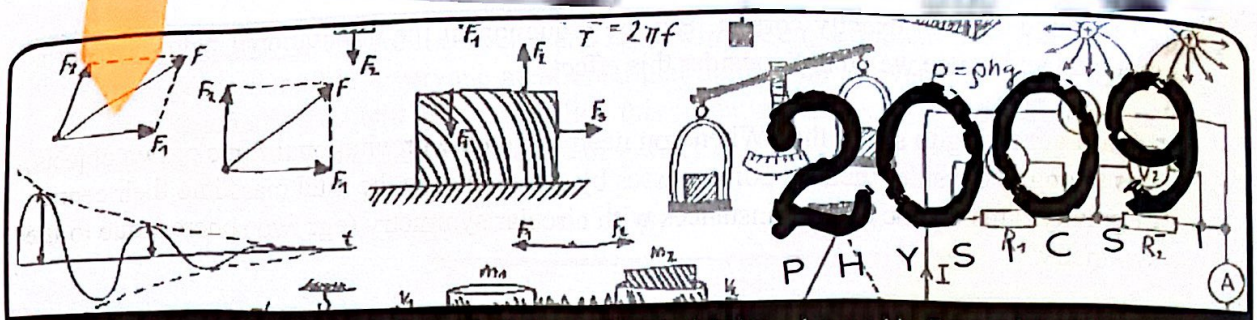


(g=10 N kG^{-1})

01 **Unit and Dimensions**

01. SI unit of 'activity' of a radioactive element is

(1) Bq (2) Ci (3) Gy (4) Sv (5) rad

11 **Radioactivity| Unit and Dimensions**

Even though this is the first question, some have got it wrong. For children with many correct choices, this was an unexpected question. Sometimes this may be because radioactivity is the final unit. The SI unit of activity is Bq (Becquerel). Ci (Curie) is also a unit of measuring activity. Even Marie Curie and Her husband Pierre Curie discovered many things related to radioactivity, to honour the person who first observed radioactivity, the SI unit of radioactivity has become Bq.

Gy is a unit that measures the radioactive absorption dose. The health risk due to radioactive absorption dose is measured from Sv. This absorption dose is also measured from rad (radiation dose). But it is not the SI unit of radioactive absorption dose.

2 Energy E of a photon of frequency f is given by E=hf. The dimensions of h are

(1) ML^2T^{-1} (2) $ML^{-1}T^{-2}$ (3) $ML^{-2}T^{-1}$ (4) ML^2T^{-2} (5) $ML^{-3}T^{-1}$

01 **Unit and Dimensions**

A simple relation is given in the question to find the dimensions of h. Using that the dimensions of h can be found very easily and quickly. Dimensions of h = dimensions of energy/ dimensions of frequency = $MLT^2.LT = ML^2T^3$

You do not need to memorize the dimensions of constants. When needed, you recall the simple relation and then you can find the dimensions of the constant. The dimensions of energy are equal to the dimensions of work. Once you consider work as (force X distance) and decide that the reciprocal of frequency is time, then you can easily get the answer.

3 Astronomical telescope has an objective lens of focal length f_0 and an eyepiece of focal length f_e. If the telescope is in normal adjustment, the total length and the magnifying power of the telescope are given respectively by

(1) $2(f_0 + f_e)$, and $\left(\frac{f_0}{f_e}\right)$ (2) $2(f_0 + f_e)$, and $\left(\frac{f_e}{f_0}\right)$

(3) $(f_0 + f_e)$, and $\left(\frac{f_e}{f_0}\right)$ (4) $(f_0 + f_e)$, and $\left(\frac{2f_0}{f_e}\right)$

(5) $(f_0 + f_e)$, and $\left(\frac{f_0}{f_e}\right)$

03 **Optical Instruments**

It is a sin to devote time for such questions. How many times has it been asked? The distance is equal to the total of focal lengths of the lenses. The magnification (විශලනය) is f_o/f_e.In the magnification there is the letter වි. Consider as ව and that letter is only there is the objective (අවතෙත). Therefore, the focal length of the objective should come to the numerator (top). If you can remember by this way, then it gives a hint to get the correct expression.

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

(1) The intensity of the light

(2) Time of exposure of the plate to the light.

(3) The thermal conductivity of the material of the plate

(4) The area of the plate

(5) The material of which the plate is made

Photoelectric Effect **11**

Have not this also been checked? The occurrence of photoelectric effect is only decided by the frequency of the incident radiation and the material that it is incident upon (the work function of the material). So, if the frequency is given, then the emission is only decided by the material that the disk was made. If the given frequency is lesser than the frequency of threshold, then there is an opportunity for the emission by changing the material (take a material with less work function). But there is no effect on the occurrence of emission by increasing the intensity or increasing the exposure time of the disk or increasing the area of the disk.

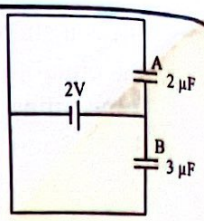
5 A transformer having which of the following characteristics is suitable to reduce a 220 V ac voltage to 20 V as?

	Transformer type	Number of turns in secondary coil / Number of turns in primary coil
(1)	Step-down	$\frac{1}{22}$
(2)	Step-down	$\frac{1}{11}$
(3)	Step-down	11
(4)	Step-up	$\frac{1}{11}$
(5)	Step-up	11

Mutual Induction **08**

This is a question of O/L. If you do not do a change in numbers, then finding the answer is simple. If 220 V should be reduced to 20V, then this is clearly a step-down transformer. If it is a step-down transformer, the number of turns in the secondary should be lesser than the primary. That means (3) is not possible. Do you need to write the division of 20 by 220? The answer is (2). Unfortunately, due to a jumble of numbers, there were students who chose (1) also.

6 Magnitude of charge stored in the two capacitors A and B shown in figure respectively are



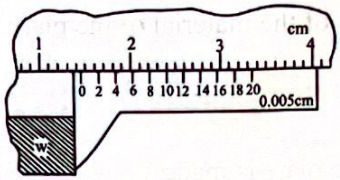
(1) 0, 0 (2) 0, 6 μC (3) 4 μC, 0

(4) 4 μC, 4 μC (5) 4 μC, 6 μC

06 Electrostatic Potential

This is just peanuts. You can get the answer by the memory. 2 by 2 is 4. 2by 3 is 6. (Q = CV) Both capacitors have the same voltage across them (2 V).

7 The length of a rectangular wooden block (W) is measured using vernier calipers. The figure shows the relevant sections of the vernier calipers and the block. (Only relevant divisions in the vernier scale are shown.)



If there is no zero error in the vernier calipers, then the length of the wooden block is

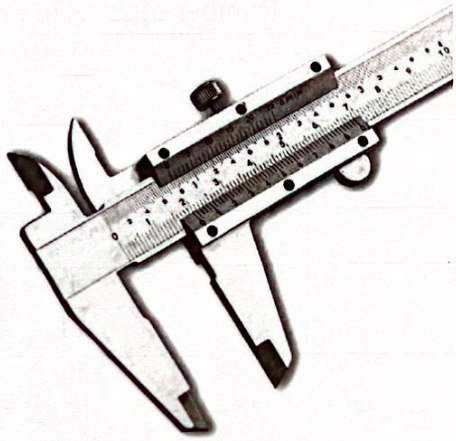
(1) 1.30 cm (2) 1.35 cm (3) 1.45 cm (4) 1.50 cm (5) 1.55 cm

01 Measuring Instruments

The least count has been marked on the vernier scale clearly. 20 parts of the vernier scale is coinciding with 19 mm of the main scale. Therefore, the least count = 1 – (19/20) = 1/20 = 0.05 mm

In the vernier scale, parts of 1, ,3, 5 are not shown (due to convenience). The 10th part of the vernier scale is coinciding with the part of a main scale accurately.

So, the measurement is 1.4 cm + (10 X 0.05) cm. That is 1.45 cm.



Some children have taken 1.35 cm as the correct answer. That is wrong. That reading is obtained when you start to read the reading from the corner of the jaw. The reading should start from 0 mark of the vernier scale. When the jaws are tightened without the wooden block, 0 mark of the main scale is coinciding with 0 mark of the vernier scale, not to the corner of the jaw. This pattern is there for any vernier caliper (Look at the figure).

8 A person cannot see clearly the objects beyond a distance of 50 cm from his eyes. In order to see distant objects he must wear

(1) concave lenses of focal length 10 cm.

(2) convex lenses of focal length 50 cm.

(3) concave lenses of focal length 50 cm.

(4) convex lenses of focal length 100 cm.

(5) concave lenses of focal length 100 cm.

Defects of Vision **03**

This is also a question that has been given many times. If you cannot see objects clearly away from 50cm, then he is suffering from short sightedness/ myopia. Cannot see the distance. For short sightedness, you need to wear concave lenses. Make sure that the rays coming from far away should be seen to come from 50 cm. The answer is (3).

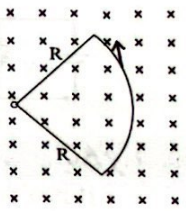
9 Minimum amount of heat that is necessary to melt completely an ice cube of mass 30 g at 0^0C is (specific latent heat of fusion of ice is 3.3×10^5 J kg^{-1})

(1)11 J (2) 990 J (3) 1 100 J (4) 9 900 J (5) 11 000 J

Calorimetry **04**

You need a small calculation. $30 \times 10^{-3} \times 3.3 \times 10^5 = 9.9 \times 10^3 = 9900$ J. There is no way that you cannot do from the memory. The powers of 10 should be sorted out properly.

10 Figure shows the path of an electron travelling along an arc of a circle of radius R with a speed v in a uniform magnetic field. The magnitude (B) of the magnetic flux density is given by (m=mass of an electron; e= charge of an electron)



(1) $B = \sqrt{\frac{mv}{eR}}$ (2) $B = \left(\frac{mv}{eR}\right)^2$

(2) $B = \frac{mv}{2eR}$ (4) $B = \frac{mv}{eR}$ (5) $B = \frac{2mv}{eR}$

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

You need to write the known equation. $evB = mv^2/R$. You just get the expression for B. There is a mistake in the drawn figure. As the charge of the electron is negative, the velocity should be to the opposite direction. Even teachers make mistakes. But it does not have an effect on the expression.

11 The moment of inertia of a certain spinning star has dropped to $\frac{1}{3}$ of its initial value due to contraction. The ratio, $\frac{\text{new rotational kinetic energy of the star}}{\text{initial rotational kinetic energy of the star}}$ is equal to

(1) $\frac{1}{9}$ (2) $\frac{1}{3}$ (3) 3 (4) 9 (5) 27

Rotational Motion **02**

Here if you can express rotational kinetic energy from angular momentum, then it will be a quick approach to the answer. That is because the angular momentum of the system is constant.Rotational kinetic energy $= \frac{1}{2}\frac{L^2}{I}$ (where L =angular momentum I = moment of inertia) Recall the expression of $\frac{1}{2}\frac{p^2}{m}$ for translational kinetic energy. If we apply L instead of linear momentum and I instead of m, then you will get $\frac{1}{2}\frac{L^2}{I}$. If you write the rotational kinetic energy like this then the answer is on your hand. As L is conserved,

New rotational kinetic energy/ Initial rotational kinetic energy $= I_1/I_2 = \frac{I_1}{1/3I_1} = 3$

(rotational kinetic energy $\propto \frac{1}{I}$)

However, the new kinetic energy should be greater than initial value can be decided from normal logic. So, the answer cannot be 1/3. Even there is no wrong in doing this question by taking the relation of ½ I ω^2. But it will take some time.

$\frac{1}{2} I_2\omega_2^2 / \frac{1}{2} I_1\omega_1^2 = 1/3 I_1\omega_2^2 / I_1\omega_1^2$ but $I_1\omega_1 = I_2\omega_2$ then $\omega_2^2 = I^2_1\omega_1^2 / I_2^2 = 9\,\omega_1^2$

So, the answer is getting lengthened as 1/3 X 9 = 3

In a situation where the angular momentum is conserved, it is more productive to use $\frac{1}{2}\frac{L^2}{I}$.

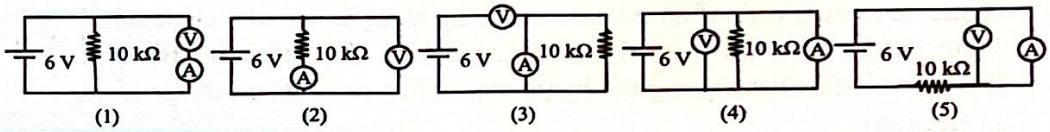
12. A uniform copper wire of cross-sectional area 10^{-7} m^2 carries a current of 1.6 A. If there are 10^{29} free electrons In 1 m^3 of copper, the drift velocity of electrons in the wire is (magnitude of the charge of an electron is 1.6×10^{-19}C)

(1) 1.0mm s^{-1} (2) 1.6mm s^{-1} (3) 2.0mm s^{-1} (4) 10.0mm s^{-1} (5) 20.0 mm s^{-1}

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

You need a small calculation. You cannot escape from it. You need to apply directly to the equation $i = nqAV_d$. $1.6 = 10^{29} \times 1.6 \times 10^{-19} \times 10^{-7} V_d$. The current is given as 1.6 A to cutoff. Then you will get $V_d = 10^{-3}$ ms^{-1}. Is not this 1 mms^{-1}? All the answers are given in mms^{-1}.

13 In the circuits shown below **A** and **V** represent an ammeter and a voltmeter meter respectively. In which circuit arrangement the ammeter will have the highest risk of getting damaged?



08 **Moving Coil Meters**

It is a very easy question. You do not have to think far. The question is asking only about the ammeter. Big damage to the ammeter can happen when the maximum current of the ammeter is flowing across it. If so, it should be connected directly across the battery. It is reduced (controlled) when the current is flown across a resistor to the ammeter. Only (4) has this arrangement. Has not it?

In (1), the ammeter and the voltmeter are connected in series. The internal resistance of a voltmeter takes a higher value. Actually if we consider the voltmeter as an ideal one, then the current that is flown acorss is zero.

In (2), there is 10 kΩ in series with the ammeter. From that, the current is being controlled.

As in (3), if you need to flow a current across the ammeter, it should flow across the voltmeter before that. In (5), there is 10 kΩ before the ammeter.

14 If the absolute value of the surface temperature of the sun were three times the exiting value, the radiation of the sun would have been mostly in

(1) microwave range. (2) infrared range. (3) visible range.

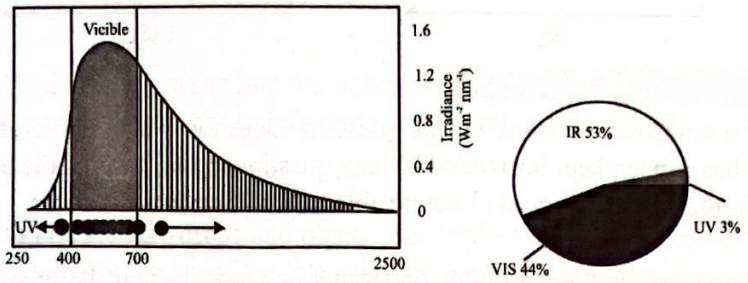
(4) X-ray range. (5) ultraviolet range.

11 **Radiation**

There can be a small confusion in this question. The examiners might have expected the wavelength or range for maximum intensity that solar radiation will fit in. If you think like that, then the question is easy. We know that the visible range matters for the radiation of maximum intensity emanting from the surface of the sun. The surface temperature (absolute) is tripled, then according to Wein's displacement law the wavelength related to the maximum intensity should be shorter than the wavelengths of visible range. λ_{max} T = constant

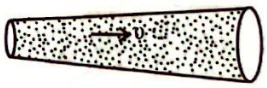
When T increases λ_{max} gets decreased. If you argure like that, then only (4) and (5) are correct. The wavelengths of microwave and infra red are greater than the visible light. The wavelength related to maximum intensity is needed to come into X ray range, then the temperature should be at a higher value. Therefore, the correct answer is ultraviolet.

Normally, if we take the wavelength of yellow light in visible light as 5000 Å, then according to Wien's displacement law, when T becomes 3T, λ_{max} should be 5000/3. Wavelengths in 1000 range of Å are there for ultra violet radiation. If the rough wavelength of X rays is taken as 1Å, then, λmaxto be 1Å, T should be multiplied by 5000 times from the current value.So, X rays are omitted. If a child thought about where should solar radition belong from the view point of total intensity and interpret the question like that, then getting an answer will be cumbersome. The distribution of radiation is shown below.



Here, the total range of solar radiation is being given as a percentage from the total radioactive energy. But we do not need to keep these in our minds. Therefore, if the question is understood like this, then finding the answer is inconvenient. To get the area under the curve, you need to do integration.

15 A non viscous fluid of density d has a streamlined flow through horizontal pipe of variable cross-section as shown in the figure. If the pressure of the fluid is P at a point where the velocity of flow is v, what is the pressure at another point where the velocity of flow is 3v?



(1)P-3dv² (2) P-4dv² (3) P+4dv² (4) P+8dv² (5) P-8dv²

As soon as you see the question, you will get to know that it is a question that you need to apply Bernoulli eqaution.

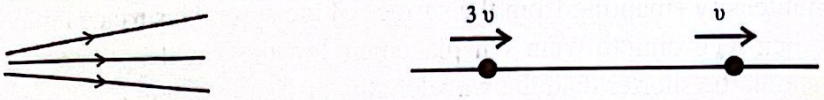
$$P + \frac{1}{2}dv^2 = P' + \frac{1}{2}d(3v)^2$$

$$P + \frac{1}{2}dv^2(1-9) = P'$$

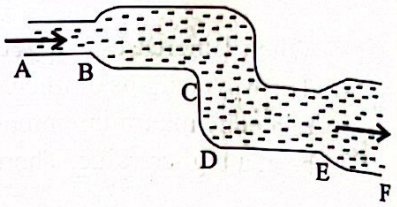
$$P' = P - 4dv^2$$

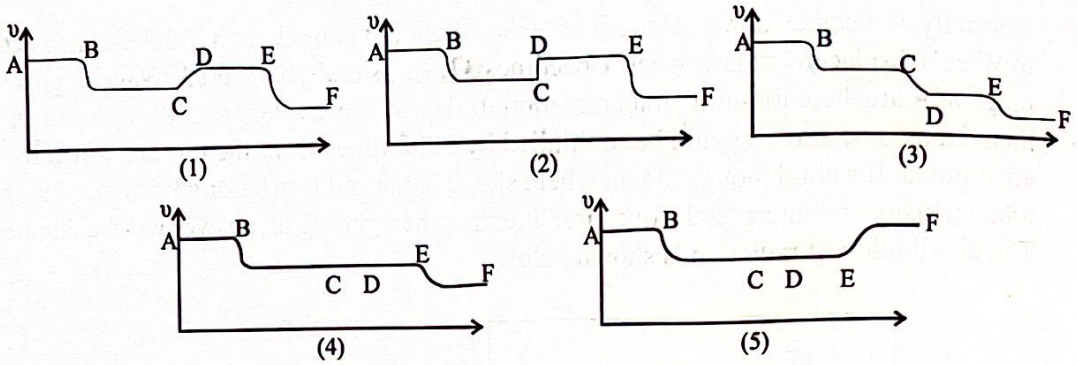
3 v is given as $3^2 = 9$ and 9-1 = 8 and 8 is divisible by 2. When the velocity is increased, the pressure should decrease. Therefore, (3) and (4) choices are just getting out. Out of the

answers, you can get it wrong with (2) and (5). If you forget to divide by 2, then you will cross (5). As Bernoulli theorem should be applied to a streamline, the other point should also be in the same level of the given point.There is no issue regarding the difference of height.



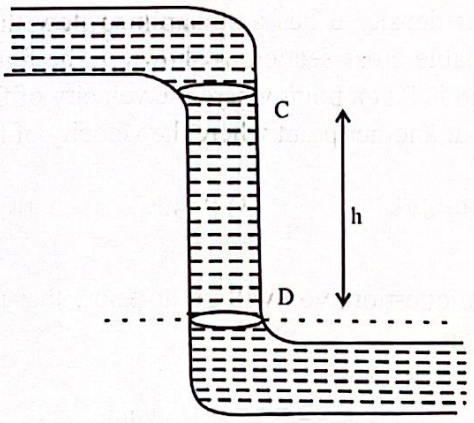
16 Non viscous, incompressible fluid flows steadily through the pipe shown in the figure. The variation of the flow speed v of the fluid along the tube from A to F is best represented by





There was a controversial issue in this question. Does the vertical part of the tube is really vertical or has it been kept horizontal? Many questioned like that. Some argued that, as it is not given in the question, you will not be able to find the correct answer.

But if that part of the tube is either horizontal or vertical, then the answer is same. Many argued that, if that part of the tube is vertical, then when it is coming down, the speed of the fluid should increase due to gravity. That argument is not correct. Most of the time we just get the feeling that the speed should be increased. It is fair to think like that. But what is fair is not always correct. Consider the botton part of the tube with the fluid.

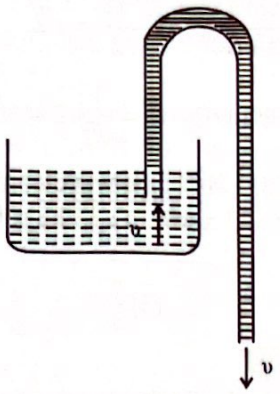


As the cross-sectional area of the shown tube is same, the speed of the fluid has to be in same value. It is the same either the tube is horizontal or vertical. The reason is that the multiplication of Av should be a constant. The speed of the fluid at D cannot be greater than at C even if the tube is vertical. If it gets increased, then how can the multiple of Av be constant?

But if the tube is vertical, then the fluid pressure of D is higher than C.According to Bernoulli eqaution,

$$P_C + \frac{1}{2}\rho v^2 + h\rho g = P_D + \frac{1}{2}\rho v^2 + 0$$

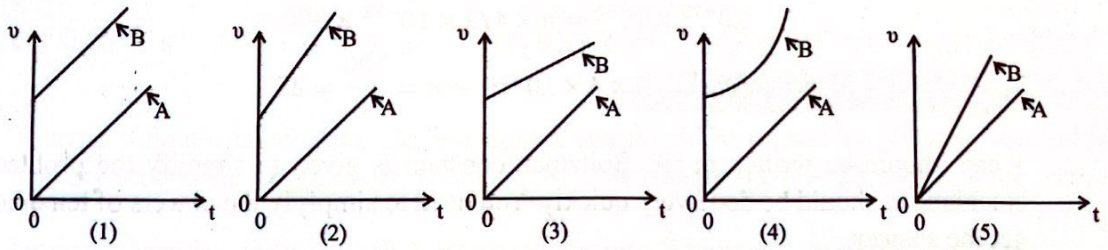
$$P_D = P_C + h\rho g$$



If the tube is horizontal, then $P_C = P_D$. Therefore, there is no problem in this question. If the pressure difference of the fluid is asked, then the horizontal or vertical orientation is affecting the question. But it is not affecting the flow speed of the fluid. Consider the siphon which is familiar to you.

The fluid speed that is coming into the siphon is equal to the out going speed. Is not it? If the internal cross sectional area is not changed and the tube is fiiled with the fluid, then the fluid speed cannot be changed.

17 A person simultaneously drops and object, and throws another object vertically downwards from a certain height. which of the following graphs best represents the velocity (v) – time (t) curves for the two objects? (Curve A represents the dropped object and curve B represents the thrown object.)



Linear Motion 02

It is a very simple question. The srtaight lines should be parallel to each other. Both fall with the same gravitational acceleration. The acceleration cannot be changed even if they are released or throwen vertically downwards. The initial velocity is zero in the object that is released. There is an initial velocity for the object that is thrown downwards. The lines get parallel only in (1).

8 Alight ray deviates from a prism with the minimum deviation of 30°. If the angle of the prism is 60°, the refractive index of the material of the prism is

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

Refraction through prisms 03

You need a small calculation. You need to substitute for the known formula.

$$n = \frac{\sin\left(\frac{A+D_{min}}{2}\right)}{\sin\frac{A}{2}}$$

$$n = \frac{\sin 45^0}{\sin 30^0} = \frac{1/\sqrt{2}}{1/2} = \sqrt{2}$$

You know the values from your memory. $n = \frac{1}{\sqrt{2}}.2 = \sqrt{2}$

19 A light wave of frequency 4.5×10^{14} Hz has a wavelength of 4×10^{-7} m in a certain medium. If the velocity of light in vacuum is 3×10^8 m s^{-1}, the refractive index of the medium for that light is

(1) $\frac{6}{5}$ (2) $\frac{4}{3}$ (3) $\frac{7}{5}$ (4) $\frac{3}{2}$ (5) $\frac{5}{3}$

03 **Refraction**

You can get the answer by using the basic definition of refractive index.

Refractive index = speed of light in vacuum/ speed of light in the medium and $v = f\lambda$

$$n = \frac{3 \times 10^8}{4.5 \times 10^{14} \times 4 \times 10^{-7}} = \frac{30}{18} = \frac{5}{3}$$

20 The best vacuum that can be achieved in a laboratory has a pressure of 10^{-13} Pa. The number of gas molecules present in 1 cm^3 of such a vacuum at 300 K is (take Boltzmann constant =$4/3 \times 10^{-23}$ J K^{-1})

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

04 **Expansion of Gases**

Again it is a simple calculation. (PV = nkRT)

$$10^{-13} \times 10^{-6} = n \times 4/3 \times 10^{-23} \times 300$$

$$10^{-19} = n \times 4 \times 10^{-21} \rightarrow n = \frac{100}{4} = 25$$

1 cm^3 should be written in m^3. Boltzman constant is given to simplify the problem. Such calculations should be done very quickly. You need to simplyfy the powers of ten quickly and get the answer.

21 The motion of an insect living on sand generates transverse waves travelling at 50 m s^{-1} and longitudinal waves travelling at 150 m s^{-1} along the sand surface. A scorpion can estimate the location of the insect from the difference Δt in the arrival times of these waves. If $\Delta t = 4.0 \times 10^{-3}$s, the distance from the scorpion to the insect is

(1) 0.05 m (2) 0.10 m (3) 0.20 m (4) 0.30 m (5) 0.40 m

03 **Wave Praperties**

Such questions have been given. Finding the place of lightning origin from the time difference of it is seen and heard is such a question like this. This is a similar question when there is an earthquake, the place of origin of the earthquake can be detected from the time difference of longitudinal and transverse waves that appraoch a certain place. (Look at the 31st question of paper 2006)

The speed ratio of the two waves is 1:3. That means, if longitudinal waves come in 1 s, then the transverse wave come in 3 s. So, the time difference is 2s. As the time difference in the question is 4×10^{-3} s, the longitudinal wave takes a time of 2×10^{-3} s where as a transverse time takes a time of 6×10^{-3} s to arrive. Why is that? The difference is 2 when the ratio is 1:3. So, if the difference has to be 4, then the ratio should be 2:6. (3 -1 = 2; 6 -2 = 4)

Now by considering the longitudinal wave or transverse wave, we can find the needed distance.$2 \times 10^{-3} \times 150$ or $6 \times 10^{-3} \times 50$. That means 0.3 m. This can be done from your memory, if you have the practice by doing the previous question.

Normal method

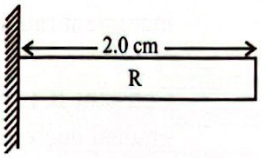
If the distance is d, then d

$$\left(\frac{1}{50} - \frac{1}{150}\right) = 4 \times 10^{-3}$$

$$\left(\frac{d \times 100}{50 \times 150}\right) = 4 \times 10^{-3} \rightarrow d = 0.3$$

Some animals have the ability to sense these waves. Before tsunami, it has been told that some animals especially the animals with hoofs felt the danger. The frequencies from an earthquake are not felt by ourselves. These are lower than the audible frequency range of us. But some animals can feel these low fequency waves from their hoofs to their body. Sometimes hoofs can be a compressional medium to transmit those frequencies.

22 In a certain experiment the unclamped end of an aluminium rod R of length 2.0 cm has to be moved at a constant speed of 100 nm s^{-1}. The rate at which the temperature of the rod be increased for this to happen is (linear expansivity of aluminium = 2.0×10^{-5} $^0C^{-1}$)



(1) 0.25 $^0C\ s^{-1}$ (2) 0.30 $^0C\ s^{-1}$ (3) 0.55 $^0C\ s^{-1}$ (4) 0.65 $^0C\ s^{-1}$ (5) 0.75 $^0C\ s^{-1}$

There is a simple calculation. The unclamped end should be moved by 100 nms^{-1} means that in every second the length of the rod should be increased by 100 nm. So, by using the relation,

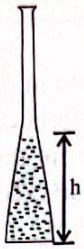
Increased length = initial length X linear expansivity X temperature difference

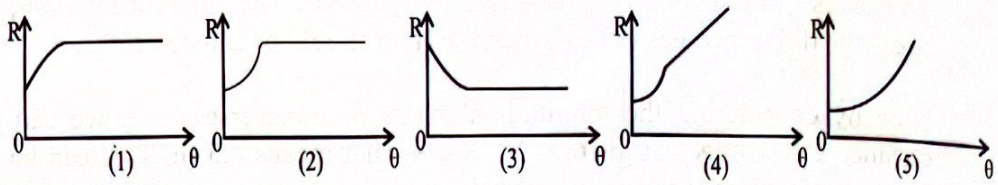
$100 \times 10^{-9} = 2 \times 10^{-2} \times 2 \times 10^{-5} \times \Delta\theta$

$\Delta\theta = ¼ = 0.25$

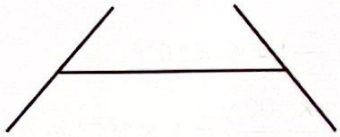
The powers of 10 are easily cut off.

23 A glass container with a narrow area of cross-section as shown in figure is filled with a liquid to a height h. If the expansion of the container is negligible, the rate of change (R) of h with temperature (θ) is best represented by





This is a question that you need to think. It is clear that the internal cross section of the container gradually decreases initially and then takes the same value.



If the cross section is like this and when the temperature gradually increases, it is not a secret that the value of h is increased quickly for an equal temperature increment. Next, when the liquid comes to the uniform cross section, you can decide even from the general knowledge that the change of h is equal in a certain same temperature increment.

It is clear that, when the value of h is increased quickly, the rate in which h changes with temperature also increased quickly and when the change of h is at the same value, then the increment rate is at a constant.

Constant R is shown after a θ value only in (1), (2) and (3). In (3), R has been drawn as a gradual decrement initially. So, even if you do not know Physics, you can remove the choices of (3), (4) and (5) from your general knowledge. Then only (1) and (2) will be left. It should get wrong either from (1) or (2). As I say it always, such questions are easy to solve with the elimination method.

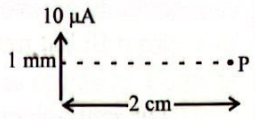
If you focus the eyes on (1) and (2), tehn you can decide that (2) should be correct. In (1), eventhough R is increased, the increment of R is gradually decreasing at same temperature differences. According tho the relavant shape of the container this cannot happen. Therefore, (2) is correct.

There were some criticisms for this question. Initially, many teachers suggested that the uniform heat supply has not been mentioned. As I feel, it is not necessary to mention about the heat supply in the question. It is true that heat should be supplied if the liquid needs to be expanded. But the graphs are drawn with temperature (θ). It is not with the time. We know that when θ is marked on the axis, it is done with equal intervals. Therefore, the value of R has been measured to a corresponding θ value. So, even if the heat is uniformly supplied or not, the values of R are marked for certain equal values of temperature variations. Therefore, I think that the rate of heat supply is not necessary to mention.

The other point is that, whether the word rate is conneted to the time or not. Some argure that the rate indicates a variation of something with time. This is normally true. When we find the rate of change of displacement or rate of change of velocity, there is no secret that there is time

in it. But in this question it has been mentioned that the rate of h with the temperature. Then the rate of h should be taken with the temperature. Here dh/dθ (Δh/Δθ) is measured. If it was just mentioned as the rate of h, then it is fair to connet with the time. We donot say that rate of change of velocity with time. As soon as it is mentioned as rate of change of velocity, time is included. But if we need to measure displacement with velocity (dv/ds), then it should be mentioned. Can you mark the variation of h with θ? Is not it according to (4)? The change of h is linear in the unifrom cross section. For each constant temperature change, the change of h is same. If the variation h with θ is linear, then its gradient (the rate of change of h with θ → dh/dθ) is a constant.

24 When a person performs a certain task a weak current of 10 μA is produced along a conducting path between brain cells. The figure shows such a small path of length 1 mm. The magnitude of the magnetic flux density produced by this current element at a point P at a distance of 2 cm from it is ($\mu_0 = 4\pi \times 10^{-7}$ T m A^{-1})



(1) 2.5×10^{-10} T (2) 1.0×10^{-10} T (3) 2.5×10^{-11} T

(4) 1.0×10^{-11} T (5) 2.5×10^{-12} T

Magnetic Effect of Electric Currents 07

As you have a small current path, directly you need to apply Bio- Savart law. You cannot consider as a straight conductor with an infinite length.

$$\frac{\mu_0}{4\pi}\frac{I\,\delta l \sin\theta}{r^2} = \frac{10^{-7} \times 10 \times 10^{-6} \times 10^{-3}}{(2 \times 10^{-2})^2} = 2.5 \times 10^{-12}$$

(As $\theta = 90^0$ then $\sin 90^0 = 1$)

When we are doing some work such as reading a book or holding a pencil from the hand, the corresponding places of our brain get activiated. If we can measure the magnetic field densities generated due to small currents, then we can find the activiated part of the brain according to the action. From that we can prepare an active map associated to the brain. The magnetic field detection process according to this method is known as MEG (Magneto Encephalo Graphy)

25 The radius of a spherical asteroid is 60 km. The acceleration due to gravity on its surface is 3 m s^{-2}. The escape velocity at the surface of the asteroid is

(1) 400 m s^{-1} (2) 600 m s^{-1} (3) 800 m s^{-1} (4) 1 200 m s^{-1} (5) 3 600 m s^{-1}

Gravitational Force Fields 05

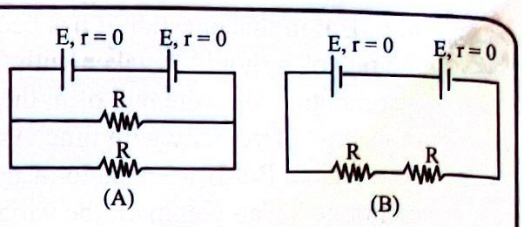
You need to substitute directly to the equation of escape velocity. As the gravitational acceleration is given, it should be aplied to the relevant equation. It is $\sqrt{2gR}$, if you can if you can remember. If not, you need to get the equation quickly.

½ mv^2 = GMm/R → v^2 = 2GM/R but, g = GM/R^2

Then $v = \sqrt{2gR} = \sqrt{2 \times 3 \times 60 \times 10^3} = 6 \times 10^2$

Simplification can be done very quickly. Numbers are given in such a way that their square root can be obtianed easily. 3 X 2 = 6. As there are two 6, once you get the square root of them, you will get 6. The square root of 10^4 is 100.

26 Power dissipation in circuit (B) can be made equal to that of (A) if the resistances in (B) are changed from R to



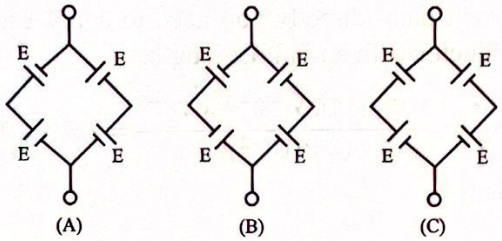
(1) 8R (2) 4R (3) 2R
(4) R/2 (5) R/4

08 Heating Effect of Electric Current

You do not have to calculations for this or write equations. As soon as you saw power loss you will remember i^2R and then find i. This can be solved in a simple way. The cells are identical in both of the circuits. They are being connected in series as well. If the current of the two circuits are made equal, then the power loss (2 Ei) will be the same in both circuits. Think from Ei but not from i^2R.

The equivalent resistance of the first circuit is R/2. It is 2R in the second circuit. How can 2R be equal to R/2? The resistance in 2R should be changed to R/4. Is not it? You can do it from the memory (if you think like that). The current of the circuits must be equal. R and R is R/2. It is 2R in the other. So, R of the second circuit should be changed to R/4.

27 Four identical batteries with negligible internal resistances are connected as shown in figure (A),(B) and (C).



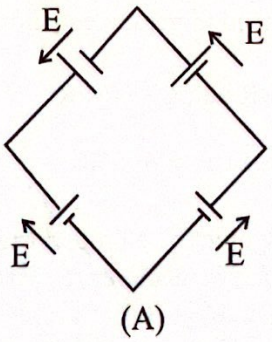
Currents through the batteries are zero in the arrangement/s

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

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

08 Kirchhoff's Law - Combinations of cells

If you take your eyes around the circle,then it is enough. Within seconds you can get the correct answer. Go around (A) in the anti-clockwise direction. E + E + E - E. It is not zero. In (B), it is E + E + E + E. It is not zero. However, you should set into the answer of (C) even if you did not look at the question like that. E + E - E – E = 0. What else to see? The question asks about the currentacross the battery not the current that flows to an outside circuit. Therefore, avoid connecting the resistors at the top and the bottom of the arrangement.

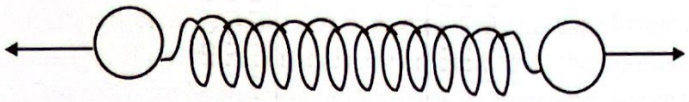


28 Two masses M and m, placed on a frictionless horizontal surface, are connected together as shown in figure using a spring whose mass is negligible. Two masses are first pressed together so that the spring is compressed, and then released. If the initial acceleration of mass m is a, what be the magnitude of mass M at that moment?

(1) $\frac{ma}{M+m}$ (2) $\frac{Ma}{M+m}$ (3) $\frac{ma}{M}$ (4) $\frac{Ma}{m}$ (5) $\frac{(M+m)a}{m}$

Newton's Law and Momentum **02**

This is just a beautiful question. There are many of them in the past papers. As the weight of the spring is neglected, the forces that are acting on m and M are equal and opposite. Force is ma. Therefore, the acceleration of M is (ma/M). (Look at the 46th question of paper 1999.)



29 Fig. 2 shows the variation of the current (I) through the battery with R_3 of the circuit shown in fig. 1. The values of R_1 and R_2 are respectively,

(1) 1 Ω, 2 Ω (2) 1 Ω, 3 Ω (3) 2 Ω, 4 Ω (4)2 Ω, 6 Ω (5) 4 Ω, 8 Ω

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

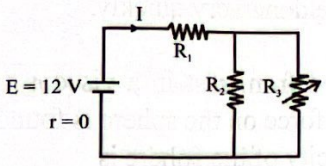


Fig. 1

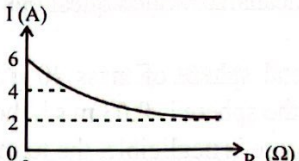


Fig. 2

You need to think in a simple way. When $R_3 = 0$ then I = 6A. $R_3 = 0$ means that there is no resistance across the road. It is being short circuited. Then there is no current across R_2. Why you should go in the difficult road as there is a convenient road? The value of R_1 is obtained directly. 12/6 = 2. When R_3 gets larger (when it goes to infinity), I current reaches to 2 A. The value of R_3 reaching infinity is equivalent to the breaking of the relation. Now, there is current across R_1 and R_2. The current across $(R_1 + R_2)$ or else $(2 + R_2)$ is 2 A. That means R_2 should be 4 Ω. 12/6 =2. If you can do this by your memory, then you are a fan of MCQ. Division of 12 by 6 is 2. Therefore, R_1 is 2. Division of 12 by 2 is 6. Therefore, R_2 is 4.

30 A 6 km long underground cable AB consists of two parallel conducting wires of same dimensions and are separated from each other. A short circuit has occurred between the two wires at a single point inside the cable. In a test conducted in order to find the faulty position, the measured resistance between two wires at the end A of the cable was found to be 3 kΩwhile the same measurement done at the end B of the cable gave 5 kΩ. The distance to the faulty position from the end A of the cable is

(1) 1.80 km (2) 2.25 km (3) 3.60 km (4) 3.75 km (5) 4.50 km

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

his question was completelygiven in a past paper (look at the 34th question of paper 1999). If it was done from the method that I say, then is not this easy? All you need is to take simple ratios. If 6 is for 8, then how much for 3? (6/8) X 3 =9/4 = 2.25. Total resistance is 8 kΩ in 6

km distance. Then what is the distance for 3 kΩ? Even there is no justice of writing 4 lines for this question.

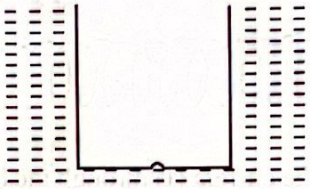
31 A cylindrical metal vessel of height 5 cm has a small circular hole of radius 0.2 mm at its bottom. This vessel is lowered vertically in a certain liquid of density 800 kg m^{-3}, keeping the bottom down. What should be the minimum value of the surface tension the liquid must have so that the vessel can be lowered up to the brim without liquid entering in to the vessel through the hole?

(1) 0.02 N m^{-1} (2) 0.03 N m^{-1} (3) 0.04 N m^{-1}

(4) 0.05 N m^{-1} (5) 0.06 N m^{-1}

10 **Surface Tension**

There are plenty of such questions. 2T/r = hρg. Is not it?



$$\frac{2T}{0.2 \times 10^{-3}} = 5 \times 10^{-2} \times 800 \times 10$$

T = 40 X 10 X 10^{-4} = 0.04. You need to sort all the powers of 10. When 2 is cut by 0.2, then it is 0.1. 0.1 means 10^{-1}. Such questions should be done very quickly.

32 A small metal sphere of mass 40 g is released from rest in a viscous medium. When the velocity of the sphere is 0.03 m s^{-1}, the viscous force on the sphere is found to be 0.1 N. If the buoyancy force is negligible, the terminal velocity of the sphere is

(1) 0.06 ms^{-1} (2) 0.09 ms^{-1} (3) 0.12 m s^{-1} (4) 0.15 ms^{-1} (5) 0.18 m^{-1}

10 **Viscosity**

There is a simple calculation. The viscous force is F = 6 πηav. But you do not need to write everything. The same sphere is there in both occasions in the same liquid.

So, F ∝ v→0.1∝0.03….(1)

If we neglect buoyant force, then the viscous force is equal to the weight of the sphere when it attains terminal speed. If the terminal speed is v, then 40 ×10^{-3}×10∝v…(2)

$$(2)/(1)\frac{v}{0.03} = \frac{4}{1} \rightarrow v = 0.12$$

You really do not need to come this far to solve the problem. The weight of the sphere is 40 ×10^{-3}×10=0.4 N. Therefore, if 0.03 for 0.1, then how much is for 0.4?

If you consider the upthrust, you cannot solve easily like this. But it is convenient if the value of that force was given.

Were there any children who did this question from memory? The related speed is 0.03 for the

viscous force of 0.1. At the terminal velocity, the viscous force is equal to the weight (as we neglect the upthrust). If 0.03 for 0.1, then it is 0.12 for 0.4.

33 Radioactive element $^{232}_{90}Th$ transforms to stable $^{208}_{82}Pb$ after several radioactive decays. The number of α particles and the number of β^- particles emitted in these decays respectively are

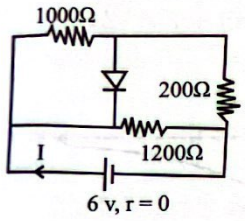
(1) 6, 2 (2) 6, 4 (3) 6, 12 (4) 4, 4 (5) 4, 8

Radioactivity 11

Such questions are given in recent papers. If you have mastered them, then this question should be easy for you. In the emission of β particles, there is no change in A. A is reduced only in the emission of α particles. 232-208 = 24. The mass number of an α particle is 4. Therefore, 6 α particles have been emitted. You can get this straight.

The atomic number of an α particle is 2. In 6 α particles, it will be 12. But when it is decaying from Th to Pb, the atomic number has been changed by 8. So, 12-8 = 4. This should be equal to the number of β^- particles. Emission of β^- particles means the change of neutrons (n) in the nucleus to protons (p). If only 6 α particles are emitted, then the number of protons should be reduced by 12. But they are being reduced only by 8. Therefore, the rest of 4 are filled again by decays of β^-.

This also can be done from the memory. You can find the α particles directly. The reduced number compared to the related reduction of protons is equal to the number of β^- particles.

34 

If the voltage necessary to forward bias the diode shown in figure is 0.7 V, the current (I) drawn from the battery would be

(1) 0 (2) 5 mA (3) 10 mA

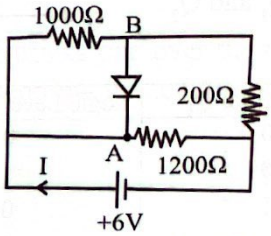
(4) 30 mA (5) 60 mA

Semi Conductor Diodes 09

This may have been a troubling question for many children. In such questions, first we need to find out whether there is a current flow or not across the diode. That means you need to check whether the diode is forward or reverse biased.

If the diode is forward biased, the finding I is a tedious job. Do we know the current that flows across the diode? What is its resistance when it is forward biased? If you think about these things, then you should feel that the diode is not forward biased by instinctively. You can verify that the diode is in reverse biased mode.

The potential of point A is +6 V (relative to the negative end). Likewise, the potential of B is (6/1200) X 1000 =+5 V. So, when we consider across the diode, $V_B < V_A$.(V_B- V_A) should be at least 0.7 V if the diode has to be forward biased.



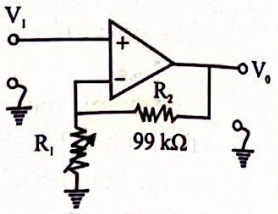
If the diode is removed from the scene, then is it hard to find I? Actually, that is what has happened here. The question was made appear harder by putting a diode. If you can remove

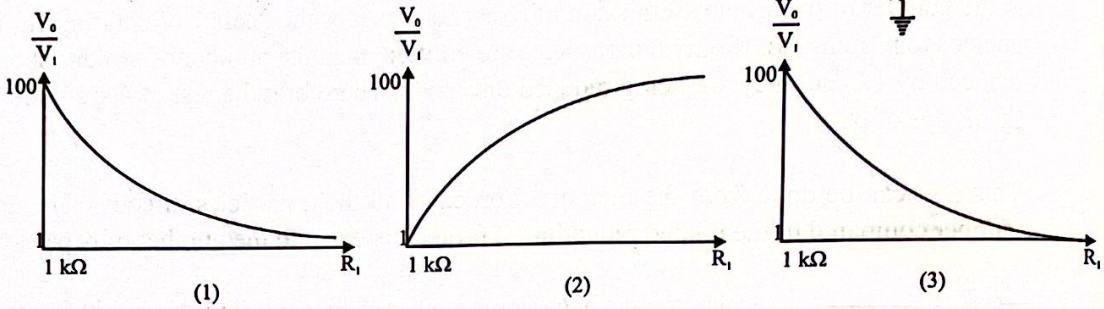
the obstacles, then what is felt as hard will be easy. If the diode is not considered, then the question becomes an O/L question. Both 1000 and 200 are in series. 1200 and 1200 are in parallel configuration. Then, the equivalent resistance is 600. $6/600 = 10^{-2}$ A = 10 mA

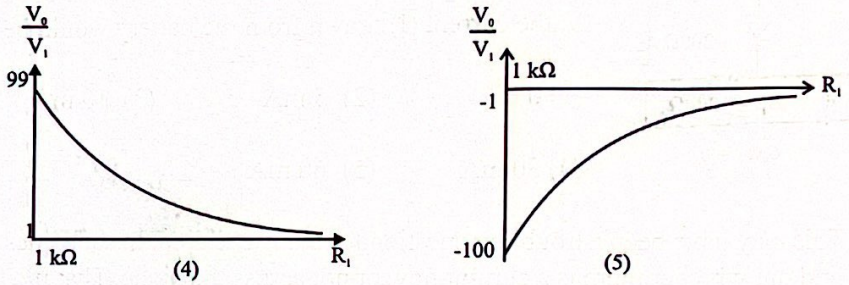
How easy is that?

As I mentioned before, if the diode is forward biased, then I cannot be found from the given data. You will be stuck if you send a current of I across the diode and write equations. Then you need to use your insight and think that, no this should be simpler in a cunning way and come to the correct track.

35 Which of the following curves correctly represents the variation of the voltage gain (V_0/V_1) of the circuit shown when the value of R_1 is changed from 1 kΩ to infinity? (V_0/V_1) is not drawn to scale.



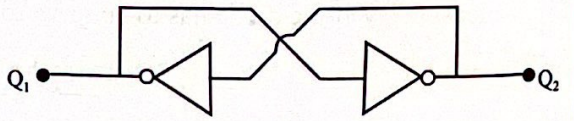




09 Intergrated Circuits

This is a straight forward question. You know that $\frac{V_0}{V_i} = \frac{R_1+R_2}{R_1} = 1 + \frac{R_2}{R_1}$. Even if you do not know, you can write this expression by looking at the circuit. When $R_1 = 1$ kΩ, then $\frac{V_0}{V_i} =$ 100. When $R_1 \to \infty$, then $\frac{V_0}{V_i} = 1$. So, the correct variation is (1). Is not it?

36 Two NOT gates are connected as shown in figure. Consider following combinations of logic levels for the outputs Q_1 and Q_2



Logic Level for Q_1	Logic Level for Q_2
0	0
0	1
1	0
1	1

Which of the above combination/s will provide stable logic levels for Q_1 and Q_2 outputs?

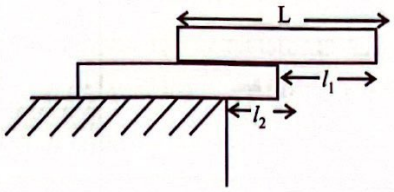
(1) (A) only (2) (D) only (3) (A) and (B) only

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

Logic Gates 09

Get the logic level of Q_1 and then find Q_2 from that. If that Q_2 is really there in Q_2, then the work is done. If Q_2 obtained from Q_1 is not there, then there cannot be such a thing. It can be clearly seen that when $Q_1 = 0$, then Q_2 should be 1. Likewise, if $Q_1 = 1$, then Q_2 should definitely be zero. 0, 0 and 1, 1 can not stay stable. Either one's input is the other's output or his input is the output of other's. Then there cannot be equal logic levels. Opposite levels to each other stay stable.

37 Two identical uniform bricks of length L are stacked without being toppled on a table as shown in figure. The respective maximum possible values for l_1 and l_2 are



(1) $\frac{L}{2}, \frac{L}{4}$ (2) $\frac{L}{2}, \frac{L}{6}$ (3) $\frac{L}{2}, \frac{L}{8}$

(4) $\frac{L}{4}, \frac{L}{4}$ (5) $\frac{L}{4}, \frac{L}{6}$

Centre of Gravity 02

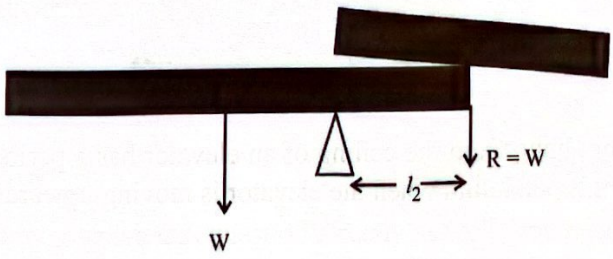
It is a very easy qustion. It can be just seen that l_1 =L/2. If it is more than that, the centre of gravity of the first brick goes out of the vertical line of the right end of second brick. Then it will fall.

Then we will consider the second brick and its instance where it is about to fall.

The first brick is at the instance where it is about to fall in the maximum length of l_1. Then the first and second bricks are touched only at the corner of the second brick. The reaction R which acts on the second brick by the first brick is equal to W. W is the weight of a brick.

Now consider the second brick and take the moments on the corner of the table.

$$W\left(\frac{L}{2} - l_2\right) = Wl_2 \rightarrow \frac{L}{2} = 2l_2 \rightarrow l_2 = \frac{L}{4}$$



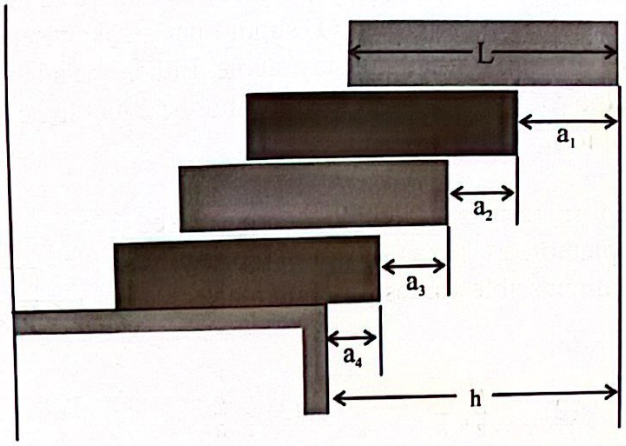
We can keep such a series of bricks one over the other. Thevalue of l decreases as it goes down. The value of l varies according to the following pattern.

$$\text{L/2, L/4, L/6, L/8.....} = \frac{L}{2}\left(1 + \frac{1}{2} + \frac{1}{3} + \cdots + \frac{1}{n}\right)$$

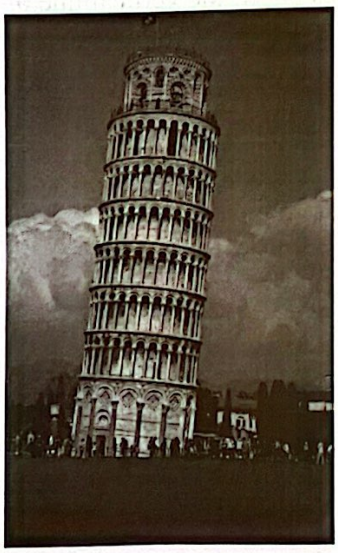
As I mentioned earlier, it can be just decided that l_1 = L/2. Next, when there are two bricks,

the common centre of gravity of them should be taken to the top of the table corner. From that also l_2 can be found.

The logic is same eve if you keep a group of bricks one over the other. The common centre of gravity of the bricks group should be located on the vertical line across the table corner. Look at the following figure.



It can be seen that if the common centre of gravity of a particular structure does not go out of the bottom, then it can stay until for a certain maximum range out of the upper bottom of the structure. Is not The Leaning Tower of Pisa like this? Even if the tilt of the tower is 0.001^0 per year, it is said that, it will take a long time to move the centre of gravity of the tower out of the area of the bottom.



38 A simple pendulum hung from the ceiling of an elevator has a period T when the elevator is at rest. Period of this pendulum when the elevator is moving upwards with an acceleration of 5 m s^{-2} is

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

03 **Simple harmonic motion**

You do not have to write lot of equations. When the lift is going up with acceleration, it is a famous fact that the net gravitational acceleration in the lift is getting increased. There cannot be a child who does not know about this. There is an increment of g when it is going in an upward acceleration. When it is coming down in a downward acceleration, g gets reduced.

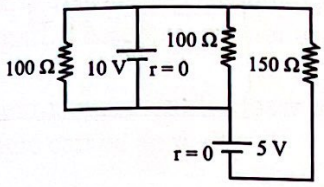
When it goes up with 5 ms^{-2} acceleration, the felt acceleration of the simple pendulum is 10 +5 (15). When it is at rest it feels 10. We know that, the oscillation time is proportional to $1/\sqrt{g}$ .When the experienced acceleration is increased, then the oscillation time gets decreased. Therefore, new period should

be $\sqrt{\frac{2}{3}}\,T\left(\sqrt{\frac{10}{15}}\,T\right)$. It cannot be $\sqrt{\frac{3}{2}}\,T$.

If you write equations, donot write more than this. $T \propto \frac{1}{\sqrt{10}} T' \propto \frac{1}{\sqrt{15}}$

$$T' = \sqrt{\frac{10}{15}}\,T$$

39.



In the circuit sown the current through the 150 Ω resistor is

(1) 0.01 A (2) 0.05 A (3) 0.10 A

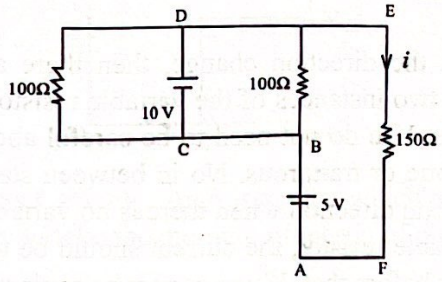
(4) 0.33 A (5) 0.50 A

Kirchhoff's Law Combinations of Cells 08

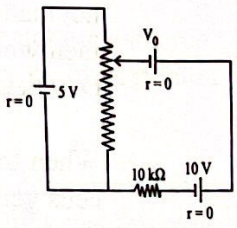
If you do not go from the correct road, then solving will be very difficult. It will consume some time, even if you put Kirchhoff's laws. Even you cannot take all three resistors together.

If you see the road of ABCDEFA, then it will be very easy. If you do not see that road, then you are in trouble. For that road, $i = \frac{15}{150} = 0.1\ A.$

Such problems should be notified at once. Therefore, do not waste more time for these. Leave out if you cannot solve.



40 In the circuit shown in figure, there is a possibility for a centre-zero ammeter A to indicate current in either direction if V_0 is



(1) 1 V (2) 2 V (3) 4 V

(4) 5 V (5) 6 V

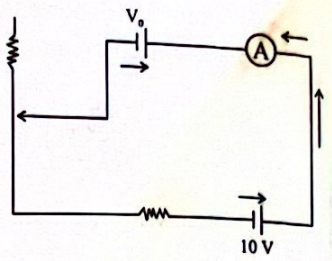
Potentiometer 08

You cannot see how to solve this question directly as well. You need to think logically. Here are the steps that can be taken to get the answer without doing any calculations.

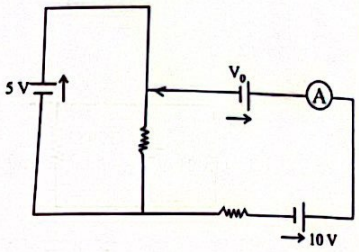
1) If both directions are to be shown in the ammeter (1), then the current should flow across to one side of the ammeter when the bottom part of the variable resistor is touched (without it) as well as to the other side when the toppart of the variable resistor is touched (taken completely).

First you need to decide this. If the direction of the current (across the ammeter) is not changed as it goes to the top, then when can it be changed?

2) If the touch key is brought down to the variable resistor, then only 10 V and V_0 are affecting to the current of the ammeter.There is no contribution from the battery of 5V to the current across the ammeter. All the values that are given for V_0 are less than 10 V. Therefore, the current is flowing to the left side across ammeter.



3) If the connecting key is brought to the top of the variable resistor and to flow the current to the other side of the ammeter, then the value of V_0 should be higher than 5 V. If $V_0 = 5$ V, and then the e. m. f values balance properly. Then the reading of the ammeter is zero. 6 V is the only answer that is higher than 5 and lesser than 10.



It is a stupid thing to calculate the current without thinking the problem in a simpler way. All you need to decide is the direction of the current across the ammeter only. Therefore, take your eye on the road of 5 V, V_0 and 10 V. The e. m. f of 5 V and V_0 are in the same direction whereas 10 V is to the opposite direction. So, if the current of the ammeter is needed to be to the right side, then V_0 should be greater than 5 V. Only 6 is there as the answer which is greater than 5.

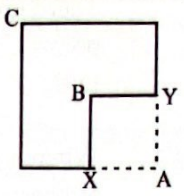
There cannot be values greater than 10 V in the answers. If so, the current will flow across the ammeter to the right side even if the variable resistor comes down. Then there will be no change of directions ever.

If you decide about the direction change, then there are two ends that you need to consider. That is the two instances of the variable resistor when it is not there and when it is completely there. You do not need to be careful about the intermediate states of it. Either you are patriotic or traitorous. No in between stages. If the current flows across the ammeter to a certain direction when there is no variable resistor, then definitely at the other end of the variable resistor, the current should be to the opposite direction. It does not matter if it occurs before that. If you cannot be against even if you go to the other side, then when can that happen? If we do not correct our mistakes before we die, then when can they be corrected?

When the connecting key is brought downwards, the resistor 10 kΩ is there to stop the cells getting short circuited. It is not there to be used for calculations by using its value.

The solution of this problem can be summarized in a simple way. 5 V and V_0 are there to the same direction but 10 V is to the opposite direction. Therefore, if the current is needed to flow across the ammeter to both sides, then Vo should take value greater than 5 and lesser than 10. Only one is given like that for the answer. You cannot give any more value in between 5 and 10.

Figure shows a uniform square plate from which the part XBYA has been removed. If the moment of inertia of the plate around axes perpendicular to the plate and through the points A,B and C are I_A, I_B and I_C respectively then



(1) $I_A = I_B = I_C$
(2) $I_A = I_B > I_C$
(3) $I_A > I_B > I_C$
(4) $I_A > I_C > I_B$
(5) $I_A < I_C < I_B$

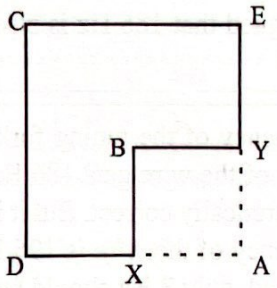
This also can be solved using logic in a simple way. When the mass distribution is away from the rotational axis, then the moment of inertia is increased across that axis. The farthest the mass distribution is around A. Is not it? The nearby points of A which are XBYA does not have a part. Therefore, are not the remaining points stay relatively far away?

Next is not point B closer to the mass distribution? To build this logic, the following simple logic can be applied.

1) The distance to the farthest point of mass distribution from A is AC.

2) The distance to the farthest point of the plate relative to B is BC. (BC = BD = BE)

3) The distance to the farthest point of the plate from C is CD (CE).



AC > AD > BC. That means $I_A > I_C > I_B$. As A is a point which does not belong to the plate and in the space, is it necessary to take the moment of inertia of plate A? There is no problem.

Theoretically, the moment of inertia of a mass distribution around any axis can be considered. Practically, if Y_A and X_A are considered as light wires, then the plate can be even rotated around A.

Taking the total mass of an object to its centre of gravity/centre of mass is not correct when deciding the rotating effect. It is valid for rotational motion. For example, think that the plate is completely there (without cutting into pieces). Then, its centre of gravity is at the centre at B. But the moment of inertia is not zero in an axis around B. Even the distance from B to the centre of gravity is zero, the plate has a moment of inertia around B. If it is not so, then it will be awesome. Then we could have rotated the plate around B without any rotational inertia.

Therefore, do not concentrate the mass of an object on its centre of mass for rotational motion. Think the plate as a group of people. If we remove men from XBYA part, then there is nobody to bump into for a person at A. The nearby person will be at either X or Y. The farthest one is at C.

There are many near to B by staying closer to each other. The farthest person is staying at points C or E or D. Even C is not lonely compared to A, there is no trouble or joy compared to B.

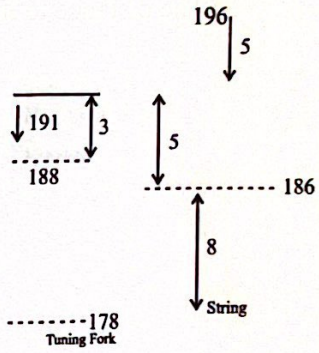
42 When a guitar string sounds together with a tuning fork of frequency 191 Hz, at the room temperature, five beats per second are heard. When the tuning fork is heated up to a certain temperature, the beat frequency heard increased to eight beats per second. Frequency of the note produced by the guitar string at the room temperature is

(1) 181 Hz (2) 186 Hz (3) 191 Hz (4) 196 Hz (5) 201 Hz

03 **Transverse Waves**

This is not an unfamiliar question to you. You have done many questions like these. You can decide from the first sentence that, the frequency of the guitar wire should be either 196 Hz or 186 Hz. The second data is given to find the correct value out of these two. When the temperature is increased, the lengths of the prongs in the tuning fork get increased. When the length of the prongs is increased, the vibrating frequency gets reduced. This is a known fact by yourself. It has been checked in the previous papers too. The vibrating frequency is low in a long tuning fork. A short tuning fork has a high vibrating frequency ($f \propto \frac{1}{l}$). According to that, when the temperature is increased, the frequency of the tuning fork gets a lower value than 191 Hz. Then as it is given that the beat frequency gets increased, the frequency of the wire should be 196 Hz. If it is 186 Hz, then the beat frequency should get reduced when the frequency of the tuning fork is reduced.

Some children and teachers argued that 186 Hz is also correct. Look at the figure.



Their argument is, if the frequency of the tuning fork reduces till 178 Hz, then the frequency of the wire gets 186 Hz and we can get eight beats. This is theoretically correct. But it is hard to obtain practically. If the frequency of the wire is 196 Hz, then once the temperature is increased, only 3 Hz should be reduced from the tuning fork to get eight beats. That means from 191 to 188. If 186 Hz is correct, then the frequency of the tuning fork should be reduced by 13 Hz. This difference is very high.

Actually, the increment of beats frequency (8) when the temperature is increased is not necessary to the question. I doubt that this confusion has occurred to some extent by giving that value. It should have been adequate to mention that the beat frequncy increased when the temperature was increased.

But even it was mentioned like that, the people who argue this way can argue in the same way. This logic can be also applied on the familiar questions of ours. For an example, if we put wax on a prong, then how many questions have you solved in the given nature?

This question can be given as applying wax on prongs instead of increasing the temperature. Even people can argue in the same way as they do in the second way. I donot get how a controversy has occured for this particular question although the controversy was not applied for such questions.

Here what is accepted and more correct logic is that the frequency change is occurred with a

small gap in the tuning fork. We apply little amount of wax. From that there can be a frequency change of 3 Hz not 13 Hz.

As there was a critism on this question, I estimated the temperature increment that should be applied to a tunig fork for a frequency change of 3 Hz. If the prongs are made of steel, for a frequency change of 3 Hz, the temperature should be increased at least by 500^0C. Some can argure that this is also a higher practical value. To get a frequency change of 13 Hz,the temperature should be increased at least by 3500^0C. This is not practical at all. You also can calculate it.

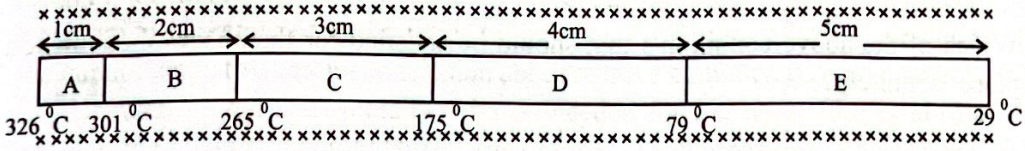
$$191 \propto \frac{1}{l}$$

$$188 \propto \frac{1}{l+\Delta l}$$

$$\alpha = \frac{\Delta l}{l\Delta T}$$

$$\Delta T = \alpha\left(\frac{\Delta l}{l}\right)$$

43 Five cylindrical metal bars (A,B,C,D and E) are made from five different materials. All bars have the same cross sectional area but different lengths, and they are connected end to end as shown in figure. When the free ends are maintained at temperatures 326 ^{0}C and 29 ^{0}C, steady state temperatures at the interfaces are indicated in the figure. Assume that the system is fully lagged except its free ends. Which metal bar is made out of the material with the smallest thermal conductivity?



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

This is a question that checks arithmetic skills with Physics logic. The rate of heat flow from the rods and the cross- section of them are same. Therefore, the temperature gradients of the rods are inversely proportional to the heat conductivity. The smallest heat conductivity is there for the rod with the highest temperature gradient. If the heat conductivity is less, then the temperature drops very quickly.

Temperature gradient for A = 25/1 = 25

Temperature gradient for B = 36/2 = 18

Temperature gradient for C = 90/3 = 30

Temperature gradient for D = 96/4 = 24

Temperature gradient for E = 50/5 = 10

The highest value is there for C. You need to find the temperature differences. There is no short cut for that. Some differences can be written at a glance. (326-301) and (79-27). But the lengths of the rods are given to divide the differences nicely.

44 Many rock musicians wear special ear-plugs to protect their hearing during performances. If an ear-plug decreases the sound intensity level by 20 dB, it reduces the intensity of sound waves by a factor of

(1) 10^4 (2) 10^3 (3) 10^2 (4) 10 (5) $\sqrt{10}$

03 Intensity of Sound

If these questions are not easy for you, then that means you have not studied the previous papers. The question has mentioned about 'rock' music to make the question more beautiful. Actually, it happens like that. The sound intensities are at a higher level in such musical shows. The sound intensity may get higher enough to break the ear drum. If such musicians continuously hear such intense sound/noise, then can get hearing defects. Always the difference of the intensity levels $20 = 10 \log (I_2/I_1)$ and I_2/I_1 should be 10^2. You should do this from your memory. $10 \rightarrow 10, 20 \rightarrow 10^2, 30 \rightarrow 10^3$……Do not you know these things?

45 When a person wearing spectacles move from room P to room Q he observed that a thin film of water is deposited on the lenses. Consider the following that are given as necessary condition for this to happen.

(A) Temperature of room P > Temperature of room Q

(B) Temperature of room Q > Temperature of room P

(C) Relative humidity of room P > Relative humidity of room Q

(D) Relative humidity of room Q > Relative humidity of room P

Which of the above condition/s that should be satisfied for the above phenomenon to take place definitely?

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

(5) (B) and (D) only

04 Hygrometry

This question was subjected many people's discussion and arguments. Actually, this happens practically. If we go outside from an air-conditioned room or vehicle, this can happen. It does not have to occur every time.

The reason behind this is simple. When you stay in a room of less temperature (for some time), the temperature of the lenses that you wear also reach to the room temperature. That means it cools. After it cools, if you go to a place with a higher temperature, then the air around the lens gets cooled. Outside temperature is higher than the temperature of the lens. Therefore, as heat from the air is flowing to the lens, the air around the lens gets cooled. If the air temperature comes to the relevant dew point when cooling, then dews are formed. This is the simple Physics explanation. If this to occur, definitely room temperature of Q should be higher than the room temperature of P. That means the temperature of the place where you go should be higher than the temperature of the place where you come from. If you go from a cool room to a cooler room, then it will never happen. What happens here is that, the heat will flow to the air from the lens not heat flow into the lens from the air.

Therefore, you need to go to a warmer place from a cooler place if you need to form dew. Then only the water vapour in the air around the lens can get condensed. So, whatever the value of

relative humidity, this situation has to be satisfied. Even the place where you go has a relative humidity of 100%, this will not happen if the temperature of the place where you stayed is at a higher temperature compared to the temperature of the place where you go. As I mentioned early, the heat will be given from the lens to the air. Opposite side of heat transfer should occur.

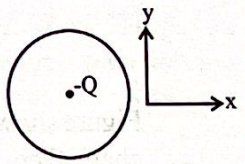
Therefore, state (B) must be satisfied definitely. Many argued that (D) should be satisfied. But that argument is not correct. We definitely cannot say anything about relative humidity. Whether the relative humidity is high or low at room Q, if the cooled lenses can reduce the air down to the dew point, then the water film will be formed.

If the relative humidity of room Q is at a higher value, then the probability of forming dews is high. Because dew point is quickly reached by the air around the lens when it cools down. Likewise, if the relative humidity is less, then the chance of forming water film is less. Because the dew point in room Q is at a lower value. The air around the lens should be reduced to that dew point.

So, the compulsory state of the formation of water film is only (B). (room temperature of Q> room temperature of P). But as soon as this is satisfied, we cannot say that the water film will be formed. It is true. The temperature difference is a compulsory factor. But it is not enough to form dew. For the formation of dew, it should be cooled down to the dew point. This is also true.

But as I mentioned before, we cannot exactly decide that which room has highest relative humidity or not. From the given data we know that the water film will be formed. Therefore, the room temperature of Q should be higher than P. We can definitely decide only that fact. We cannot come to a certain conclusion about relative humidity. (C) can be correct. Likewise, (D) also can be correct. Actually, what is needed for the water film is not the difference between the relative humidity levels of the rooms. The formation of dew is not decided upon the temperature of each room. It is decided by the value of the relative humidity of room Q. If it has a higher value, then the tendency of forming dew is high. If it is at a lower value, sometimes dew can be formed. Sometimes it cannot be formed. The tendency of forming dew is low.

46 A charge +q is uniformly districuted along a very thin non-conducting circular ring of radius R and a charge -Q is placed at the centre of the ring. Now, a very small part containing a charge Δq is removed from the ring has shown in figure. The electrostatic force acting on the charge -Q at the centre of the ring is



(1) $zero$

(2) $\frac{1}{4\pi\varepsilon_0}\frac{Q(q-\Delta q)}{R^2}$ along $+y$ direction

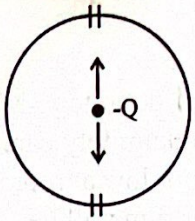
(2) $\frac{1}{4\pi\varepsilon_0}\frac{Q(q-\Delta q)}{R^2}$ along $-y$ direction

(4) $\frac{1}{4\pi\varepsilon_0}\frac{Q(\Delta q)}{R^2}$ along +y direction

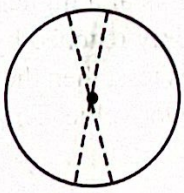
(5) $\frac{1}{4\pi\varepsilon_0}\frac{Q(\Delta q)}{R^2}$ along $-y$ direction

This is a very easy question, even it is seen as a hard one. The force on the -Q charge at the centre of a uniformly charged ring is zero. If we consider the whole ring, there is an opposite and equal friend to every infinitely small charge particle. Therefore, the forces acting upon -Q are balanced with each other.

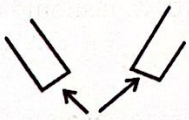
Now if we remove Δq charge from the bottom, then the opposite upper friendly part gets lonely. Now to balance the force from the top part on -Q is gone from the bottom. So, the force should be upwards on -Q. As the part of Δq charge is very small, it can be considered as a point charge. Therefore, the magnitude of the force can be written using Coulomb's law. The correct answer is (4).



Now the gone person is gone. The rest is the same. The related force to the associated person is left and the person is gone.



If the ring is not thin, then Δq charge distribution cannot be certain about the distance from the centre. It is not equal to R. If it is a conductor, then the charges are not stayed inside the ring. If it is a conductor, when a part is removed from the bottom, the charges come to the surface area of the two ends.



Here the charges come freely to the two free ends as shown. Before removing the part, there is no possibility to have charges in those places. Net charges cannot exist inside a conductor under the static state. But if the ring is not conducting, there will be charges inside the ring also. Even a part is removed, the rest of the charges stay still as it is.

47

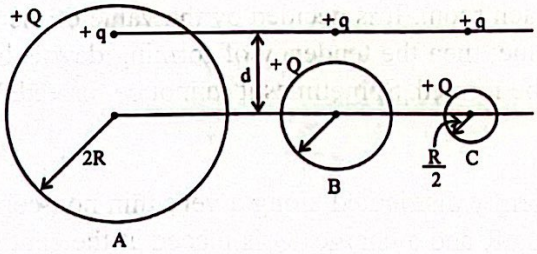


Figure shows three isolated systems (A,B and C) each having a point charge +q and uniformly charged conducting shell of charge +Q. If the respective electrostatic forces between the point charge and the shell are given by F_A, F_B and F_C then

(1) $F_A = 0, F_B > F_C$ (2) $F_A = 0, F_B = F_C$ (3) $F_A = 0, F_C > F_B$

(4) $F_A < F_B < F_C$ (5) $F_A = F_B = F_C$

There is no problem in A. The charge +q is inside the shell. The electric field intensity of a uniformly charged conducting shell due to its inside +Q charge is zero. Therefore, there is no force on +q in A. So, $F_A = 1$.

There were some criticisms about the systems of B and C from some people. Their argument was, there will be an effect from +q charge on +Q charge distribution of the shell. It has been

clearly mentioned in the question that +Q charge is uniformly charged. This means that, the effect from +q point charge on +Q has been neglected.

The question has not mentioned that +q charge has been taken near to +Q charged shell. The question says that +q and +Q are existing like this way.

When +q charge is taken near to the shell of +Q, it is true that +q is affecting the distribution of +Q. But you need to answer according to the question. As it has been given that +Q is uniformly distributed, you need to consider that fact when finding the answer.

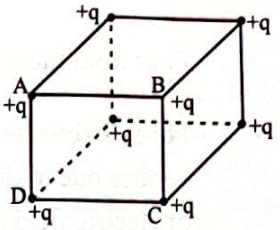
This cannot occur practically as well. If Q>>q, then we can neglect the charge redistribution of the crust due to +q. According to this, shell theorems have been mentioned even in many books as below.

1) A uniformly charged shell attracts or repels a charged particle that is outside in such a way as the charge in the shell is concentrated at the centre.

2) If a charged particle is located inside a uniformly charged shell, then there is no net static electric force on the particle by the shell.

Therefore, the correct answer is (2). It is fair as some children and teachers are thinking beyond the question but it cannot be justified.

48 Eight +q point charges are placed at the vertices of a cube as shown in the figure. The number of electric field lines passing through the face ABCD due to charges is



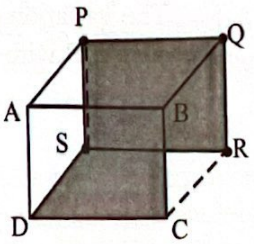
(1) $\frac{q}{3\varepsilon_0}$ (2) $\frac{q}{4\varepsilon_0}$ (3) $\frac{q}{6\varepsilon_0}$

(4) $\frac{q}{24\varepsilon_0}$ (5) $\frac{q}{48\varepsilon_0}$

You need to think this as a modification of the 48th question of year 2008. Your Physics knowledge and problem-solving skills can be developed by designing new questions from the past paper questions. As soon as you saw this question, you should remember the question of year 2008. It is hard to solve this question if you treat it as a lonely question. But if you consider as an extension of the question of 2008 (like Mahinda Chinthanaya), then solving will be very easy.

There is no electric flux flowing across ABCD surface by the charges at the points of A, B, C and D. You will know that the number of electric lines goesacross ABCD surface due to the charge at behind is $q/24\varepsilon_0$ if you have studied the question of year 2008. Here instead of one charge, there are four charges at the same symmetric places. So, if $q/24\varepsilon_0$ from one, then is not $q/6\varepsilon_0$ from 4? (four times as from one).

Here it is a neck breaking thing if you try to design fictious boxes to cover the four charges at the back like you did in the question of year 2008. But you can consider one and do that (as we did in year 2008).



Next, we will consider the symmetry and use the principle of superposition. Compared to the front face, the four corners of the

back side are not special from each other. Therefore, if what is true for one should be correct for others.

This time electric flux has not been asked. Number of electric flux lines or standard electric flux is going hand in hand with q. But number of electric field lines or the flux from the electric field intensity goes with q/ε_o. Even in 2008, it is there as the 48th question.

Only the front faces of the cubes which are designed to cover the charges of P, Q, R and S respectively in a complete symmetrical way are shown above.

Four front faces that belongs to P is 1, 2, 3 and 4.

Four front faces that belongs to Q is 2, 5, 6 and 3.

Four front faces that belongs to R is 9, 8, 3 and 6.

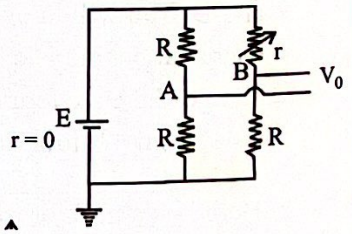
Four front faces that belongs to S is 7, 8, 3 and 4.

For each four faces of ABCD (3) surface is common. Number of electric field lines across ABCD surface due to the charge in P is $q/24\varepsilon_o$ (Look at the solution of year 2008.). Likewise,number of electric field lines across ABCD surface due to the charge in Q is $q/24\varepsilon_o$. It is same for the other two. Therefore, the total amount is four times of $q/24\varepsilon_o$.

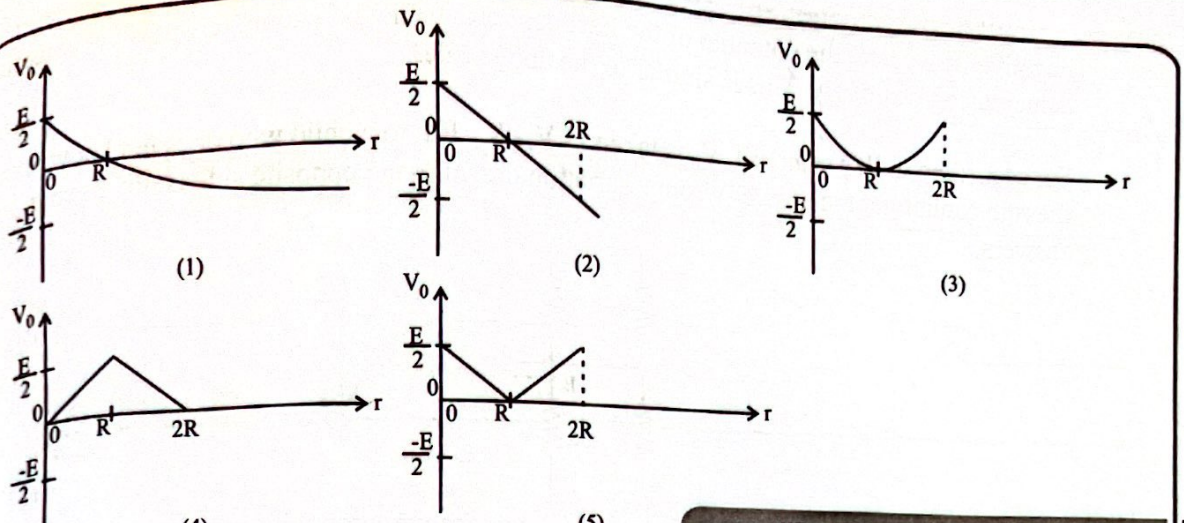
It is a tedious task to design all the cubes in 3D way. In the review of 2008, it has been shown for one charge. The trick of this question is to find the total amount due to three more similar placements as it was found for one charge in year 2008.

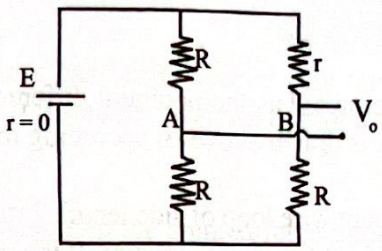
It is wrong to consider superposition principle as a simple and useless principle. If it is not there, studying of Physics is all over. But superposition principle cannot be applied to people. We change our behavioural patterns due to the nearby people.

49 Three fixed resistors of value R and a veriable resistor of resistance r are connected to a battery of e.m.f. E, with zero internal resistance as shown in the figure.



The variation of the potential difference (V_0) between points A and B with r best represented by





You do not have to put any equation or do any calculation. Consider the two instances of r = 0 and r→∞. Then you will just get the shape.

As the negative end of the battery is earthed (potential = 0), the potential of A is E/2. E is divided equally among the identical two resistors of R. The potential of A is E/2 for whatever value of r.What is meant by r = 0 is that you put a wire without a resistance to the place of r. Then there is no potential difference across r. Total E is dropped across its branch of R. Then is not E the potential of B?

That means $V_B - V_A = E - E/2 = E/2$. Even though it has been shown on how to do, actually you do not need to write them.

Now r→∞ means the breaking of that relation. How many times has this been tested? Then there is no current flow across that branch. Then VB = 0. Is not it?

Then, $V_B - V_A = 0 - E/2 = -E/2$.

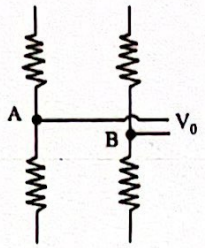
So, is not the correct shape (1)? Vo is reaching towards – E/2 when r is reaching towards ∞ (infinity). This variation is not shown from any other shape. You know that when r = R, V_o = 0 (from the balanced Wheatstone bridge circuit).

Some questioned that the potential difference of A and B (V_o) as$V_B - V_A$? or $V_A - V_B$? Here there is a little rule. The lowest part of the circuit is earthed. To measure V_o, the connection of A junction is taken out and drawn lower to the connection of B. Then according to the tradition,Vo is decided as $V_B - V_A$.

When it is going from the bottom zero to the top, the potential differences are decided from top to bottom. If the top potential is greater than the bottom, then the potential difference is positive. Likewise, if the top potential is lesser than the bottom, then the potential difference is

negative. If we take the potential of the Earth as zero, then when going upwards the potential is increasing positively. This is similar to the above rule.

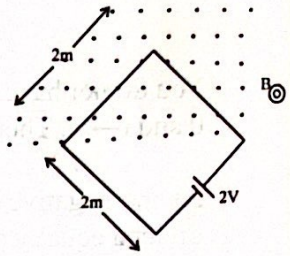
So, according to this standard, V_0 is taken as $V_B - V_A$. But to a child who does not know about the rule cannot get the answer wrong. Variation drawn to the opposite side is not given in the answers.



Therefore, for a child who takes V_0 as $V_A - V_B$, gets the variation with positive negative sides changed. But that shape is not given. At such an instance, you need to select the most relevant answer.

Even V_0 has not been interpreted as the potential difference of A to B. If V_O was marked as shown, then as terminal A is drawn above B, according to the standard $V_o = V_A - V_B$.

50 A part of a conducting square wire loop of side length 2 m is placed in a uniform magnetic field as shown in the figure. If the magnitude of the magnetic flux density decreases at a constant rate of 0.8 T s^{-1}, the net e.m.f. in the circuit would be

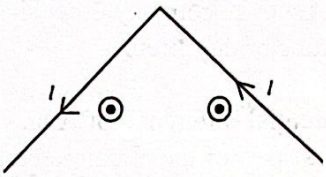


(1) 0.4 V (2) 1.2V (3) 2.8V

(4) 3.6V (5) 5.2V

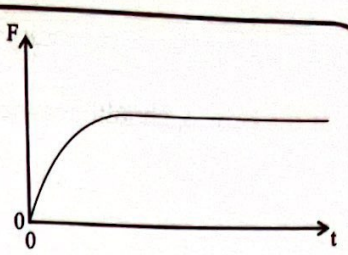
Even though this is the 50th question, it is a very familiar question. Is not the 28th question of paper 2006 in the same way? The magnetic field is there only for a half of the loop. According to Faraday's law, the induced e. m. f is 2 X 0.8 = 1.6 V. This can be obtained from your memory. Do you need to do rough work to find half of the area of a square? Half of 2 is 1. 1 by 2 is 2.

Now the answer is either 3.6 V (2 + 1.6) V or 0.4 V (2 – 1.6) V. You do not have to look into other answers. The magnetic field is working away from the paper. It is reduced with the time. So, the current should flow in the loop to fulfill the gradually decreasing field which is inside the top part of the loop where it is out of the paper. If so, the induced current in the loop should flow in anti-clockwise direction as shown below.

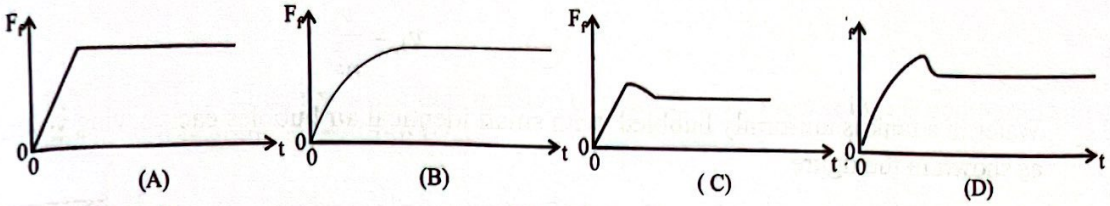


Then the magnetic field of the loop will be directed from the inside to the outside. Even the current from the cell is flowing into the same direction. So, the e. m. f of the cell and the induced e. m. f are added together. If the anti-clockwise current is not increased in the loop, it cannot react positively to the change in the field. Nature (Physics) always reacts in a positive manner.

51 A box is placed on a horizontal surface and a horizontal force F is applied on the box. Variation of the magnitude of F with time is shown in the graph.



Which of the following graphs show/s the possible variations of the magnitude of the frictional force F_f acting on the box with time?



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

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

Friction 02

Physics related to the question has been checked may times. The question asks about the variations about the friction. It is implied from the question that they are not asking about one variation.

We know that the friction is equal to the applied force initially. If we think from that factor, then only (B) and (D) are correct. In the other two shapes, the frictional force varies with time in a linear way. But the applying force (F) is not changing linearly. The shape of F is there for Ff in (B) and (D). Therefore, it is easy to reach the answer even if youdo not think far.

We do not know whether friction has come to its limiting value. If F_f does not come to its maximum limiting value, then F_f varies according to the way how F varies.If it comes to the limiting value, then it will reduce a little afterwards (dynamic friction) and will remain at a constant.

These points are the facts that any child learns. So, there cannot be any difficulty in this question. All are known things.

52 An oil drop falling through still air at its terminal velocity v suddenly explodes to form n number of identical droplets. The subsequent terminal velocity of the droplets would be

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

Hydrostatics 02

This is also a familiar question. This has been given in 1980s. You should not try to write unnecessary equations. This can be solved by writing equations as we do it for a normal question. But there is a shorter method to get the answer easily. Same oil is there in both occasions. They are falling also in same air.

So, you know that terminal speed $v \propto a^2$. Here a is the radius of the drop before the burst. The weight of the oil drop and the upthrust that is acting upon is proportional to a^3. The viscous force goes with a. Therefore, $v \propto a^2$.

Now if a_1 is the radius of the burst oil drop with terminal speed v_1 then $v_1 \alpha a_1^2$.

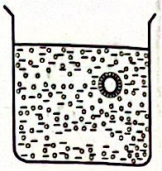
Now a_1 should be written with a. As the total volume of the oil is constant,

$$a^3 \propto n{a_1}^2 \rightarrow a_1 \propto \frac{a}{n^{\frac{1}{3}}} \rightarrow {a_1}^2 \propto \frac{a^2}{n^{\frac{2}{3}}}$$

The answer can be seen now. Put v for a^2 and v_1 for ${a_1}^2$.

$$v_1 = \frac{v}{n^{\frac{2}{3}}}$$

53 Water in a tank is uniformly bubbled with small identical air bubbles each having volume v_0 as shown in the figure.



A sphere of mass M and volume Vfloats in water as shown due to the attachment of certain number of air bubbles on its surface. If d_w is the density of water, and the minimum number of air bubbles that is needed to be attached to keep the sphere floating in water isn, then

(1) $n = \frac{M - Vd_w}{v_0 d_w}$ (2) $n > \frac{M - Vd_w}{v_0 d_w}$ (3) $n < \frac{M - Vd_w}{v_0 d_w}$ (4) $n > \frac{v_0 d_w}{M - Vd_w}$ (5) $n < \frac{v_0 d_w}{M - Vd_w}$

This is also a question subjected to the curiosity of many people. Most of the people have selected (1). That means the similar answer. Everybody questioned that why it is incorrect. The trick in this question is that the density of water (d_w) was given not the density of water with air bubbles. You should assist the density of water with air bubbles to the answer. It is lesser than the normal density if water.

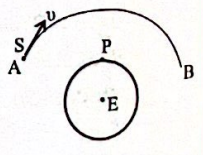
In many places, it has been mentioned that the density of water with air bubbles is taking a lesser value. There are air bubbles at the place where a waterfall falls into the river. Because of this reason, the net density of the water gets less and there can be a tendency that people can get drowned. If gases (like ammonia) are mixed to the water in large quantities, then there can be difficulties even for naval transport.

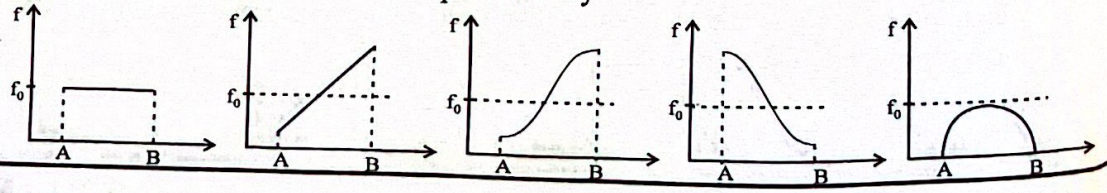
$$n = \frac{M - Vd_w}{v_o d_w} \rightarrow \quad (M = Vd_w + nv_o d_w)$$

The equation is correct only if the density of water with air bubbles is used for d_w. But we do not know that value. But we know it is a lesser value than d_w. When you put a small value to the denominator, the value of the numerator increases whereas the value of the denominator gets decreased. Because of both facts the value of $\frac{M - Vd_w}{v_o d_w}$ gets increased. Therefore,

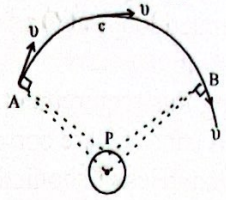
a greater number of bubbles for the value n are needed to float the sphere. Therefore, the correct answer is (2) not (1).

54 A satellite S is moving with constant speed v relative to the earth (E) along a fixed circular orbit as shown in figure. The satellite is emitting radio signals of frequency f_0. A station located at P on the earth detects these radio signals. The variation of the frequency f of the detected signal as the satellite moves from A to B is best represented by





If you have done the 59th question of year 2000, then there is no difficulty in solving this question. It is a true practical application of Doppler's effect.

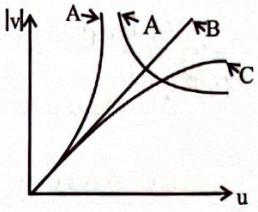


In the question cannot you see that relative to point P, at A, the satellite is coming towards P and at B, it is going away from P?

At C, the velocity is perpendicular to the CP line. Therefore, it can be clearly seen that in the journey from A to C, the detected frequency of radio waves is greater than f_o, at C it is fo and in the journey from C to B it should be less than f_o. Only (4) shows the variation from a higher value across fo and then to a lower value. So, is it hard to find the answer? Look at the review of year 2000.

The frequency change that occurs due to Doppler effect should be corrected at the hosting centre.

55 The figure shows three curves (A,B and C) of object distance (u) and corresponding magnitude of image distance (|v|) for three types of mirrors.



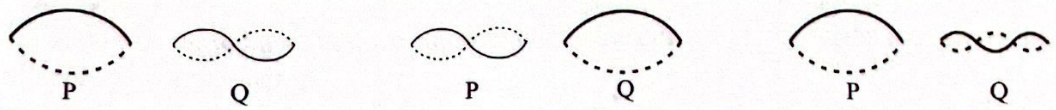
Which curve corresponds to which mirror?

	A	B	C
(1)	Convex	Plane	Concave
(2)	Concave	Plane	Convex
(3)	Plane	Concave	Convex
(4)	Plane	Convex	Concave
(5)	Convex	Concave	Plane

This is not worth for the 55th question. At a glance, you can get the answer. Any O/L student may know that B is for the plane mirror. In a plane mirror, the object distance and the image distance are same in magnitude. So, (3), (4) and (5) can be just removed.

In a concave mirror, when u = f, then v$\rightarrow\infty$. It is not so in a convex mirror. The correct answer is (2). The numerical value of v is given because in a plane mirror and a concave mirror (when u<f) v gets negative according to our sign convention.

56 Two strings P and Q are identical, and string P is under greater tension than string Q. Figures show three situations in which standing wave patterns exist on the two strings.



Which of the above situation/s could represent/s the strings vibrating at the same frequency?

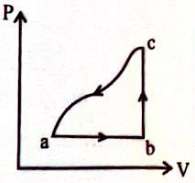
(1) only in (A) (2) only in (A) and (B) (3) only in (A) and (C)

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

Very simple. Do not write any equation. As P and Q strings are identical, their lengths are same. They are made from the same material. The cross-section is same. As the tension of P is greater, their speed of transverse waves is greater than Q. If the strings are vibrating in the same frequency, at any point the wavelength of P waves should be higher than that of Q. That means there should be more generated loops at Q compared to P ($\lambda_Q < \lambda_P$).

Instance (A) and (C) are satisfying this requirement. In (B), P has two loops and Q has one loop. This cannot happen. Only (A) and (C) are correct. If T is greater, then v gets increased. The related wavelengths for same f and less T should be shorter. If the wavelengths are shorter, then loops in a certain length are more. If you look at this, then you will get the answer instantly.

57 Figure shows a closed P-V cycle for an ideal gas. The change in internal energy along path ca is – 160 J. The heat transferred to the gas is 200 J along path ab, and 40 J along path bc. The work done by the gas along path ab is



(1) 80 Jq (2) 100 J (3) 280 J (4) 320 J (5) 400 J

A simple calculation is needed. In a cyclic process, total ΔU should be 0.

As the path of ca $(\Delta U)_3 = -160$ J, $\Delta U_1 + \Delta U_2 = 160$ where,

$\Delta U_1 = \Delta u$ over the path ab

$\Delta U_2 = \Delta u$ over the path bc

$\Delta U_3 = \Delta u$ over the path ca

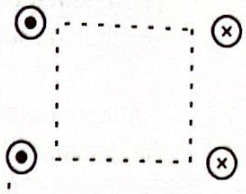
Now, apply $\Delta U_1 = \Delta Q_1 - \Delta W_1$ and $\Delta U_2 = \Delta Q_2 - \Delta W_2$.

$200 - \Delta W_1 + 40 = 160$ in the path bc, $\Delta W_2 = 0$

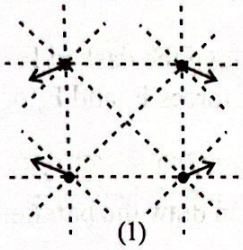
$\Delta W_1 = 80$

You are clever if you can write the above relation instantly. The heat is being absorbed in both of the occasions. Therefore, ΔQ_1 and ΔQ_2 are taking positive values.

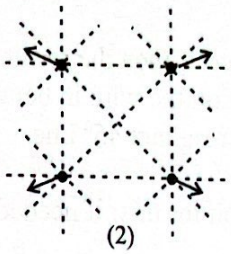
58 Four long, parallel, straight wires run normal to the plane of the paper through vertices of a square as shown in the figure. .



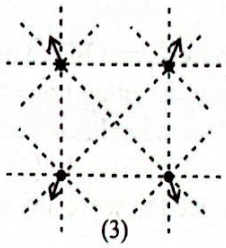
If currents of equal magnitude are set up in the wires along the directions (⊙or⊗) shown, and if the wires are free to move, the arrows in which of the following diagrams correctly represent the directions that the wires will tend to move?



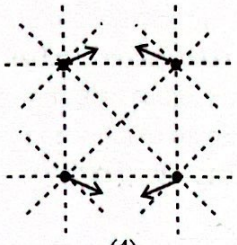
(1)



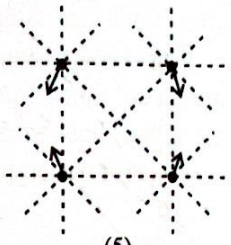
(2)



(3)



(4)

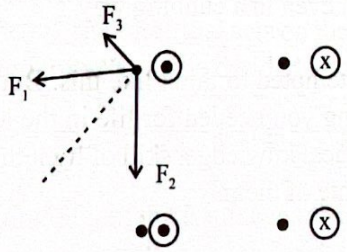


(5)

Even though it is seen difficult, if you can decide the resultant force on one wire, then you are done. Consider the wire that is on top left side. Mark the direction of the forces in the figure.

Need to know: There is an attraction form the currents for the same side and a repulsion from the currents flowing to opposite directions. Even two persons with the same mind set get attracted when they walk together for the same side.

Consider the forces that act on the top left wire.



I will use symbols for the explanation only.

F_1: The force on the wire that we consider due to the current that flows on the opposite direction of two upper wires

F_2: The force on the wire that we consider due to the current that flows on the same direction of upper and lower wires

F_3: The force on the wire that we consider due to the current that flows on the opposite direction of the wire that is on the diagonal

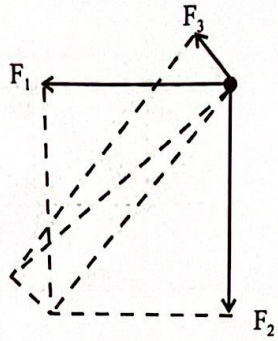
If you just mark them, then it will be enough. It is clear that F_1 and F_2 are equal in magnitude.

The resultant of these two forces is acting on the middle of these forces (bisecting them) which is marked with the dashed line. This dashed line is marked in every answer.

But there is another force on that wire (F_3) which is smaller in magnitude of F_1 and F_2. Because the distance along the length of the diagonal is greater than the distance along the length of the square. Therefore, the direction of the resultant force of F_1 and F_2 is lifted upwards (to the clockwise direction) due to F_3.

If only F_1 and F_2 are being acted, then the resultant is along the dashed line which makes 45^0. But F_3 is acting upwards not on the wire in between of forces F_1 and F_2 or downwards. So, it is more towards F_1 from the resultant 45^0 line.

No need to write any equation for this. If needed you can draw the parallelogram of forces.



Luckily, in (1)this direction is correct for the top left wire. The arrows in the paper show the direction that the wire that tends to move but not the magnitude of the resultant force. The wire tends to move to the direction of the resultant force.

You will not select (1) without considering other wires as soon as you saw the correct direction that the top left wire tends to move. It is true. But if you just look at the other choices, the direction that top left wire tends to move is not marked correctly.

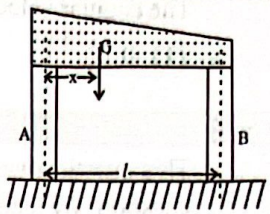
Due to that reason you do not need to consider or other wires or other answers. You can decide that the correct answer is (1) even in a cunning way.

I know that you will not be tempted to think like this. But if you catch that trick, the work is very easy. There is everything you needed for life in the MCQ paper of Physics. Knowledge of Physics, simple mathematical knwledge, skill of light thinking, cunning tricks that does not hurt anyone and luck are some of them.

All the arrows are drawn to a certain pattern in the answers and it is not random. So, if one gets correct out these pattern, then the others get wrong. Examiners are humans. They have done a good deed by giving the correct answer for (1). However, most children think these questions as compensations for bad deeds.

It is happy fact to think that you can solve the 58^{th} question by looking at one wire.

59 A and B are two iron columns with exactly the same length. A has a square cross-section of side length a, while B has a circular cross-section of diameter a. One end of both A and B are firmly fixed on horizontal ground. A non-uniform concrete beam is placed over two colomns as shown in figure. If the lower side of the concrete beam remains horizontal, the distance x to the centre of gravity of the beam from the axis of A is given by, (a<<l)



(1) $x = \frac{4l}{(\pi+4)}$ (2) $x = \frac{2l}{(\pi+1)}$ (3) $x = \frac{l}{(\pi+1)}$ (4) $x = \frac{\pi l}{(\pi+1)}$ (5) $x = \frac{\pi l}{(\pi+4)}$

There is nothing new or unknown logic in this question. You can decide directly that moments haveto be taken around G. But you do not need to use unnecessary symbols and build relations.

Both pillars are made from the same material. Their initial lengths are same. If the lower part of the beam is horizontal, both are compressed by the same amount. As the initial length is same, the strain is also same. Even Young modulus is same. So, the copressional forces on the pillars are proportional to its related cross sectional areas. These forces are felt to the corners of the beams separately as eqaul and opposite forces.

If we take moments around G,

$$a^2 x = \frac{\pi a^2}{4}(l - x)$$

Do not write any other symbol (Young modulus, intial length, compressed amount) for this eqaution. If you do so, they are being cut off. Now the answer is on your hand.

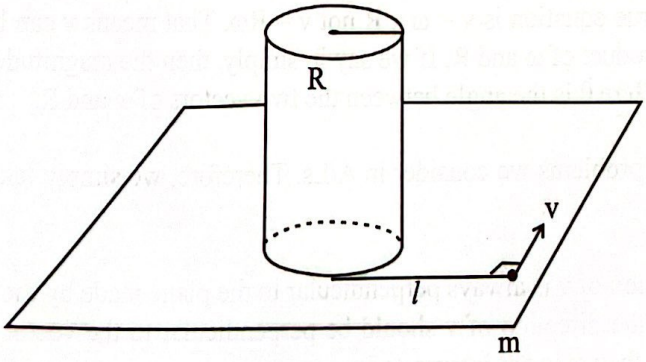
$$4x = (\pi l - \pi x)$$

$$x = \frac{\pi l}{\pi + 4}$$

You can find x from the ratios without writing the eqaution. The force that acts on the beam from pillar A is proportional to a^2. The force that acts on the beam from pillar B is proportional to $\pi a^2/_4$. So, to find x, the length of l should be divided into $\pi/4$: 1.

$$x = \frac{l}{\frac{\pi}{4}+1} \cdot \frac{\pi}{4} = \frac{4l}{\pi+4}\left(\frac{\pi}{4}\right) = \frac{\pi l}{\pi+4}$$

60 One end of a thin inelastic string of length l is attached to a small object of mass m resting on a frictionless horizontal surface and the other end is fixed to a point on the surface of a vertical cylindrical pillar of radius R, so that the string remains horizontal. A velocity v is given to the object, perpendicular to the string and along the surface as shown in the figure.

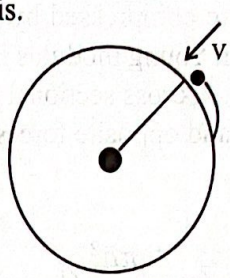


The angular velocity of the objectaround the axis of the pillar when it hits the pillar is

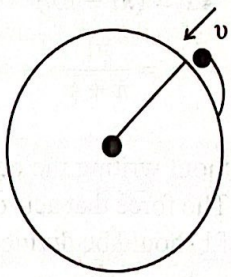
(1) 0 (2) $\frac{v}{R}$ (3) $\frac{v}{l}$ (4) $\frac{v}{\sqrt{R^2+l^2}}$ (5) $\frac{2v}{R}$

This question was asked by everybody. The answer is known by the people who solved the question. We tend to write eqaution fro this question. But to get the correct answer there is no need to write equations. Most of the time, you can be tempted to put conservation of angular momentum around the axis of the pillar. But that cannot be done. The reason for that is the tension that is acting on m is creating a torque around the axis. The conservation of angular momentum can be applied only if there is no net external torque or around an axis where such a torque is zero. If you look at the figure clearly there is a torque of T X R around the axis on the mass.

It is fair to think and apply conservation of angular momentum. That is because you cannot think of any other principle for this.



The angular velocity is being asked in the question not the velocity of the mass. When the object hits the pillar as shown, its velocity is directed perpendicularly towards the radius of the pillar. Initially T and v are perpendicular to each other. That means there is no work on the mass by T.So, the magnitude of v cannot be changed. There are no external forces that are acting on the mass.

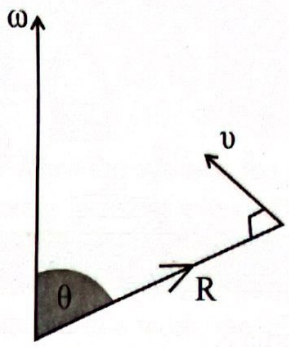


If we tie up a string attach to a mass and gradually allow to coil around our stomach area, the mass is hitting our stomach. As it hits directly, there can be a pain which can be felt. As the direction of the velocity is perpendicular to the axis, angular velocity is zero. If the velocity is directed towards a radius, then there is no rate of change of angle around the axis. So, the angular velocity is zero. Here you cannot apply $v = R\omega$. It is wrong to apply this equation and argue that, as v has a value then ω also should have a value.

Actually, the true equation is $v = \omega \times R$ not $v = R\omega$. That means v can be obtained from the vector cross product of ω and R. If we say in simply, then the magnitude of V is obtained by $v = \omega R \sin\theta$. Here θ is the angle between the two vectors of ω and R.

θ is 90^0 in the problems we consider in A/Ls. Therefore, we simply take $v = \omega R$ ($R\omega$). ($\sin 90^0 = 1$)

Here the direction of v is always perpendicular to the plane made by the two vectors of ω and R. that means the direction of v should be perpendicular to the vector R also. If v is in the direction of R, then ω is not interpreted.



The equation $v = R\omega$ is applied to find v when there is a value for ω and not to find ω to a related value of v. There is no meaning in saying that there is a related ω for every velocity. It is a meaningless expression. But if a system is rotating (then there is ω), then we can find v of a certain place relative to the system.

The universal equation of finding ω $\quad \omega = \Delta\theta/\Delta t \; (d\theta/dt)$

If $\Delta\theta = 0$, then $\omega = 0$.