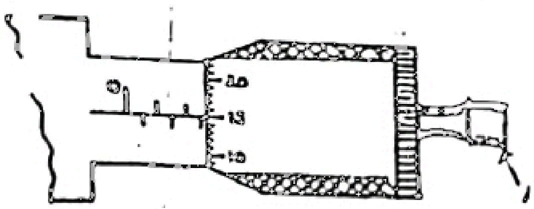
PAPER II PART A - STRUCTURED ESSAY

01. Figure shows a section of a micrometer screw gauge. (it is not drawn to a scale.) it has 50 divisions on the thimble scale and when the thimble is rotated one compete turn.it moves through one division (0.5 mm) on the sleeve scale.



(a) What isthe least count of the instrument ? *(1 line)*

(b) When taking a measurement, the component marked A (the ratchet) serves an important function.

(i) What is it ? *(2 lines)*

(ii) How do you make sure that the ratchet has been utilised correctly in performing t function mentioned in b (i). ? *(2 lines)*

(c) How do you determine the zero error, if any, of the screw gauge ? *(3 lines)*

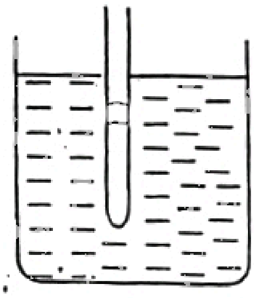
(d) The screw gauge is used to measure the diameter of a steel ball and the reading obtained is sho n in the diagram given at the beginning of the question, if there is no zero error in the instrum what is the diameter of the ball ?

(e) For measuring the diameter of a thin wire a micrometer screw gauge is more suitable tha vernier caliper, give the main reason. *(1 line)*

(f) Using a micrometer screw gauge, how do you obtain a better value for the diameter o sonometer wire. *(2 lines)*

(g) Name two other measurements which could be performed with vernier caliper but not micrometer screw gauge. *(2 lines)*

02. You are provided with an uniform, long glass tube immersed in a tall beaker of water . One end of the tube is closed and a column of air is trapped inside the tube by means of a small pellet of mercury as shown in the figure. A burner, a tripod and a wire gauge are also provided.



(a) What other important apparatus would you require in order to use this setup to verify the Charle`s law. *(1 line)*

(b) Give a reason why it is desirable to use a narrow tube rather than a capillary tube in this experiment. *(2 lines)*

(c) State two reasons as to why a mercury pellet is more suitable to trap air instead of a water pellet. *(2 lines)*

(d) Write down the two quantities that have to be measured in order to draw a graph to ver. Charle`s law. *(2 lines)*

(e) What precautions would you take in order to obtain accurate readings with respect to the qu mentioned under (d) *(2 lines each)*

(f) Draw a rough sketch of the graph that you would expect in this experiment, and label the axes

(g) If a small droplet of alcohol is trapped inside the air column, as the temperature is increase i gradually introduce alcohot vapour into the trapped air column. Can this setup still be verify the charle`s law ? Explain your answer. *(3 lines)*

03. A spectrometer is used for the determination of refactive index of glass in the form of a prism.

(a) How would you adjust the spectrometer for parallel light ?

(i) Eye piece *(3 lines)*

(ii) Telescope *(3 lines)*

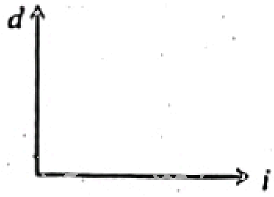
(iii) Collimater *(3 lines)*

(b) (i) The prism table is levelled and a prism is kept on the prism table. How do you verif t prism table is properly levelled ? *(4 lines)*

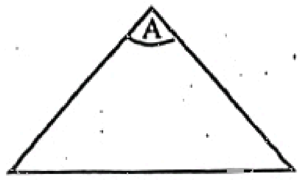
(ii) In an experiment to measure the refracting angle A of a prism the relevant spe readings were found to be 38° 40' and 278° 28' respectively. What isthe value of A ? *(3 lines)*

(c) In an experiment to find the minimum deviation, the deviation (*d*) of a light ray is plotted against the angle of incidence (*i*).

(i) Give a rough sketch of the curve that you would obtain.



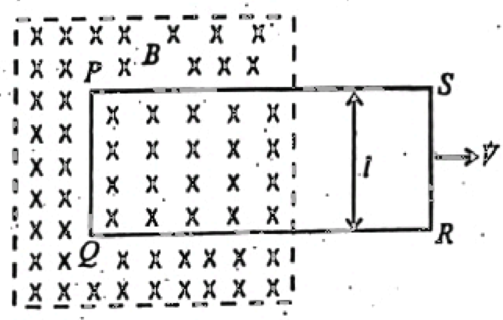
(ii) Draw the path of a ray when the prism is at the minimum deviation position.



(iii) Derive the relationship between the refracting angle A, the angle of minimum deviation D and the refractive index μ of the prism material. *(3 lines)*

(d) Explain why it is not desirable to use an electric filament light as the source for minimum deviation measurement. *(3 lines)*

04. A rectangular loop of wire *P Q R S* of width *l* is being pulled at a uniform speed *V* to the right through a uniform magnetic field of flux density *B*. The magnetic field is directed perpendicular and into the plane of the loop as shown in the figure.



(a) (i) What is the magnetic flux cut by the side *PQ* of the loop in time t ? *(1 line)*

(ii) What is the e.m.f induced in the loop ? *(1 line)*

(b) Due to the motion, a current will be induced in the loop.

(i) Indicate the direction of this current on the side *PQ*.

(ii) State the law of electromagnetic induction which governs the direction of this induced current. *(4 lines)*

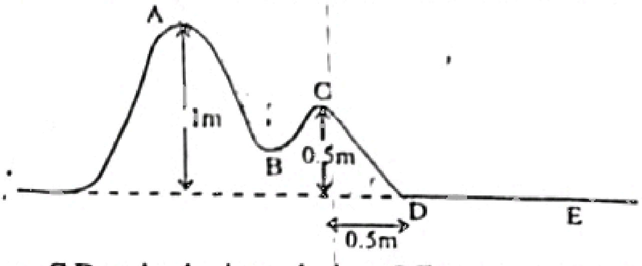
(c) Is there a force acting on the side *PQ* ? If so give its direction. *(1 line)*

(d) If the loop cannot be moved to the right or left by what other two ways can an e.m.f. be induced in the loop. *(2 lines for each way)*

(e) Give two devices that are based on the principle of electromagnetic induction. *(2 lines)*

01. Answer either part (a) or part (b)

(a) Is it possible to rebounce an object to a height $2h$, if it is dropped freely from rest from a height h ? Explain your answer.



An object starts to slide from rest from point A on a frictionless curved surface A, B, C and then continues its motion on an inclined plane C,D and a horizontal plane DE as shown in the figure. Assuming that the object always remains in contact with the surface.

(i) Find the speed of the object when it reaches point C.

(ii) If the surface C,D,E is rough with a coefficient of friction of 0.2, find the speed of the object when it reaches point D.

(iii) If the object comes to rest at E, calculate the distance DE.

(iv) Draw a rough sketch of the speed - time curve for the motion of the object between points C and E.

(b) Give the essential steps of a laboratory experiment which would enable you to determine the young's modulus for rubber in the form of a tube. Draw a rough sketch of a suitable graph showing the relation between stress and strain you would expect for rubber. How would you use the graph to find the work done when stretching the tube up to its elastic limit.? Assume that the rubber obeys Hook's law. A toy rocket of mass 250 g makes use of the entire energy stored in a stretched rubber cord of unstretched length 20 cm and cross - sectional area 2.5×10^{-5} m^2 for its projection. Find the legth by which the cord must be extended if the rocket is to be probjected vertically to a height of 25 m from the point of projection. the young's modulus for rubber is 8.0×10^8 N m^{-2}.

02. Explain the existence of surface tension of a liquid using the simple molecular theory. A glass capillary tube open at both ends contains a small pellet of a liquid of density 1.2×10^4 kg m^{-3} and surface tension 0.5 Nm^{-1}. The angle of contact of this liquid with glass is 120^0. When the tube is help vertically, the pellet moves to the bottom of the tube and remains there. Explain why the liquid does not pour out of the tube.

If the diameter of the capillary is 0.02 cm find the maximum length of the pellet that can be retained in the capillary tube in the vertical position.

03. Define the terms (a) specific heat capacity (b) specific latent heat of vapourization for a liquid. In a thermal electric power plant high pressure steam is used to rotate the turbines of an electric generator. High pressure steam is produced by heating water from 80^0C to 260^0C under high pressure. Under these conditions water boils at 250^0C.

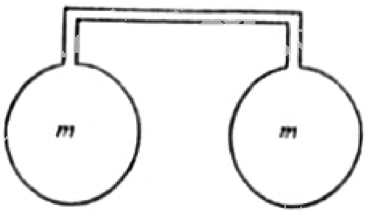
(i) Calculate the power in mega-watts (MW) needed to convert 8 kg of water per second into high pressure steam at 260^0C in this plant.

(ii) If 35% of the energy transferred to the water results in production of electrical energy, what is the total amount of electrical energy produced by this power plant in an hour ?

(Spicific latent heat of vapourization of water	$= 4.2 \times 10^3$ J Kg^{-1} K^{-1};
Specific latent heat of vapourization of water	$= 2.3 \times 10^6$ J Kg^{-1};
Specific heat capacity of steam	$= 2.0 \times 10^3$ J Kg^{-1} K^{-1})

04. State the Boyle's law and the charle's law, and use them to obtain the relationship

$$\frac{PV}{T} = \text{constant, for an ideal gas.}$$

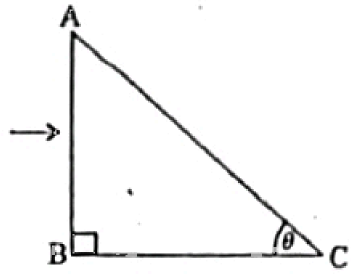


Two identical vessels each containing an ideal gas of mass m at temperature T_1 are connected by a narrow tube of negligble volume as shown in the figure. The temperature of one of the vessels is increased to T_2 keeping the other at its initial temperature of T_1 if the expansion of the vessel is negligible show that the mass (Δ m) of the gas transfered from one vessel to the other can be given by

$$\Delta m = \frac{m(T_2 - T_1)}{T_1 + T_2}$$

05. Answer either part (a) or part (b).

(a) Explain what is meant by critical angle in the refraction of light. If you are provided with pins,a drawing paper, a glass prism and other necessary items, describe how you would obtain a value for the refractive index of glass by critical angle method.



A ray of light is incident normally on the face AB of a right angled glass prism (refractive index = 1.52) as shown. The prism is immersed in water (refractive index 1.33) . find the largest value for the angle θ (∡ACB), so that the ray is totally reflected at the face AC.

(b) Define the terms "linear magnification" and "angular magnification" of a telescope. You are asked to design a telescope from two converging lenses of focal lengths 10m and 3m to view an object 100 m from the objective. With the final image formed 1.0 m from the eyepiece.

(i) Draw a ray diagram through the telescope showing the path of the light- rays from the object to the eye.

(ii) Find the separation between the two lenses.

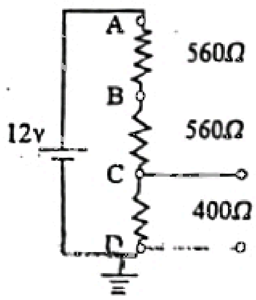
(iii) Calculate the linear and angular magnifications of the telescope.

06. Explain what is meant by resonance.

A vibrating tuning fork held over a narrow tube containing variable amounts of water is found to give resonance when the consecutive lengths of the air column are 0.359 m and 1.079 m. In a separate experiment the tuning fork gives beats of 4 Hz when sounded together with a second tuning fork of frequency 234 Hz. The second tuning fork too gives resonance with the above mentioned air columns, when those lengths are slightly increased. Find the end correction of the tube and the speed of sound in air.

07. Answer either part (a) or part (b)

(a) How would you modify an ammeter to be used as a voltmeter. A voltmeter with an unknown internal resistance is connected across a 10Ω resistor, and a current of 0.22 A is passed through the resistor- voltmeter combination. If the voltmeter reads 2V calculate the internal resistance of the voltmeter.



(i) If the above mentioned voltmeter is now connected between the points C and D of the network shown in the figure, what would be the reading on the voltmeter ? (Assume that the 12 V cell has negligible internal resistance).

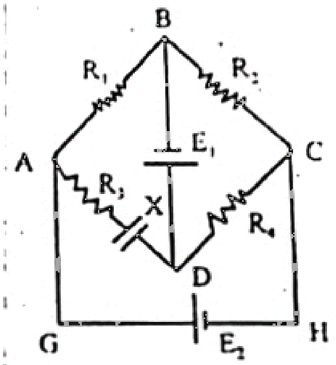
(ii) Calculate the potentials at A and B with respect to D when the voltmeter is connected as in (i)

(iii) What would be the potentials at A, B and C with respect to D when the voltmeter is disconnected ?

(iv) Compare the potential values obtained in (iii) with the corresponding values calculated in (i) and (ii), and explain the differences, if any.

(v) How would you make sure that the values obtained in (i) and (ii) are almost equal to the corresponding values obtained in (iii).

(b) State Kirchhoff's laws for an electrical network.



In the circuit shown, X is a capacitor with a capacitance of 2 μF and the other components have the following values :

$R_1 = 10\Omega$, $R_2 = 20\Omega$, $R_3 = 30\Omega$, $R_4 = 40\Omega$, $E_1 = 2.0$V and $E_2 = 6.0$ V.

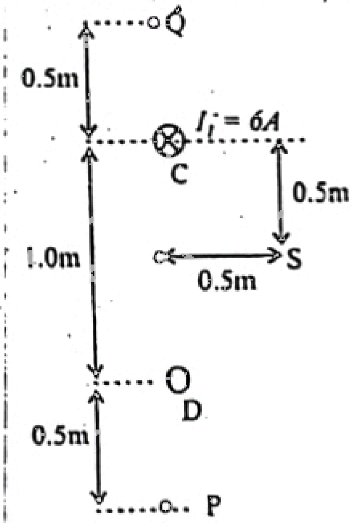
Assuming that the cells have negligible internal resistances,

(i) find the steady currents through each of the resistors, after the capacitor is fully charged.

(ii) What is the charge stored in the capacitor ?

08. Write down an expression for the magnetic flux density B at a distance r from a long straight wire carrying a current i.

Two long straight parallel wires C and D are kept 1.0 m apart and the upper wire carries a current I_1 of 6A into the plane of the paper as shown in the figure.



(i) What is the magnitude and direction of the current I_2 that must be established in the lower wire in order to produce a magnetic null point at P

(ii) Calculate the resultant flux densities at points Q and S under the situation mentioned in (i)

(iii) when the current I_2 is reversed, find the new magnitude and direction of the magnetic flux density at S

$\mu_0 = 4\pi \times 10^{-7}$ T A^{-1}m

(Neglect the influence of the earth's magnetic field.)