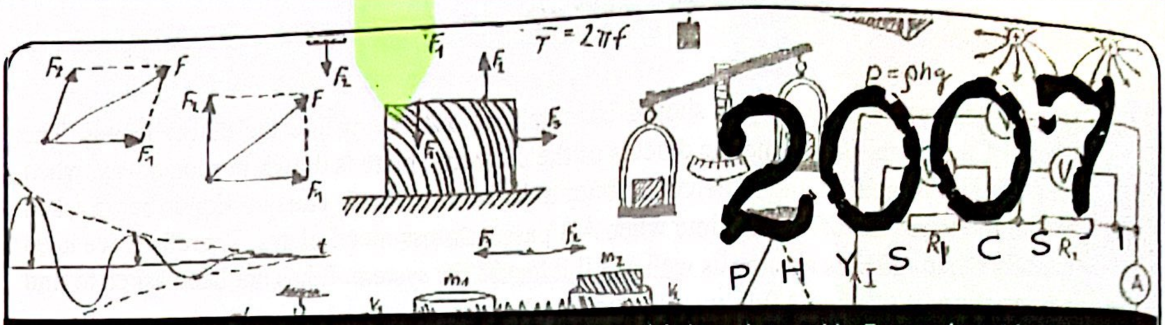


General Certificate of Education (Adv. Level) Examination

(g= 10 N kg-1)

1 SI unit of surface tension is

(1) N (2) Nm^{-1} (3) N m (4) $N m^{-2}$ (5) $N m^2$

10 **Surface Tension**

Many can be tempted to think surface tension as a tension. If so, you will get the first question wrong unnecessarily. The definition of surface tension is the force acting on a unit length. Therefore, the unit is Nm^{-1}.

2 Dimensions of a certain physical quantity when multiplied by $[L]^3$ yield the dimensions of work. The physical quantity would be

(1) force. (2) momentum. (3) pressure. (4) mass. (5) velocity.

01 **Unit and Dimensions**

Even though this is the second question, you may spend more time unnecessarily. If you could sense that $[L]^3$ represents a volume, then spontaneously you will remember the multiple of PV. It is a foolish act to find the respective quantity by writing the dimensions of work and divide it by$[L]^3$. Or else, each choice in every answer can be multiplied by $[L]^3$ from the mind and you can get the correct answer. If you want to get work from the force, then it should be multiplied by a distance or [L]. You can directly see that the given choices of momentum, mass and velocity are not matching. The easiest method is to identify $[L]^3$ as a volume. Then the answer can be obtained quickly.

3 If the absolute temperature of a body is doubled, the rate at which the energy is radiated will

(1) remain the same. (2) increase two times.

(3) increase four times. (4) increase eight times.

(5) increases sixteen times.

11 **Black Body Radiation**

This is a very easy question. If you recall Stefan's law you will remember T^4. You can get 2^4 even in your dreams.

4 An e.m.f. is induced across the length of a wire when it is moving in a uniform magnetic field. This e.m.f. does not depend on

(1) velocity of the wire. (2) radius of the wire. (3) length of the wire.

(4) flux density of the magnetic field.

(5) the angle that the wire makes with the magnetic field.

08 **Electro Magnetic Induction**

This is also based on theory. If you can recall Blv, then instantly you get the answer. The radius of the wire (width) is not affecting on the e. m. f but it contributes to the resistance.

5 Consider the following statements made regarding the photoelectric effect.

(A) This effect can be explained by assuming light as energy packets.

(B) For a given incident monochromatic light, the energy of emitted electrons does not depend on the material.

(C) Rate of emission of electrons depends on the intensity of the incident light.

Of the above statements,

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

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

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

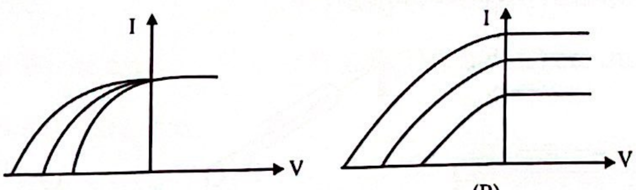
This is also a theory question. The basics of photoelectric effect is checked from this question. It is described from the concept of photons (energy packets). Therefore, (A) is correct. For a given frequency, the energy of emitting electrons is dependent upon the work function. Therefore, (B) is wrong. You should see the bold letters that are shown here. Statement (C) is correct. According to the photon theory, intensity is the number of incident photons in a unit time. If you throw more stones (with an aim) you can pluck more mangoes (if there are mangoes in the tree).

There is a question that many ask based on the photoelectric effect. That is, if you change the frequency, then there is a change in the energy of a photon (hf) and due to that, does not the intensity of the ray change? At a glance, the conclusion is correct. But the above conclusion is not true. Because due to photon theory, the intensity of the photon ray is not changed even though the energy of a photon is changed. The intensity due to number of particles can be changed from the number of photons that goes behind each other in a unit time and across a unit area.

Think of number of balls that are hitting on the wall. The intensity here is defined as the number of balls hitting on the wall in a unit time. The kinetic energy of the balls is irrelevant to the definition of intensity. For waves, intensity is connected with energy for definition. When talking about a wave, there is no meaning in the number of waves hitting in a second.

Therefore, when describing photoelectric effect, we should be only stable in considering on the photon (particle) theory of light (radiation). Here, we need to omit the concepts of waves. You cannot change parties like politicians whenever you want.

Look at the following I-V curves for an observational set up of photoelectric effect.



(A) (B)

Curve (A) is corresponding to an instance of changed frequency without a change of an intensity. The intensity is not changed even the energy is increased due to the increased frequency. Therefore, there is no change in the saturated current. When all electrons emitted from the cathode come to the anode, the photo current gets constant (saturated). When more and more electrons come to the anode, then the saturated current gets increased. To emit more and more electrons from the cathode, more and more photons should be incident on the cathode. That means the intensity of the ray should be increased. There is no increment or decrement in the current of the external circuit (photo current) even if the kinetic energy of emitting electrons gets increased.

The curve (B) is corresponding to an instance where both frequency and intensity are being changed.

6 A sound emitted by a source of intensity I reaches a certain point. The change in the sound intensity level at the same point when the sound intensity is increased to 2I is (log 2= 0.3)

(1) 0.3 dB (2) 3 dB (3) 6 dB (4) 9 dB (5) 15 dB

03 **Intensity of Sound**

You can just do this question as you have done many such questions. Most of the time, the intensity of these questions is changed in the multiples of 10. Then you can easily get log. If the value of log 2 is not given, then you cannot solve. When I becomes 2I, the change in the intensity level is 10 log 2.

7 Consider the following statements made regarding a monochromatic light ray refracting through a glass prism placed in air.

(A) The speed of the light ray inside the prism is lower than that outside the prism.

(B) The frequency of the light ray inside the prism is lower than that outside the prism.

(C) The wavelength of the light ray inside the prism is lower than that outside the prism.

Of the above statements,

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

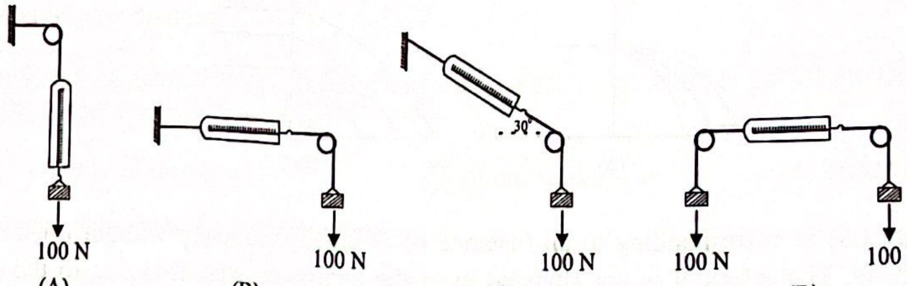
(3) only (A) and (B) are true. (4) only (A) and (C) are true.

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

03 **Optics**

This is also very simple theory question. You know that, the speed is reduced inside the prism but not the frequency. If the speed is reduced without changing the frequency, then definitely the wavelength should be reduced. The correct answer is (4).

8. Figures A, B, C and D show four ways in which alight spring balance can be loaded with a weight of 100 N using frictionless pulleys.



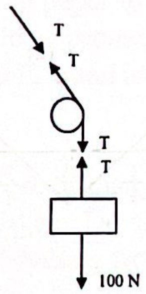
(A) (B) (C) (D)

The scale readings of the spring balances in the four cases would be

(1)	100 N	100 N	100 N	100 N
(2)	100 N	0	200 N	100 N
(3)	100 N	100 N	100 N	200 N
(4)	100 N	0	200 N	200 N
(5)	100 N	100 N	200 N	200 N

Equilibrium of Forces 02

You do not need a calculation. The readings are of the same value in each scale. The readings of the balances are the string tensions that are attached to the spring. The tension of each string is 100 N. It is the same string in whichever way it is being rotated. Some children may do a resolution of forces at (C) and write T sin 30^0 = 100. This equation is wrong. Which object' s equilibrium doesyou consider here?



The tension of the string is T everywhere. If you consider the forces on the pulley, there are two forces of T as shown in the figure. You can find the resultant of those two forces.

There is an opposite and equal force from the hinge's centre of the pulley which is stationary. Therefore, for whom are you writing T sin 30^0 = 100? T = 100 (considering the equilibrium of the weight)

9 Consider the following statements made about the linear expansivity of a material.

(A) Its SI unit is K^{-1}

(B) Its value changes when the temperature is measured in Celsius instead of Kelvin

(C) Its value changes when the temperature is measured in Fahrenheit instead of Kelvin

Of the above statements,

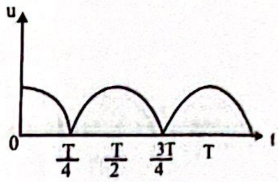
(1) only (A) is true.
(2) only (A) and (C) are true.
(3) only (A) and (B) are true.
(4) only (B) and (C) are true.
(5) all (A), (B) and (C) are true.

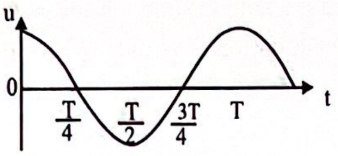
Expansion of Solids 04

You can directly decide that statement (A) is correct. As there is a difference of 273 in between Kelvin and Celsius (T K = θ^0C + 273), a difference of one Kelvin and a difference of one Celsius is equal. But Fahrenheit is not like that. 100 parts of Celsius is equivalent to 180 parts of Fahrenheit. Therefore, a temperature difference of one Celsius is not corresponding to a temperature difference of one Fahrenheit. So, statement (B) is wrong whereas (C) is true.

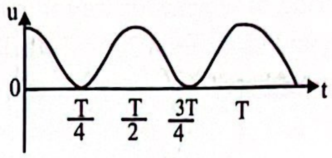
Even it is not relevant here, I feel that it is better to put a note on Kelvin temperature. Zero of Kelvin is the real zero (relevant to temperature). So, Kelvin temperature is called as the absolute temperature. Zero of Celsius is a zero that is put from the hand. Any genius cannot take the temperature below (negative values) than Kelvin zero. In addition, according to the third law of thermodynamics, absolute zero cannot be obtained. This is equivalent to the fact that any particle or system cannot get the speed of light. You can try with all your mighty powers. But you cannot get these absolute values. They are called as absolute due to that reason. If there is a belief that there is an almighty god, then that god is absolute. So, it is a meaningless question to ask who created such a god. We can try to reach such almighty god but we cannot be a one. If you can, then the absolute concept converts into a useless thing.

10 The variation of the speed u with time t of a simple harmonic oscillator is shown in the figure. The variation of its velocity v with time t is best represented by

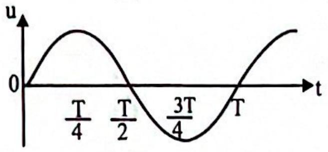




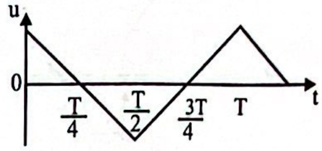
(1)



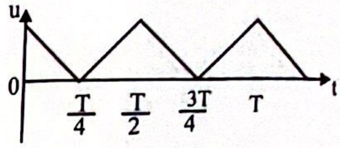
(2)



(3)



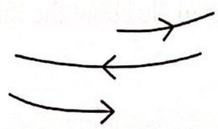
(4)



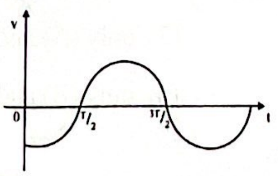
(5)

03 Simple Harmonic Motion

Speed is a scalar quantity. But velocity is a vector quantity. In a simple harmonic pendulum, the direction of the speed should be opposite at any instance. You can just remove (4) and (5). They are dumb answers. Only the direction should be changed in speed and velocity. The numerical value should not be changed any time. Left is (1) and (3). As the u-t graph has not started with zero,the respective v-t curve cannot start with zero. Therefore, the correct answer is (1). The speed-time graph has started from the centre of the pendulum (when the speed is maximum). That means, the following motion is represented as shown below.

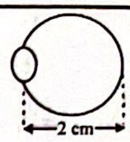


Therefore, after T/4 the direction of the speed changes. So, if the velocity from 0 to T/4 is taken as positive, then from T/4 to 3T/4 the velocity should be negative. This is being satisfied in only (1). The graph of v-t is below.



If it was drawn like this below, it is also correct. It is up to us to decide about the positive and negative direction of v. We can take any direction as positive. If the u-t curve is given like this, (3) can be taken as the correct v-t curve. In any v-t curve of an oscillation, v should be in one direction during the half of the oscillation whereas on the other half, it should be in the opposite direction.

11. A normal eye ball has a diameter of 2 cm as shown in the figure. The magnitude of the minimum power of the eye lens is



(1) 0 (2) 10 D (3) 25 D (4) 50 D (5) 100 D

Defects of Vision **03**

You can do it from the memory. The power of the eye lens (without being tired) is minimum when a far object is being focused on the retina. That means, parallel light rays are focused on the retina. Then the focal length of the lens is 2 cm. To find the power, 2 cm should be changed into m and get the reciprocal.($\frac{1}{2/100} = \frac{100}{2}$) Luckily, there are no answers such as 0.5, 5 or 500. The correct answer is 50. What else?

12 The size of the image of an object placed at a distance of 10 cm from a convex lens is twice that of the object. If the image is erect, the focal length of the lens is

(1) 7 cm (2) 10 cm (3) 20 cm (4) 30 cm (5) 40 cm

Refraction through lenses **03**

According to my decision, you need a paper to write a calculation initially to this question. As the image is not inverted, it should be produced on the same side of the object. The image distance should be 20 cm as the magnification is 2. You can do these from your memory. Now using the lens equation, $\frac{1}{20} - \frac{1}{10} = \frac{1}{f}$

There is no doubt that you might have done many questions using these values. Therefore, at a glance you need to identify that f = 20 cm. Do not take 10 by subtracting 20 from 10! A child who has done past papers can do everything from the memory. No doubt that some children might remember the answer.

13 The focal length of the lens of a simple microscope is 10 cm. If the near point of an eye is 25 cm, the approximate value of the object distance required to obtain the maximum angular magnification is

(1) 5 cm (2) 6 cm (3) 7 cm (4) 8 cm (5) 9 cm

Optical Instruments **03**

You need a small calculation for this question. To get a maximum angular magnification, the image should be produced at the near point of the eye. Directly apply the lens formula.

$$\frac{1}{25} - \frac{1}{u} = \frac{1}{10}$$

$$\frac{1}{u} = \frac{1}{25} + \frac{1}{10} = \frac{35}{250}$$

$$u = \frac{250}{35} = \frac{50}{7}$$

The answer is nearly equal to 7. Even the question it is asking a near value. Therefore, you should decide that the answer does not simplify completely.

The other method is that applying the equation of magnification which you know (M = 1+ D/f). According to that you get 3.5 as the magnification directly. Now the object distance can be found from the magnification ratio of (image distance/ object distance).

3.5 = 25/u u = 250/35 = 50/7

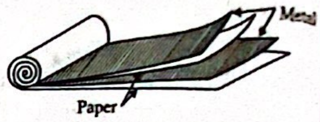
14 An object weight 100 N on the earth surface. When it is carried to a height equal to the radius of the earth, from the earth's surface, its weight becomes

(1) 10 N (2) 25 N (3) 50 N (4) 75 N (5) 100 N

03 **Gravitational Force Fields**

It is a sin to do calculation to this question. When the distance is doubled, gravitational froce should be reduced by a factor of ¼. $F \propto \frac{1}{r^2}$ When 100 is divided by 4, you will get 25. Do not write equations, expressions for such questions.

15 A cylindrical capacitor is formed by inserting two sheets of paper of dielectric constant 4 and thickness 10^{-4} m, alternately between two rectangular sheets of metal foils, each of length 1 m and breadth 10^{-2} m, and rolling them as shown in the figure. ($\varepsilon_0 = 9\times10^{-12} F\ m^{-1}$)



The capacitance of the capacitor is

(1) 3600 pF (2) 360 pF (3) 36 pF (4) 18 pF (5) 3.6 pF

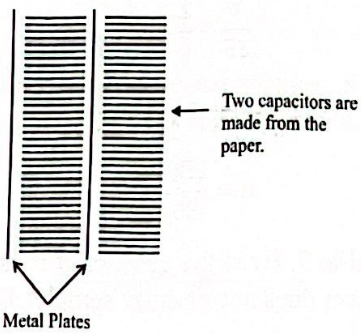
06 **Electrcstatic Potential**

If you think of a cylindrical capacitor, you will get the feeling that it is not in the syllabus. But if it was clicked as a parallel plate capacitor which has been rolled, then you are in the safe side. By rolling there is convenience in usage by saving the space. Actually there are such capacitors in the market. The capacitance that you get from the parallel plate capacitor can also be obtained by rolling. Such capacitors are easy and economical when considering about the space. So, use the equation of parallel plate here.

$$\frac{4 \times 9 \times 10^{-12} \times 1 \times 10^{-2}}{10^{-4}} = 36 \times 10^{-10} F$$

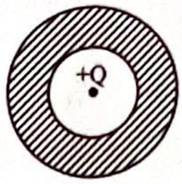
As all the parameters are given in meters, the task is easy. But the answers are given in pF (picoFarads). Therefore, you should know the prefix of pico as 1 pF = 10^{-12}F. The correct answer is 3600 pF. If it is nanoFarads, then the answer is 3.6.

What is the importance of the paper at the below that is drawn in the figure? It is not affecting the calculation. When the dielectric paper is put in between the metal plates, the parallel plate capacitor is being created.



If there is no paper below, then the lower plate and the upper plate will be touched with each other when they are being rolled. Think a bit. If so, then the capacitor process will be stopped. Once the plates are touched, they become a single conductor that are connected with each other. The paper is there to prohibit that. But it does not affect the capacitance. There exists only one parallel plate capacitor with a dielectric paper in the middle.

16 The figure shows a spherical conducting shell. A point charge +Q is placed at the centre of the shell and a charge –q is given to the shell.



Finally the shell will have

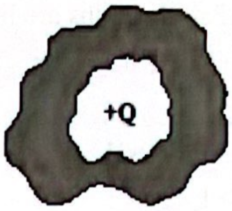
(1) zero charge on the inner surface, -q on the outer surface.

(2) –Q charge on the inner surface, -q on the outer surface.

(3) –Q charge on the inner surface, -q +Q on the outer surface.

(4) +Q charge on the inner surface, -q -Q on the outer surface.

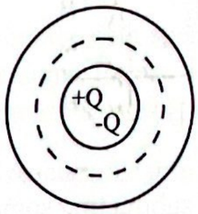
(5) -Q-q/2 on the inner surface, +Q-q/2 on the outer surface.



First think of +Q charge. From that, there will be an induced charge of -Q in the internal surface and +Q charge in the outer surface of the shell. This is a known fact by everybody. If the +Q charge is kept in the middle of the shell or kept in any place of the hollow space, then the total amount of induced charge that is mentioned above will be the same. As the spherical shell covers the total flux of charge +Q, the charge does not need to be kept at the centre. Even the shell does not need to be in spherical shape. As long as the charge +Q is being covered completely, then there is no effect from the shape of the shell to the answer.

Next, -q charge is being given as an extra charge to the conductor. Then it should be situated at the outer surface. Under static condition, there cannot be an extra charge inside the conductor material. It should move to the outer surface. If an extra charge is retained in the conducting material, then the electric field intensity inside of it will not be zero.

The correct answer is (3). Even if you consider -Q in the internal surface and +Q in the outer surface, then only (3) will be correct. The generation of induced charge of -Q on the internal surface is not a problem.



If you consider the Gaussian surface of the conducting material in a dashed line, then the charge inside of it is zero (+Q - Q =0). Hence, there is no electric field inside the conductor. But there cannot be the extra charge or part of it inside the Gaussian surface. If so, then E cannot be zero.

So, under a static condition, the excess charge should lie on the outer surface of the conductor.

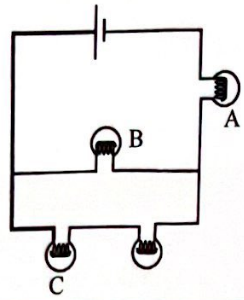
17 If a wire of resistance R and length l is used to form anther wire of length 2l without changing its volume, the resistance of the new wire is

(1) 4R (2) 3R (3) 2R (4) R (5) R/2

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

You can do it from the memory. Truly, you should do from the memory. Otherwise it is an unfair act that is done by yourself to you. The length has been doubled. As the volume is unchanged, once the length is doubled, the cross sectional area should be half of the initial value. Therefore, the resistance should be increased four times from the initial value. ($R \alpha l/A$)

18



Four identical electric bulbs are connected to a battery as shown in the figure. If all the bulbs are lit, and the intensities of the bulbs A,B and Care I_A, I_B and I_C respectively then

(1) $I_A > I_C > I_B$ (2) $I_A > I_B = I_C$

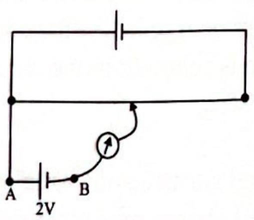
(3) $I_B > I_C > I_A$ (4) $I_A > I_B > I_C$

(5) $I_A = I_B = I_C$

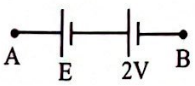
08 **Heating Effect of Electric Current**

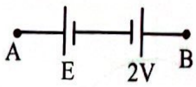
As the bulbs are identical, their resistances are the same. Therefore,
if you compare the currents across them, then the answer is in your hand. The whole current from the battery is flowing across A. Next, a child in year 9 can tell that more current is flown from B compared to C. So what else? Is not the answer (4)?

19



A potentiometer is balanced by connecting a cell of e.m.f 2V acrossA and B, as shown in the figure. The same balanced length can be obtained if another cell E of suitable e.m.f. is connected in series with the 2V cell as

(1)


(2)


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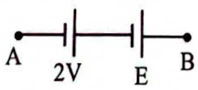
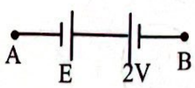
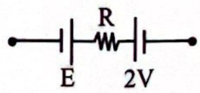
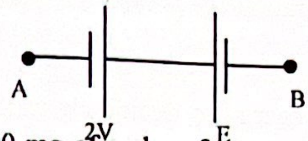


(4)


(5)


08 **Potentiometer**

If you put the logic simply, by adding or subtracting something to 2, then you can get only 2 from 4-2. This is correct. Is not it? (without a mathematical application). If you think like that, then you will understand that the correct answer is (2). But if you are not tempted to think like that, then what you have to do is to check each answer by the eye and process from the mind. As soon as you see (1), you can see that the equivalent is greater than 2 directly. (2) is correct. Actually, E = 4V. In (3), all are in the other way around. Having the equivalent on the other way is useless anyway. Can you get 2 from the reduction of something from 2? It is in (4). If E = 4V, the net in between A and B is -4 + 2 =-2.If E is less than 4 (E =1 V), then the net is -1 +2 = +1. (5) has the same thing of (4). There is a resistance in between the cells for nothing. There is no harm from it. However, at the equillibrium there is no current across the cells. Instead of the correct answer of (2), is this correct? Can you change the politicians even if they go to the party of the government from the opposition?



20 An archeologist extracted 100 mg of carbon from an ancient wooden tool and found that it is 1/4 as radioactive as 100 mg of carbon retracted from a live tree. Half-life of carbon-14 is 5730 years. How old is the wooden tool?

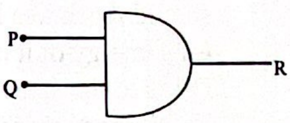
(1) 1 432.5 years (2) 5 730 years (3) 10 162.5 years

(4) 11 460 years (5) 22 920 years

Radioactivity **11**

You do not have to do calculations. After one half life, the activity drops to a ½. If it is dropped to ¼, then there should have been two half-lives. Is not it? Multiply 5730 by 2. How hard is it? Even can you have the answers with decimal places? The value of the mass is given to emphasize the fact that the same mass has been used for comparison.

21 Consider the following statements made regarding the logic gate shown in the figure.



(A) When P=1,R=Q (B) When Q=0,R=P
(C) When P=0,R=0

Of the above statements,

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

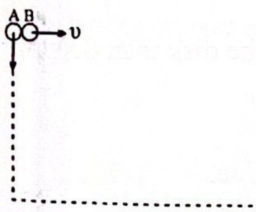
(3)only (A) and (C) are true. (4) only (B) and (C) are true.

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

Logic Gates **09**

I will solve such questions by writing simple logical expressions. This is a gate of AND. Therefore, R = PQ. As soon as you write this, you can just decide the correct and incorrect expressions. When P =1, R =Q. When P or Q or both gets zero, R should be zero.

22 A ball B is projected horizontally with speed v and a ball A is dropped vertically from rest at the same instant as shown in the figure. Which of the following statements is true? (Neglect air resistance)



(1) A reaches the ground first with a higher speed than B.

(2) B reaches the ground first with a higher speed than A.

(3) A reaches the ground first with a lower speed than B.

(4) Both A and B reach the ground at the same instant with the same speed.

(5) Both A and B reach the ground at the same instant but B with higher speed than A.

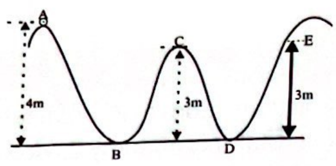
Linear Motion **02**

There is no surprise to see children who had done calculations for this question. Do you really need to do a calculation? Is not that a waste of time? The initial horizontal velocities are zero in both of the balls. The same vertical distance is being travelled when the balls hit the ground.

The vertical downward acceleration (g) is also the same. Therefore, the time taken for the journey should be the same.

If you think from the side of energy to decide about the speeds, then it will be easy. The gravitational potential energy change is same for both of the balls. But ball B has an initial kinetic energy. The initial kinetic energy of A is zero. Therefore, the speed of B should be higher than A when reaching the ground. If you try to calculate the speeds without thinking from the point of conservation of energy, then you are wasting your time.

23 As shown in the figure a ball of mass 6 kg released from rest at point A on a smooth track ABCD slips without rolling. The portion DE of the track is rough. If the ball climbs upto a vertical height of 3 m along the rough surface, the energy lost due to friction is

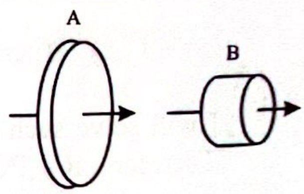


(1) 240 J (2) 180 J (3) 120 J (4) 60 J (5) 0

02 **Work Power and Energy**

If you argue correctly, then there is no need to do calculations. If all are smooth, then the ball should reach to a height of 4 m in the part of DE. As the ball was released from rest at A, the total energy of it is only the potential energy mg X 4. If there is no energy lost and the part of DE is to the same height, then the ball should merely go to the height of 4 m. But as the part of DE is rough, the ball goes only up to 3 m. It only goes to 3 m to a place that it should go 4 m. Therefore, the lost energy to stop the friction should be equal to 6 X 10 X 1. A height of 1 m was not gone due to this friction. Otherwise, the ball will nicely go towards a height of 4 m.

24 The two uniform disks A and B shown in the figure are made of the same material and have equal masses. The radius of the disk A is greater than that of B.The disks are kept in isolation at outer space. Consider the following statements.



(A) The disk A takes a longer time than B to gain a given speed under an external force acting through the centres of the disks.

(B) The disk B takes a longer time than A to gain a given angular speed under an external torque about the axis of the disks.

(C) The disk B has a higher rotational inertia about the axis of the disk than disk A.

Of the above statements,

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

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

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

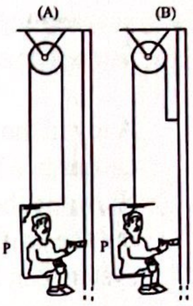
02 **Rotational Motion**

This is a simple theory question. Mass of an object is associated with the translational motion. In the rotational motion, this factor is changed into moment of inertia or rotational inertia. As the mass of the disks are equal, their acquired accelerations are in the same value under an equal force. Therefore, time taken to attain a given speed should be in the same value. So, (A) is false. Even though the mass of A and B are equal, the radius of A is greater than B. So, the moment of inertia (rotational inertia) is greater in A. From this you can understand that statement (C) is false. An object with a higher moment of inertia does not like to rotate very much. Therefore, at a given torque B is rotating very quickly. So, the time taken for B should be lesser than A. That means statement (B) is wrong.

Why it is mentioned that the disks are isolated and kept in space? Practically disks cannot be kept like that. They should be kept on the table or ground. If so, then the asked statements cannot be universally fair. Because there are extra force acting on them. If they are isolated in the space, then these disks can be just kept as the way they are drawn. There is no weight on the disks too. In addition, there are no gravitational forces from the extra objects. So, the asked statements can be asked as it is because there is no wrong in it. If it was not like that, you have the space to ask the cross questions such as how can this be happened?

25 Figures A and B show two ways in which a painter could use a system consisting of a platform P, a pulley and a rope in painting tall buildings. The total weight of the painter and the platform is 400 N. If the rope is light then the tensions of the rope in the two cases are

	A	B
(1)	400 N	400 N
(2)	400 N	200 N
(3)	200 N	400 N
(4)	200 N	200 N
(5)	100 N	200 N



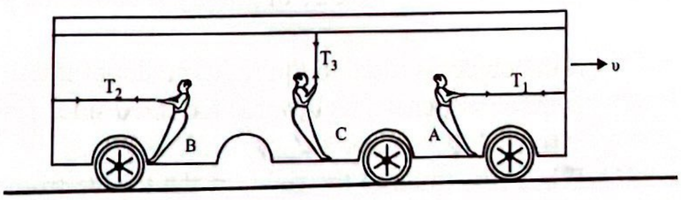
This is a sweet question. At instance (A), the stage and the man are held by both sides of rope. It is not so in (B). At (B), the tension of the rope is 400 N. At (A) it is reduced to half of it. (2 T = 400 then T =200)

Equilibrium of Forces **02**

If you consider the convenience of up and down transport, then set up of (A) is more practical. The left rope that has been tied up to the stage can be released and pulled. So that the man also can go upwards with the stage. Likewise, by carefully loosening the rope, you can come downwards. Can you go up and down like that in (B)?

26 A trolley is moving with a constant velocity v. Three men, A,B and C, are pulling three strings in such a way that their tensions are T_1, T_2 and T_3, respectively, as shown in the figure. When the trolley moves a distance L, the work done by the men are

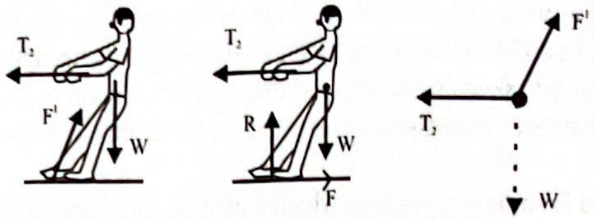
	A	B	C
(1)	$T_1 L$	$T_2 L$	$T_3 L$
(2)	$-T_1 L$	$T_2 L$	0
(3)	$T_1 L$	$-T_2 L$	0
(4)	$T_1 L$	$T_2 L$	0
(5)	0	0	0



Work Power and Energy **02**

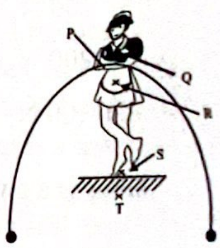
This is a question that you can get wrong. Many children have a possibility in going for choice

(2). But the correct choice is (5). Three persons are not doing an external work what so ever. They are just pulling the string like fools. I wonder for what reason do they keep pulling? There is no motion in them relative to the trolley. As the tension that is acting on the man in (C) is vertically upwards, the horizontal component is zero. So, it is tempted to take the work as zero. But one can argue that it is not so in the case of A and B. When we consider the horizontal forces of the man in B, we forget the force from the floor of the trolley to the man. The forces that are acting upon B are shown below.



The string is being pulled to the right by B. Therefore, the force on B (tension) from the string is towards the left. The surface of the trolley is pulled to the left by the legs of B. Then the surface of the trolley creates a force (frictional force) to the right. As the man is not accelerating $F = T_2$. That means there is no net force on the man. So, he is not doing an external force. The story is same for A. Draw the forces that are acting on A.

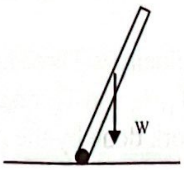
27 A toy in the form of a child-figure holding a section of a thin ring, which carries two identical heavy metal balls, is made from a thin metal sheet as shown in the figure. If the toy can be balanced in stable equilibriumfrom the toe of the child-figure, most probably the centre of gravity of the system can be found close to a point



(1) P (2) Q (3) R (4) S (5) T

02 **Centre of Gravity**

This was a question which was subjected to controversy. The answer can be obtained directly. Once you see the word of stable equilibrium, you should conclude that the centre of gravity of the system should be below the point of suspension.There is only one point that is below the point of suspension. That is T. It is common for any system. Look at the following figure.



Centre of gravity is above the point of suspension

If the object is tilted to the right, no doubt it will fall. The torque due to the weight from the point of suspension is towards the tilted side. 

When it is tilted to the right, as the torque from the weight is to the left,  it tends to straighten up. If it is tilted to the left, then as the point of gravity is displaced to the right, the object again tends to straighten up.

Centre of gravity is below the point of suspension

Some argue that it should be given as an ALL question as the point T is not drawn vertically downwards to the point of suspension (the finger tips). There is no validity in this. The child figure is drawn slightly bent towards left. Therefore, the point where the centre of gravity should lie must be towards to the right (relative to the vertical axis across the point of suspension).

When the figure is swinging from side to side, the point where the centre of gravity lies does not remain still. Think for a while. If the figure is only vertical, then point T is definitely be at the vertical axis across the point of suspension. Therefore, this is not a question that should be treated as ALL.

The centre of gravity could not be placed at S. S is even drawn little bit above the point of suspension. If the centre of gravity is above the point of suspension, then definitely the figure will fall down irrespective of the tilted side.

What will happen if the centre of gravity is on the point of suspension? If so, then there should be an equilibrium at anywhere of the figure (neutral equilibrium). Even though it is not practical to take the centre of gravity to the finger tips, if it was done, then the beauty of the toy will be lost. Such a toy does not need to stay straight when swinging to from side to side. It needs to be in vertical equilibrium again without falling when swinging to from side to side. This is the secret of the stable equilibrium.

The bangle with heavy metal balls has used to keep the centre of gravity downwards. It gives a beautiful quality to the toy as well. From the view point of Physics, it is essential. As Physics is beautiful there is no problem with it. Is not it beautiful when it is swinging?

28 Starting from rest, a sphere takes a time t to roll down a rough inclined plane. If the plane is made frictiorless the time taken by the sphere to down will be

(1) t. (2) higher than t. (3) lower than t.

(4) determined by the mass of the sphere. (5) determined by the radius of the sphere.

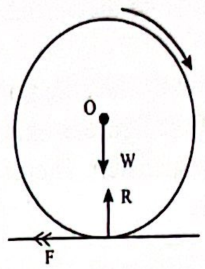
Rotational Motion 02

If you are tempted to do a calculation, then may Lord Buddha bless you! God bless you! This is the logic of it. If the surface is rough, then the sphere will fall down and come downwards (as there is friction). If the surface is smooth, then the sphere will just slide down. If you think further in Physics, then in the rough surface the sphere gets the translational kinetic energy as well as the rotational kinetic energy. If the surface is smooth, then the sphere gets only translational kinetic energy only.

As the sphere starts from the rest, it has the gravitational potential energy. If the surface is rough, then this initial energy is given to both translational kinetic energy and rotational kinetic energy. Both should share the initial potential energy. But in the smooth inclined plane, the initial potential energy is absorbed only by the translational kinetic energy. Therefore, the acquired speed of the sphere when it is coming by sliding below must be greater than the speed when it is coming by rolling. When love is divided between two, one is getting less love. The work done under less love get delayed.

Therefore, the ball that is in the smooth inclined plane comes quickly. You can go quickly by sliding instead of rolling. Just think without mathematics. Even we tend to slide when we get a problem.

Even it is not directly relevant to the question, it is better to describe a question that has been asked by many people from me. Consider a freely falling disk/ sphere on a rough surface. We will draw the acting forces on it.



If we use F =ma for the translational motion, then -F =m a

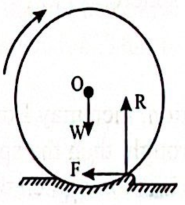
That means, the disk will decelerate and its speed will be less. There is no problem. But a big confusion occurs when we write equations for the disk when it is rotating around its centre O.

↻ O $\quad F a = I \alpha$

Here a is the radius of the disk. The angular acceleration of the disk is α. According to this, the disk is subjected to an angular acceleration. That means the angular velocity should be gradually increased. Very good!

If the angular velocity is increased, then the linear velocity also should be increased. If it is correct, then there will not be an energy crisis. How can we solve this contradictory? This issue has been mentioned below. Do not look at it directly and do concentrate on this crisis.

When the wheel is rolling freely, the diagram which I have drawn earlier with the acting forces was wrong. Following is the correct diagram.



Even though we cannot see the wheel and the floor surface it is deformed even at a microscopic level. As the wheel does not have a driving force, the surface is deformed as shown. Due to the surface of the floor, the net force acting on the wheel is from a point that is in front of the vertical line across the centre of the wheel. Its net action line is towards the back (relative to the motion of the wheel).

The vertical component of that force is the reactive force (R) and the horizontal force is the frictional force (F). Consider that R is not going across the centre of the wheel. The angular speed is increased by the torque due to F but the torque due to R is acting opposite to that motion.

Now if we apply $\tau = I \alpha$, $F y - R x = I \alpha$

Here y and x are the distances to the active lines of the forces from the centre. The distance of y is nearly equal to the radius r of the wheel. $F r - R x = I \alpha$

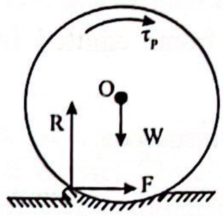
If we apply $F = ma$ to the linear motion, then $-F = ma$

If the wheel is not sliding, then $a = r\alpha$

When I is taken as $\frac{1}{2} mr^2$, you can show that $R x = - 3/2 F r$

That means $Rx > Fr$. It indicates that you will get a negative value for α. That means an angular retardation. Now the problem is solved.

If the wheel has a driving torque, then the force diagram is shown below.



29 An organ pipe filled with O_2 has a fundamental frequency f_0 If the pipe is filled with H_2 at the same temperature and pressure, the new fundamental frequency of the pipe is (relative molecular masses of H_2 and O_2 are 2 and 32 respectively),

(1) $\frac{1}{4}f_0$ (2) $\frac{1}{2}f_0$ (3) f_0 (4) $2f_0$ (5) $4f_0$

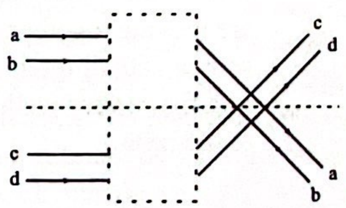
Longitudinal Waves **03**

The length of the tube has not been changed. Therefore, the wavelength of the generated standing wave is not changed. But as the gas was changed, the sound velocity has been changed. As the temperature is not changed while both gases are being di-atomic, the sound velocity

$v \propto 1/\sqrt{M}$. M is the molecular weight. Di-atomic story has been mentioned to prove that γ of both gases are equal. 2 and 32 have been taken as 16 is obtained by the division of 32 by 2. Then the square root of 16 becomes 4. Therefore, clearly the sound velocity of H_2 is four times the amount of O_2 (as H_2 is lighter).

When V is increased by four times, f is also increased by four times ($v = f \lambda$). Therefore, the answer is (5). If our throat is filled by inserting different gases into the mouth, then there will be strange sounds coming out of it due to different frequencies (pitches).

30. Rays from a monochromatic source of light are deviated by an optical element as shown in the figure. This optical element is likely to be



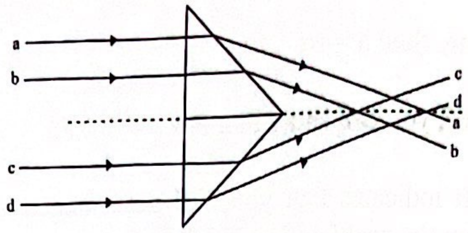
(1) a convex lens. (2) a concave lens.

(3) a single prism. (4) a combination of two prisms.

(5) a combination of a prism and convex lens.

Refraction through Lenses **03**

As soon as you saw the ray diagram, you can remove lenses. Parallel rays are being converged by a convex lens whereas a concave lens diverge the rays. Therefore, the answer should clearly be a prism.



There is a little confusion here. This can be obtained separately from two rectangular prisms or from one prism. Even you can consider the shown two prisms as a single prism.

31 Figures A,B and C show wave fronts emitted from three sources of sound.

These figures respectively represent sources

(1) moving to the right, moving to the left, and stationary.

(2) moving to the left, moving to the right, and stationary.

(3) stationary, stationary, and moving to the right.

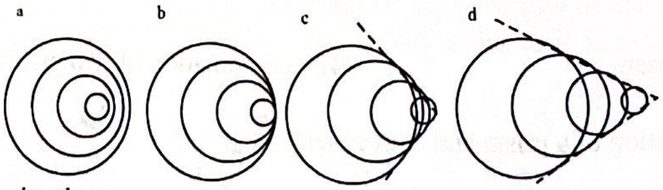
(4) moving to the left, moving to the right, and moving to the left with the speed of sound.

(5) moving to the left, moving to the right, and moving to the right with the speed of sound.

03 ***Doppler Effect***

What is expected from this question is very clear. You can decide the answer when you read the question. Everybody knows the fact that the wavelength is getting shorter towards the travelling direction whereas it gets longer when moving away. The examiners might be expecting (5) as the answer but there is a little mess in the figures A and B. Except the outer circle in A and B, the centres of all the other three inner circles are drawn in the same place. If the sources are moving, then the centres should be displaced towards the moving side with time. Actually, the sources are represented by the centres. The wave patterns emanating from the source (centre) have been drawn.

As there is no such movement in the centres of the inner circles, it is correct if one argues as A represents an instance where the source isinitially moved to the left a little and then remains at rest afterwards. Same logic can be applied to B also. As soon as you see C you can decide that it is a source that moves to the right with the speed of sound. Both the sound and the source are moving together. Wherever there is the source, there is the sound. Different instances of a source with different speeds that moves to the right have been shown below. If you look at the first figure very well, then you can observe that the centres of the circles are gradually shifted to the right.



υ less than υ_w υ equals υ_w υ exceeds υ_w υ greatly exceeds υ_w

32 A student vibrates a tuning fork and listened to its sound. while keeping it in air. Then he vibrated this tuning fork again with the same amplitude and listened to the sound while holding its handle against a large wooden board.

(1) Sound intensity heard by him in both cases is the same.

(2) Sound intensity heard when the tuning fork is in air is larger than when it is held against the wooden board.

(3) The time during which the tuning fork goes on vibrating is the same in both cases.

(4) The time during which the tuning fork goes on vibrating is higher when it is kept on the board than an air.

(5) The time during which the tuning fork goes on vibrating is higher when it is kept in air than on the board.

Even though this is not a hard question, you need to read each choice one by one to find the aim of the question and the correct answer. The choices are given about sound intensity and the vibrational time. When a tuning fork is vibrated, the sound intensity (loudness) we hear is not strong. It is weak. But if we vibrate and its handle is kept on a wooden board, we hear the sound louder. The reason is that, the bigger area of the wooden board allows the air to vibrate more. When the tuning fork is vibrating alone, the number of air molecules vibrating from it is relatively small. But when the handle of the vibrating tuning fork is kept on the wooden board, we forcefully allow the wooden board to vibrate as well. This is known as the forced vibration in Physics. You get the things done forcefully.

When the wooden board is vibrated, the air molecules that contain in its area is bigger. So, due to a combination of many molecules the sound intensity is relatively higher. Therefore, statements (1) and (2) are wrong.The other three sentences are about the time that the tuning fork is vibrated. The vibrating energy of the tuning fork is given to the wooden board and when the wooden board is vibrating, the air is vibrated again. When the tuning fork is kept in the air alone, the energy transfer is happening relatively to a smaller number of gas molecules. When the fork is kept on the wooden board, the energy should be given to that also. Therefore, the tuning fork is vibrating more time in the air. If the sound intensity is increased with a more vibrational time, then it is against the law of conservation of energy. Therefore, the correct answer is (5).

Actually, the air is not a good conductor of sound. Especially, as the molecules of solids are closer to each other, the vibration of a molecule is picked up by the other very quickly. But the distance of air molecules is larger on average. Therefore, the vibrational energy is damaged quickly. Sound energy is transformed into the heat. But sound energy generation is lessinside a solid. So, the sound travels a long distance. You can clearly hear the sound of an incoming train which is coming from a far away by keeping the ear to the rail track. But please do not try this as you can lose your neck by keeping the ear. Put a watch that sounds 'tik tik' on a table and keep the ear on the table. Then you can hear the sound of 'tik tik' clearly.

Fortunately, our ear is a very sensitive detector. The pressure changes of 10^{-11} from the normal atmospheric pressure can be detected from our ear. Musical instruments like guitars have sound boxes due to this reason. If not, the produced musical notes will be heard very weakly. But electric guitars do not need sound boxes. You can think of the reason for that.

33 A tuning fork is at resonance with a sonometer wire. Consider the following statements

(A) A standing wave is set up in the wire.

(B) If the tension of the wire is increased its resonance length will decrease.

(C) The amplitude of vibrations would be maximum if it resonates in the fundamental mode of vibration

Of the above statements,

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

This is a very simple theory question. As soon as you see (A), you can decide that it is correct. Hope you have done many questions of this nature. If the tension of the wire is increased, then the speed of transverse waves of the wire increases. As the tuning fork is not changed,it should resonate with that particular frequency. If v is increased and f is constant, then λ should be increased. To increase λ, the resonant length should be increased. You can just feel that (C) is correct.

34 Which of the following statements is true for a mixture of ideal gases at a given temperature?

(1) All the gas molecules in the mixture have the same speed.

(2) Molecules of each component of the gas mixture have the same average kinetic energy.

(3) Lighter gas molecules have a lower average kinetic energy.

(4) Heavier gas molecules have a lower average kinetic energy.

(5) Root mean square velocities of gas molecules of each component of the gas mixture are the same.

04 **Expansion of Gases**

You do not have to think a lot for questions like these. If the temperature is same, then the average (mean) kinetic energy of the molecules is in the same value. Temperature is a measurement of the kinetic energy. (1) is wrong. Even it is a mixture or a single gas, the gas molecules have a speed distribution. As (2) is wrong, (3) and (4) are useless. Even if you have many gas components in a given temperature, it should be $\frac{1}{2}m_1\bar{C}^2{}_1 = \frac{1}{2}m_2\bar{C}^2{}_2 = \frac{1}{2}m_3\bar{C}^2{}_3 = \cdots$ Therefore, the root mean square velocity of the lighter gas component in the mixture should be greater.

35 A volume V_1 air at 100% relative humidity is mixed with volume V_2 of completely dry air at the same temperature and pressure so that the final volume becomes $V_1 + V_2$. The relative humidity of the mixture is

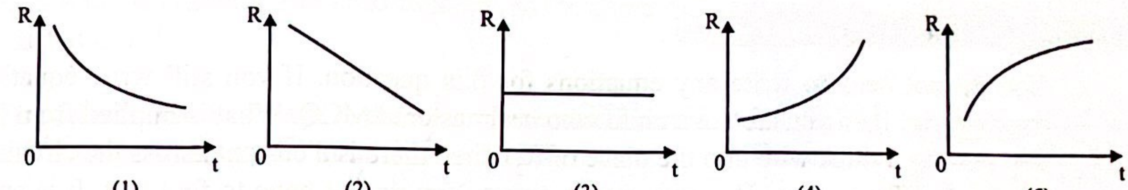
(1) $\left(\frac{V_1}{V_2}\right) \times 100\%$
(2) $\left(\frac{V_1 - V_2}{V_1 + V_2}\right) \times 100\%$
(3) $\left(\frac{V_1}{V_1 + V_2}\right) \times 100\%$
(4) $\left(\frac{V_2}{V_1}\right) \times 100\%$
(5) $\left(\frac{V_2}{V_1 + V_2}\right) \times 100\%$

04 **Hygrometry**

If m is the mass of water vapour in gas volume V_1, then as it is saturated the mass of water vapour needed to saturate volume V_1 is m. If m is needed to saturate V_1, then thewater vapour mass needed to saturate a volume of $(V_1 + V_2)$ is $\frac{m}{V_1}(V_1+V_2)$. As V_2 initially did not contain water vapour, once it was added to V_1, there was a mass of water vapour m (the amount that initially had). Now $(V_1 + V_2)$ also has m. But to saturate, it needs $\frac{m}{V_1}(V_1+V_2)$. So, the new relative humidity is $\frac{m}{\frac{m}{V_1}(V_1+V_2)}$. That means the answer is (3). If the problem is caught, then all you need is to write this expression on the rough paper. Even if you look at the expressions, we do not know whether V_2 is greater or equal or less than V_1. So, there cannot be a ratio like V_1/V_2 or V_2/V_1 in the answers. If $V_1 = V_2$, then the relative humidity becomes 100% again. If $V_2<V_1$, then the ratio of V_1/V_2 becomes more than 1. $V_2>V_1$ but always the ratio

$\frac{V_1}{V_1+V_2}$ or $\frac{V_2}{V_1+V_2}$ is less than 1.

36 Consider a situation where a layer of ice is being formed on Arctic sea water due to a constant temperature difference between sea water and the atmosphere. The variation of the rate (R) at which the heat is extracted from a unit area of ice-atmosphere interface by the atmosphere with time (t) is best represented by



Conductivity 04

It has been mentioned that the temperature difference between the two sides of the ice sheet is kept constant. Therefore, the heat drawing rate per a unit area (R) is inversely proportional to thickness of the ice sheet. $R \propto 1/d$

As the time lapses, d is gradually getting increased. Therefore, when d is increased, R should be gradually decreased. So, the answer should be (1). You can directly remove (3), (4) and (5). Due to the nature of inverse proportionality, the reduction cannot be linear.

The other point is that, when time passes by, R should reach a certain value. The thickness of ice sheet cannot be increased continuously. These facts are being satisfied only in curve (1). If (2) is correct, then at a certain time, R=0. If so, then d should be increased continuously. No need to write any equation. You can even decide from general knowledge that R should be reduced with time. Such questions are given in many occasions.

37 A particle with charge q and mass m travels perpendicular to a uniform magnetic field along a circular path of radius R with frequency f. The magnitude of the magnetic flux density is given by

(1) $\frac{mf}{q}$ (2) $\frac{2\pi fm}{q}$ (3) $\frac{m}{2\pi fq}$ (4) $\frac{m}{qR}$ (5) $\frac{qf}{2\pi R}$

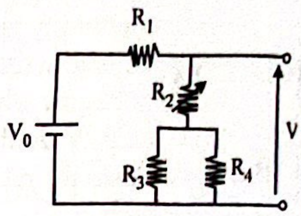
Force on a Moving Charge in a Magnetic Field 07

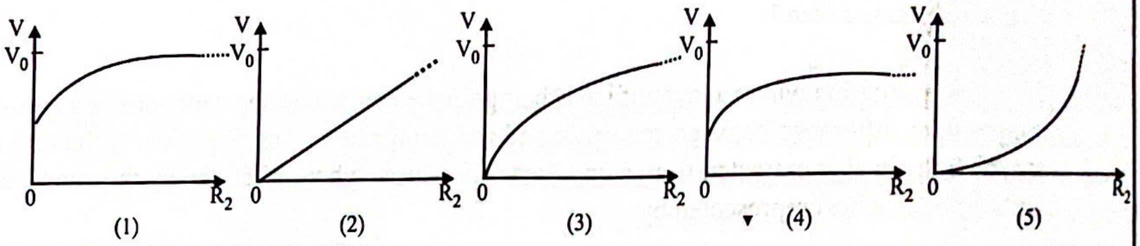
You need to write equations for this question. In such an occasion, write $mv^2/R = qvB$ equation that you always write and get the expression for v $v = \frac{qBR}{m}$

$$\text{Now } f = \frac{v}{2\pi R}\text{. Then } f = \frac{qBR}{m\,2\pi R} \rightarrow B = \frac{2\pi fm}{q}$$

You need to spend some time for this. That is to write equations. But no need to argue. All you need is to write down some expressions that you are already familiar with. The special fact is that f is not dependent on R. Even if the charged particle goes around in any radius, f does not change. This frequency is known as the cyclotron frequency. A particle accelerator known as cyclotron is used to accelerate charged particles like protons. It is important that f is independent from R for its functionality.

38 When the value of R_2 in the figure shown is varied from 0 to infinity, the corresponding variation of V with R_2 is best represented by



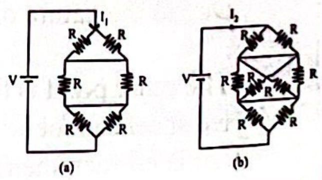


08 **Ohm's Law Combination of Resistances.**

You do not need to write any equations for this question. If you still write equations and expressions, then you are not a child who has mastered MCQ. What is implied from $R_2 = 0$ is that putting a thick wire into the place of R_2. Then there is a current across the circuit (across R_1, R_4, R_3).That means V gets a certain value. You do not have to find that. It is enough to know that it is a particular value (less than V_0). V will not be zero even if $R_2 = 0$. Even from that you can remove (2), (3) and (5).

R_2 is getting an infinite value means breaking the connection of R_2. The road is closed. Then there is no current across the circuit. So, $V = V_0$. If the connection of R_2 is broken then there is no current across R_1. Therefore, when R_2 is reaching infinity, it is enough to see that V is nearing towards V_0. Except for (1), this characteristic is not found in any variation.

39 If the currents passing through networks shown in figure (a) and (b) are I_1 and I_2 respectively then the ratio, I_2/I_1 is equal to (Neglect the internal resistance of the cell)

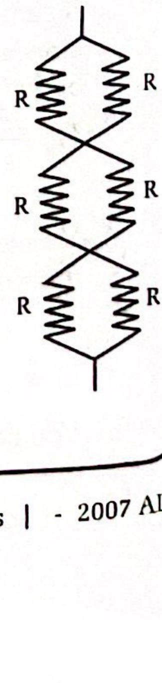


(1) $\frac{4}{3}$ (2) $\frac{5}{3}$ (3) $\frac{7}{4}$

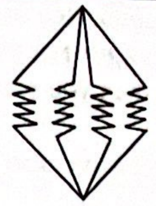
(4) $\frac{6}{5}$ (5) 2

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

It is good that if you can do little bit of rough work on this question (not a lot). You need to find the equivalent resistance on both situations. As V is same, you can take the ratio of currents. In the network of (a), first two R resistors are parallel. Second two R resistors and likewise the third two R resistors are also in parallel to each other. If you cannot see at a glance, then look at this figure.



Both ends of the two wires without the resistors are at the same potential. Now can you get the equivalent resistance using the memory? R and R are parallel. The equivalent is R/2. Such three of R/2 are in series. 3 times of R/2 is 3R/2. You need to write 3R/2 in the paper only. Writing any other thing is a time-wasting activity.



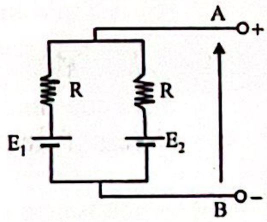
The only difference in the network (b) is, there are 4 resistors instead of 2 resistors. But can you see that these 4 are parallel to each other? Again, the top ends of each four are from the same point. The bottom ends are also like the same.

The equivalent of four R is R/4. This R/4 is in series with R/2 on the top and R/2 on the bottom. Do you need to write to add them? ½, ½, 1. A quarter added to 1 is 1 ¼. That means 5R/4. Now the currents are proportional to the reciprocal of the resistors.

Therefore, $\frac{I_2}{I_1} = \frac{3/2}{5/4} = \frac{3}{2}.\frac{4}{5} = \frac{6}{5}$

The value for I_2 for bottom (denominator) and I_1 for the top (numerator). However, there is no 5/6 in the answers. But unfortunately, in the paper of Tamil medium, it was printed as I_1/I_2 instead of I_2/I_1.

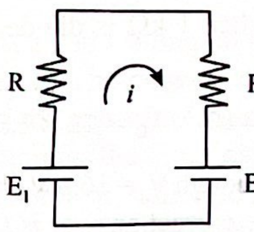
40 The cells E_1 and E_2 shown in the figure have zero internal resistance. The voltage V across the terminals A and B is



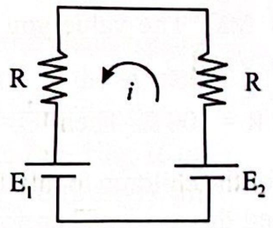
(1) $E_1 - E_2$ (2) $E_1 + E_2$ (3) $\frac{E_1 + E_2}{4}$

(4) $\frac{E_1 - E_2}{2}$ (5) $\frac{E_1 + E_2}{2}$

You need to do some work. When you have such answers, you need to write expression/s most of the time. If you need to find V, then you must find the current across the cells. If the current across the cells (circuit current) is i, then you can write 2i R = $E_1 - E_2$ quickly. Here I have taken as $E_1 > E_2$. If needed, take as $E_2 > E_1$. It eventually does not create a problem.



When $E_1 > E_2$



When $E_2 > E_1$

Now V = E_1 - iR or E_2 + iR (if $E_1 > E_2$)

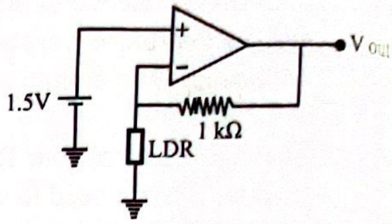
$V = E_1 - (E_1 - E_2)/2 = (E_1 + E_2)/2$

The above final result can be obtained however even by taking any side. If $E_1 = E_2 = E$, then V = E. This is a known fact by yourself. If the cells with same e. m .f of E are connected parallely, then the equivalent e. m. f is also E. When $E_1 = E_2 = E$ and V=E can be obtained only by the expression of (5). I am sure that this fact is not falling into your head. I also saw once I did the problem. Such a simple answer cannot obtained if R values are not equal. Then V also will be dependent on R values. Do it and see (by taking as R_1 and R_2).

When the cells with e. m. f of E are connected in parallel, their equivalent e. m. f is E either due to their internal resistances are negligible or their internal resistors are equal to each other. If the internal resistors are not equal, then you cannot take the equivalent e.m.f as E.

It has been mentioned here that the cells have zero internal resistances. If needed, you can take R as their internal resistor.

41 The figure shows an operational amplifier circuit with a light dependent resistor (LDR) and a 1 kΩ resistor.



The supply voltage to the operational amplifier is ±16.5 V and its saturation voltage is ± 15 V. The resistance of the LDR is 1 MΩ at complete darkness and 100 Ω at bright light.

The approximate value of the output voltage of the circuit V_{out} at complete darkness and bright light will be respectively

(1) 1.5 V and 15 V
(2) 1.5 V and 16.5 V
(3) -1.5 mV and -15 V
(4) -1.5 V and -16.5 V
(5) 1.5 mV and 15 V

09 **Integrated Circuits**

Such questions can be seen in essay questions too. This is a non-inverting operational amplifier circuit. If the resistance of LDR is R (kΩ), then you know that,

$$\frac{V_0}{1.5} = \frac{R+1}{R} = 1 + \frac{1}{R}$$

Either you should know these equations by heart or else you should be able to derive them very quickly.

$$\frac{1.5}{R} = \frac{V_0}{R+1}$$

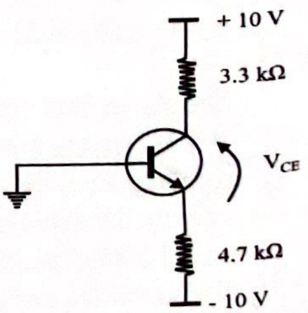
(considering the current that is flowing into the operational amplifier as zero and $V_+ \approx V_-$)

In the dark, R = 1 MΩ. The value you get when 1 kΩ is divided by 1 MΩ, is very small (0.001). Therefore, $V_0 \approx 1.5$ V

In the bright light, R = 100 Ω. Then $\frac{1}{R} = \frac{10^3}{10^2} = 10 \quad V_0 = 11 \times 1.5 = 16.5\ V$

Here there is apit for the children to fall. Even though $V_0 = 16.5$ V, the saturated voltage is 15V. So, it cannot exceed this value. Therefore, the correct answer is (2) not (1). Exactly 16.5 V is given to put into the pit if you like. If there is no such information about saturated voltage, then there is no problem in taking 16.5 V. Here both values of 16.5 V and 15 V are given to put you in trouble.

42 In the circuit shown, the transistor operates in the active mode with V_{BE}=0.6 V. The collector-emitter voltage V_{CE} in the circuit is approximately



(1) 0
(2) 2 V
(3) 4 V
(4) 6 V
(5) 10 V

09 **Transistors**

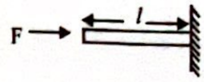
You need to work a little. There is no wrong if you see the circuit as abnormal. As V_E is in a negative value even though $V_B = 0$, V_{BE} is positive. No issue is there. As $V_B = 0$, $V_E = -0.6$ V. Now I_E can be found.

$$I_E = \frac{-0.6 - (-10)}{4.7} = 2\, mA$$

As $I_C \approx I_E$ 10 - V_C = 2 X 3.3 V_C = 3.4 V V_{CE} = 3.4 – (-0.6) = 4 V

There is a time-consuming calculation but everything simplifies easily.

43 As shown in the figure, a device is made to measure the magnitude of a force by applying it to a uniform metal rod of length l and area of cross-section A, and measuring the resultant compression (Δl). E is the Young's modulus of the material of the rod



The smallest value of the compression that can be measured with a measuring instrument attached to the rod is Δl_0. If the smallest value of F that can be measured with the device is F_0, then the length l of the rod should be such that

(1) $l \geq \frac{EA}{F_0}\Delta l_0$ (2) $l \geq \frac{F_0}{EA}\Delta l_0$ (3) $l \leq \frac{F_0}{EA\,\Delta l_0}$ (4) $l \geq \frac{F_0 A}{E\,\Delta l_0}$ (5) $l \leq \frac{EA}{F_0}\Delta l_0$

Elasticity 10

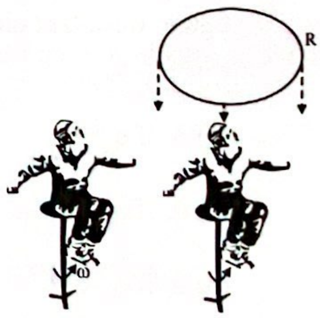
It is simple even it seems difficult. It is enough to write the related equation of Young modulus.

When F = F_0, Δl = Δl_0. Therefore, $E = \frac{F_0/A}{\Delta l_0/l} = \frac{F_0}{A}\frac{l}{\Delta l_0} \rightarrow l = \frac{EA\Delta l_0}{F_0}$

To measure the smallest Δl_0 related to F_0, the value of l from the above expression at least should be equal. If it is smaller than that, the work will get confusing as the compression you get is lesser than Δl_0(l α Δl_0). There is no problem if l gets greater than this value. It is better. Therefore, the correct answer is (1).

The competition is between (1) and (5). You do not need to look at other expressions. You can remove (5) directly at least if you felt that l should take the above value.

44 As shown in figure A, a child sitting on a rotating chair, rotates with an angular speed ω. The moment of inertia of the system with the child around the axis of rotation is 2 kg m². As shown in figure B, while rotating, the child catches a thin ring R of mass 4 kg and diameter 1 m, which id falling vertically with its plane horizontal, and with no angular momentum. The final angular momentum of the whole system would be



(A) (B)

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

Rotational Motion 02

This is a question that you are familiar with. All you need is conservation of angular momentum. Fortunately, or unfortunately instead of finding final angular velocity, it has been given to find the final angular momentum. There is nothing new to find in final angular momentum. It is the initial value (2). If the final angular velocity is ω', then 2ω = [2 + 4 X (1/2)²] ω' ω'=2/3 ω

You should know the moment of inertia of a thin ring as mR². No need to know the moment of inertia of a disk or a rod. But a thin ring is equivalent to a mass m from a distance R from the centre. Therefore, if you do not know mR^2, then what else should you know?

45 A boat made of metal floats in water with one fifth of its volume submerged. If a second boat is made with a volume five times bigger than the first using the same mass of the same metal that has been used to construct the first boat, then the ratio,

$$\frac{\text{the maximum load that can be carried by the second boat.}}{\text{the maximum load tha can be carried by the first boat}} \text{ is equal to}$$

(1) 3 (2) 5 (3) 6 (4) 8 (5) 10

02 Hydrostatics

You should not waste time by writing equations for this question. You can build everything from logic. Take the initial volume of the boat as V. When there is no load, the sunk volume of the boat is 1/5 V. Then the maximum load (m_1) that could be put into should be proportional to 4/5V.

$$m_1 \propto \frac{4}{5} V$$

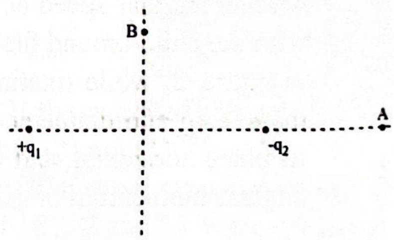
When the maximum load is put, totally the boat should float slightly. Therefore, the load must be put to sink the rest of 4/5. Now the mass of the boat is unchanged and the volume is made to 5V. Even the volume was 5V, as the weight of the boat is same as before, when floating it sinks to its initial volume of 1/5 V without a load. If the weight of the boat is in the same value, then the upthrust should also take the initial value (as water was not changed). As the second boat is also sunk to 1/5 V, the residual volume above the water is 24/5 V (5 V- 1/5V). Now if m_2 is the maximum load that can be put to this boat, then it is proportional to 24/5 V.

$$m_2 \propto \frac{24}{5} V$$

$$m_2/m_1 = 6$$

Actually, there is no need to write the symbol V also. First load is proportional to 4/5. The second load is proportional to 24/5. Therefore, the ratio is 6.

46 Two point charges $+q_1$ and $-q_2$ are placed as shown in the figure. Resultant electric field intensity could be zero at a point



(1) A, if $q_1 = q_2$ (2) A, if $q_1 > q_2$

(3) A, if $q_1 < q_2$ (4) B, if $q_1 = q_2$

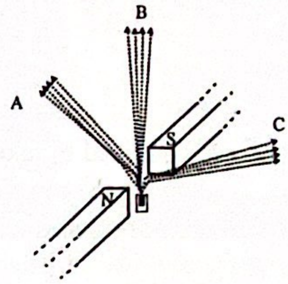
(5) B, if $q_1 > q_2$

06 Electric Field Intensity and Coulomb's Law

You do not need to write equations for this too. You can get just the answer by logic. All five answers mention about points A and B. Null points are occurred near to the weaker one and far to the stronger one. There are positive and negative charges here. When their values are equal, there cannot be null points anywhere. Only (2) stays near to the weaker and stays away from the stronger. Even if there can be any value, there cannot be a null point in the perpendicular bisector of the line joining the two charges. The field intensity of any point in it is not even placed opposing to each other. Then how can you get the null point? If your father is strict and mother is kind, then stay away from father and stay close to mother. By this way you can be in a neutral way.

If q_1 and q_2 are alike charges (both are positive or negative), then the null point of intensity is placed on the line joining the two charges and in between them. Here also stronger-weaker personal law is correct. If $q_1 = q_2$ then the null point is in the middle. If q_1 and q_2 are unlike charges and they have differences in the magnitude, the null point will be situated on the line joining the two charges but outside to the charges on the straight line. If the charges are unlike but same in magnitide, there is no such a null point. If your father and mother both are equally kind, then why do you need a null point?

47 A radioactive source is placed at the bottom of a hole in a lead block. The beam of radiation emanating through the hole is allowed to pass through a magnetic field as shown in the figure. Three separated beams A,B and C could be, respectively



(1) α, β^- and γ

(2) β^-, γ and α

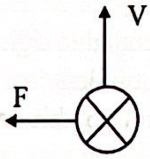
(3) γ, α and β^-

(4) α, γ and β^-

(5) γ, β^- and α

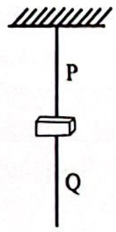
Radioactivity **11**

This very easy. B which goes without a deflection should be γ rays. There is no charge for γ rays. Only (2) and (4) are left out. If we consider that the magnetic field is going inside the paper (from N to S), positive charges should deflect to the left (qvB). The deflection of right is from negative charges.



The other point to consider is that as α particles are heavier in mass compared to β particles, greater deflection should be possessed by β particles than α particles. Therefore, definitely C should be β^-.

48 A metal block is hung from a support by a string P as shown in the figure. An identical piece of string Q is attached underneath the block.



Consider the following statements,

(A) If Q is taut the tension in P is greater than that of Q.

(B) If Q is pulled with slowly increasing tension, then P has a tendency to break before Q.

(C) If Q is pulled with a jerk, then Q has a tendency to break before P.

Of the above statements,

(1) only (A) is true.

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

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

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

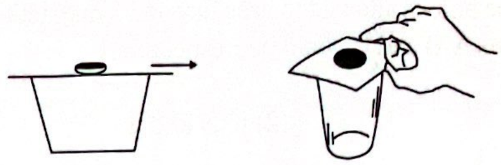
(5) all (A), (B) and (C) are true.

Elasticity **10**

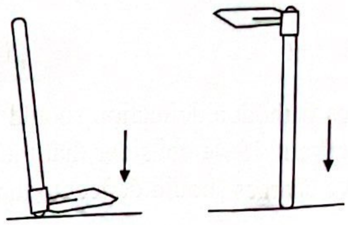
Statement (A) is straight forward. There is no problem in it. The weight of the metal block is held by the string P. Therefore, the tension of P should be greater than tension of Q. Law of inertia is being checked by the other two sentences. If Q is pulled with an instant impulse, it is not gone to P due to the metal block. The mass of the metal block (inertia) is bearing that impulse. But once Q is pulled slowly the opportunity is given to go towards P (by time). Therefore, all the sentences are correct.

More examples for the above phenomenon.

(i) The coin is kept above the cardboard piece and suddenly when the cardboard is pulled, the coin will not come with the cardboard piece. It falls into the glass. If it was pulled slowly, then the coin will come with it.



(ii) If you need to take a cloth from the bottom of a clothes stack, then you can do this without allowing the top clothes to fall as you pull it instantly. If you do it by pulling slowly, the whole stack of clothes will fall down.



(iii) If the bottom part of a mammoty is needed to tightened, what is the best method from above? What is the best? Should the mammoty blade be hit with a rough floor (in a concrete floor)? Or else should the handle of the mamoty be hit on the rough floor?

Even to tightened the handle of the hammer, you need to do the same thing.

(iv) If a heavy metal block is kept on the stomach of a lying person and then hit with a bedge-hammer, that person does not feel it.

49 A decoration consists of four independently rotating sets of small lanterns P,Q,R and S which are fixed to a rotating central pole as shown in the figure(A). All the rotating take place around vertical axes. Which of the following modes of rotations provides the best stability to the entire decoration?

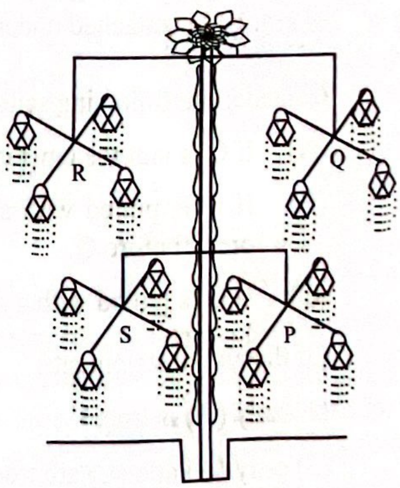
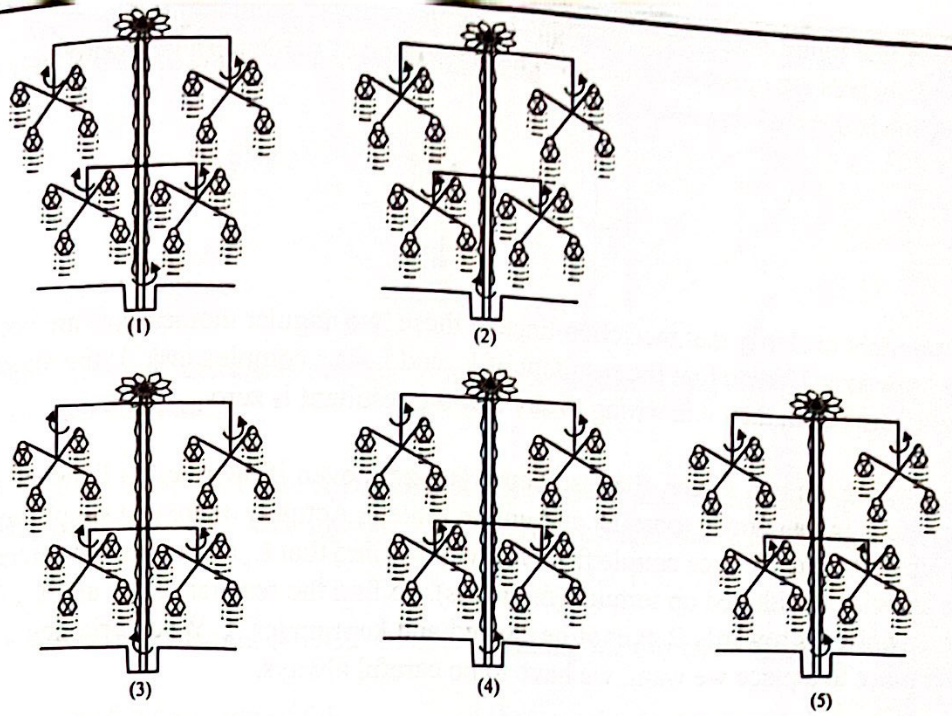


Figure (A)



This question was the victorious question of the year. It was a question that was spoken by the children and the teachers. Still, some are presenting numerous arguments. Some others are scolding.

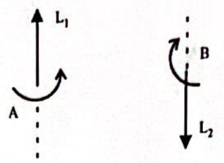
The simple logic inside is that if the angular momentum is high in a rotating system, then its rotating stability is increased. Angular momentum checks the 'strength' of the rotation of an object around an axis. Therefore, as long as the angular momentum is increased, such a rotating object cannot be toppled. That means the rotational motion is relatively stable. You can give many examples such as rotating drum, rotating wheel etc. for this. It is a known fact by us that someone can be balanced in a moving bicycle (driving) than a still bicycle. Therefore, I cannot understand why this question is under so much conversation. Everybody is rotating to the same side in (4).

Many are arguing that such Vesak lanterns are practically not rotating according to the method of (4). I feel that there is truth about it. Many say that relative to the main rotation, the rest of the lanterns are rotating to the other side. Even though it is true the logic that is brought to explain it is wrong. You need to think for a while before saying the statement that, if the angular momentums are in opposite directions, then they can be cancel off. This I will describe it. I think that the accompanying lanterns are made to rotate to the opposite direction to increase the beauty and the attractiveness of the lantern. I feel that saving energy or any other scientific factor cannot be obtained by this. If somebody thinks that I am not correct, this question is open to him/her. Send me the logic. Such conversational arguments are good for the progress of Physics.

Before providing the note of mine about the angular momentum, you should be able to figure out why the examiners have hidden the word of Vesak lanterns in the question.

We know that angular momentum is a vector quantity. As a convention, its direction is towards the direction of the angular velocity whereas it is directed towards the rotational axis. Think that L1 as the angular momentum of the system which rotates about the middle pole. It is directed upwards towards the middle pole.

(Look at this figure here.) Now consider L_2 as the angular momentum if a single lantern is rotating towards the opposite direction. The action line of the lantern is towards its rotational axis which is directed downwards.



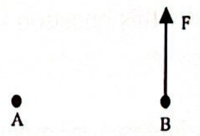
It is important to clarify that the action lines of these two angular momentums are not situated in the same axis. Here to find the resultant of L_1 and L_2 is a complex task. If the magnitude of L_1 and L_2 are equal, then it is wrong to say that the resultant is zero.

Although they are two forces, the resultant is not zero even if their action lines are different but are equal in magnitude (parallel and unlike forces). Actually, there is a simple equivalent torque in it. It makes a force couple from it. Keep in mind that L_1 and L_2 are not forces. L_1 and L_2 are associated with tied up torques (moments). To find the resultant of L_1 and L_2, L_2 that is acting downwards towards B cannot be carried and kept under A. When bringing a thing in another place to a place we want, we have to be careful always.

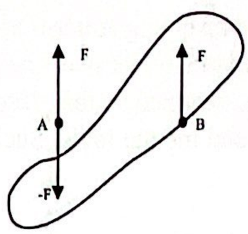
The total angular momentum cannot be zero as the accompanying lanterns rotated to the opposite direction. Therefore, I need to emphasize that the concept of easily rotatable is not correct.

However, when such lanterns are built, the middle pole is kept still and stable to the ground or it is being connected to something. But the correct answer is (4) for what is being asked in the question. If there is a good and strong angular momentum, then the rotation is a lot stable. If the angular momentum is weak, then it can fall even at a small issue.

Even it is more than the level of A/L, I will mention the theorem of vectors (forces) here. If you feel like this is unnecessary, then forget about it.

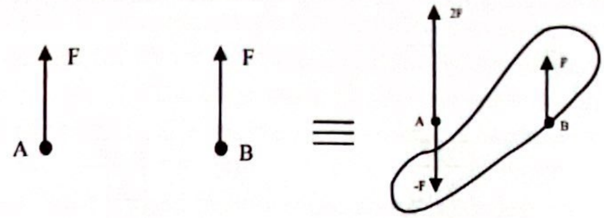


If force F that is acting in B is needed to be taken to A, you need to do a little trick. Put upward and downward two acting extra forces of equal F (in magnitude) in the point A. We can do that as it does not do any damage.



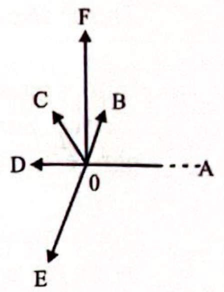
This figure is balanced to the previous figure. (F and -F are being negated with each other.) But now instead of the force F acting in B, there is an acting force in A which acts to the same direction. Even there is a generated force couple from the force F in B and -F in A. This indicates that the force F acting in B just cannot be taken to A. Following is a universally fair theorem of these forces. Remember this is unnecessary.

Force system that is acting on a solid subject can be replaced by a single force that is acting in a required point and from a suitable moment.



Now think that there was another force F upwards in A initially. Then are you clear with the balanced diagram?

50 A system of coplanar forces OA,OB,OC,OE and OF acts on an object as shown in the figure. Magnitude of OA=2 OD and OE = 2 OB. The resultant force on the object is most likely to be

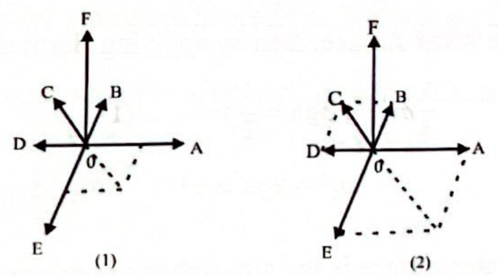


(1) along the direction of OC. (2) along the direction of OE.

(3) along the direction of OF. (4) along the direction of OA.

(5) zero.

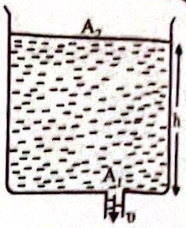
You need a good eye than Physics for this question. If you like Physics, then your two eyes should also be good. Then only you can have a nice experience on this beautiful world. As the question has mentioned about the magnitude, you can start from there. When OD is cut off by OD, the resultant of those two forces comes to the middle of OA. The story of OE and OB are the same. Next, when the parallelogram is completed to find the resultant of half of OA and half of OE, you can see that it is equal and opposite to OC. Then what is left will be OF only. There is no problem if you can draw a rough sketch on the paper as shown in (1) to get the answer.



There is no wrong in arguing according to the figure (2). The resultant of OD and OB is exactly equal to OC. With the existing OC, the total will be double (2 OC). Nowas you can see, the diagonal of the parallelogram drawn with OA and OE is also equal and opposite to 2 OC. Therefore, all cancel and OF is left alone.

The start of solving such a question is very important. The two initial starts that are easy have been shown above. There is no such a good start is my decision. For example, the problem cannot be solved if you start from OF. With whom are you going to couple? That man is alone.

51 Water drain through an opening of area A_1 in a container of cross-sectional area A_2 as shown in the figure. If the motion of the water surface in the container is not ignored the speed v at which the water drains is given by



(1) $v=\sqrt{\frac{2gh}{1-\frac{A_1^2}{A_2^2}}}$ (2) $v=\sqrt{2gh}$

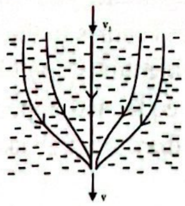
(3) $v=\sqrt{\frac{gh}{\frac{A_1^2}{A_2^2}+1}}$ (4) $v=\sqrt{\frac{2gh}{\frac{A_1^2}{A_2^2}-1}}$ (5) $v=\sqrt{\frac{gh}{\frac{A_1^2}{A_2^2}-1}}$

02 **Hydrodynamics**

You need to write one or two equations for this question. There is no doubt that you might have done this question under Bernoulli theorem by considering A_2 is relatively bigger than A_1 and assuming the motion of the water surface is very slow (that means assuming the speed of the water surface as zero). Sometimes you may know the answer as $v=\sqrt{2gh}$ by your memory. This is also known as Torricelli's theorem.

In this question it has been mentioned that not to neglect the speed (motion) of the water surface. Some have blamed for this statement. There are two negatives in 'not to neglect' phrase. Such statements are normally not in use.

But normally how this problem is solved by neglecting the motion of the water surface. So, by saying not to neglect, it gives a command to go away from the normal solving method. It is true that not to neglect means to consider. My feeling is that it is more suitable to say not to neglect the motion of the water surface instead of saying consider the motion of the water surface. It gives more weight and power to the meaning of the sentence by saying like that. Instead of saying stay in love, does not it sound more serious to the heart by saying do not stay in lack of love? Even the word not to neglect is being bold. So, anybody with eyes should directly see it.



If v_1 is the speed of the water surface, then by applying Bernoulli theorem to a flow line,

$$\frac{1}{2}\rho v_1^2 + \rho gh = \frac{1}{2}\rho v^2 \quad \ldots\ldots (1)$$

$$v_1^2 + 2gh = v^2$$

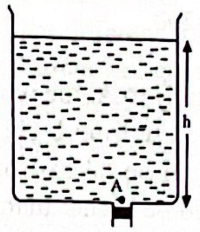
The pressure of the water surface is the atmospheric pressure. As the hole is open to the air, its pressure is also the atmospheric pressure. Therefore, the pressure terms are not written on both sides. The horizontal level across the hole is considered as the zero potential energy level. Now to find v, you need another equation. It can be obtained from the continuity equation. $A_2V_1 = A_1v$ What is pulled from the above should flow from the bottom.

When v_1 is substituted to equation 1, $\frac{A_1^2 v^2}{A_2^2} + 2gh = v^2$

From this you can get the answer. $v = \sqrt{\frac{2gh}{1-\frac{A_1^2}{A_2^2}}}$

If A_2 is relatively larger than A_1, (A_2>A), then the term $\frac{A_1^2}{A_2^2}$ gets less than 1. If you neglect that term you will get the familiar relationship of $v = \sqrt{2gh}$. This requirement is satisfied in the relationship of (1). If you cannot get the problem solved by writing equations, by using mathematics you can go for the correct answer. Luckily, the denominator has not been given as $(1 + \frac{A_1^2}{A_2^2})$. When $A_2 > A_1$, by the expression of (3), you get $v = \sqrt{gh}$. Number 2 is not inside the square root. In (4) and (5), the square root is taking a negative value. It is not real.

I feel it is important that I should review more about this question.



Think that the water injection point is closed from a cork. Then the water is still. Now what is the pressure at point A (inside the water)? No doubt that you will say that it is (π+hρg). Yes you are correct. If you want, you can apply Bernoulli theorem to the water surface and point A. As the water is still, the kinetic energy term gets zero. You will get as π+ρgh= P_A. Here ρgh is there to indicate the potential energy of a point in the water surface relative to point A. Actually, you get pressure in a still liquid due to the weight of the liquid above (potential energy). In a place where g=0, there is no weight in the liquid (no gravitational potential energy). Therefore, there is no pressure in the liquid (from the liquid).

The term ρgh of the Bernoulli theorem is wrong to take as the pressure. It is the potential energy of a unit volume of the liquid. If the water is still, the inherent pressure in the liquid is given by ρgh. Therefore, we say the pressure is obtained by ρgh (hρg). But once the liquid is flown, the pressure changes inside the liquid.

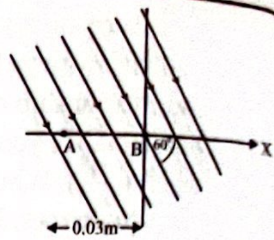
Now think that the cork was removed in the above set up. When the water is flowing, now the pressure in point A is getting less than the previous value. It is wrong to take as π+hρg= P_A. Now the water is not static. It flows. It means there is kinetic energy. So, the pressure of point A definitely reduces. It is the atmospheric pressure. Water is exposed into the atmosphere.

Another place which can get wrong is when writing ρgh to the right side of the equation (1). That

means $\frac{1}{2}\rho v_1^2 = \rho gh + \frac{1}{2}\rho v^2$

This confusion is there if ρgh is being considered as a pressure. If taken as pressure, one can argue as the pressure below needs to be higher. But as I mentioned early, ρgh is a potential energy term. Do not mix it up with pressure. If we consider the bottom level potential energy as zero, then the potential energy on the water surface is higher. It is ρgh. If the water surface is taken as zero potential level, then the bottom level potential energy is -ρgh. There is no problem in it. Even naturally we know that $v>v_1$.

52 A uniform electric field of magnitude 400 V m^{1} is acting in the direction as shown in the figure. If V_A and V_B are the electric potential at points A and B respectively, then V_B -V_A is equal to



(1) -6V (2) -3V (3) 0

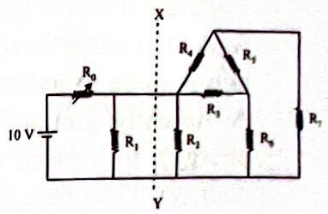
(4) 3V (5) 6V

06 ***Electrostatic Potential***

There is a simple calculation here. If there is a point charge in B, the force on it towards x direction is E cos 60^0 = 400 X ½ =200.

Now when the charge is taken from B to A, the work that should be done against the electric field is 200 X 0.03 = 6. There is no use from E sin 60^0 component. It is acting perpendicular to the x axis. A point charge should be taken from B to A. For that we need to do work. Therefore, the potential of A should be higher than the potential of B. So, VB- VA should be a negative. What can go wrong is the selection of one answer from either -6 or 6. You can get the value instantly. 400 X ½ X 0.03

53 The internal resistance of the battery shown in the circuit is zero. The value of $R_0$is adjusted until the voltage across it becomes 5 V. The equivalent resistance of the part of the network to the right of XY is



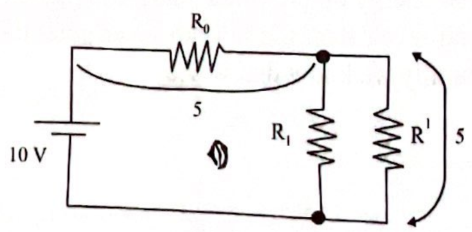
(1) R_0 (2) $R_0 + R_1$

(3) $\frac{R_0 R_1}{R_1 - R_0}$ (4) $\frac{R_0 R_1}{R_1 + R_0}$ (5) R_1

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

You will be lost if you jumble the question. You will be in a big confusion if you try to find the equivalent resistance of the network on the right side of XY. Some have gone on that path and got trapped. They might have scolded that this question is not in the syllabus. Some have argued that you need Δ, Y transformation for this question. (transformations of resistance networks are not in the syllabus).

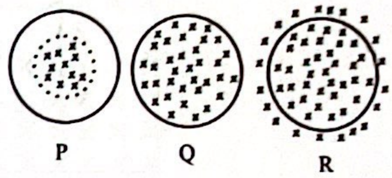
If you look at the answers, you will not go in the wrong track. Even there are only R_0 and R_1 in the answers. Therefore, the logic to get the equivalent resistance is different. The needed parts are given in the question. As the internal resistance is zero in the battery, there is no voltage drop across it. So, if the voltage drop is 5V across R_0, then the voltage drop across R_1 and the rest should also be 5V. Therefore, if the equivalent resistance of the network to the right of XY is R', then the parallel equivalent resistor of R_1 and R'should be equal to R_0. If R_0 and that equivalent resistor equally divideeach by 5, then R_0 and that equivalent resistance should be equal to each other.



So, $\frac{1}{R_1} + \frac{1}{R'} = \frac{1}{R_0} \rightarrow \frac{1}{R'} = \frac{1}{R_0} - \frac{1}{R_1} = \frac{R_1 - R_0}{R_0 R_1}$ The answer is (3).

This is actually a practical method to be used in an equipment if we do not know the equivalent resistance/ cannot calculate the resistance or to find the balanced resistance of a resistor network. There you do not even need R_1. By using a variable resistor (R_0) if we can find the value of R_0 that both are sharing equally, then the equivalent resistance of the unknown network is R_0. If R_1 is not in the question, then R_0 is the answer. There is no need of the drawn part that is right of XY. If it is not drawn, then the task gets easy.

54 Three identical circular wire loops are placed perpendicularly to uniform magnetic fields of flux density B. The extent of the magnetic field are different from one another in situations P,Q and R as shown in figures. The extent of the magnetics field in Q is equal to the area of the loop. When the flux density B varies with time at the same constant rate, the induced e.m.f. s of the respective wire loops are E_p,$E_Q$and E_R. Which of the following is true regarding the magnitude of E_p,E_Q and E_R?



(1) $E_P=0, E_Q=E_R$ (2) $E_P=0, E_R>E_Q$ (3) $E_P=E_Q=0, E_R\neq 0$

(4) $E_P<E_Q, E_Q=E_R$ (5) $E_P<E_Q<E_R$

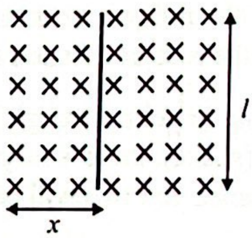
Before reviewing this question, look at the note below. According to Faraday's law, the induced e. m. f (E) is E= - Δφ/ Δt (the rate of change of magnetic flux)

Let us take φ = BA. That means there is a magnetic flux density of B perpendicularly for an area of A. If you need the magnitude of E, then it can be written as E =Δ(BA)/ Δt

If both A and B are changing, the above expression can be written like this by dividing them into two.

$$E = B.\frac{\Delta A}{\Delta t} + A.\frac{\Delta B}{\Delta t} ....(1)$$

Such expressions are very familiarto the students of mathematics. If not, you should be able to understand the division of these two. You will understand it is fair to keep one as constant and take the change of the other whereas in the next term the second is kept constant and take the change of the first oneif a change of a multiple is taken.



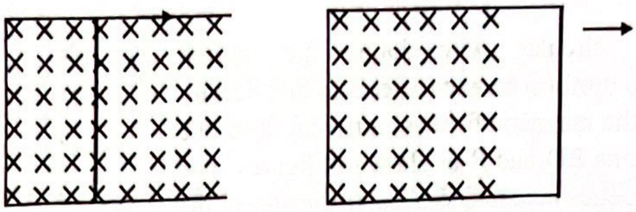
According to the relation (1), it can be seen that there are two methods that an e. m. f can be induced. According to the first term, keep B as constant and make a change in the area somehow. We are much more familiar with this. Method. For example, think of an instance where a wire with l length is taken across a constant magnetic field. A =lx

ΔA/Δt= Δ(lx)/Δt = l (Δx/Δt) = l v

Here l is a constant. Δx/Δt is the speed of the rod. Now the first term in Blv. This is our familiar equation. This first term is called as the motional induced e. m. f.

In most of the cases that we consider, B is constant. Therefore, the second term is zero. But an e. m. f can be induced by varying the magnetic field with time. This term is known as an e. m. f generated from the time dependent magnetic field or an induced electric field. When the magnetic field is varying with time, there will be an induced electric field from it.

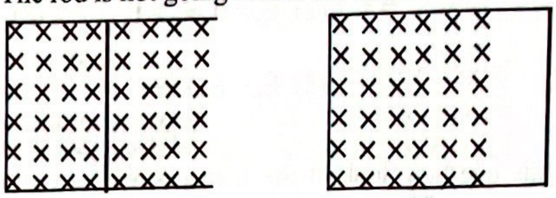
According to the two terms, the generation of an e. m. f can be explained from the figures below.



(a) (b)

a) B is constant. The rod is crossing the force lines. An e. m. f is generated

b) B is constant. The rod is not going across the field. An e. m. f is not generated



(c) (d)

c) B is changing with time. The rod is still in the field.An e. m. f is generated

d) B is changing with time. The rod is kept away from the field. But an e. m. f is generated

The result from the two terms can be simply explained like this.

__When B is constant:__ To get an induced e. m. f there should be an area change in the field. If a rod is moved outside the field, then there will be no generated e. m. f. B is static. It is not moving. So, what to do if shaken from far away?

When B is changing with time: At this instance, as B is not static (there is an induced electric field in the space) even the rod is outside the field,there will be a generated e. m. f.

In simple terms, if the magnetic field is kept still (static), the rod should be shaken or rotated inside the field. There is no use if the rods are shaken outside the field. But if the magnetic field is shaking (dynamic), then if the rods are shaken from far away it can be felt even a bit.

We will build up this story matching to younger time. Think that you need to win the love of another one. If s/he does not react (shake), there is no point in your dancing far away. But if s/he has a reaction, even from a distance you two will build up a relation (interaction).

The answer to the question is (4). The area related to the change in the magnetic field is greater in loop of Q. In R, the induced e. m. f. on the loop is zero due to the change of field outside the loop. All you need is the area surrounded by the loop. This fact is mentioned by me in the review of 2006.

Here, you need to understand very clearly that A represents the area related to the magnetic field change which is surrounded by the loop from equation (1) and not the area of the loop. Consider the radius of the loop as R. Consider r as the radius of the circular part that the magnetic field is acting on the instance of P.

Now the induced e. m. f of the loop at instance P (according to the second part of equation 1)

$$E_P = \pi r^2 \frac{\Delta B}{\Delta t}$$

For Q it is

$$E_Q = \pi R^2 \frac{\Delta B}{\Delta t}$$

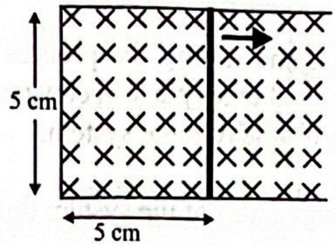
For R also

$$E_R = \pi R^2 \frac{\Delta B}{\Delta t}$$

The first part of equation 1 is zero for these instances. There is no

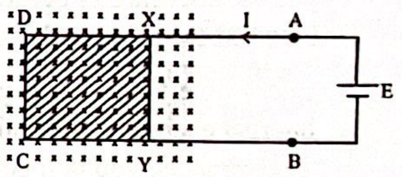
(There is no motion happening from the outside)

Look at the following problem



A 5 cm length metal rod is moving to the right in a reel in 2 cms^{-1}. At an instance when the rod is at 5 cm distance the magentic field intensity is 0.2 T and it is acting into the paper. The strength is increasing by 0.1 Ts^{-1} at that moment. Find the induced e. m. f of the rod. [Hint: You need to consider the two terms of equation (1) here. Be careful about the direction of the induced e. m. f also.]

55 A rectangular wire frame made from a smooth resistive wire is connected to a battery of e.m.f. E with negligible internal resistance as shown in the figure. XYis a piece cut from the same wire, which can slide along the wire frame. A non conducting liquid film of surface tension T is formed in the region CDXY, and the entire structure is placed in a uniform magnetic field of flux density B acting in the direction shown. If XY=XD=CD=CY, and the current through AX is I, then the wire XY will tent to move to the right when,



(1) $B > \frac{8T}{3I}$ (2) $B > \frac{4T}{I}$ (3) $B < \frac{8T}{3I}$ (4) $B > \frac{4T}{3I}$ (5) $B < \frac{4T}{3I}$

Forces on current conductors **07**

Even though there is lot written in this question, such questions are not new. Therefore, you can very quickly put what is being asked in the question to the head.

There is a force due to the surface tension on the left side of XY wire. Therefore, if XY needs to be moved to the right slightly then the force due to the magnetic field of the current across XY, should be slightly biggerthan the force of surface tension.

By mistake you can decide that I current is also flowing across XY. This is the mistake that can occur here. As the frame and XY wire is made from the same wire and the respective lengths are equal, current I is divided in X as 3:1 ratio. XY is one way. In the path of XDCY, there are three such XY. Therefore, the current across XY is 3I/4.

More current should flow across the less resistor. Now the rest is easy. If the length of XY is l,

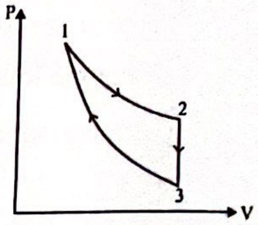
$$B\frac{3}{4}Il > T2l$$

$$B > \frac{8T}{3I}$$

When taking surface tension force, you should not forget to take the two sides of the film. If 2 is forgotten, then there is an answer for that as (4) to fall in the trap. There is no such answer if you take I instead of 3I/4. Therefore, that trap was not set.

These are known questions. So, it is useless to spend time on these.

56 An ideal gas is taken through a thermodynamic cycle as shown in the figure.



Process 1→2 is isothermal and during the process 60 J of heat enters the system. Process 2→3 takes place at constant volume and during this process 40 J of heat leaves the system.

The change in internal energy (ΔU) of the system during process 3→J is

(1) –40 J (2) –20 J (3) 0 (4) + 20 J (5) + 40 J

04 ***Thermodynamics***

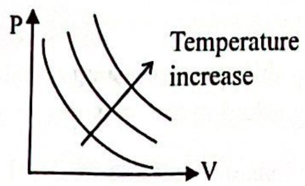
Where ever you go around and come back finally to the starting point, the algebraic sum of the internal energy change is zero. As the process of 1→2 is isothermal, for an ideal gas Δu is zero. Actually, there is no use to the question from 60 J. Even if you consider it, for 1→ 2 you cannot find Δu_1 because you cannot find ΔW for that process. You cannot find the area in between the curve and V axis. Even the values of pressure and volume are not given.

Every time for an ideal gas in an isothermal process Δu is zero. The reason for that is the internal energy of an ideal gas is dependent on the temperature only. Even if you find ΔW for 1→2 process, you will get ΔW as 60 J. $\Delta Q - \Delta W = \Delta u$, 60-60 =0

As the volume is constant in 2→3 process, there is no work from the gas or has been done from the gas. ΔW =0. As heat is going out from the system ΔQ = -40. Therefore, $\Delta u_2 = -40$

Now $\Delta u_1 + \Delta u_2 + \Delta u_3 = 0$ and Δu_3 should be 40.

If we look under physical conditions, for the process of 2→3 Δu should take a negative value. That is because point 3 is below point 2. Following figure shows if isothermal curves are drawn in PV diagram.



The temperature can be reduced without changing the volume by removing heat from the system only. For the process 3→1, you can get from the logic that Δu should get a positive value. 1 and 2 belong to an isothermal curve. The isothermal curve that goes across the point 3 should be blow the curve 1, 2. Therefore, the temperature of point 1 is definitely higher than the corresponding temperature of point 3. So, when going from 3 to1, the internal energy should be increased.

57 Thermometer must possess good sensitivity as well as good accuracy. In this connection which of the following is true regarding a mercury-in-glass thermometer?

	To increase accuracy	To increase sensitivity
(1)	Reduce the radius of the capillary.	Increase the volume of mercury in the glass bulb.
(2)	Increases the volume of mercury in the glass bulb.	Reduce the radius of the capillary.
(3)	Reduce the volume of the glass bulb.	Reduce the radius of the capillary.
(4)	Increase the radius of the capillary.	Reduce the volume of the glass bulb.
(5)	Reduce the volume of the glass bulb.	Increase the volume of mercury in the glass bulb.

What is implied as the accuracy is that the temperature that needs to be measured should take the same value as far as it can. If that can be done, then the thermometer is accurate. The accuracy for a glass-liquid thermometer is to show an expanded length for a particular temperature difference. Then even a small temperature difference can be measured easily.

As asked in the question, these two facts should be achieved separately. To increase the accuracy, less heat should be drawn from the system that measures the temperature. Otherwise, it will measure a low temperature. To make this happen you need to use a small volume of mercury. Same thing is indicated as the used volume of mercury and the volume of the bulb. If we consider only about increasing the accuracy, it is better to reduce the volume of the bulb. But it is badly affecting the sensitivity. If there is less mercury, then the expansion at a certain temperature difference is less. If there is less expansion, then it reduces the sensitivity.

The increased length is more for a certain expansion if the radius of the capillary tube is reduced. It is good for sensitivity. The calibrated divisions can be moved further for some distance.

In such instances, the characteristics of accuracy and sensitivity are not independent to each other. Once the volume of the bulb is reduced, the volume of the used mercury gets reduced. Even though it increases the accuracy, it reduces the sensitivity. If the bulb is made bigger, it is good for the sensitivity but reduces the accuracy. Therefore, practically there is no use in increasing or decreasing the volume of the bulb very much. The volume of the bulb should be kept at a medium level which is not higher or lower. The capillary radius is not affecting the accuracy.

Sometimes finding the answer for this question we get bit uncomfortable because we are hesitant to think from our intelligence for an instance where both accuracy and sensitivity can be achieved separately instead of not thinking both of the facts separately.

If we take (1), then there is no connection between the reduction of capillary radius and accuracy. But increasing the volume of mercury is good for sensitivity. Only one is correct.

If we take (2), then increment of the mercury volume decreases the accuracy. Reduction of capillary radius increases the sensitivity. One is correct.

If the two points in (3) are true separately then both are correct.

Argue (4) and (5) like that.

Most of them might have tried to satisfy these two points at the same time to find the correct answer. For example, as the correct choice is (3) they ask how can you increase the sensitivity by reducing the volume of the bulb? If you tend to think like that, then there is no correct answer. You need to understand the question. There are some squares for accuracy as well as for sensitivity. You need to pick the correct square/s under accuracy (eg: 3 and 5). Like wise find the square/s under sensitivity (eg: 1, 2, 3, 5). Both sides of the squares are matched in (3) and (5) only. The two sentences in both sides of (5) are contradictory to each other. Even though both are separately correct for each square, by reducing the volume of the bulb you cannot increase the volume of mercury. These two sentences are not tallying with each other.

Therefore, the correct answer is only (3).

This question is not asking a correlation as if this is correct, then does the other is correct? or if the other is correct then does this is correct?

If both are tried to connect with each other, then solving gets harder. Do accurate persons are always sensitive? Do sensitive persons are always accurate? We can argue till we die. But cannot get a clear answer.

58 Two bulbs, A (110 V, 40 W) and B (110 V, 100 W) are connected in series with an electric supply of 220 V. Which of the following statements is false?

(1) The current through A is the same as the current through B.

(2) The potential drop across A is greater than the potential drop across B.

(3) The current through B is less than its rated current.

(4) The power dissipation of A is greater than the power dissipation of B.

(5) There is a higher probability of burning the bulb B.

08 **Heating Effect of Electric Current**

To find the correct answer, you need to go across each statement. There is no alternative. As the correct answer is (5), you need to work hard on it.

Once you read it, you can understand that (1) is correct. As the bulbs are being connected in series the same current goes across two bulbs. There is no problem.

The voltage of 220 V is not divided equally among the two bulbs. Why? Because the filament resistance of bulbs is not equal. The resistance is higher in the bulb with lower Watts. You can get it by $R = V^2/W$. Even have not you seen the thicker filament of a bulb with larger Watts? Once there is more thickness by being fat, the resistance reduces. Then more current is flown and get heated. When the temperature is high, the radiation energy is high. Take 40 W and 100 W bulbs. Therefore, (2) is correct. As the same current flows across the two bulbs, higher voltage drop occurs with a higher resistance.

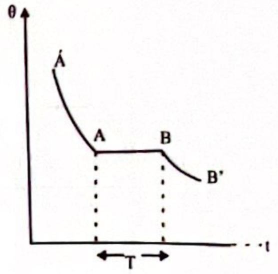
Now as a greater voltage drop occurs across A, there is a voltage drop more than half of 220 V, 110 V. Two gets equal 110 V by each only if the resistors are equal. There is a voltage drop of more than 110 V across A and less than 110 V of voltage drop across B. You do not need to find the exact values. As the needed 110 V is not getting by B, the current that is flowing across it is lesser than the quantitative current. Therefore, (3) is also correct.

The rest of the two statements can be argued around this. No need to think differently. As the voltage drop across A is greater than 110V, the current that is flowing across is greater than the quantitative current. So, A can be quickly burnt not B. $V_A > V_B$

As the same current goes across the two bulbs, the generated power in A is higher than B. Even you can find the values and solve the problem but it is not needed. You can decide everything from logic. It might take a long time if you try with the numbers. Using the same logic, (3), (4) and (5) can be solved.

If the current across B is lesser than the quantitative current, B cannot be burnt out quickly. Even the power generation of B should be less.

59 Figure shows the cooling curve of liquid wax m, specific heat capacity S_t and latent heat of fusion L.The heat capacity of the container can be neglected.



Consider the following statements.

(A) Gradient of the curve AA' at A is equal to the gradient of the curve BB' at B.

(B) The rate of that released to the surrounding during the time T is mL/T

(C) Gradient of the curve AA' at $A = 1/S_t . L/T$

Of the above statements,

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

Here there is a small mistake has occurred. In specific latent heat of fusion word, the specific term is missing. Due to this there could have been a confusion among the students. As the symbol of L has been used, there will be no problem if it is considered as specific latent heat of fusion. If it was a latent heat, then symbol of Q should have been used. Other than that, this question is a familiar question to you.

You can directly see that (A) is wrong. There is a liquid in A. A solid is there in B. There is same temperature. As there is same temperature, the excess temperature also become same and the rate heat loss of A is same as B. But the rate of temperature reductionsis not equal. From the gradient of θ-t curves give the rate temperature reduction.

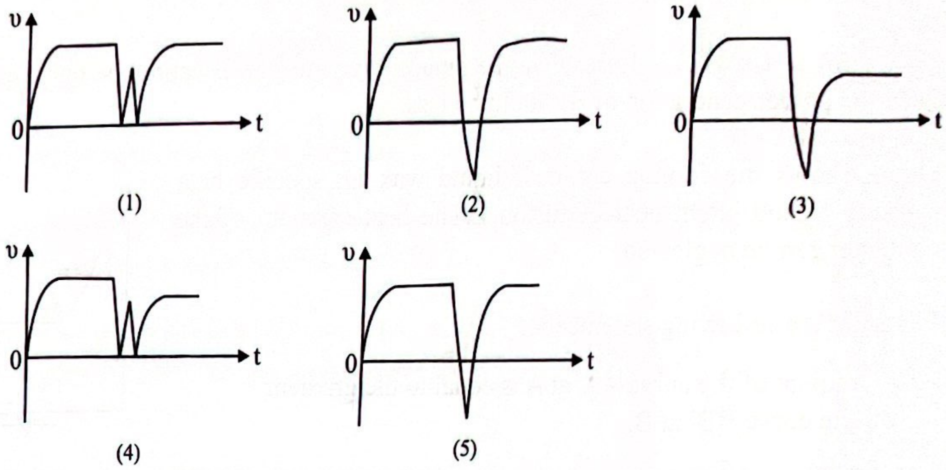
(B) is correct. The heat that is released when the liquid completely becomes the solid is mL. Therefore, the rate of heat release is mL/T. The rate of heat release in (A) is also the same as the above amount. As point A is common to AA' curve and AB horizontal line, the rate of heat release should be equal from any side.

$$ms_l\frac{\Delta\theta}{\Delta t}=\frac{mL}{T}$$

Therefore, (C) is correct.

60 A tiny sphere with a static charge +q starts to fall through air under gravity at t=0.After the sphere has reached terminal velocity, a vertically upward electric field E of constant magnitude is applied. A short time after the sphere changes direction of its motion, the electric field is removed.

The variation of the velocity (v) of the sphere with time (t) is best represented by

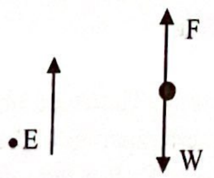


10 Viscosity

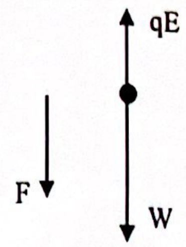
This is easy even though it is the 60th question. In the question it has been mentioned that the direction of the sphere is changed. There are three graphs that show the variation of the direction of v.They are (2), (3) and (5). You can remove (1) and (4) directly.

The first part of the graph is known to everybody. As it has been mentioned as very small, we can neglect the upthrust. But we need to consider the viscous force. If not, it cannot attain the terminal velocity. Once it attains the terminal velocity, the weight of the sphere (W) is equal to the viscous force (F).

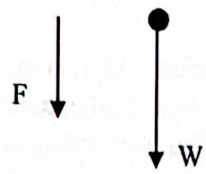
Now if an electric field is applied upwards, there will be an upward force on the positive charge. When there is an upward force to the sphere which is travelling at adownwards uniform speed (with balanced forces) it should decelerate. That means the downwards velocity should gradually reduce. When the velocity is reducing the viscous force (F) will get reduced. E and W are constant.



But as F is dependent upon v (F= 6πηav), the resultant force is not constant with the time. Therefore, deceleration also cannot take a constant value. So, the relevant part of v-t curve cannot be a straight line. If you can decide this, the correct variation can be obtained easily.



F = 0 when the velocity gets zero after deceleration. Now what is indicated is qE> W from saying the direction of motion of the sphere is changed. You really do not have to know about this. Now the sphere is going upwards whereas the viscous force is acting downwards.



Next, after sometime the electric field is removed. That means qE is gone. Now all the forces on the sphere are downwards.

Therefore, now the sphere is decelerated upwards and the velocity gets zero again. When the velocity is zero, F= 0. At this moment there is only the weight of the sphere. So, it falls downwards and get the previous terminal velocity. Only (2) gets the previous terminal velocity.

If qE<W then draw the relevant v-t graph. It has been mentioned that the sphere is changing its direction of the motion. It should be given. Otherwise, we cannot decide whether the applied electric field is strong or weak.

From the following three points you can come to the correct answer.

(i) As the direction is changed, we can remove (1) and (4).

(ii) As the viscous force is dependent upon velocity, there cannot be changes in the uniform velocity. That means there cannot be straight lines in v-t curve. From this, you can remove (5).

(iii) As everything is getting back to normal, it should come back to the previous terminal velocity. You can remove (3) from this.