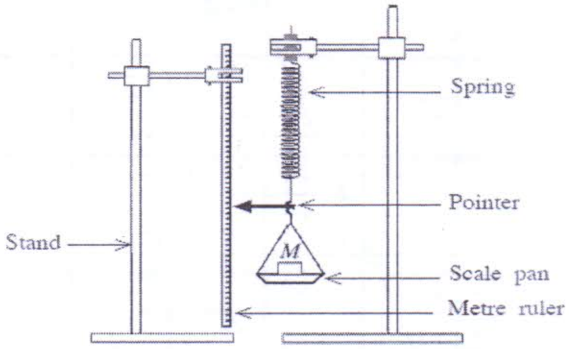
PART A – Structured Essay

*Answer **all four** questions on this paper itself.*

($g = 10\,m\,s^{-2}$)

1. You are asked to determine the spring constant (k) of a helical spring by plotting a graph of extension against load. In the experimental setup shown in the figure, one end of the spring is attached to a scale pan and the other end is firmly connected to a stand. Assume that the masses of the scale pan and the spring are negligible.



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(*a*) When a force F is applied to the spring, the length of the spring is increased by an amount x. Write down an expression for F in terms of k and x.

$F = kx$ $F = -kx$ ✓ .... **(02)** /0

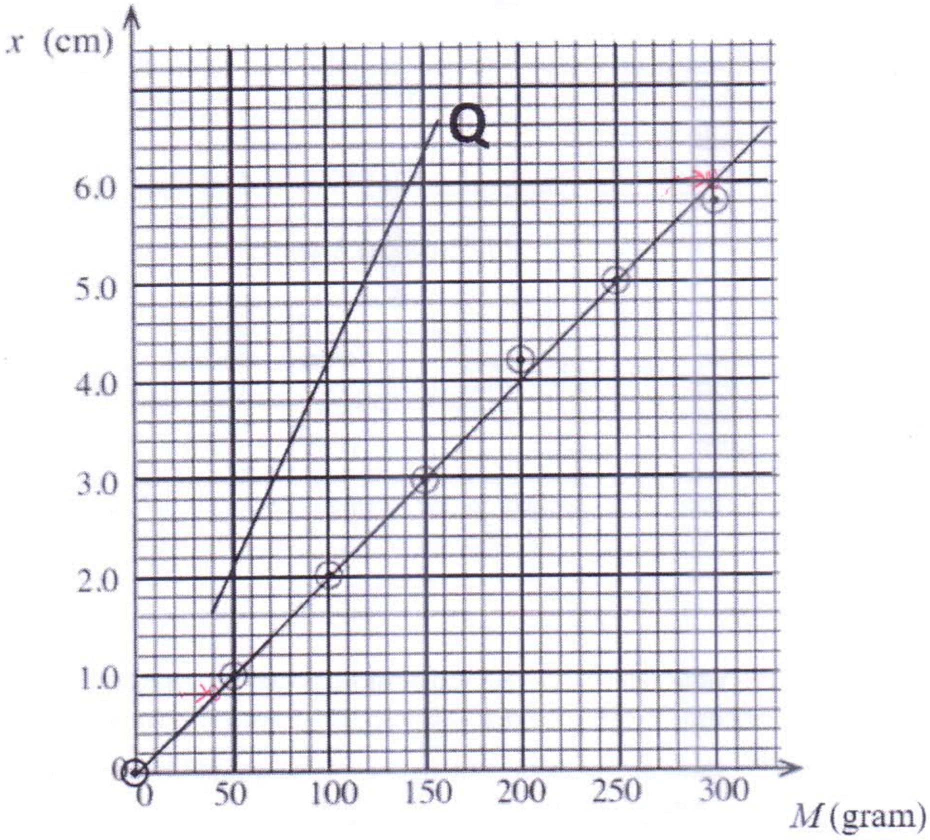
(*b*) (i) The table below gives the values of mass (M) placed on the pan and the corresponding readings of the pointer. Complete the extension column in the table.

Mass on the scale pan, M (gram)	Reading of the pointer (cm)	Extension x of the spring (cm)
0	1·0	0
50	2·0	1.0
100	3·0	2.0
150	4·0	3.0
200	5·2	4.2
250	6·0	5.0
300	6·8	5.8

All entries correct .... **(02)**

(At least three entries correct **01** mark)

(ii) Plot a graph of extension x (cm) against mass on the scale pan M (gram) on the following grid.



Selecting the proper scale for M .... **(01)**

(No other selections are accepted)

Selecting the proper scale for x .... **(01)**

(No other selections are accepted)

Marking of ***<u>at least five points</u>****correctly on the grid* .... **(02)**

[Points should be marked by dots (with or without circles) OR crosses]

(At least three points are correctly marked - **01** mark)

For drawing the straight-line graph asshown .... **(01)**

(No other lines are accepted)

(iii) Using the graph drawn above determine the value of k in SI units.

Gradient$= \frac{6.0-0.8}{300-40} = \frac{5.2}{260}$ .... **(02)**

Students can select any two points lying on the graph to determine the gradient.

$= 0.02$ cm gram^{-1} (m N^{-1})

$$Identifying\ k = \frac{1}{gradient} OR \frac{1}{0.02}$$ ………… **(01)**

$$k = 50\ N\ m\text{-}1$$ ………… **(02)**

(For correct value and the correct unit)

[Value correct, unit incorrect – **01** mark]

(*c*) Write down **two** essential experimental steps that you have to follow when taking readings.

(1) Loading of masses must be done gently*OR* reading should be noted only when the pointer comes to rest/equilibrium.

(2) Pointer should not touch the metreruler*OR* the pointer should move over the ruler OR pointershould not be far away/should be close to the metre ruler.

(3) Record the corresponding reading of the pointer while loading and unloading (and take their average)

(4) Look straight through the pointer when taking readings *OR* take readings without parallax errors.

(5) The extension of the spring should not exceed the proportional limit………. **(02)**

(Any two correct steps)

(Any one correct step – 01 mark)

(*d*) To maintain the percentage error of k within 5% what should be the maximum error (Δk) of the value of k?

$$\frac{\Delta k}{50} \times 100 = 5$$ ………… **(01)**

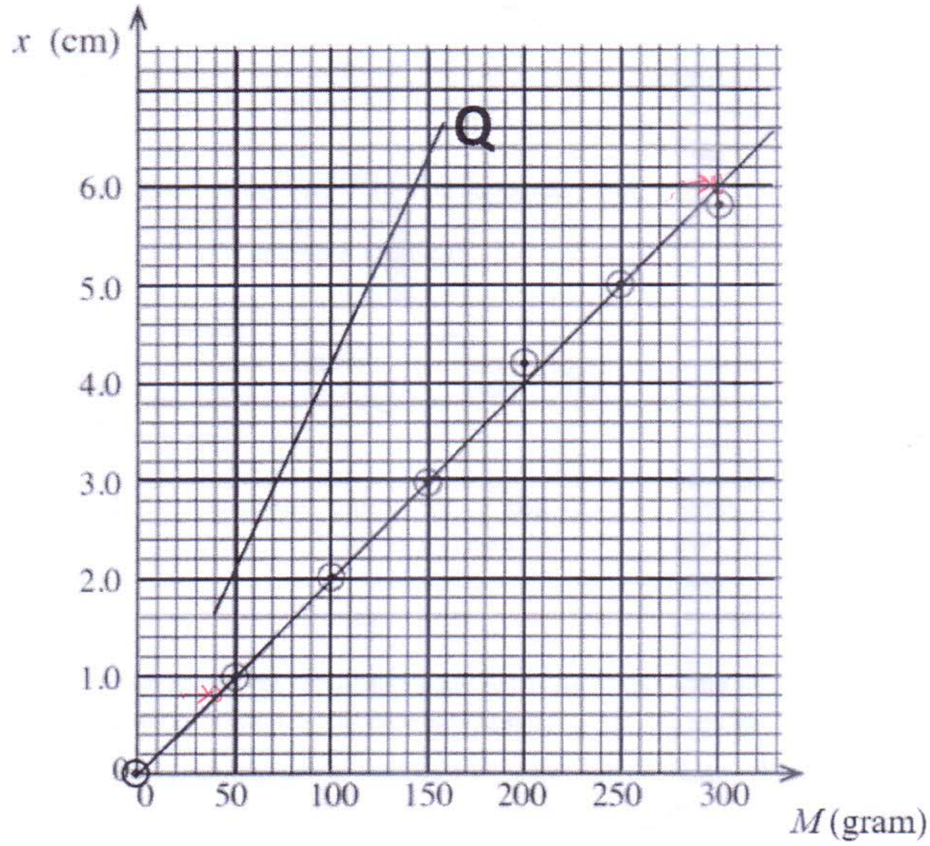
$$\Delta k = 2.5\ \text{N m}^{-1}$$ ………… **(01)**

[When awarding this mark, disregard the unit]

(*e*) Another spring of negligible mass is connected in series with the above spring and the experiment is repeated with the same masses. Draw the expected graph in this situation on the same grid in (*b*) (ii) above, and label it as Q.

(Extensions will be increased for the same mass. Therefore, the effective spring constant would be reduced.)

(ii) Plot a graph of extension x (cm) against mass on the scale pan M (gram) on the following grid.



Selecting the proper scale for M .... **(01)**

(No other selections are accepted)

Selecting the proper scale for x .... **(01)**

(No other selections are accepted)

Marking of ***at least five points*** *correctly on the grid* .... **(02)**

[Points should be marked by dots (with or without circles) OR crosses]

(At least three points are correctly marked - **01** mark)

For drawing the straight-line graph as shown .... **(01)**

(No other lines are accepted)

(iii) Using the graph drawn above determine the value of k in SI units.

Gradient $= \frac{6.0-0.8}{300-40} = \frac{5.2}{260}$ .... **(02)**

Students can select any two points lying on the graph to determine the gradient.

$= 0.02$ cm gram^{-1} (m N^{-1})

$$\textit{Identifying } k = \frac{1}{gradient} OR \frac{1}{0.02}$$ .... **(01)**

$$k = 50\ N\,m\text{-}1$$ .... **(02)**

(For correct value and the correct unit)

[Value correct, unit incorrect – **01** mark]

(*c*) Write down **two** essential experimental steps that you have to follow when taking readings.

(1) Loading of masses must be done gently*OR* reading should be noted only when the pointer comes to rest/equilibrium.

(2) Pointer should not touch the metreruler*OR* the pointer should move over the ruler OR pointershould not be far away/should be close to the metre ruler.

(3) Record the corresponding reading of the pointer while loading and unloading (and take their average)

(4) Look straight through the pointer when taking readings *OR* take readings without parallax errors.

(5) The extension of the spring should not exceed the proportional limit........... **(02)**

(Any two correct steps)

(Any one correct step – 01 mark)

(*d*) To maintain the percentage error of k within 5% what should be the maximum error (Δk) of the value of k?

$$\frac{\Delta k}{50} \times 100 = 5$$ .... **(01)**

$$\Delta k = 2.5 \text{ N m}^{-1}$$ .... **(01)**

[When awarding this mark, disregard the unit]

(*e*) Another spring of negligible mass is connected in series with the above spring and the experiment is repeated with the same masses. Draw the expected graph in this situation on the same grid in (*b*) (ii) above, and label it as Q.

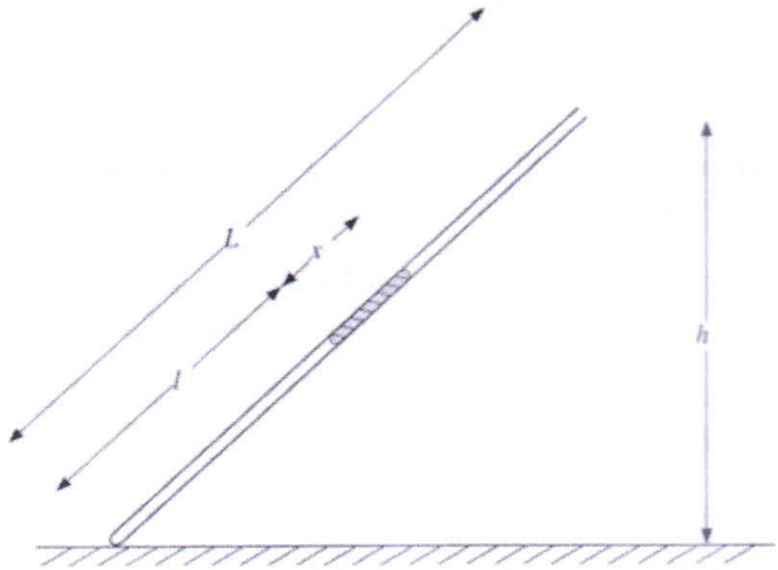
(Extensions will be increased for the same mass. Therefore, the effective spring constant would be reduced.)

Straight line with a higher gradient/above the line drawn earlier ......(01)

Line with no intercept/going through the origin (OR seem to go through theorigin) ....(01)

[Drawing a parallel line to the line drawn earlier – NO marks; Drawing a line below the line drawn earlier – NO marks]

2. You are asked to determine the atmospheric pressure using a dry air column trapped in a quill tube of length L. The figure shown is incomplete and not drawn to scale.

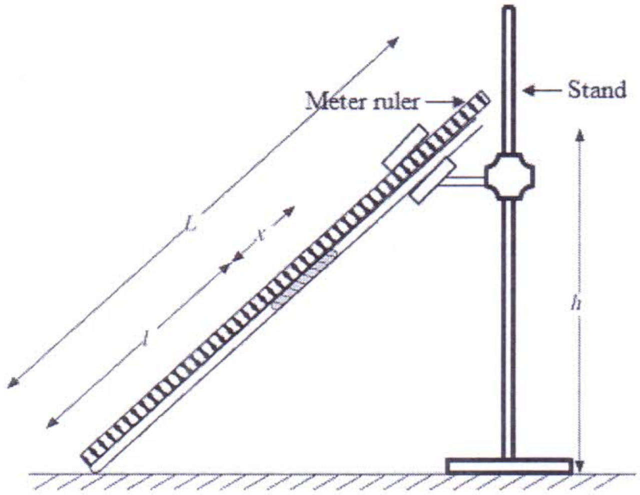


(*a*) Complete the experimental set up by drawing appropriate items and name them.

<u>Meter ruler</u> (or two rulers) and a (clamp) <u>stand.</u> .... *(02)*

[Drawing (and naming)the ruler 01 mark; Drawing (and naming)the stand 01 mark]
The ruler (or scale) must be along the quill tube and must touch the tube, (with zero mark of the ruler at the lower end of the tube).
[Award the mark for the stand even if it holds a vertical ruler, with/without supporting the tube]

Award + fixed to a vertical ruler



(*b*) What are the approximate values of length and internal diameter of the quill tube used in this experiment?

Length : ..80 - 100..cm .... **(01)**

Internal diameter : ..2 - 3......mm .... **(01)**

(*c*) What should be the approximate length of the mercury column used in this experiment? Underline the correct answer.

(1) 2 cm (2) 10 cm (3) 30 cm ..... **(01)**

[Award 01 mark for 30 cm *or*10 cm]

(*d*) The internal cross-sectional area of the tube is *A* and the atmospheric pressure is *H* (in cm Hg). Here *l*, *x* values are in cm and *A* is in cm^2.

(i) Write down an expression for the pressure (in cm Hg) of the trapped air column in terms of *H*, *h*, *x* and *L*.

$$\text{Pressure} = H + \frac{xh}{L}$$ ......**(01)**

(ii) Applying the Boyle's law to the trapped air column, write down an expression to determine *H* in terms of *h*, *x*, *L*, *l*, *A* and a constant (*k*).

$$\left(H + \frac{xh}{L}\right)Al = k$$ ......**(01)**

[Award the mark if wrong pressure in (d)(i) is substituted to the Boyle's law]

(iii) Rearrange the expression obtained in (*d*) (ii) above to determine *H* by plotting a straight line graph.

$$\frac{1}{l} = \left(\frac{Ax}{Lk}\right)h + \frac{AH}{k}$$ .... **(02)**

[Award 01 mark for rearrangement and 01 for correct expression]

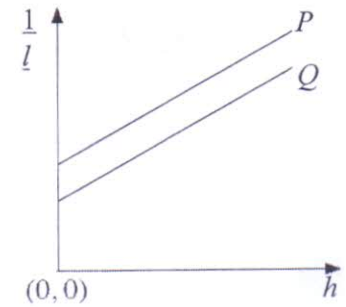
(iv) In the graph mentioned in (*d*) (iii) above identify the independent and dependent variables.

Independent variable : ....h........ .... **(01)**

Dependent variable : ....$\frac{1}{l}$........ .... **(01)**

[No marks for variables of a wrong expression]

(v) Label the axes and draw a roug h sketch of the graph expected by you label the line drawn as *P*.



Correct labelling of both axes ....**(01)**

Straight line with a positive gradient and a positive intercept ....**(02)**

[01 mark for the positive gradient; 01 mark for the positive intercept]

(vi) Write down an expression for the atmospheric pressure *H* using the informations extracted from the graph and relevant parameters.

$\text{Gradient} = \frac{Ax}{kL}$ $\qquad$ $\text{Intercept} = \frac{AH}{k}$

Atmospheric pressure $H = \left(\frac{\text{Intercept}}{\text{Gradient}}\right)\frac{x}{L}$ ....**(02)**

[Award 01 mark for identifying gradient and intercept]

(*e*) What is the best experimental procedure to vary *h* values? Underline the correct answer.

(i) From a lower value to a higher value / from a higher value to a lower value.

(01)

(ii) Give the reason. ...

(ii) Give the reason

To keep the mercury column inside the quill tube for all readings.

OR To avoid the mercury leaving the tube.

OR To change the pressure of air column from lower values to higher values

OR To change the length of air column from higher values to lower values

................**(01)**

(*f*) If the air trapped in the tube is not dry and contained saturated water vapour throughout the experiment, sketch the expected line on the above graph and label it as *Q*.

Parallel line with lower intercept ....*(02)*

[01 mark for the parallel line; 01 mark for the lower intercept]

3. In order to determine the speed (v) of transverse waves in a stretched wire using resonance, you are provided a sonometer setup as shown in figure (1). You are also provided with a set of tuning forks.

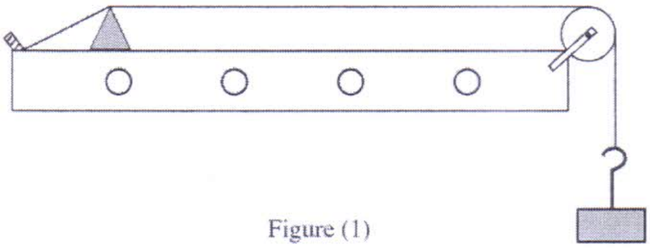


Figure (1)

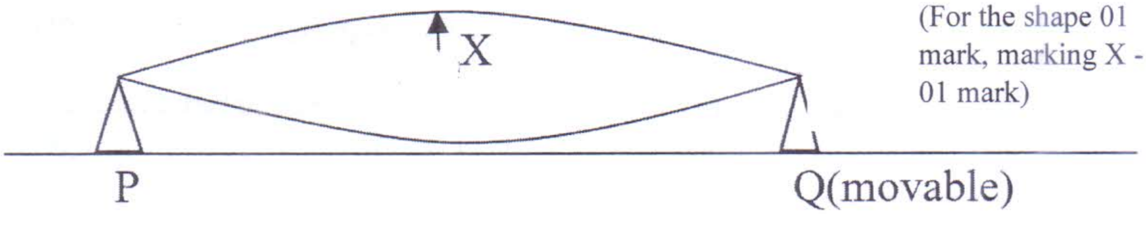
(*a*) In this experiment the fundamental mode of resonance of the wire is used. What is the reason for this?

Amplitude/Energy/Loudness of vibrating string is maximum (in fundamental resonance) ...... **(02)**

(*b*) Draw the wave pattern formed between bridges *P* and *Q* on the following figure (2) for fundamental mode of vibration of the wire. Indicate on same diagram by drawing an arrow, the best position, where the paper rider has to be placed and mark it as *X*.

..................**(02)**

(For the shape 01 mark, marking X - 01 mark)



(*c*) (i) The distance between the bridges in part (b) above is l and the frequency of the tuning fork is f. Write down an expression for the speed (v) of transverse wave in the sonometer wire in terms of l and f.

$v = f\lambda,$

$\lambda = 2l,$ ....**(01)**

$v = 2fl$ ....**(01)**

(forcorrect final expression award 02 marks)

(ii) Rearrange the expression in part (*c*) (i) above to determine the wave speed *v* by drawing a straight line graph using the set of tuning forks with known frequencies, so that dimension of the gradient to be LT^{-1}.

$l = \frac{v}{2}\frac{1}{f}$ .... **(01)**

(No marks for other forms)

(iii) State the independent and dependent variables of the graph mentioned in (*c*) (ii) above.

Independent variable: $\frac{1}{f}$ .... **(01)**

Dependent variable: l .... **(01)**

(iv) Coordinates of two points selected to determine the gradient of the above graph are (0·002, 22) and (0·004, 42), Here *l* is measured in cm and *f* is in Hz. Find the value of wave speed *v* in $m\,s^{-1}$.

Gradient $= \frac{v}{2}$ .... **(01)**

(for identifying the gradient as $\frac{v}{2}$)

$$\text{gradient} = \frac{(0.42 - 0.22)\,m}{(0.004 - 0.002)s}$$

$$\frac{v}{2} = \frac{0.2}{0.002}$$

$v = 200\,ms^{-1}$ .... **(01)**

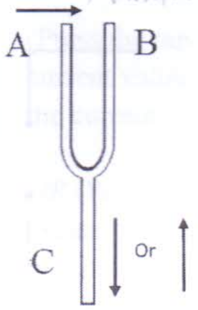
(Disregard the units)

(*d*) Considering the length of the prongs of tuning forks, which tuning fork is the best for taking the first measurement? Give reason for your answer.

Tuning fork to be used: Smallest tuning fork/Shortest prongs .... **(01)**

Reason: Highest frequency is generated by shortest prongs/highest frequency tuning fork will give the shortest resonance length of the wire .... **(01)**

(*e*) Vibrating directions of two prongs of tuning fork at a given moment is indicated by arrow heads in figure (3). Indicate the vibration direction of particles of stem (*S*) of the tuning fork at the same moment by drawing an arrow head appropriately on the same figure.



.... **(01)**

(*f*) Masses 1 kg, 2 kg and 3 kg can be used to stretch the sonometer wire. What is the most suitable mass to be used in the experiment? Give reason for your selection.

Mass to be used is3.0kg .... **(01)**

Reason; Maximum length for (fundamental) resonance mode will be obtained and percentage/fractional error of length measurement can be minimized with highest tension of the string. .... **(01)**

(*g*) If the wire is resonating with frequency *f*, write down an expression for the amplitude (*A*) of the wire in terms of *f* and *g* when the paper rider just jumps off.

$\omega^2 A_{min} = g \text{ or } 4\pi^2 f A_{min} = g$ .... **(01)**

$A_{min} = \frac{g}{4\pi^2 f}$ .... **(01)**

(*h*) Write down a possible error that could happen when determining the resonance length *l* and action that you would take to minimize it.

Error: Paper rider jumps off within a range of length on the wire *or* uncertainty of obtaining the resonance length .... **(01)**

Action: Repeat the measurements for resonance length severaltimes (and obtain the average length) by changing the distance between two bridges for the same tuning fork

.... **(01)**

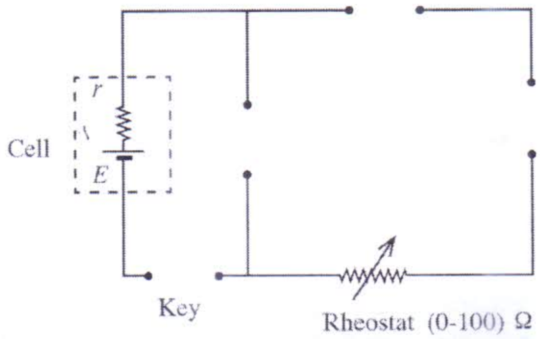
4. A student plans to perform an experiment to determine the electromotive force (e.m.f.) E and the internal resistance r of a given cell using a graphical method. An incomplete circuit diagram that can be used for the experiment is given beow. The student is provided with following items.

Milliammeter —(mA)—

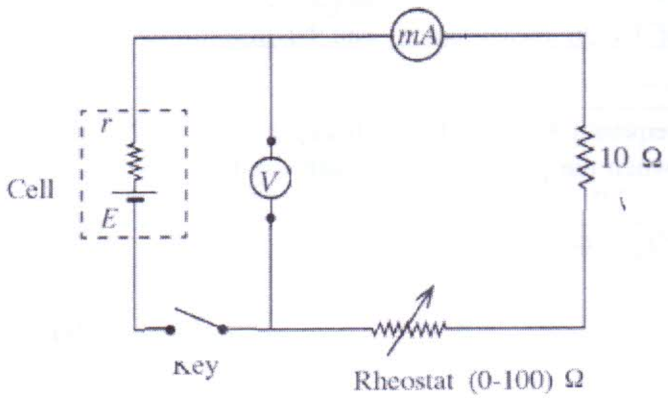
Digital voltmeter —(V)—

Standard resistor 10 Ω

Keys and



(*a*) Complete the circuit diagram correctly by drawing the appropriate symbols of the items given above.



[Accept interchange of milliammeter and 10 Ω] .... **(02)**
[01 mark for correct position of voltmeter; other mark for completing the rest of the circuit]

(*b*) (i) Name the type of the key that the student must use:

Tap key .... **(01)**

(ii) Give the reason for selecting the key.

To avoid discharge of the cell during the experiment/ to maintain constant E and r.
OR To pass current through the circuit only when readings are taken.
OR To avoid heating of resistors/cell .... **(01)**

(*c*) Write down an expression for the voltmeter reading V, using the milliammeter reading I, the e.m.f. E and the internal resistance r.

$V = -rI + E$ *OR* $V = E - Ir$ .... **(02)**

(*d*) To plot a straight line graph, the student must select appropriate six values for the independent variable. How does the student identify the approximate range of the independent variable in order to select its suitable values?

(Press the tap key.) Move the sliding key of the rheostat to one end and measure the current value. Move the sliding to other end and measure current. These two values give the current range.

OR (Press the tap key.) Move the sliding key of the rheostat to maximum resistance and measure the minimum current. Move the sliding to minimum resistance and measure the maximum current. These two values give the current range. .... **(02)**

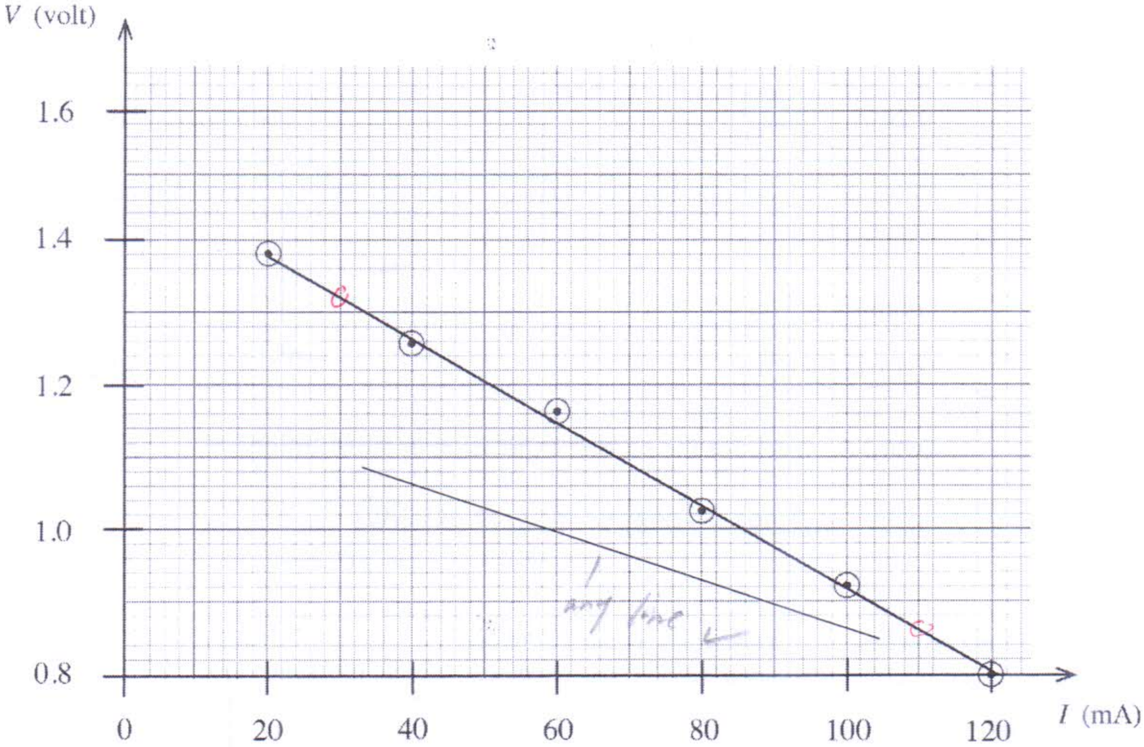
[Sliding the key to one end/Minimum current 01 mark; sliding the key to the other end/maximum current 01 mark]

(*e*) Write down the procedure that the student must follow to take readings.

<u>Press the tap key.</u> ....**(01)**

Move the sliding key of the rheostat to obtain the <u>current in the milliammeter to a selected (known)</u>value and <u>measure the voltmeter reading</u>. Repeat the procedure (for six values of current.) .... **(01)**

(*f*) In this experiment, the graph plotted by the student is given below.



(i) Calculate the gradient of the graph using two suitable points.

Selecting two suitable points (30, 1.32) and (110, 0.86) .... **(01)**

$$\text{Gradient} = \frac{(1.32-0.86)\,\text{V}}{(30-110)\times 10^{-3}\,\text{A}}$$

$= -5.75\ \Omega$ [range (-5.75 to -5.78)Ω] .... **(01)**

[Gradient with negative sign; disregard the unit]

(ii) Determine the internal resistance r of the cell.

$r = 5.75\ \Omega$[range (5.75 to5.78)Ω] .... **(01)**

[Award the mark for identifying r as the positive value of the gradient]

(iii) Determine the e.m.f. E of the cell.

$E = 1.5$ V .... **(01)**

(*g*) (i) What is the short-circuit current (in ampere) that can be obtained from the given cell? Give your answer to two decimal places.

Short-circuit current $I_{sc} = \dfrac{1.5}{5.75}$ (substitution) .... **(01)**

[Award this mark for the division]

$= 0.26$ A .... **(01)**

(ii) What is the maximum power that can be obtained from the cell by connecting an appropriate resistance?

$$\text{Maximum power} = \left(\frac{I_{sc}}{2}\right)^2 r$$

$= (0.13)^2 \times 5.75$ .... **(01)**

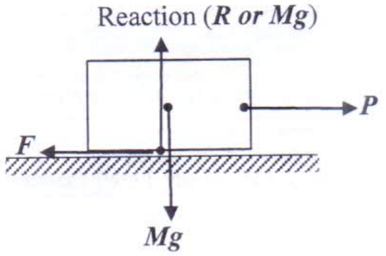
[Award the mark for the correct expression or substitution]

$= 0.097$ W (0.097 – 0.098) W [*OR*(97-98) mW] .... **(01)**

(*h*) If the same experiment is done for a nickel-cadmium (Ni-Cd) cell having a lower e.m.f. and a lower internal resistance, sketch the expected line in the same grid given in (*f*) above.

[Award 01 mark for a lower intercept, 01 mark for a lower gradient] .... **(02)**

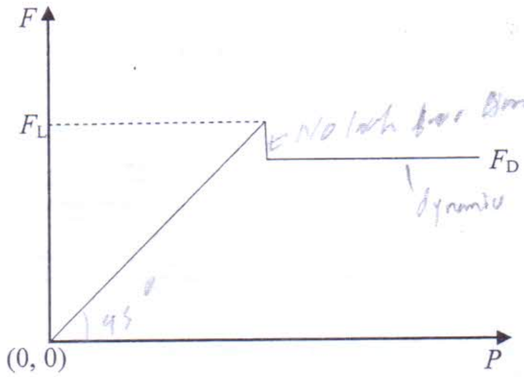
(a) (i)



Award marks for the diagram (keeping a gap between object and the surface) and correct labelling

	F and *P*	………… **(01)**
	R and *Mg*	………… **(01)**

(ii)



For the correct axes (with origin) and the shape of the curve ………… **(01)**

[Check straight inclined line, peak point and the horizontal line]

For identifying and labelling F_L and F_D ………… **(01)**

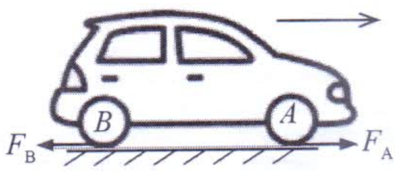
(iii)

$$\mu_L = \frac{F_L}{R}$$ ………… **(01)**

$$\mu_D = \frac{F_D}{R}$$ ………… **(01)**

[Accept word "Reaction" *OR* *N* "normal reaction" *OR* *Mg*]

(b)(i)



Drawing both forces from the bottom of the tyres and labelling F_A and F_B ………… **(01)**

$F_A > F_B$ ………… **(01)**

(ii) When limiting friction is acting the maximum driving force is exerted and therefore, $\mu_L = 0.8$ is acting in this situation .... **(01)**

(This mark can be awarded if the student has used $\mu_L = 0.8$ in the followingcalculation)

Weight on one wheel $= \frac{1200}{4} \times 10$ N .... **(01)**

Normal reaction (R) on one wheel = 3000 N

Applying $F = \mu R$

$F_L = 0.8 \times 3000$
$= 2400$ N

The driving force from two front wheels which is $2F_A$

$= 4800$ N .... **(01)**

Alternative Method:
[Award full marks if the normal force for the whole weight is calculated and divided by two for front wheels]

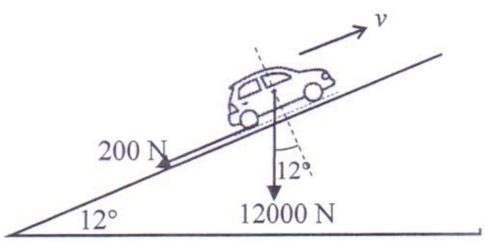
(iii) Converting velocity 72 km h^{-1} into SI unit, 20 m s^{-1} .... **(01)**

Power against frictional force is given by the equation

$P = Fv$ .... **(01)**

Using $F = 520$ N and $v = 20$ m s^{-1}
$P = 520 \times 20$
$= 10\ 400$ W (*or* 10.4 kW) .... **(01)**

(iv)



When the car is climbing at uniform velocity forces acting against the motion consist oftwo parts.

F $= 12\ 000 \sin 12° + 200$ .... **(02)**

[Award 01 mark for finding the component of weight and 01 mark for addition]

$= 12\ 000 \times 0.2 + 200$
$= 2\ 600$ N

Applying. $P = Fv$

$10\ 400 = 2600 \times v$
$v = 4$ m s^{-1} .... **(01)**

(v) I. When tyres of the car slip the coefficient of dynamic friction is acting

$\mu_D = 0.5$ .... **(01)**

(This mark can be awarded if the student has used $\mu_D = 0.5$ in the following calculation)

Since all four wheels are slipping, the normal reactions of all wheels contribute to the frictional force.

Applying $F = \mu R$

$F_1 = 0.5 \times 1200 \times 10$ .... **(01)**
$= 6000$ N

Applying $F = ma$ .... **(01)**

$\rightarrow$: $-6000 = 1200 \times a_1$
$a_1 = -5$ m s^{-2}

Applying $v^2 = u^2 + 2as$

$\rightarrow$: $0 = 20^2 - 2 \times 5 \times s_1$ .... **(01)**
$s_1 = 40$ m .... **(01)**

The car hits the obstacle .... **(01)**

Alternative Method:

Applying the law of conservation of energy

$\frac{1}{2}mv^2 = Fs$ .... **(01)**

$\frac{1}{2} \times 1200 \times 20^2 = 6000 \times s_1$

.... **(01)**

$s_1 = 40$ m .... **(01)**

The hits the obstacle. .... **(01)**

II. When ABS are acting the coefficient of friction becomes 0.75.

Applying $F = \mu R$

$F_2 = 0.75 \times 1200 \times 10$ .... **(01)**

$= 9000$ N

Applying $F = ma$

$\rightarrow$: $-9000 = 1200 \times a_2$

$a_2 = -7.5$ m s^{-2}

Applying $v^2 = u^2 + 2as$

$\rightarrow$: $0 = 20^2 - 2 \times 7.5 \times s_2$ .... **(01)**

$s_2 = 26.7$ m .... **(01)**

The car does not hit the obstacle.

<u>Alternative Method:</u>

Applying the law of conservation of energy

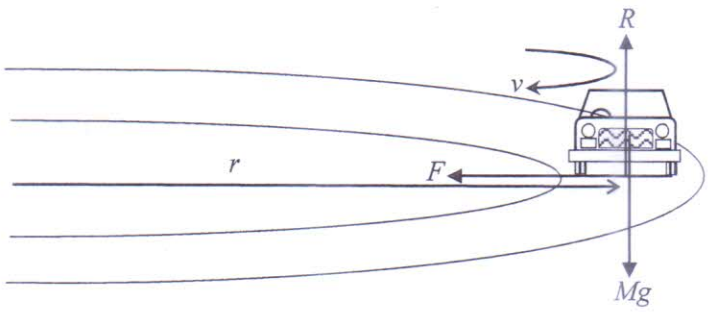
$$\frac{1}{2}mv^2 = Fs$$

$$\frac{1}{2} \times 1200 \times 20^2 = 9000 \times s_2$$ .... **(01)**

$$s_2 = 26.7\text{m}$$ .... **(01)**

The car does not hit the obstacle

(vi)



When moving without slipping $\mu_L = 0.8$ is acting .... **(01)**
(This mark can be awarded if the student has used $\mu_L = 0.8$ in the following calculation)

Also, the normal reactions of all four wheel ($mg = 12000$ N) are acting.

The frictional force (F) between tyres and the road toward the centre of the circular road must provide the centripetal force to move on the circular road (of radius r at the maximum safe speed v) without slipping.

The centripetal force $= F = \frac{mv^2}{r}$

For circular motion $\mu mg = \frac{mv^2}{r}$ ………… **(01)**

$v = \sqrt{\mu rg}$

$v = (0.8 \times 18 \times 10)^{1/2}$ ………… **(01)**

$v = 12 \text{ m s}^{-1}$ ………… **(01)**

(a) Difference in index of refraction between air and cornea is large/Refractive index of air is 1 whereas it is 1.38 for the cornea .... (01)

(b) (i) $n_C = \frac{\sin i}{\sin r}$ .... (01)

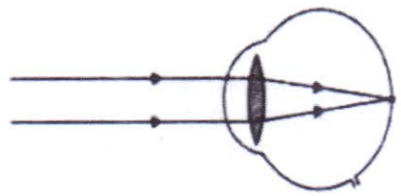
(c) (ii) Angle of deviation = $30^0 - 21^0\,14'$ .... (01)

[For the subtraction]

$= 8^0\,46'$ .... (01)

(d) (i) Maximum focal length occurs when $u = \infty$

Therefore, the maximum focal length = 2.5 cm



.... (02)

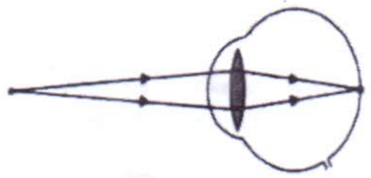
[To earn this mark two parallel rays should converge at the retina; deduct 01 mark if at least one arrow is not marked on a single ray; drawing the total boundary of the eye is not essential, but a boundary should be drawn at the point where rays meet each other]

Hence the minimum power of the compound lens = $\frac{1}{2.5} \times 100$

$= +40$ D .... (01)

(when awarding marks disregard the + sign)

Minimum focal length occurs when $u = 25$ cm.



.... (02)

[To earn this mark two diverging rays should converge at the retina; if 01 mark wasdeductedearlier due to a missing arrow, do not look at the arrows here; drawing the total boundary of the eye is not essential, but a boundary should be drawn at the point where the image is formed]

Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ for the compound lens, ... (01)

[For writing the lens formula]

$-\frac{1}{2.5} - \frac{1}{25} = \frac{1}{f}$ .... (01)

$$\frac{1}{f} = -\frac{11}{25}$$

Hence the maximum power of the compound lens $= \frac{11}{25} \times 100$

$= +44$ D .... **(01)**

(ii) Applying $\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$ (or $D = d_1 + d_2$) for the lens combination, ... **(01)**

[For writing the equation for the compound lens]

$$40 = 30 + d_2$$

Power of the eye lens = +10 D .... **(01)**

$$44 = 30 + d_2$$

Power of the eye lens = +14 D .... **(01)**

(*d*) (i) Applying $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$ for the compound lens,

$-\frac{1}{2.5} - \frac{1}{50} = \frac{1}{f}$ .... **(01)**

$$\frac{1}{f} = -\frac{21}{50}$$

Hence the power of the compound lens $= \frac{21}{50} \times 100$

$= +42$ D .... **(01)**

(ii) Power of the eye lens = 42 – 30

= +12 D .... **(01)**

(iii) The power of the reshaped cornea = 44 – 12

= +32 D .... **(01)**

(iv) $\frac{1}{50} - \frac{1}{25} = \frac{1}{f}$

$$\frac{1}{f} = -\frac{1}{50}$$

Hence the power of the eye-glass $= \frac{1}{50} \times 100$

$= +2$ D .... **(01)**

Type – Convex/converging .... **(01)**

(*e*)It is absorbed in a very thin layer of tissue, decomposing that tissue into a vapor(of small molecules, which fly away from the surface so fast) leaving too little energy behind to damage the adjacent tissue./It will not damage the adjacent tissue .... **(01)**

(*f*)If the thickness of the tissue removed from the corneal surface is d,

Mass of the removed corneal tissue $= \frac{22}{7} \times (0.5 \times 10^{-3})^2 \times d \times 10^3$ .... **(01)**

Heat absorbed form 30 ^{0}C to 100 ^{0}C $= \frac{22}{7} \times (0.5 \times 10^{-3})^2 \times d \times 10^3[4 \times 10^3 \times 70]$ .... **(01)**

[for the $mc\Delta\theta$ term]

Heat absorbed to vaporize the tissue $= \frac{22}{7} \times (0.5 \times 10^{-3})^2 \times d \times 10^3 \times 2.52 \times 10^6$ .... **(01)**

[for the mL term]

$0.55 \times 10^{-3} = \frac{22}{7} \times (0.5 \times 10^{-3})^2 \times d \times 10^3[4 \times 10^3 \times 70 + 2.52 \times 10^6]$ .... **(01)**

[For equating L.H.S. to R.H.S.]

$d = 2.5 \times 10^{-7}$m (0.25 μm) .... **(01)**

(*g*) (i) Peak power $= \frac{20 \times 10^{-3}}{10^{-14}}$

$= 2 \times 10^{12}$ W .... **(01)**

(ii) Average power $= 20 \times 10^{-3} \times 500$

$=$ 10 W .... **(01)**

(*h*) Production of microelectronic devices/production of integrated circuits............ **(01)**

(Any one of the above uses)

(a)(i) A – Proportional limi .... **(01)**

B – Elastic limit .... **(01)**

C - Yield point .... **(01)**

D – Breaking point .... **(01)**

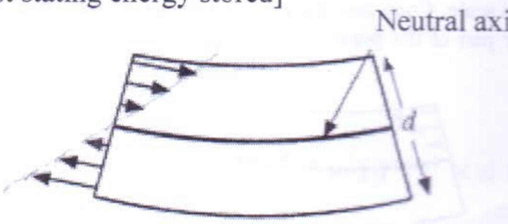
(ii) The wire will not return to its initial (original) length/ the final length will be longer than the initial (original) length/ a permanent extension will occur in the wire/apermanentdeformation occur in the wire ....(02)

~~(02)~~

(iii) Energy stored <u>per unit volume</u> .... **(02)**

[No marks for just stating energy stored]

(b)



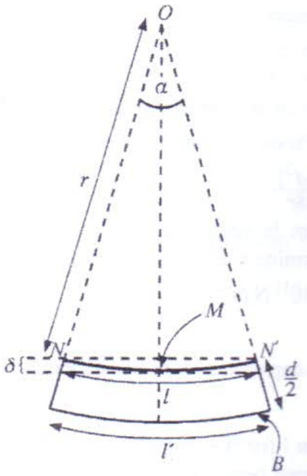
Arrows (at least two) pointing towards left at the left end *OR* right at the right end (tensile forces) .... **(01)**

[Arrows could be drawn inside the beam]

Length of the arrows gradually increasing from neutral axis to the bottom

.... **(01)**

Arrow heads linearly increasing as shown .... **(01)**



(c) (i) $l = r\alpha$ .... **(01)**

(ii) $l' = (r + \frac{d}{2})\alpha$ .... **(01)**

(iii) Extension of the bottom layer $= l' - l$ .... **(01)**

[For the subtraction]

$$= \frac{d}{2}\alpha$$

Average extension of the lower section of the beam $= \frac{l'-l}{2}$ ………… **(01)**

[For dividing the extension by 2]

$$= \frac{d}{4}\alpha$$

∴ the average strain of the lower part of the beam $= \frac{d}{4}\frac{\alpha}{l}$ ← original length ………… **(01)**

[For dividing extension by upstretched length l]

$$= \frac{d}{4}\frac{\alpha}{r\alpha} = \frac{d}{4r}$$

(*d*) (i) The force acting along the neutral axis (NN') = 0 ………… **(01)**

(ii) The force acting along the bottom layer (B) of the lower section of the beam = $2F$ 2F ≠ 0

………… **(01)**

(iii) Tensile stress $= \frac{F}{w\frac{d}{2}}$ ………… **(01)**

$$Y = \frac{2F}{wd} \times \frac{4r}{d}$$ ………… **(01)**

[For equating Young's modulus to Tensile stress/Tensile strain]

$$\therefore F = \frac{wd^2Y}{8r}$$

(iv) $Y = \frac{\text{Tensile stress}}{\text{Tensile strain}}$

$$\frac{d}{4r} = \frac{1.0 \times 10^8}{2.0 \times 10^{11}}$$

$r = \frac{d \times 2.0 \times 10^{11}}{4 \times 1.0 \times 10^8} = \frac{20 \times 10^{-2} \times 2.0 \times 10^{11}}{4 \times 1.0 \times 10^8}$ ………… **(01)**

[For the correct substitution]

$r = 100$ m ………… **(02)**

(v) $\alpha = \frac{l}{r} = \frac{5}{100}$

$\alpha = 0.05$rad ………… **(01)**

(vi) Depression $= r\left[1 - \cos\left(\frac{\alpha}{2}\right)\right]$ ………… **(02)**

$= 100(1 - 0.9997) = 100 \times 0.0003$

$= 0.03$ m (3.0 cm) .... **(01)**

(e) The maximum compression occurs at the top layers of the upper section of the beam .... **(01)**

Similarly, the maximum elongation occurs at the bottom layers of the lower section of the beam .... **(01)**

Therefore, the best advantage of an I-beam is that the material is present where it should be and inright quantities.

This makes the beam more economical/less expensive/lighter/less mass/less weight .... **(01)**

(a). (i). Initial voltage = 0

After charging, voltage difference between two plates = V

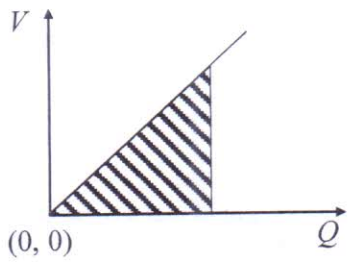
Average voltage used to store charge Q, $=\frac{0+V}{2}$ .... **(01)**

Energy stored in the Capacitor, $W = \frac{V}{2}Q = \frac{V}{2} \times CV$

Therefore, energy stored in the capacitor, $W = \frac{1}{2}CV^2$ .... **(01)**

(No marks, if $W = \frac{1}{2}CV^2$ is written directly)

<u>Alternative method</u>



From the graph, energy stored in the capacitor, W = area under the curve $OR \frac{1}{2}VQ$ .... **(01)**

Energy stored in the Capacitor, W = Area under the curve

Energy stored in the Capacitor, $W = \frac{1}{2}VQ = \frac{1}{2}V \times CV$

$W = \frac{1}{2}CV^2$ .... **(01)**

(ii) Energy stored in a capacitor $W = \frac{1}{2}CV^2$

$48 = \frac{1}{2}C \times (400)^2$ .... **(01)**

(award for substitution)

Capacitance of the capacitor in the device $C = 600 \times 10^{-6}$F (600 μF)............ **(01)**

(iii) By applying $Q = CV$

Total charge in the capacitor $Q = 600 \times 10^{-6} \times 400$ .... **(01)**

(award for substitution)

$Q = 0.24$ C .... **(01)**

(iv) By applying $Q = It$

$0.24 = I \times 12 \times 10^{-3}$ .... **(01)**

(Award for substitution)

Constant current pass through the body within 12 ms time period,

$$I = 20 \text{ A}$$ ………… **(01)**

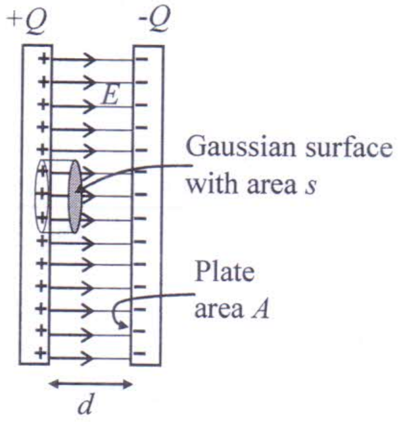
(v) By applying $V = IR$

$$400 = 20R$$ ………… **(01)**

(award for substitution)

Effective resistance of the path mentioned, $R = 20\ \Omega$ ………… **(01)**

(b) (i) Consider a Gaussian surface shown in the figure.



For the Figure (for selecting a proper Gaussian surface, with indicating electric field lines) ………… **(01)**

$$\text{Charge density } \sigma = \frac{Q}{A}$$

If the flux due to charge Q and electric field Eisϕ, from Gauss's law,

$$\emptyset = \frac{\sigma s}{\varepsilon} = Es$$ ………… **(01)**

$$\varepsilon = k\epsilon_0$$

$$E = \frac{Q}{Ak\epsilon_0}$$ ………… **(01)**

(ii) $E = \frac{Q}{Ak\epsilon_0}$

$$E = \frac{0.24}{80\times10^{-4}\times5000\times9\times10^{-12}} = \frac{2}{3\times10^{-9}}$$ ………… **(01)**

(award for substitution)

Electric field intensity in the medium, $E = 6.67 \times 10^{8}\text{Vm}^{-1}$ ………… **(01)**

(iii) $E = \frac{V}{d}$

Separation between the plates, $d = \frac{V}{E}$

$d = \frac{400\times 3\text{x}\ 10^{-9}}{2}$ .... (01)

(award for substitution)

$d = 6.0 \times 10^{-7}\text{m}$ .... (01)

OR

$d = \frac{400}{6.67\times10^{8}}$ .... (01)

$d = 5.9 \times 10^{-7}\text{m}$ .... (01)

Alternative method

$$d = \frac{Ak\epsilon_0}{C}$$

$d = \frac{80\times10^{-4}\times5000\times9\ \text{x}\ 10^{-12}}{600\times10^{-6}}$ .... (01)

$d = 6.0 \times 10^{-7}\text{m}$ .... (01)

(c) (i) Energy of one capacitor 48 J

Therefore, total energy of five series capacitors, $W_s = 5 \times 48$ .... (01)

$W_s = 240\ \text{J}$ .... (01)

(Award 02 marks if final answer is given)

Alternative method

If the equivalent capacitance is C,

$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \cdots$

In (a)(iv) (ii) Capacitance = 600 μF

$\frac{1}{C} = \frac{5}{600}$ or $C = 120\ \mu\text{F}$ .... (01)

Equivelent Capacitance $C = 120\ \mu\text{F}$

Voltage drop between the equivalence capacitance = 400 V × 5 = 2000 V

Total energy of five series capacitors, $W_s = \frac{1}{2} \times 120 \times 10^{-6} \times (2000)^2$

$W_s = 240\ \text{J}$ .... (01)

(ii) Energy of one capacitor 48 J

Therefore, total energy of five parallel capacitors, $W_p = 5 \times 48$ .... (01)

$W_p = 240\ \text{J}$ .... (01)

(Award 02 marks if final answer is given)

Alternative method

If the equivalent capacitance is C,

Equivalent capacitance $C = C_1 + C_2 + \cdots$

In (a)(iv) Capacitance = 600 μF

$C = (600 + 600 + 600 + 600 + 600)\mu F = 3000\ \mu F$ .... **(01)**

Voltage drop 400 V

$W_p = \frac{1}{2} \times 3000 \times 10^{-6} \times (400)^2$

$W_p = 240\ J$ .... **(01)**

(iii) Since the voltage across the electrodes is high the intensity of current pulse is greater/it can provide a large electric shock .... **(02)**

(d)(i) Very high electric field/high charge density/high voltage, shape of the conductor (sharp point, thin wire etc.)/ Radius of curvature .... **(01)**

Medium (fluid /moisture/ air) .... **(01)**

(ii) The electric field strength of the capacitor (medium) $E = 6.67 \times 10^8\ V\ m^{-1}$

The breakdown electric field strength in the medium $= 8.0 \times 10^8\ V\ m^{-1}$

The breakdown electric field strength in the medium is greater than the electric field strength of the capacitor .... **(01)**

Therefore capacitor will not get damaged .... **(01)**

(e) Initial energy $W_1 = \frac{1}{2} V_0 Q_0$

Energy after 12ms $W_2 = \frac{1}{2} \times 0.37V_0 \times 0.37Q_0$

$W_1 - W_2 = \frac{1}{2} \times V_0 \times Q_0 - \frac{1}{2} \times 0.37V_0 \times 0.37Q_0$ .... **(01)**

$W_1 - W_2 = \frac{1}{2} \times V_0 \times Q_0(1 - 0.37 \times 0.37)$

Percentage of energy released by the capacitor during the first 12.0 ms

$= \frac{\frac{1}{2}V_0Q_0(1-0.37\times0.37)}{\frac{1}{2}V_0Q_0} \times 100$ .... **(01)**

= 86 % .... **(01)**

(a)

i. $E = I^2Rt$ .... **(02)**

ii. $V_{rms} = \frac{V_p}{\sqrt{2}}$ .... **(02)**

iii. D .... **(01)**

C .... **(01)**

iv. Ability to change(increase/decrease) voltage using transformers/To reduce power loss (by decreasing current) .... **(01)**

v. $E = I_{rms}^2 Rt or E = \frac{{V_p}^2 t}{2R} or E = \frac{{V_{r.m.s}}^2 t}{R}$ .... **(01)**

(b)

i. Total power consumption = $L_1 + L_2 + L_3$ =1200 +300 +800 = 2300 W

Applying $P = VI,$

$I = \frac{2300}{230}$ .... **(01)**

(mark awarded for dividing by 230 V)

$= 10$ A .... **(01)**

(If the student assumes peak current as the maximum current, then the answer shouldbe$10\sqrt{2}$ A or 14.12 A)

ii. Joule heat $\Delta Q = I^2Rt$

Resistance of the wire, $R = \frac{\rho l}{A}$ .... **(01)**

$= \frac{(1.8 \times 10^{-8} \times 10\ )}{1 \times 10^{-6}}$ .... **(01)**

(For the substitution)

$\Delta Q = \frac{10^2 \times (1.8 \times 10^{-8} \times 10\ ) \times 10}{1 \times 10^{-6}}$ .... **(01)**

(For the substitution)

$= 1.8 \times 10^2$J

$\Delta Q = mc\Delta\theta$

$100 \times 10^{-3} \times 360\ \Delta\theta = 1.8 \times 10^2$ .... **(02)**

(01 mark for LHS and 01 for equating)

$\Delta\theta = \frac{180}{100 \times 360} \times 10^3 = 5\ ^0$C .... **(01)**

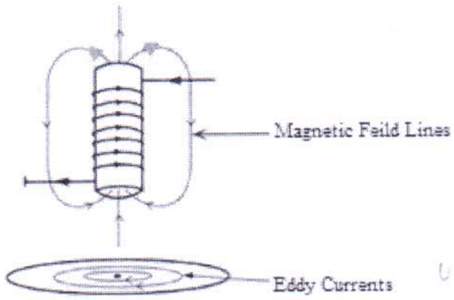
(for$I$=$10\sqrt{2}$the answer is 10 ^{0}C)

iii. Current flowing is divided among wires and less current through each wire or the effective resistance reduces .... **(02)**

(c) (i) Magnetic field lines and correct directions .... **(02)**

(01 mark for drawing the lines; 01 mark for the direction)

Eddy current lines and correct directions .... **(02)**



(01 mark for drawing the lines; 01 mark for the direction)

(ii) Eddy currents generated on the disc create a magnetic force which acts against the motion .... **(02)**

(d)

i. Revolutions per minute at 8.30 pm is 4

1 kWh is equivalent to $1 \times 1000 \times 60$ W min .... **(01)**

$$\therefore 4 \text{ rpm is equivalent to} \frac{1 \times 1000 \times 60}{500} \times 4$$

Electric power consumption $= 480$ W .... **(01)**

ii.

$$7.00 \text{ to } 8.00 \text{ hrs. total turns} = 2 \times 60$$
$$8.00 \text{ to } 9.00 \text{ hrs. total turns} = 4 \times 60$$

$\therefore$ total turns during 7.00 to 9.00 $= 6 \times 60 = 360$ .... **(01)**

Energy consumption or units consumed $= \frac{360}{500}$ kW h .... **(01)**

$$\text{Total cost} = \frac{360}{500} \times 40.00 = \text{Rs. } 28.80$$
$$6.00 \text{ to } 7.00 \text{ hrs. total turns} = 1 \times 60$$
$$9.00 \text{ to } 10.00 \text{ hrs. total turns} = 2 \times 60$$

$\therefore$ total turns during off peak hours $= 3 \times 60 = 180$ .... **(01)**

$$\text{Total cost for off peak hours} = \frac{180}{500} \times 10.00 = \text{Rs. } 3.60$$

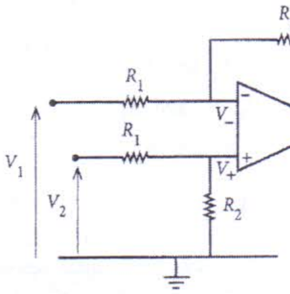
$$\text{Total cost for the period 6.00 pm to 10.00 pm} = 28.80 + 3.60 = \text{Rs. } 32.40$$ .... **(01)**

(*a*) (1) The input resistance of the noninverting and inverting (+/−) inputs is infinite. *OR* No current flows into the noninverting and inverting (+/−) inputs of the op amp. / *OR* $I_+ = I_- = 0$ .... **(02)**

(2) (In a circuit with negative feedback,) the output of the op amp will try to adjust its output so that the voltage difference between the noninverting and inverting (+ and −) inputs is zero

OR $V_+ = V_-$ *OR* $V_+ - V_- = 0$ .... **(02)**

(*b*)



(i) $V_+ = \frac{R_2}{R_1+R_2} V_2$ .... **(02)**

(ii) $V_- = \frac{R_2}{R_1+R_2} V_2$ .... **(02)**

(iii) $\frac{V_1 - V_-}{R_1} = \frac{V_- - V_0}{R_2}$ .... **(02)**

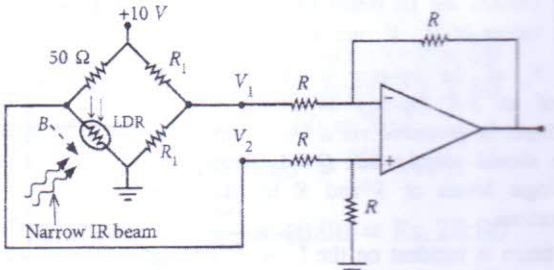
$$V_0 = R_2\left[V_-\left(\frac{1}{R_1}+\frac{1}{R_2}\right) - \frac{V_1}{R_1}\right] \Rightarrow R_2\left[V_-\left(\frac{R_1+R_2}{R_1R_2}\right) - \frac{V_1}{R_1}\right]$$

After substituting for V_-,

$V_0 = \frac{R_2}{R_1}(V_2 - V_1)$ .... **(02)**

(iv) $V_0 = (V_2 - V_1)$ .... **(02)**

(*c*)



(i) $V_1 = 5$ V .... **(01)**

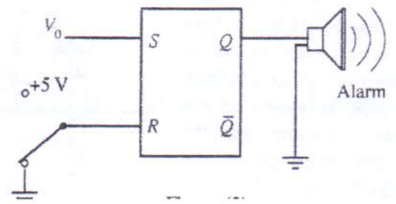
$V_2 = 5$ V .... **(01)**

$V_o = 0$ .... **(01)**

(ii) $V_1 = 5$ V .... **(01)**

$V_2 = 10$ V .... **(01)**

$V_o = 5$ V .... **(01)**



(*d*) (i) (1) $S = 0; R = 0$ .... **(01)**

(2) $S = 1$; R = 0 .... **(01)**

(ii)

S	R	Q
0	0	Previous State/No change/Q_{old}
0	1	0 (Reset)
1	0	1 (Set)
1	1	Forbidden/Not valid/? /-/Not defined/Impossible

.... **(02)**

[To earn 02 marks all entries should be correct]

(iii) When the burglar crosses the beam $Q = 1$ since $S = 1$ and $R = 0$ (set state)

.... **(01)**

(iv) When the burglar leaves/ when $S = 0$ and $R = 0$ the flip-flop will remember the set state [previous state/$Q = 1$ state/earlier state] .... **(01)**

Therefore, the alarm will ring continuously. .... **(01)**

(v) The two-way key should be connected to +5 V/*OR* to the other location.

.... **(01)**

Then the logic level at R is 1/ *OR* at 5 V/*OR* reset state/*OR* $S = 0$, $R = 1$

.... **(01)**

So the alarm will stop sounding since $Q = 0$. .... **(01)**

(a) (i) $\Delta Q = mc\Delta\theta$ .... **(02)**

(ii) Mass of super-heated water $= V\rho$
$= 1.0\times10^8\times900$ .... **(01)**
$= 9.0\times10^{10}$ kg

Amount of heat released by super-heated water $= mc\Delta\theta$

$= 9.0\times10^{10} \times 4500 \times (200\text{-}100)$ .... **(02)**

01 mark

(One mark for taking temperature difference and one mark for rest of the equation)

$= 9.0\times10^{10} \times 4500 \times 100$
$= 4.05 \times 10^{16}$ J .... **(01)**

(iii) Heat used to vaporization of water $m_1L = 4.05 \times 10^{16}$ J
$m_1 \times 2.5\times10^6 = 4.05 \times 10^{16}$ .... **(02)**

01 M 01 M

[one mark for the mL term and the other mark for equating mL to the answer obtained in a(ii)]

Mass of steam that can be produced using the energy released from superheated water
$m_1 = 1.62 \times10^{10}$ kg .... **(01)**

(b) Rate of heat transfer $\frac{Q}{t} = kA\frac{\Delta\theta}{\Delta l}$ .... **(02)**

Suppose, the temperature of the boundary between two pipes is θ
Rate of heat transfer in radial direction of the metal pipe through a unit length

$$\frac{Q}{t} = k_1 2\pi \frac{(r_1+r_2)}{2}\frac{(\theta_1-\theta)}{(r_2-r_1)}$$ .... **(01)**

$$(\theta_1 - \theta) = \left(\frac{Q}{t}\right)\frac{1}{\pi k_1}\frac{(r_2 - r_1)}{(r_2 + r_1)}$$

Rate of heat pass in radial direction of the insulating pipe through a unit length

$$\frac{Q}{t} = k_2 2\pi \frac{(r_2+r_3)}{2}\frac{(\theta-\theta_2)}{(r_3-r_2)}$$ .... **(01)**

$$(\theta - \theta_2) = \left(\frac{Q}{t}\right)\frac{1}{\pi k_2}\frac{(r_3 - r_2)}{(r_3 + r_2)}$$

Hence,

$$(\theta_1 - \theta_2) = \left(\frac{Q}{t}\right)\frac{1}{\pi k_1}\frac{(r_2-r_1)}{(r_2+r_1)} + \left(\frac{Q}{t}\right)\frac{1}{\pi k_2}\frac{(r_3-r_2)}{(r_3+r_2)}$$ .... **(01)**

$$\frac{Q}{t} = \frac{\theta_1 - \theta_2}{\frac{(r_2-r_1)}{k_1\pi(r_2+r_1)} + \frac{(r_3-r_2))}{k_2\pi(r_3+r_2)}}$$

(C)(i) $$\frac{Q}{t} = \frac{\theta_1-\theta_2}{\frac{(r_2-r_1)}{k_1\pi(r_2+r_1)}+\frac{(r_3-r_2))}{k_2\pi(r_3+r_2)}}$$

$$\frac{Q}{t} = \frac{100-30}{\frac{4\times10^{-2}}{100\times\pi\times(48+52)\times10^{-2}}+\frac{6\times10^{-2}}{0.2\times\pi\times(52+58)\times10^{-2}}}$$ .... **(03)**

(one for each term)

$$\frac{Q}{t} = \frac{70}{\frac{4\times10^{-2}}{100\times3\times(48+52)\times10^{-2}}+\frac{6\times10^{-2}}{2/11\times3\times(52+58)\times10^{-2}}}$$

$$\frac{Q}{t} = \frac{70}{\frac{4}{100\times3\times100}+\frac{6\times11}{2\times3\times110}}$$

$$\frac{Q}{t} = \frac{70}{\frac{4\times10^{-4}}{3}+10^{-1}}$$

Rate of heat pass in radial direction of the insulating pipe through a unit length

$\frac{Q}{t} = 700 \text{ W m}^{-1}$ .... **(02)**

(Disregard the units)

(ii) Rate of heat loss through the pipe $BC = 700 \times 500$ .... **(01)**

$= 3.5 \times 10^5$ W .... **(01)**

(iii) Rate of heat loss through the pipe $AB = \frac{700}{2} \times 2000$ .... **(01)**

$= 7.0 \times 10^5$

Rate of heat loss through the pipe AC = $3.5 \times 10^5 + 7.0 \times 10^5$ .... **(01)**

(For addition)

Total heat loss through the pipe= 10.5×10^5 W .... **(01)**

(iv) $$\frac{\text{output mechanical power generated by the turbine}}{\text{input power given by the steam}} = 40\%$$

$$\frac{8.58\times10^{6}}{\text{input power given by the steam}} = \frac{40}{100}$$ .... **(01)**

Input power given by the steam= 2.145×10^7 W .... **(01)**

Input power given by the steam= 2.145×10^7 W .... **(01)**

(v) Total heat loss through the pipe $= 10.5 \times 10^5$ W

Steam power enter to the turbine $= 2.145\text{x}10^7$ W

Generated power from the well $= 2145 \text{ x}10^4 + 105 \times 10^4$

.... **(01)**

(for addition)

Generated power of the well = 2250×10^4W

Total amount of heat released by water = 4.05×10^{16} J

Time period = $\frac{4.05 \times 10^{16}}{2250 \times 10^4 \times 3.0 \times 10^7}$ years .... **(02)**

(One mark for dividing by 3.0×10^7 and the other mark for the rest of the division)

Time period =60years .... **(01)**

(a)

I. Ultraviolet (UV) .... **(02)**

II. $E = \frac{hc}{\lambda}$ .... **(01)**

$E = \frac{1240}{100}$

$E = 12.4$ eV .... **(01)**

III. $\lambda = \frac{h}{P}$ .... **(01)**

$P = \frac{6.6\times10^{-34}}{100\times10^{-9}}$ .... **(01)**

$P = 6.6 \times 10^{-27}$ kg m s^{-1}. .... (02)

~~**(02)**~~

(Two marks for the correct answer with correct unit, Only one mark for correct answer, no mark for only the unit)

(b) I. Intensity (I) $= \frac{\text{Total Energy}}{A\times t}$ .... **(01)**

$I = \frac{nE}{At}$ .... **(01)**

(Award 02 marks for the correct equation without writing the above first step)

II. Energy of photons in the area of 1 m^2 in unit time= 9.92×10^{-8}J

Energy of photons in the area of 3mm × 4mm in unit time

$= 9.92 \times 10^{-8} \times 3 \times 4 \times 10^{-6}$ .... **(01)**

$= 119.04 \times 10^{-14}$ J

Energy of 100 nm photon in eV = 12.4 eV

Energy of 100 nm photon in J = $12.4 \times 1.6 \times 10^{-19}$J

Number of photons (n) $= \frac{119.04 \times 10^{-14}}{12.4 \times 1.6 \times 10^{-19}}$ .... **(01)**

(mark for dividing by the energy of a single photon in J)

$n = 6.0 \times 10^5$ .... **(01)**

III. Number of photons in the area of 3mm ×4mm = 6.0×10^5

Number of incident photons on the silver sample

$= \frac{6.0 \times 10^5}{3 \times 4} \times 2 \times 2$ .... **(01)**

$= 2 \times 10^5$

Number of photoelectrons $= 2 \times 10^5$ .... **(01)**

(c) I. Minimum value of kinetic energy $= 0$ .... **(01)**

Maximum value of kinetic energy

$K_{max} = \frac{hc}{\lambda} - \phi = 12.4 - 4.$ .... **(01)**

$= 8.4$ eV .... **(01)**

II. A = 1240 / 4.0 $0 = \frac{hc}{\lambda} - \phi$ $\lambda_0 = \frac{hc}{\phi}$

= 310 nm .... **(01)**

B = 8.4 eV .... **(01)**

III. Wavelength of photon when kinetic energy of photoelectron is zero

= 1240/5.0 $\frac{hc}{\phi}$

= 248 nm .... **(01)**

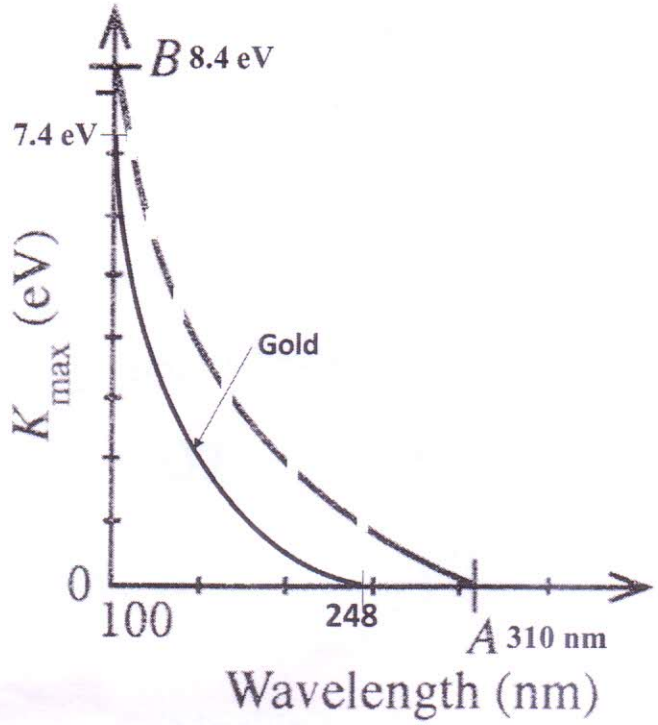
Maximum kinetic energy of the photoelectron ejected by 100 nm photon

= 12.4 – 5.0 $\frac{hc}{\lambda} - \phi$

=7.4 eV .... **(01)**

Correct shape of the graph .... **(01)**

(03 marks can be given for corresponding curve without calculating values)



IV. $i_s = i_g$ .... **(01)**

Reason: Number of photoelectrons are same .... **(01)**

(d) I. Radiation power can be used on the 1cm^2 of palm $= \frac{24 \times 10^{-3}}{8 \times 3600}$

.... **(01)**

Suppose power of source is P

Power from the source on the 1cm^2 of palm $\doteq$

$\frac{P}{4\pi \times 20 \times 20}$ .... **(01)**

$\frac{P}{4 \times 3 \times 20 \times 20} = \frac{24 \times 10^{-3}}{8 \times 3600}$ .... **(01)**

$P = 4 \times 10^{-3}\text{W}$ .... **(02)**

(One mark for correct unit, no mark for only the unit)

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව
இலங்கைப் பரீட்சைத் திணைக்களம்
අ.පො.ස. (උ.පෙළ) /க.பொ.த. (உயர் தர)ப் பரீட்சை- 2020
නව / පැරණි නිර්දේශය/ புதிய / பழைய பாடத்திட்டம

විෂයය අංකය / பாட இலக்கம்: 01

විෂයය / பாடம்: භෞතික විද්‍යාව

ලකුණු දීමේ පටිපාටිය / புள்ளிவழங்கும் திட்டம்

I පත්‍රය / பத்திரம் I

ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.	ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.	ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.	ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.	ප්‍රශ්න අංකය வினா இல.	පිළිතුරු අංකය விடை இல.
01.	5	11.	1	21.	3	31.	4	41.	3
02.	3	12.	4	22.	4	32.	3	42.	5
03.	1	13.	2	23.	4	33.	2	43.	3
04.	3	14.	1	24.	All	34.	1	44.	2
05.	1	15.	5	25.	1	35.	5	45.	5
06.	4	16.	4	26.	5	36.	1	46.	2
07.	4	17.	3	27.	4	37.	2	47.	5
08.	4	18.	2	28.	3	38.	5	48.	2
09.	1	19.	2	29.	5	39.	4	49.	4
10.	3	20.	3	30.	2	40.	1	50.	2

✪විශේෂ උපදෙස්/விசேடஅறிவுறுத்தல் :

එක් පිළිතුරකට/ஒருசரியானவிடைக்குலකුණු 01 බැගින්/புள்ளிவீதம்
මුළු ලකුණු/மொத்தப் புள்ளிகள் 1× 50= 50