sound speed in the air depends on the temperature and humidity. Look at the 32nd question of paper 1998. When the temperature and humidity increase, the speed of sound in the air also increases.

4. Of the thermometers given below, the most suitable thermometer to measure the temperature of a drop of liquid is

(1) thermocouple. (2) mercury thermometer. (3) Alcohol thermometer

(4) pyrometer (5) gas thermometer

Thermometer 04

The answer is thermo-electric couple. The answers in the 40th question of paper 1997 have the answer for this question. Certain volume of a liquid is needed to measure the temperature from the liquid-glass thermometer and gas thermometer. Pyrometer is used to determine the temperature of bright objects that emit radiation such as light and heat.

5. The volume expansivity of a metal is equal to

(1) its linear expansivity.
(2) twice its linear expansivity.
(3) three times its linear expansivity.
(4) half of its linear expansivity.
(5) one third of its linear expansivity.

04 **Expansion of Solids**

This is a question that can be answered using the memory. Volume expansivity is equal to three times of its linear expansivity.

6. When one touches piece of metal in the environment one feels it to be colder than a piece of wood, because

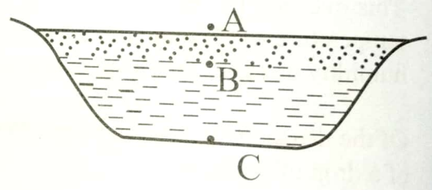
(1) the temperature of metal pieces in the environment is generally lower than that of wood.
(2) metal pieces have a higher heat capacity.
(3) the temperature of wood is generally closer to the body temperature.
(4) metal has higher thermal conductivity than wood.
(5) surface emissivity of metal is higher than that of wood.

04 **Expansion of Liquids**

This is an ordinary level question. When you touch a metal piece, there is a cooling touch due to its heat conductivity. But there is another point which is essential. Our body temperature is higher compared to the temperature of the environment. So once the metal piece is touched, the heat flows to the metal from the body. We do not feel the cold if the body temperature is equal to metal's temperature. Even though the heat flow is convenient in the metal, it is necessary to have a temperature difference to flow the heat. But from the given answers, (4) can be chosen as the correct answer.

07. During the formation of ice in a pond (see figure) due to cold weather, the possible temperatures at A,B, and C shown in the figure are

(1) -5 ^{0}C,0 ^{0}C and 0 ^{0}C respectively.
(2) -5 ^{0}C,0 ^{0}C and 4 ^{0}C respectively.
(3) 5 ^{0}C,0 ^{0}C and 4 ^{0}C respectively.
(4) -5 ^{0}C, 4 ^{0}C and 4^{0}C respectively.
(5) -5 ^{0}C , 4 ^{0}C and 0 ^{0}C respectively.

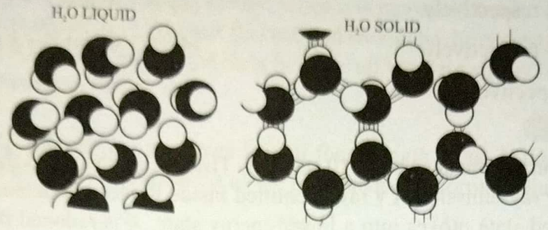


04 **Change of state**

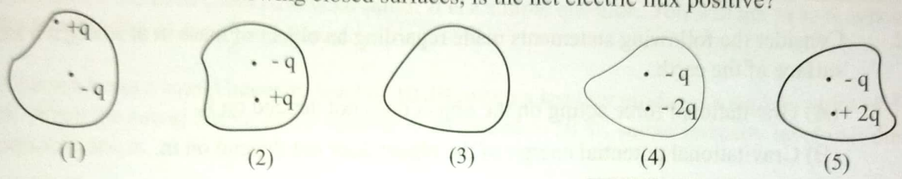
Under the normal atmospheric pressure, water is transformed to ice in 0 ^{0}C. Therefore, the temperature at B should be 0^{0}C. The surface temperature of A should be less than 0^{0}C as the ice is continuously formed. If not, heat will not flow upwards from water. If the surface temperature is 0^{0}C, the freezing of ice will be stopped. The maximum density of water is at 4^{0}C. Therefore, the temperature of water at the bottom is 4^{0}C. The correct answer is (2).

How does this anomalous expansion of water occur? This is a question that is asked by many children. The reason for this is more towards Chemistry. Ice has a crystalline structure. The volume of most crystalline structures is lesser than the volume of the molecule's liquid state. But ice behaves differently. Due to the angular shape of the water molecule and strong

molecular bonding energy at some orientations, ice crystals take a structure that is 'open' or swollen hexagonal structure relative to water. Look at the following figure. So, the water possesses a greater volume at its solid (ice) state compared to its liquid state. Therefore, ice is less dense than water.It is a fortunate thing. If it does not happen like this, the freezing will occur from the bottom to the top when water becomes ice. Then the destiny of the animals living in water during winter season will be pathetic.



8. Across which of the following closed surfaces, is the net electric flux positive?



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

Gauss Theorem 06

This is very simple. Many such questions can be found in the past papers. If the net electric flux should be positive, there should be a net positive charge inside the closed surface. It is given by the figure (5). (+2q- q = q)

9. An ideal transformer has 100 windings in the primary and 200 windings in the secondary. The primary is connected to an A.C. supply of 120 V at 10 A. Then the 'voltage / current' in the secondary is

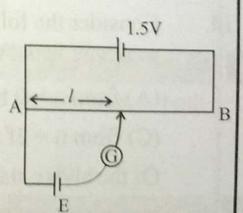
(1) 240 V / 5 A (2) 240 V / 10 A (3)240 V / 2.5 A

(4) 120 V / 5 A (5) 120 V / 2.5 A

Mutual Induction 08

This is also very simple. This can be done from the memory. As the number of coils in the secondary is twice as the number of coils in the primary, the secondary voltage should be double the amount of voltage in the primary. As energy dissipation is not considered in an ideal transformer, the multiplication of Vi should be a constant. That means the current in the secondary is half of the amount of current in the primary. You do not need to write down calculations in a piece of paper for such questions. Number of coils has been doubled in the secondary. Then the secondary voltage should be doubled where as its current should be halved.

10. In the potentiometer circuit shown, the balanced length for a cell E of e.m.f. 1.3 V was found to be 65 cm. When another cell of unknown e.m.f. was substituted for E the balanced length was found to be 45 cm. The e.m.f. of the second cell is



(1) 1.5 V. (2) 1.1 V. (3) 1.0 V. (4) 0.9 V. (5) 0.8 V.

Potentiometer 08

You simply get the answer by $E \propto l$. $E = 1.3 \times \frac{45}{65} = 0.9$. You get 9 from dividing 45 by 5 and 13 from dividing 65 by 5. 1.3 and 13 easily simplify.

11. A radioactive nucleus ${}^{A}_{Z}X$ decays by emission of an α - particle followed by a λ ray. The daughter nucleus thus formed has a mass number and atomic number

(1) A – 5 and Z – 2 respectively.
(2) A – 4 and Z – 2 respectively.
(3) A – 5 and Z – 3 respectively.
(4) A – 4 and Z – 3 respectively.
(5) A – 4 and Z respectively.

11 **Radiocativity**

Very simple. You can get the answer by 10 seconds. There is no change in the values of A and Z when there is a γ ray emission.A γ ray is emitted inside the same nucleus. That is when a nucleus at an excited state moves into a lower energy state. A is reduced by 4 whereas Z is reduced by 2, when there is an alpha particle emission. Therefore, the correct answer is (2).

12. Consider the following statements made regarding an object of mass m at a height h from the surface of the earth.

(A) Gravitational force acting on the object does not depend on h.
(B) Gravitational potential energy of the object does not depend on m.
(C) Gravitational potential energy of the object depend on h.

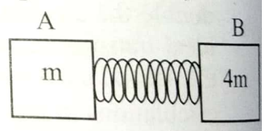
Of the statements.

(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 true.

There is no complexity in the sentences. Everybody knows that gravitational force is dependent on the distance. Therefore, statement (A) is false. Even the potential energy is dependent on m (mgh). Potential is not dependent on m. Therefore (B) is false. Potential energy is clearly dependent on h. Therefore, (C) is true.

13. Two masses m and 4m lying on a smooth table are compressed against a spring as shown in the figure. As the masses are released the speeds of masses, V_A and V_B' are related by

(1) $V_A = V_B$ (2) $V_A = 2V_B$ (3) $V_A = 4V_B$
(4) $2V_A = V_B$ (5) $4V_A = V_B$



02 **Newton's Law and Momentum**

It is a question that has been asked many times. It is a shame to describe as well. $V_A = 4V_B$.

14. Consider the following statements made about the magnification m of an image produced by a convex lens. As the object distance u increases

(A) from u = 0 to u = f, m increases. (B) from u = f to u = 2f, m decreases.
(C) from u = 2f to u = ∞, m increases.

Of the above statements.

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

You can check the true or false nature of the statements, without drawing ray diagrams as follows. when u = f, v = ∞. Therefore, when u is increased from u = 0 to u = f, m should get increased. The highest value of m is obtained when u is near to f. When u = 2f, then v = 2f. Due to this, when u = 2f, m = 1. Therefore, when u is increased from u = f to u = 2f, m should be reduced as m is decreased from a large value to 1. Again, when u = ∞, v = f situation, u gets =∞, m should approach to zero. Hence, when u is increased from u = 2f to u = ∞, m should be reduced more (from m =1). I think this method should be the easiest way to solve the problem. The reason is that, the mentioned facts here are all known facts by ourselves without an effort or ray diagrams or graphs.

15. A simple microscope has a convex lens of focal length 5 cm. If the least distance of distinct vision is 25 cm, the magnification of the microscope in normal adjustment is

(1) 2. (2) 4. (3) 5. (4) 6. (5) 8.

Optics **03**

This is also has been checked several times. It is a simple question. You will get m as 6, when the relationship of $m = \frac{D}{f} + 1$ is used.

16. A person hears a sound intensity level of 10 dB, when a speaker produces a sound output of 5 W. When the sound output of the speaker is increased to 50 W, sound intensity level that the person hears, is

(1) 15 dB. (2) 20 dB. (3) 40 dB. (4) 80 dB. (5) 100 dB.

Intensity of Sound **03**

There is no need for any calculation. Each year it has been discussed that how such questions can be done using the memory. Sound intensity is increased by 10 times from 5 W to 50 W. Then the increment of respective sound intensity level is 10 dB.

Increment of I	Respective increment in dB
10	10 (log 10 = 1)
100	20 (log 10^2 = 2)
1000	30 (log 10^3 = 3)

If the increment is 10 dB, the new level will be 20 dB (10 + 10). Previous value is given as 10 dB.

17. A sound wave of intensity 2.0 μWm^{-2} passes normal to a surface area of 10 cm^2. The amount of energy passes through the area in 1 hour is

(1) 7.2 μJ. (2) 72 μJ. (3) 0.072 J. (4) 7.2 J. (5)72 kJ.

It is a question of numbers. All you need is to multiply with correct units.

$2 \times 10 \times 10^{-4} \times 3600 = 7.2\ \mu J$

Intensity of Sound **03**

18. The frequencies of the fundamental and the first overtone of a stretched string fixed at both ends are f_1 and f_2 respectively. the ratio of $\frac{f_2}{f_1}$ is

(1) 0.5 (2) 1 (3) 2 (4) 4 (5) 6

Transverse Waves **03**

It is a common question. Can answer from memory. The ratio of frequencies is equal to the opposite ratio of wavelengths. The wavelength of the fundamental wave is twice the length

of the string ($\lambda_1 = 2l$). In the first overtone, the wavelength is equal to the length of the string ($\lambda_2 = l$). The correct answer is (1).

19. An observer is moving at a speed of 40 m s^{-1} towards a stationary siren sounding at a frequency of 600 Hz. If the speed of sound in air is 320 m s^{-1} what is the frequency of the sound heard by the observer?

(1) 686 Hz. (2) 675 Hz. (3) 600 Hz. (4) 533 Hz. (5)525 Hz.

03 **Doppler Effect**

You can get the answer by direct substitution to the equation $(\frac{V+V_s}{V}) \times f$

$$\frac{360}{320} \times 600 = \frac{9}{8} \times 600 = 9 \times 75$$

We can conclude that, as the observer is walking towards the source, the apparent frequency should be greater than 600 Hz without calculation.

20. Two bodies having thermal capacities in the ratio 1 : 4 are heated to a few degrees above the room temperature and allowed to cool. If their rates of fall of temperatures are the same at a particular instant, then their rates of loss of heat would be in the ratio

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

04 **Convection**

Very simple $\frac{\Delta Q}{\Delta t} = ms\frac{\Delta \theta}{\Delta t}$.

As $\frac{\Delta \theta}{\Delta t}$ is equal, the ratio of $\frac{\Delta Q}{\Delta t}$ should be equal to the ratio of heat capacities (ms).

21. 10 g of steam at 100 °C is mixed with 10 g of ice at 0 °C. The final temperature of the mixture will most likely to be

(1) 40 °C (2) less than 40°C (3) 45 °C (4) 50 °C (5) greater than 50 °C

04 **Calorimetry**

Here the examiners do not check whether you know the values of specific latent heat and specific heat capacity. Actually, if the calculations are done with the given values, a mixture of steam and water at 100°C can be obtained finally. If needed, try to compare with the correct values. According to that, the answer should be 100°C. But a guess work is expected here. As the specific latent heat of steam is greater than the specific latent heat of fusion of ice (this should be known), you can directly guess that the final temperature of the mixture should be greater than 50°C. It is true that the real answer is 100°C. If it was given as one of the choices, you need to do a calculation using the values to decide that. Then it is not a question of multiple choices. Even though the final temperature is greater than 50°C may seem as foolish answer to somebody instead of 100°C, it is unfair to think like that to a question with multiple choices. Such a question has been given in the essay question of 6(a) under heat in the past paper 2000.

22. An ideal gas of volume 300 cm^3 at a pressure of 1 atmosphere and temperature of 27 °C is compressed to 5 atmospheres, and then heated to 127 °C at constant pressure. The new volume of the gas would be

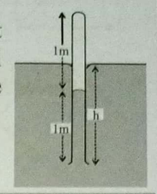
(1) 1500 cm^3 (2) 300 cm^3 (3) 80 cm^3 (4) 60 cm^3 (5) 45 cm^3

04 **Expansion of Gases**

Here the gas has undergone an intermediate state and has come to its final state. So, you will be tempted to apply equations to initial and intermediate states as well as intermediate and

final states. But if you connect initial and final state by $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ equation, simply the answer is obtained. Even though it passes many intermediate states, you can connect initial and final states for the same mass of gas. That is the shortest answer for this. $\frac{1\times300}{300} = \frac{5\times V}{400}$ V =80 cm^3.

23. A uniform glass tube of length 2 m with one end sealed contains air at atmospheric pressure. It is pressed vertically down into a mercury bath until the mercury rises halfway up in the glass tube as shown in the figure. If the atmospheric pressure is 76 Hg cm, the depth h would be



(1) 124 cm. (2) 150 cm. (3) 174 cm. (4) 176 cm. (5) 200 cm.

Expansion of Gases **04**

This question is also being included in many past papers. It can be done from the memory. As the volume of air has been halved in the tube, its pressure has been doubled. That means mercury level in the tube should be situated below 76 cm from the outside mercury level. Then h = 176 cm. Look at 34th question of past paper 1999. It is surprising to see how some has decided this question as a question connected to surface tension as well.

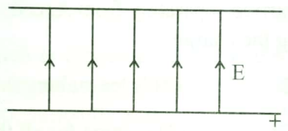
24. At what temperature is the r.m.s. speed of nitrogen molecules equal to that of hydrogen molecules at 27 ^{0}C ? (A nitrogen molecule is 14 times as masive as a hydrogen molecule.)

(1) 6000 ^{0}C (2) 5200 ^{0}C (3) 4927 ^{0}C (4) 4900 ^{0}C (5) 3000 ^{0}C

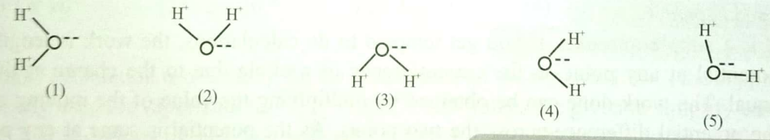
Expansion of Gases **04**

It is a very simple question. Unfortunately, the correct answer has a printing error of a number. The root mean square value is proportional to $\sqrt{\frac{T}{M}}$. As the speeds are equal, 300 =T/14 and T = 4200 K = 3927^{0}C. It has been mentioned as 4927^{0}C instead of 3927^{0}C by a mistake.

25.

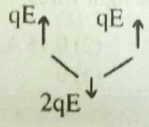


If a water molecule is placed in the electric field shown in figure, which orientation would it take in order to minimize its energy?



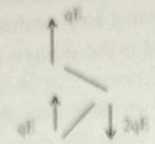
Electric Field Intensity and Coulomb's Law **06**

No need to think a lot. Positive charges tend to direct towards electric force lines whereas negative charges tend to direct to a direction which is opposite of the electric force lines. You can conclude the correct answer as (2), just by thinking only that. Positive charges should be closer to the negative plate whereas negative charges should be directed towards the positive plate. Even though the forces are marked on the H^+ and O^- atoms, you can clearly decide that (2) should be the stable equilibrium position.

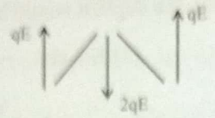


Forces are acting in Figure 1 as follows. Even though the resultant force is also zero here, the net torque acting on the molecule is not zero. For example, the algebraic sum of the moments

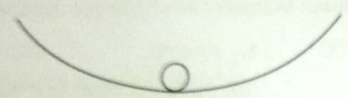
of forces across O atom is not zero.



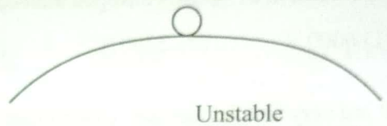
Forces are acting in Figure 3 as follows. What is the difference between this and (2)?



In both of the orientations, the resultant force and resultant torque are zero. But on th 3rd orientation, the molecule is at unstable equilibrium. The 2nd orientation is at the stabl equilibrium. In that formation, the molecular potential energy is at its minimum. If a molecul of the 3rd orientation is given a slight rotation, then there is a tendency to rotate and come int the 2nd position. If the molecule in the 2nd orientation is a given a slight rotation, then it wil rotate back and forth on its equilibrium position. An equivalent example is given below.

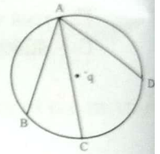


Stable Equilibrium



Unstable Equilibrium

26. A point charge +q is placed at the centre of a circle as shown in the figure. Another point charge +q is carried separately from A to B, A to C, and A to D. The work done in carrying the charge



(1) is least along the path AB. (2) is least along the path AD.

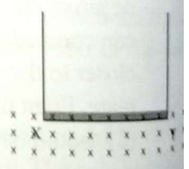
(3) is least along the path AC. (4) is same for all the paths, but has a non-zero value

(5) is zero along all the paths.

06 **Electrostatic Potential**

It is a simple question. If you get tempted to do calculations, the work is lengthened. Th potential at any point on the circumference of a circle due to the charge at the centre is equal. The work done can be obtained by multiplying the value of the moving charge wit the potential difference across the two points. As the potential is same at any point on th circumference, the potential difference is zero between two such points. If you do not see thi logic, then it is difficult to get the answer.

27. A horizontal conducting wire XY of length 20 cm and mass 4.5 g is suspended by a pair of light wires in a magnetic field of 0.15 T which is directed into the paper and perpendicular to the wire, as shown in the figure. What magnitude and direction of current in the wire XY are required to nullify the tension in the light wires?



(1) 0.15 A, X→Y (2) 0.15 A, Y→X (3) 1.5 A, X→Y
(4) 1.5 A, Y→X (5) 0

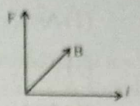
08 **Magnetic Fields/ Force having on a current Carrying Conductor**

It is a question that has been asked several times. The force on the wire (ilB) should be equal and opposite to mg.

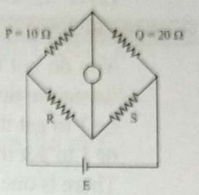
$$i \times 20 \times 10^{-2} \times 0.15 = 4.5 \times 10^{-3} \times 10$$

$$i = 1.5$$

If force ilB should be at upwards, then the current should flow from X to Y.



28. Wheatstone bridge shown in the diagram is balanced. Consider the following statements.



The balance condition does not change when

(A) the galvanometer G is replaced by another one with different resistance.

(B) the cell E is replaced by another one with different e.m.f.

(C) the resistances R and S are interchanged.

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.

Wheatstone Bridge and Meter Bridge 08

It is a very easy question. You can understand the true or false nature while you are reading the sentences. Either the resistance of the Galvanometer or e.m.f. E cell is not affectingonce you get the balanced point. If the ratio $\frac{P}{Q} = \frac{R}{S}$ remains unchanged, then the balanced situationis not affected by any other change.

29. An immersion heater which is connected to home electricity supply (230 V) and having a resistance of 115 Ω at its operating temperature, is immersed in boiling (100 ^{0}C) water. The specific latent heat of vaporization of water is 2.3 X 10^6 J kg^{-1}.

The rate of production of steam in kg s^{-1} is

(1) 1 x 10^{-4} (2) 2 x 10^{-4} (3) 3 x 10^{-4} (4) 2 x 10^{-3} (5) 1 x 10^{-1}

Heatning Effect of Electric Current 08

Simple calculation is necessary. As the temperature of the water is 100^{0}C, the supplied heat is directly used for vaporization. $\frac{230\times230}{115}$ m$\times$2.3$\times10^6$ Values are given to simplify easily. When one 230 is divided by 115, you will get 2. From 10^6 on right hand side, use 100 to multiply 2.3. Then there is 230 X 10^4 on the right-hand side. Then you can cut off left-hand 230 by right-hand side 230. Hence the answer comes directly as 2 X 10^{-4}. If a child with a basic mathematics practice can think like above, he/she can write the above formula and get the answer by memory.

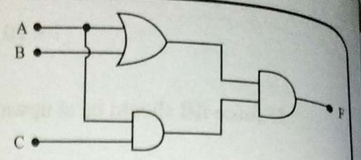
30. 100 W filament electric bulb is replaced with an energy saving bulb of 10 W. If the bulb is used 4 hours daily the electrical units (kWh) saved in 100 days would be

(1) 3.6 (2) 9 (3) 36 (4) 9000 (5) 36000

Heatning Effect of Electric Current 08

It is a not a question that cannot be done from memory. The energy that can be saved in 1 s is 90J. The total hours that werelit during 100 days is 400. Therefore, the relevant KWh value is $90\times10^{-3}\times400 = 36$.

31. In the circuit shown F becomes 1 when



(1) A=0, B=1, C=1 (2) A=0, B=0, C=1

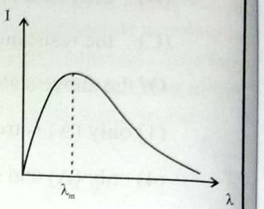
(3) A=1, B=0, C=1 (4) A=1, B=0, C=0

(5) A=1, B=1, C=0

09 Logic Gates

You do not have to think far. Preparation of truth tables is an unnecessary thing which can waste the time. If F=1, then both inputs of last AND gate should be 1. Both A and C should be 1 to get the output of first AND gate as 1. As A = 1, it is not an issue that B can either be 0 or 1 to get the output of OR gate as1. Therefore, you need to search A = 1 and C = 1 answer. There is one such answer. It is (3). Similar type of question was given as 37th question in past paper 1998.

32. Figure shows the black body radiation curve for a body at a given temperature. Consider the following statements.



At a higher temperature

(A) λ_m would be lower. (B) intensity would be higher.

(C) velocity of the emitted radiation would be higher.

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.

11 Radiation

It is a question that has been given many times under black body radiation. At a glance, you can decide that (A) and (B) is correct. Look at the 10th question of 1997.

33. A monochromatic beam of light is falling on a photosensitive surface. An increase in the intensity of the beam

(1) will increase the rate of emission of electrons.

(2) will decrease the rate of emission of electrons.

(3) will increase the energy of emitted of electrons.

(4) will decrease the energy of emitted of electrons.

(5) will not change the energy and the rate of emission of electrons.

11 Photoelectric Effect

This is also a question of bread and butter. As the intensity is increased, the rate of electron emission gets increased. Look at the review of 37th question of past paper 2000.

34. Two soap bubbles coalesce. Once they joined together, the radii of the two bubbles become aand b (a-b). The radius of curvature of the interface between the two bubble would be

(1) $b-a$ (2) $b+a$ (3) $\frac{b^2}{a}-\frac{a^2}{b}$ (4) $\frac{ab}{a-b}$ (5) $\frac{a^2b}{(a-b)^2}$

10 Surface Tension

This is also a question that has been previously asked. If you write equations and solve, then you need to write three equations to the first bubble, second bubble and the intermediate surface. But as this is a familiar question, you can quickly decide that extra pressures are

proportional to the reciprocal of radii. If the radius of curvature of the intermediate surface is R, then as b < a you can write $\frac{1}{b}-\frac{1}{a}=\frac{1}{R}$. Hence, $R=\frac{ab}{a-b}$

35 The material of a wire X has a higher value of Young's modulus than the material of a wire Y. When the two wires are subjected to the same tension, the extension of wire X is found to be more than that of wire Y. Consider the following statements.

(A) The above will happen only if the diameter of the wire X is smaller than that of wire Y.

(B) The above will happen only if the ratio $\frac{\text{original length}}{\text{diameter}}$ for X is higher than that of Y.

(C) The above will never happen if the length of the wire X is shorter than that of Y.

Of the above statements.

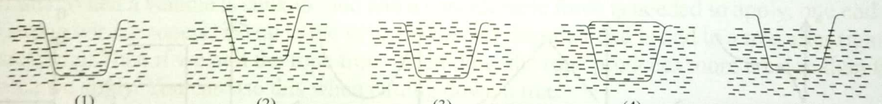
(1) only (A) is true. (2) only (B) is true. (3) only (C) is true.

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

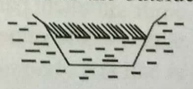
We will write the equation of Young's modulus to enter the equation.$E=\frac{TL}{Al}$ where the symbols have their usual meaning. $El=T\frac{L}{A}$. As the Young modulus of the material X is greater than the material of Y and the extension of X wire is greater than of Y wire, you can get $\frac{L_x}{A_x}>\frac{L_y}{A_y}$ directly ($E_x l_x > E_y l_y$).

Tension on both wires is equal. We can get the above difference. Even all three sentences check this difference. If this difference is written with relevance to diameter, you will get $\frac{L_x}{d^2_x}>\frac{L_y}{d^2_y}$ .You can understand that statement (A) and (C) are false accordingly. This difference cannot be achieved only by the change of diameter or length.You need to consider the whole ratio of $\frac{L}{d^2}$ together. Even though (B) was focused as the correct answer, there is a mistake in it. It should be mentioned as initial length/(diameter)^2 or (initial length/ surface area). This unseen error is an example of the demonstration of errors, weakness and mistakes by all of us. Only very few teachers have seen this weakness.They are correct. Hence, this question was put under the group of all answers correct.

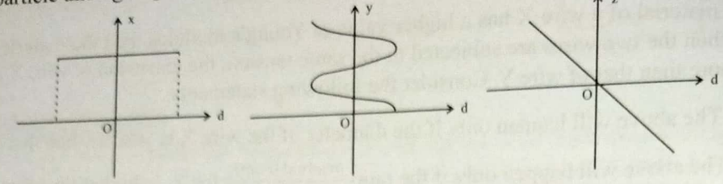
36. A steel bowl floats in water with its brim facing up. If water is poured slowly. which of the following figures shows as position at the verge of sinking?



You can understand that the answer is (1) by general knowledge even though you do not know Physics. If you argue from Physics, the logic should be built like this. The weight should be equal to the upthrust when it is floating. It sinks when the weight is slightly greater than the upthrust. From figures 2 to 5 there is no such upthrust other than the upthrust from the sunken part of the material (steel) of the cup. In every figure, either the water level inside the cup is equal to the outside water level or the water level inside the cup is higher than the outside water level. Then how can the upthrust be applied to balance the weight of the cup? As the density of steel is higher than water, the weight of the displaced water volume from steel (wall of the cup) is less than the weight of steel. Therefore, if the cup should be in equilibrium by floating, then the water level inside the cup should be at a lower level relative to the outside water level. Then there will be an upthrust from the shaded part of the shownfigure. Only in figure (1), the water level inside the cup is drawn at a lower levelcompared to the outside water level.



37. The following graphs show how certain quantities x,y, and z vary with the displacement d of a particle undergoing a simple harmonic motion.



Quantities x,y, and z represent

(1) kineticenergy, momentum, and acceleration respectively.

(2) total energy, time, and force respectively.

(3) potential energy, time, and acceleration respectively.

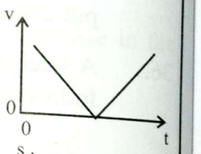
(4) total energy, acceleration, and force respectively.

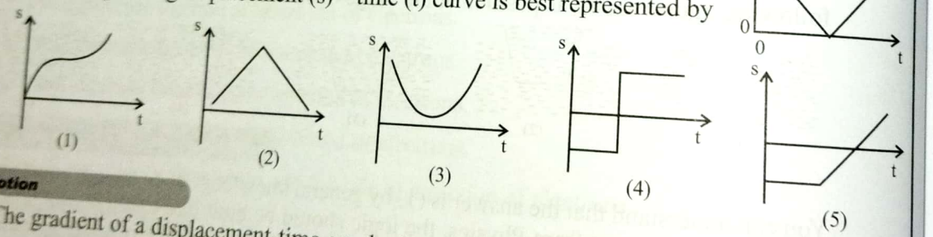
(5) total energy, time, and momentum respectively.

03 Simple Harmonic Motion

As soon as you see the 1st graph, you should be able to identify X as total energy. Only total energy (potential + kinetic) remains constant. This was also checked by the 22nd question of past paper 2000. In a simple harmonic motion, you will get the sinusoidal and cosinusoidal shape due to the variation of displacement and time. The only difference in the second graph is that it has been drawn the other way around. The normal tradition is to take time in the x axis whereas the displacement is in y axis. Here the displacement has been taken into the x axis. In a simple harmonic motion, you will get a straight line across the origin with displacement either due to force or acceleration. $F = -kd$; $a = -\omega^2 d$. The kinetic and potential energy variation has been drawnin paper 2000. Curve of momentum is equal to the curve of velocity. Can you draw the variation of d with velocity? At the maximum displacement (amplitude), v should be zero. When d is zero v should be maximum.

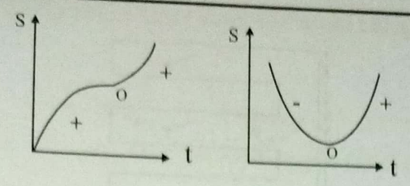
38. The graph shown represents the velocity (v) – time (t) curve for an object. The corresponding displacement (s) – time (t) curve is best represented by



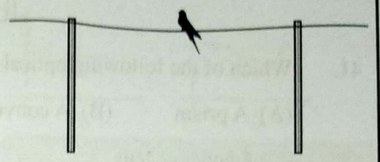


02 Linear Motion

The gradient of a displacement-time graph gives velocity (at any moment). According to v-t curve, V gradually decreases to zero and then increases. So, the gradient of s-t curve should gradually decrease, for a moment s should be parallel to t and again the gradient of s curve should increase with t. It happens in only (1). Graphs (2), (4) and (5) should be directly rejected. Graph (2) represents an object that moves with a uniform velocity and then it turns back with the same magnitude of velocity. The velocity is zero in the initial parts of graph (4) and (5). Therefore, you need to pick (1) or (3) intelligently. According to graph (3), the initial gradient part is negative. So, the velocity should be negative at that instance. Respective signs of the velocity are marked in the graphs. Can you give an example for the given v-t curve?

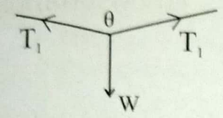


39. A bird of mass m sits on a tightly stretched telegraph wire as shown in the figure. The additional tension produced by the bird in the wire is



(1) zero. (2) less than mg. (3) more than mg.

(4) equal to mg. (5) equal to 1/2 mg.



This is similar to the question of the previous year. Need to apply the same logic again. There can be a doubt about the question as the extra tension is being questioned. Let T_1 be the tension of the wire before the bird stay if we use equations to solve. If the weight is w, $2T_1 \cos\theta = w$

When the bird started to stay, θ does not change significantly. Now if the tension of the wire is T_2, $2T_2 \cos\theta = w + mg$. Now if the first equation is subtracted from the second equation,

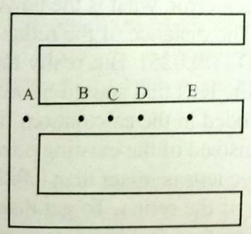
$T_2 - T_1 = mg/2\cos\theta$

As the wire is tightly stretched, $\theta = 85^0$ approximately. Then clearly $T_2 - T_1 > mg$. This logic is applied to all angles greater than 60^0 (up to 90^0). If $\theta = 80^0$, $T_2 - T_1 = 2.9mg$; If $\theta = 89^0$, $T_2 - T_1 = 28.6\ mg$

As the wire is tightly stretched, need to think a near θ value of $\theta = 90^0$. You cannot use values and solve as this is a multiple-choice question. But you can decide that θ value should be greater than 60^0. If θ value is less than 60^0, the above logic breaks down. Then $T_2 - T_1 < mg$. The above logic does not break even if we consider an instance that θ changes a little after the bird's stay (if $\theta > 60^0$). For example, consider when $\theta_1 = 81^0$ and $\theta_2 = 82^0$.

What is important here is that, if we apply a force to a tightly stretched wire, the extra tension that is produced is greater than the applied force. There are instances of practical application of this. When a vehicle is sunk in mud and a considerable force is needed to apply, one end of a strong wire or ropeis tied up to the vehicle whereas the other end is tied to a tree after tightly stretching. Then if we pull the rope from the middle, the rope produces more tension than the force we apply. You can use this when cutting down a tree.

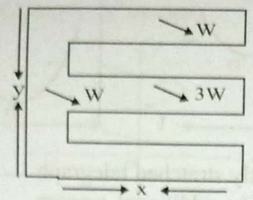
40. Figure shows a piece of metal in the shape of the letter 'E', cut from a uniform sheet. The centre of gravity is most likely to be found at



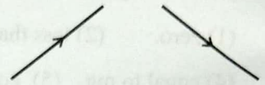
(1) A (2) B (3) C (4) D (5) E

As told by many times, you can get the answer within a very short period of time by guessing. The net centre of gravity should lie at D of the horizontal parts of the letter E. when three equal masses are kept apart by equidistance, the centre of gravity of all three should lie in the middle. The centre of gravity of the vertical section should lie at A in the middle. As there are three horizontal parts, the centre of gravity of the metal piece could not lie in B which is the middle of A and D. It should be more towards D. Such a point is C. If you look properly AD line is divided by 3:1 ratio by C. Such things are unnecessary for calculation. Equal values are there

for x and y distances.



41. Which of the following optical element/s could turn a ray of light as shown below?



(A) A prism (B) A convex lens

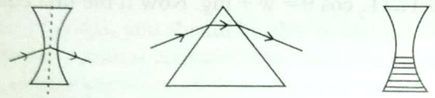
(C) A concave lens

(1) (A) only (2) (B) only (3) (A) and (B) only

(4) (A) and (C) only (5) All (A), (B) and (C)

03 Refraction through Lenses

Without an argument everybody agrees that (A) and (B) are correct. The question is with (C). Can't we get this by a concave lens? You cannot at a glance. Look at the following figure.



Is not this correct? Actually, both this instance and the prism are equal. The bottom part of a concave lens is a combination of upward prism parts. You must consider one ray in the question. Therefore, if the concave lens is kept on the proper place, you can deflect the ray as shown. It is a question that you can get it wrong. You can get wrong not just because it is hard. Once we see the path of the ray, we conclude that the path is convergent.Then we decide straightforwardly that we cannot get this path by a concave lens. You cannot decide the convergent or divergent nature just from one ray. You need beam of rays to decide that.

42. A certain person has a defective eye. The distance between the eye-lens and the retina of the eye is 0.025 m, but the power of the lens of the resting eye is 45 diopters. What should be the type, and power of the corrective lens he should wear in order to see distant objects?

(1) Convex, and 4 D (2) Convex, and 5 D (3) Concave, and 4 D

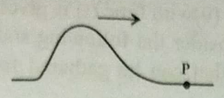
(4) Concave, and 5 D (5) Concave, and 10 D

03 Defects of Vision

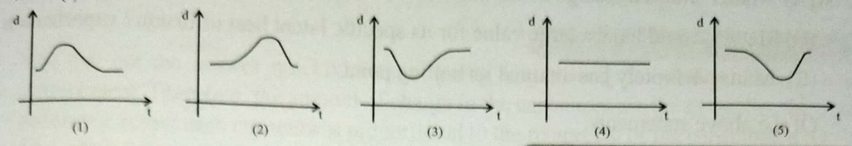
If you want, you can do it from the memory. If there is no such error, what is the power of the eye lens (when it is at rest, that means looking far away)? The distance of the retina and the lens should be 0.025 m. Then the power of the lens is 40 D (1/0.025). But really the power of the eye lens is 45 D. Then you can decide instantly that the lens that should be worn must have a power of 5 D. Is this convex or concave? It is not needed in the calculation. If there is no defect in the eye, then the power of the eye lens is 40 D instead of the existing power of 45 D. From that you can conclude that the focal length of the eye lens is lesser than 0.025 m. that means the rays coming from far away are focused in front of the retina. To get them on the retina these rays should be divergent to an extent. So, the lens that should be worn must be a diverging (concave) lens.

You can conclude that it is a concave lens by memory even if you do not apply this logic. We can instantly see that this person is short sighted (unable to see far). Then the corrective lens should be concave. However, all of us are short sighted people (who only see near but not far away)!

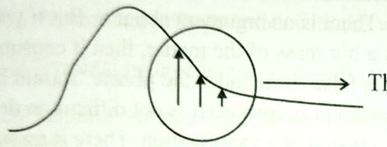
43. A pulse propagates with a uniform speed along a stretched string as shown in the figure.



Which of the following best represents the displacement (d) of the point p of the string with time (t)?



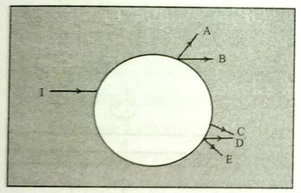
It has been asked not about the shape of the pulse across the string but about the front part of the pulse that goes towards P initially. Therefore, P initially vibrates according to the front part of the pulse. Then only it associates with the rear end of the pulse. So, initially displacement-time curve should take the shape of the front side of the pulse whereas the end should take the shape of the rear side of the pulse. That means the correct figure is (2). You can find the correct answer even by marking the displacement in the pulse.



Here the displacement is measured with relative to a certain point. It should not be a problem. If needed, the displacement of P can be taken as zero at rest and can draw the graph accordingly.

44. A ray of monochromatic light (I) approaches a spherical air bubble in a block of glass as shown in the figure. Which of the paths shown best represents the emergent ray?

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



It is a very easy question. Previously it has been checked with reference to an air bubble in water. When the ray is refracting from the glass to the air, it should deflect away from the normal. So, C, D and E can be directly omitted. Again, when the ray is going from the air to the glass, it should bend towards the normal. If needed, the path of the ray can be marked in the question paper. Then you get the answer instantly.

45. A travelling microscope is focused upon a mark at the bottom of an empty beaker. now if the m is raised by 1 cm, to what depth should water be poured into the beaker so that the mark be again in (Refractive index of water= 4/3).

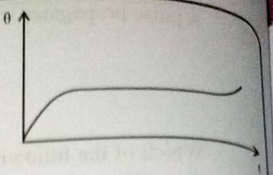
(1) 5 cm (2) 4 cm (3) 3 cm (4) 2 cm (5) 1 cm

This is a question related to apparent displacement. You can directly use the equation for apparent displacement if you can remember. If it is forgotten, you can build up on the memory. The apparent depth of a layer is (t/n) if the true depth is t. It cannot be (tn). That is because the apparent depth should be lesser than the true depth. Therefore, the apparent displacement is $t(1-\frac{1}{n})$.

$t\left(1-\frac{3}{4}\right)=1 \quad t=4$

Cannot you simplify this directly?

46. When a certain amount of matter is heated at a constant rate, the variation of its temperature (θ)with time (t) is given by the curve shown in the figure. Consider the following statements made about the information that can be gathered from this curve about the matter.



(A) Matter shows a change of state with temperature.

(B) Matter should have a large value for its specific latent heat of fusion / vaporization.

(C) Matter definitely has attained its boiling point.

Of the above statements.

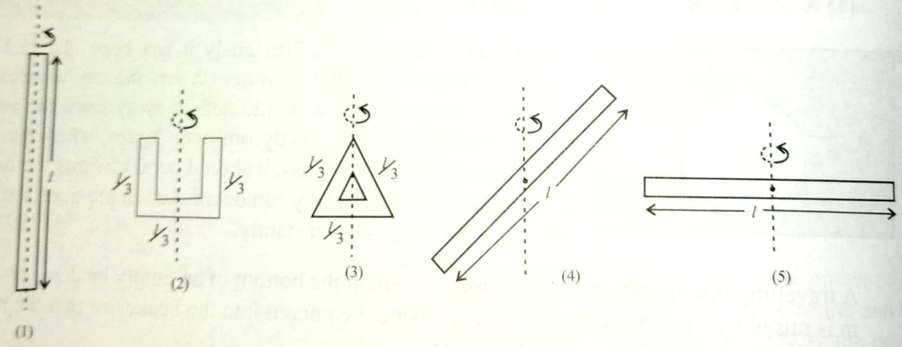
(1) only (A) is true. (2) only (C) is true. (3) only (A) and (B) are true.

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

04 Calorimetry

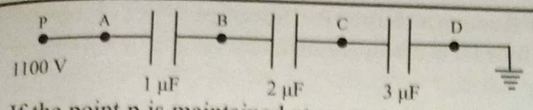
You can directly decide that (A) is correct. It does not take one second for that. Many (including myself) can get statement (B) as wrong. At a glance it is true. You can consider that, a higher value of a specific latent heat of fusion/vaporization is a definite reason which is needed to keep a constant temperature for a long time. There is no argument about it. But if you think a little bit, it is not the only reason. If there is a big mass of the matter, then it consumes more time for the state of change. Therefore, (B) is false. It includes the phrase 'should be there'. If it was given as 'can be there', then the statement is correct. It is not difficult to decide that (C) is false. We do not know whether this is a fusion or a vaporization. There is no such a hint included in the question.

47. Five identical uniform rods of length l and mass m, some of which are bent as shown below, are rotated from rest about a vertical axis. Rods are accelerated until they reach a final angular speed of ω_0. Which of the following arrangement requires the highest energy to attain its final angular speed(ω_0)?



Rotational Motion

This does not need any calculation or any equation to remember. Highest energy is needed to the structure with the highest moment of inertia. The highest moment of inertia is there for the structure with maximum mass distribution with relative to the rotational axis. It is true for the structure (5). Is not that so? The distribution with the maximum distance from the rotational axis is (5). The highest moment of inertia for the rod is there on this instance. Which structure has the least moment of inertia? Without any calculation, can you arrange the structures in the ascending order of the moment of inertia? Your two eyes and a little bit of brain are the things that you need here.

48. 

If the point p is maintained at a constant potential of 1100 V, the potential difference across AB is given by

(1) $\frac{1100}{6}$ V (2) 200 V (3) 300 V (4) $\frac{1100}{3}$ V (5) 600 V

You can get the answer quickly without going into a long calculation. This is a series arrangement. Therefore, the amount of charge in the capacitors are the same. So, the potential difference across each capacitor is proportional to the reciprocal of the capacitance (Q = CV). The ratio of the reciprocals of the capacitors are, $1:\frac{1}{2}:\frac{1}{3} \rightarrow 6:3:2$. So, the potential difference across AB is $\frac{1100}{11} \times 6 = 600\,V$. 11 is obtained by the addition of 6 + 3 + 2. The total potential difference of 1100, should be divided according to the ratio 6:3:2. Have not you done ratios before your O/Ls? Divide Rs.1100 between three people in 6:3:2 ratio. 1100 is given to ease the division by 11.

49. Which of the following does not show that a 1.5 V dry cell has an internal resistance?

(1) Its terminal voltage varies with the value of the resistance to which it is connected.

(2) Terminal voltage increases slightly when several such cell are connected in parallel.

(3) Terminal voltage depends on the internal resistance of the voltmeter used to measure its voltage.

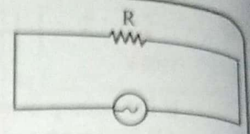
(4) The cell becomes warm when its terminals are short circuited.

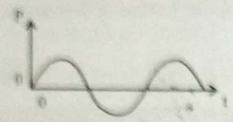
(5) Terminal voltage measured with an ideal voltmeter show 1.5 V.

You need to read each sentence. If there is luck, the correct sentence can be visible directly. If there is an internal resistance to the cell, then it gets heated when it is drawing a current. If r is not zero, then the potential difference across the two ends is (E-*ir*) when there is a current flow from the cell. Therefore, if i changes, then the potential difference across the cell changes. If there is another R connected to the cell, then *i* changes when R changes. Then the potential difference across the cell changes. If r = 0, then E is measured across the cell even though *i* changes. When r is not zero and couple of cells are connected in parallel, the voltage across the two ends gets increased as the equivalent internal resistance gets decreased. When n number of cells are connected in parallel, the voltage across the ends is $\left(E - i\frac{r}{n}\right)$. Here *i* means the current in the external circuit.

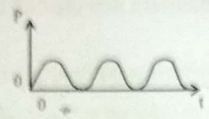
As the internal resistance of the voltmeter connects parallelly with r,the potential difference across the cell changes with the internal resistance of the voltmeter. As the internal resistance of an ideal voltmeter is infinite, theoretically there is no current from the cell when such a voltmeter is connected to a cell. Therefore, the voltmeter reads E value whether r value is zero or not. So, you cannot find the existence of an internal resistance of a cell by the connection of an ideal voltmeter to a cell.

50. A sinusoidal A.C. voltage is applied across a resistor R. The power (P) dissipated by the resistorwith time (t) is best represented by

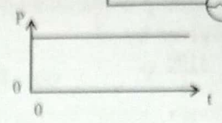




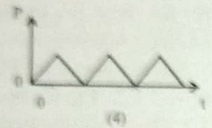
(1)



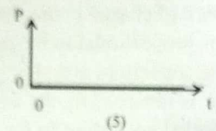
(2)



(3)



(4)

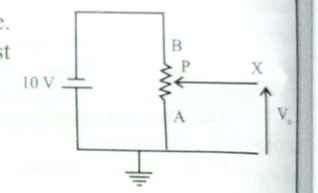


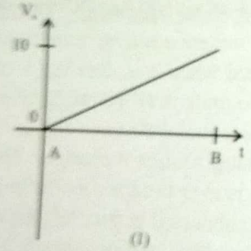
(5)

08 Metal Induction

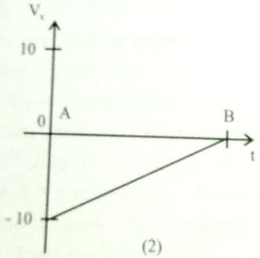
Power is equal to i^2 r. The shape of i is sinusoidal. But always i^2 is positive. Therefore, the correct answer is (2). The average power is shown by (3) but the power variation should be like (2) with time. If the frequency of the supplied voltage is 50 Hz, its period is 0.02 s (20 ms). This is a time that cannot be measured. (3) is correct if average power was asked or if we consider the time of t axis in minutes or hours.

51. The cell in the circuit shown has negligible internal resistance. As the pointer P moves from A to B which of the following best represents the variation of the potential(V_x) at X.

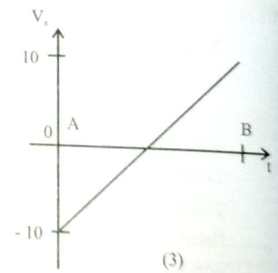




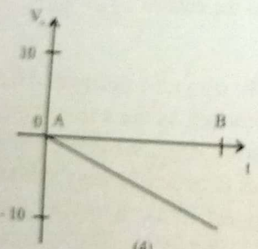
(1)



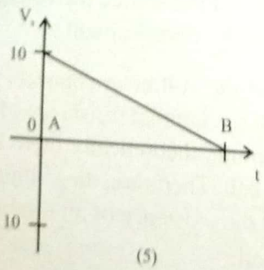
(2)



(3)



(4)

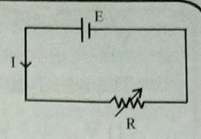


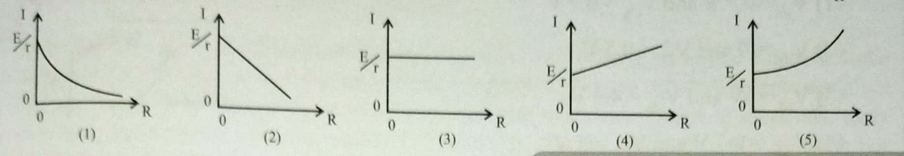
(5)

08 Potentiometer

Very easy. This question has been asked in the previous year (2001) under 47th question. The only difference is that the positive terminal of the cell is earthed. Then the potential of X gets negative. When P is at A, the potential gets zero. When P is taken towards B, V_x = -10V. Therefore, the correct variation is given by (4).

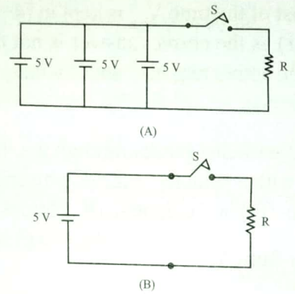
52. The circuit shows a cell of e.m.f. E and internal resistance r connected in series with a variable resistance R. Which of the following best represents the variation of the current I in the circuit with the resistance R?



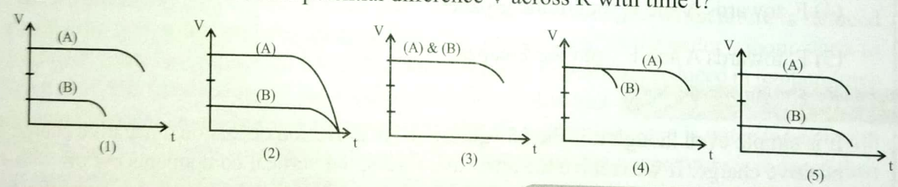


You can write $= \frac{E}{R+r}$. You can decide that, I is not linearly varying with R at a glance of the equation. According to that you can omit (2), (3) and (4) choices. When R = 0, I = E/r. When R goes to infinity, I should be equal to zero. Therefore, the correct curve is given by (1). Once you remove linear choices, out of (1) and (5), (5) should be omitted as soon as you see. How can I increase with increasing R?

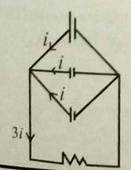
53.



The circuits (A) and (B) use identical cells with negligible internal resistance. The switches S in both circuits are closed at time t=0 and left for a long time. Which of the following best represents the variation of the potential difference V across R with time t?



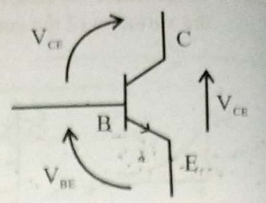
A very simple logic is checked here. Even though identical cells are being connected, the net e.m.f. is the value of one e.m.f. Therefore, the current across R in A and B circuits should be the same. By that you can remove (1), (2) and (5). If there is an internal resistance in the cells, then the current in A slightly increases as the resultant internal resistance gets r. What is the advantage of parallel connection of cells if there is the same current? The current across R can be kept for a long time from such an arrangementas there are many water sources to give water. Most of the time we think that, we can get more current if the cells are connected parallelly. But this is wrong. (Look at 24th question of paper 1991)



3 iR =E → 3 i=E/R = the current from one cell. The correct choice is (4).

54. voltages applies across a silicon transistor shown are represented with symbols V_{BE} V_{CB} and V_{CE}

The transistor will operate in the active region if



(1) V_{BE} =0.7 V and V_{CB} = 0.7 V

(2) V_{BE} = 0 and V_{CB} = 0.7 V

(3) V_{BE} =5V and V_{CB} = 4.2 V

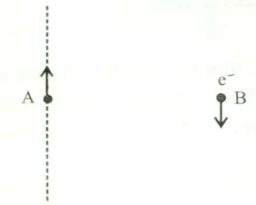
(4) V_{BE} = 0.7 V and V_{CE} = 5 V

(5) V_{CB} = 0.7 V and V_{CE} = 0

09 [redacted]

Everybody knows that V_{BE} should be 0.7 V if a silicon transistor is needed to work in the active region. Therefore, (2) and (3) can be directly omitted. (5) can be removed out of the rest three choices as V_{CE}=0. Only (1) and (4) remain. As $V_{CE} = V_{CB} + V_{BE}$, V_{CE} = (0.7+0.7) V= 1.4V according to (1). Theoretically when V_{CE} = 1.4V, it is true that it enters to the active region as $V_{CE} > 0.2$ V. But most of the time V_{CE} is kept in (4~5) V for the efficient usage of the transistor. Therefore taking (1) as the correct answer is not the most suitable one. Practically when a transistor is used in the active region, a small voltage difference of 1.4V is never kept for V_{CE}.

55. A beam of positively charged particles passes through apoint A in the upward direction, and an electron passes through B with a velocity in the downward direction as shown in the figure. The directions of electrostatic (F_e) and magnetic (F_m) forces on the electron are such that



(1) F_e towards A and F_m away from A.

(2) F_e and F_m both away from A.

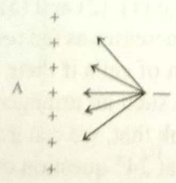
(3) F_e and F_m both towards A.

(4) F_e towards A and F_m out of the ⊙paper.

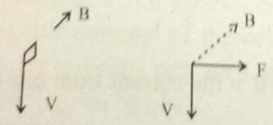
(5) F_e towards A and F_m into the ⊗paper.

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

It is simple even though it is the 55th question. An attraction occurs on a negative charge by a positive charge. If we resolve the attractive forces, the vertical components cut off with each other and remains a horizontal resultant force towards point A. To get the magnetic force, the positive charged beam of rays moving upwards can be considered as a current moving upwards. Due to that current, there is a magnetic field into the paper at the point B.



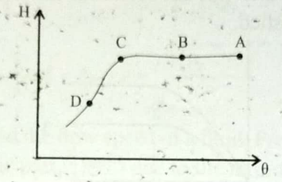
If a positive charge in B moved downwards, then the force is generated away from A.



The force on a negative charge is towards A. The correct answer is (3). The other way that you can get the magnetic force is by considering the electron (negative charge) moving downwards as the current carrying segment (positive charge) moving upwards. There will be an attraction between two parallel currents going on the same direction. That means the generated static electric and magnetic forces are both attractive.

If there are two current carrying conductors, then there will be only generated magnetic force among them. As there is no net charge in the conductors, there is no room to produce a net electric force. Even though the current is created due to the movement of electrons, there is no net charge in the conductor due to the positively charged nuclei. But this question has mentioned charged particle beam (like proton beam). Then the electric force is generated on the electrons at B due to the positive charges.

56.

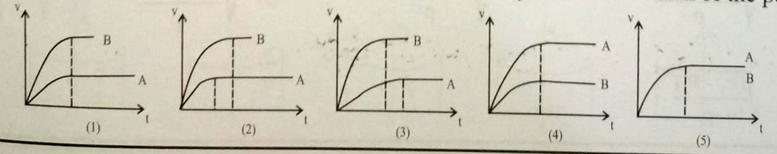


The curve shows the variation of the absolute humidity (H) of an isolated volume of atmosphere with temperature (θ). The relative humidity of the air volume corresponding to the

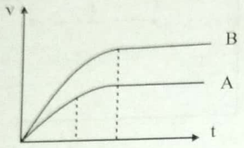
(1) point A can be 100%.
(2) point B can be 100%.
(3) points A and C can be the same.
(4) point C can be less than 100%.
(5) point D can never be less than 100%.

This question could have been an easy one if the questions of relative humidity and absolute humidity have been included (56th of 1992 and 32nd of 1991). Absolute humidity is the mass of water vapour in a unit volume of air. It remains constant as the temperature is reduced means that, the particular temperature has not come to the dew point. If the temperature is reduced passing the dew point, then the absolute humidity gets reduced as the water vapour starts to condense. Therefore, point C in the curve is the dew point. H gradually reduced in temperatures lower than this temperature. If the absolute humidity is constant with the temperature in the curves of absolute humidity, it always indicates that the air of that place is not saturated with water vapour. If it drops with the temperature, then that means the temperature is reduced than the dew point. Condensation of water vapour occurs when the temperature is less than the dew point. In points A and B, the relative humidity cannot be 100%. It gets 100% at the dew point and afterwards. It is true that relative humidity of B is greater than A. The relative humidity at C is 100%. It is 100% in D too. When the temperature is reduced than the dew point, the relative humidity of any temperature is 100% as there is sufficient amount of water vapour to saturate (if water vapour has not been removed by another way). Therefore, the correct answer is (5).

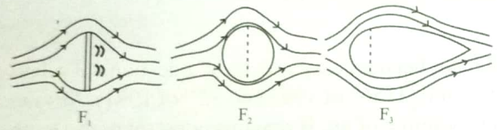
57. Two masses, A of mass m and B of mass 2m but of the same volume, are released from rest at time t = 0 at the surface of a deep pond. Which of the following graphs best represents the variation of the speed of two masses from t = 0 until they reach the bottom of the pond.



This question is with reference to the 52nd question of paper 2000 (parachute problem). The terminal speed should be higher in the heaviest sphere. But it consumes more time to achieve it. The lighter sphere quickly comes to the terminal speed where it takes a lesser value. This has been mentioned in the 52nd question of past paper 2000. So, without any hesitation you can get answer (2) as the correct graph.Even though the terminal speed is higher in B of answer (1), the spheres get the terminal speeds at the same time. This cannot occur. In (3) also the terminal speed is higher but the heavier sphere gains the terminal speed quickly. Choices of (4) and (5) can be omitted directly. Another point that can be checked is that, the areas of A and B with t axis should be equal because the distance travelled by both of the spheres are the same. This has been satisfied by (2) if it is being viewed from this point. For example, if a graph like below was drawn, then it is not correct as the areas of the graphs are not equal even the above two points are satisfied.

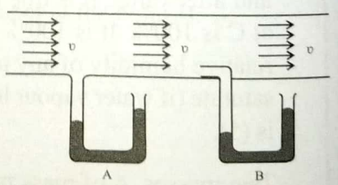


Why it was considered as ALL question? In the description, obviously I have mentioned A and B as spheres. But in the question, A and B have been mentioned as masses. Actually, when such a problem is considered, it is the normal tradition to treat the objects as spheres. But one can argue that A and B have not been mentioned as spheres. The viscous force acting upon an object depends on its shape characteristically. Even though it is out of syllabus, shown below is how viscous force (F) is dependent on the different shape of the objects.



Let the viscous forces be F_1, F_2 and F_3 for the above objects with different shapes that travel with the same speed on the same liquid. The scientists have found that $F_1 = 2F_2$ and $F_1 = 5F_3$. The viscous force on the sphere is half of the viscous force on the plate whereas the viscous force on the third shape is nearly 1/5 of F_1. So, we can conclude that, the highest viscous force is applied on the plate and the lowest viscous force is applied on the third shape. There are generated turbulent lines behind the plate. That has been prohibited from the third shape. Now do you understand the secret why moving objects like planes and cars are being manufactured according to the third shape?

58. A non-viscous, incompressible fluid of density ρ flows through a pipe at a speed of v. Two manometers A and B are connected to the pipe as shown in the figure. If the pressures measured by the manometer A and manometer B are p_1 and p_2 respectively, the speed v of the flow is given by

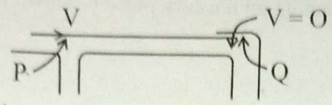


(1) $\sqrt{\frac{2(P_2 - P_1)}{\rho}}$ (2) $\sqrt{\frac{2(P_1 - P_2)}{\rho}}$ (3) $\sqrt{\frac{2(P_1 + P_2)}{\rho}}$ (4) $\sqrt{\frac{(P_2 - P_1)}{\rho}}$

(5) $\sqrt{\frac{(P_1 - P_2)}{\rho}}$

It is hard to obtain the answer if you do not start it properly. Top corner of the left-hand side of pressure meter has been bent to the opposite direction of the fluid flow. It is really important for this question. Consider the first flow line which comes into contact with the bent tube part. It is the method to get the answer.

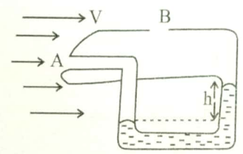
The fluid gets trapped at the bent part. Therefore, the speed of the first flow lines that come into this section becomes zero. After that, the static (still) fluid pressure is affecting on the pressure meter B. Now apply Bernoulli's theorem to points P and Q.



$$P_1 + \frac{1}{2}\rho v^2 = P_2 \rightarrow v = \sqrt{\frac{2(P_2 - P_1)}{\rho}}$$

This is an easy method to find the flow speed of a fluid. Pressure meter B always show a higher pressure. In that the dynamic part ($\frac{1}{2}\rho v^2$) due to the motion of the fluid is zero. Once the fluid is trapped in the bent part, the flow lines near the bottom wall of the tube should be bent as follows.

But you cannot get the answer that we need by applying Bernoulli's theorem to such a flow line. Think that v was increased after the fluid flow initially. Yet it does not have an effect on P_2. It is on the same (static)value. But as v increases P_1 gets decreased. Therefore, changes in the speed can be obtained using this method. Even though the speed is changed, the difference of liquid level in pressure meter B does not change. But pressure meter A varies the value according to v. Pitot tube is another instance that this method is being used.

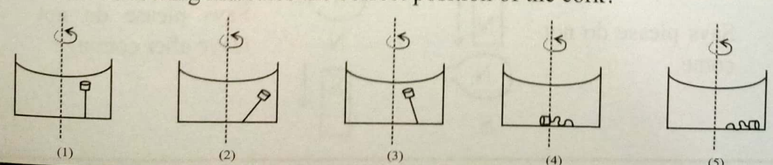


The fluid that enters from A is taken into rest whereas the fluid is flowing at a v speed from the open hole at B. The pressure difference is measured by a manometer with a liquid of density ρ_l. You can show easily that,

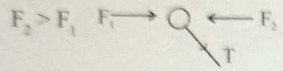
$$v = \sqrt{\frac{2h\rho_l g}{\rho}}$$

Here ρ is the density of the fluid. According to the question in the paper P_2-P_1= $h\rho_l$ g. The speed of a moving vehicle/ ship/ plane can be decided relative to the air by this tube.

59. A cork is attached to the bottom of a water beaker with a string so that it stays under the surface. The beaker is then rotated with a constant angular speed about the vertical axis. Which of the following indicates the correct position of the cork?

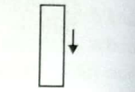


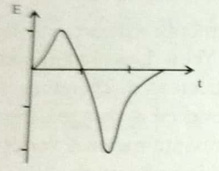
If you have studied the 60th question of paper 1994, then the same logic is applied to this question. As that question is reviewed descriptively, there is no need to explain again. There is a linear motion in that question. This is a question with angular motion. But in both occasions, there is acceleration. We know that any object that is in rotational motion, has an acceleration directed towards the centre. According to the simplest logic, if an object is at a lower density than its existing medium, it will be pulled towards the accelerated direction. If its density is greater than the existing medium, then it will be pulled to a direction opposite to the accelerated direction. Look at the review of 60th question in paper 1994 to have an idea for this logic. To build up this logic, the forces acting on the cork piece is shown below (without its weight and upthrust).



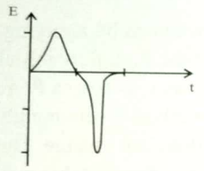
This principle is being used in the centrifuge. Low density light materials are pulled to the front of the centrifuge tube whereas high-density heavy materials are pulled to the back of the centrifuge tube.

60. A bar magnet is dropped with its axis vertical, and it accelerates through a coil as shown in the figure. Which of the following graphs best represents the variation of the induced e.m.f. (E) of the coil with time (t) ?

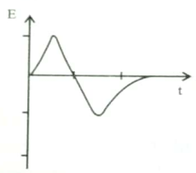




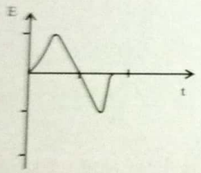
(1)



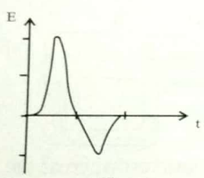
(2)



(3)



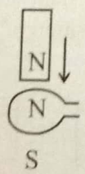
(4)

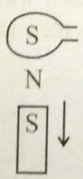


(5)

You will get into trouble if you start to derive equations. First you can conclude that, the direction of the generated electro motive force should be changed when the bar magnet goes in and out of the coil. In each graph, there is a positive part initially and a negative part afterwards. So, you cannot remove any graph based on this fact. If a graph is given without the direction change of E, then that could have been directly omitted. If the bottom of the magnet is considered as a north pole, the induced poles on the two ends of the coil is shown below when the magnet is going in and out of the coil.

Says please do not come.





Says please do not leave after coming.

You can clearly see that the direction of the e.m.f in the coil is changing. The next step to solve the problem is by moving the magnet with acceleration through the coil. The conclusion from it is that, the magnitude of E when the magnet is moving downwards away from the coil should be greater than the value when it comes into the coil. According to that, (3), (4) and (5) can be removed. The magnet falls under gravitational acceleration. It is true that there is a kind of resistance force on the magnet when it moves in and out of the coil. But in the question, it has been mentioned that the magnet is being accelerated. This indicates that, the induced resistive force is very small.

Now out of (1) and (2), how to get the correct answer? To decide that you need to have an eye on the areas of the curve parts. What do you get from an area of E-t curve? The area of a small stripe with Δtthickness is equal to E Δt.$E = \frac{\Delta\emptyset}{\Delta t}$ (Faraday's Law)

Then the area of the stripe is ΔØ. Therefore, the area of the curve with t axis is equal to the magnetic flux through the coil. So, the area of the positive side should be equal to the area of the negative side. The net flux should be zero after the whole process. Therefore, the correct shape is found in (2). As E is greater in the negative side, the time frame should be reduced on that sideto have equal areas. As E is larger, the curve on that side should be thinner than the curve on the positive side.