SECTION I (One hour)

Answer all questions in this section .

1(a). The force F acting on a metal conductor of length, l, placed on a magnetic field of flux density, B, and carrying a current, I, is given by

$F = BIl\sin 0$.

where θ is the angle between B and I. Show that the equation is physically correct.

(b) The force F between two equal charges, Q, separated by a distance, r, is

$$F = \frac{Q^2}{4\pi \epsilon_0 r^2}$$

What are the base units of ϵ_0?

(6 marks)

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2. Sketch on the same axes graphs to illustrate the temperature distribution along a metal bar heated at one end when the bar is

(a) lagged and the other end dipped in melting ice

(b) Unlagged and the other end dipped in melting ice.

In each case assume that steady state has been attained.

(7 marks)

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3. The maximum kinetic energy of photoelectrons ejected from a tungsten metal surface by monochromatic light of wavelength 248 nm was found to be 8.6×10^{-20} J . Calculate

(i) the work function of tungsten in eV.

(ii) the threshold frequency of tungsten.

(6marks)

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4. Differentiate between progressive waves and stationary waves in terms of

(i) amplitude of vibration of particles of the medium.

(ii) phase of vibration of particles of the medium.

(iii) energy transmission.

(6 marks)

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5. A "supper man" is sitting on a tree 98 m high with a baby he has rescued from the claws of a tiger. Unfortunately, the child slips and falls with an initial velocity of zero. "Super man" realised what was happening 2 seconds later and flew to catch the child at a constant speed of 39.2 m s^{-1}. Calculate.

(i) the time "super man" will fly before catching the child.

(ii) the distance "supper man" will fly to catch the child.

(8 marks)

6.

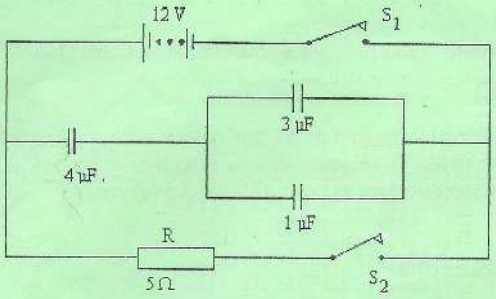

Figure 1 shows how capacitors, switches, a resistor and batteries are connected with S_1 and S_2 closed.

(i) Calculate the quantity of charge on the 4 μF capacitor with S_1 closed and S_2 open.

(ii) If S_1 is now open and S_2 closed, calculate the initial current through R.

(7 marks)

7. A rubber tyre of mass 15 kg is suspended with a rope 7.5 m long at a fixed support. A girl of mass 30 kg sits on the tyre and is made to swing. The speed of the girl at the lowest point of swing is 3 m s^{-1}. Calculate the tension in the rope as it goes through the lowest point.

(5 marks)

SECTION II (one and a half hours)

Answer all questions

Answer either 8 (a), (b), (c) and (d) or 8 (e), (f) and (g).

EITHER 8 (a), (b), (c) and (d).

8. (a) Describe one method you would use to produce a uniform magnetic field in the laboratory. **(3 marks)**

(b) A beam of electrons are accelerated through p.d , V, and enter a uniform magnetic field, B, with velocities at right angles to the field. The electrons move in a circular path. Use the above information to show that the expression for the specific charge is given by

Specific charge $= \frac{2V}{B^2r^2}$

Where r = radius of the circular path. **(4 marks)**

(c) Describe an experiment you would carry out in the laboratory using a beam of electrons following circular path in a uniform magnetic field to determine the specific charge of an electron.

(6marks)

(d) Neon ions each of mass 3.3×10^{-26} kg are accelerated through a p.d of 1400 V. The ions then enter a region of space where there are uniform magnetic and electric fields acting at right angles to each other and to the original direction of motion of the ions.

(i) Calculate the speed of the accelerated ions just before they entered the B and E field.

(ii) Calculate the magnitude of the electric field strength for the ions to go through the B and E fields un-deflected. The flux density is 0.4 T

(7 marks)

(20 marks)

OR 8 (e), (f) and (g)

(e) Define surface tension **(2 marks)**

Describe an experiment to measure the surface tension of water at room temperature. **(6 marks)**

(f) Two drops of mercury – one small and other large – are placed on a smooth polished surface. Sketch and explain the shapes.

(6 marks)

(g) A circular ring of thin wire of mean radius 1 cm is suspended horizontally by a thread passing through the 5 cm mark on a ruler pivoted at its centre and the ring is balanced by a 5 g mass suspended at the 60 cm mark. A beaker of liquid is then placed so that the ring just touches the liquid surface when the ring is horizontal. If the 5 g mass is moved to 70 cm mark the ring just parts the surface. Find the surface tension of the liquid.

(5 marks)

(20 marks)

Eeither 9 (a), (b) and (c) or (d), (e) and (f).

9. (a) (i) Explain what is meant by the resistivity of a material?

(2 marks

(ii) Sketch on the same set of axes graphs to show how the resistivity of a conductor, semiconductor, insulator vary with temperature.

(4 marks)

(b) The graph in figure 2 shows the result of an experiment to determine the resitivity of a wire of length 80.0 cm

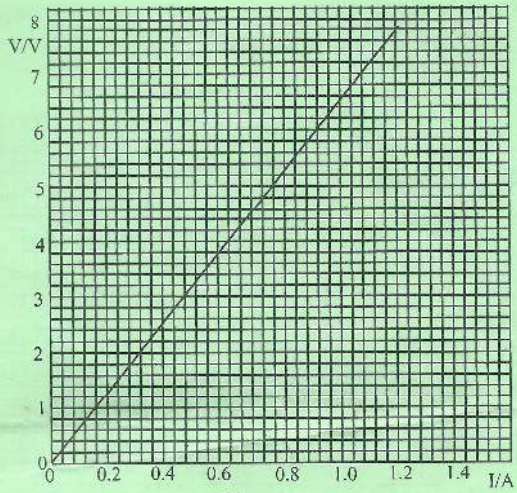

Figure 2.

(i) Draw an appropriate circuit diagram that could have been used to obtain such results?.

(4 marks)

(ii) Use the graph to calculate a value for the resistivity of the wire if its diameter is 5.0 mm

(6 marks)

(c). A car battery with a capacity of 60 ampere-hour is used to deliver current when the pd across its terminals is 12 V. How much electrical energy is available from such a battery.

(4 marks)

(20 marks)

OR

OR 9 (d),(e), and (f)

d. (i) Explain what is meant by a material is elastic? **(2 marks)**

(ii) When a piece of rubber is extended and allowed to contract, energy is dissipated in the process. Draw a force – extension graph for the extension and contraction of rubber. Explain how the energy dissipated can be obtained from your graph. **(5 marks)**

e. The graph in figure 3 shows the result of an experiment to measure the elasticity for a piece of wire 80.0 cm long.

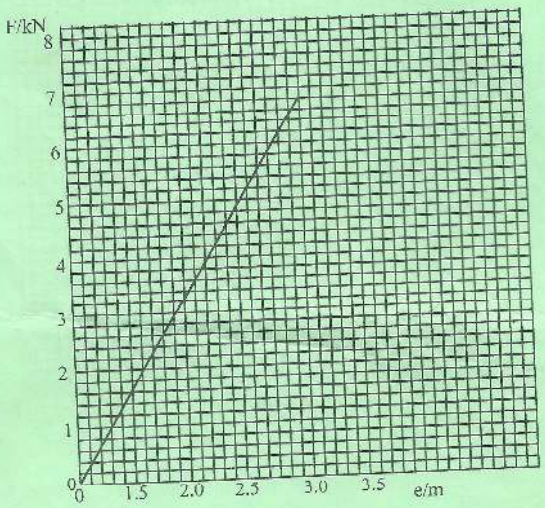

Figure 3

(i) Sketch an appropriate set-up from which such results could have been obtained. **(3 marks)**

(ii) Use your graph to calculate Young's modulus for the wire if its diameter is 5 mm. **(3 marks)**

(iii) Calculate the energy stored in the wire for the extension. **(2 marks)**

(f) A lift of mass 450 kg is designed to contain a maximum of 10 persons each of mass 75 kg. The distance from the top floor to the ground floor is 30 m. Calculate the minimum radius, the cable should have so as to just support these persons (tensile stress is 4.0×10^8 N m^{-2}) **(5 marks)**

(20 marks)

Answer either 10 (a), (b) and (c)

10 (a) Describe the formation of
(i) line emission spectra
(ii) line absorption spectra **(6 marks)**

(b) By using either line emission spectrum or line absorption spectra
(i) describe how the presence of any particles in the space could be detected
(ii) describe how the presence of different types of elements in a sample of matter could be identified **(4 marks)**

(iii) The spectrum from a sodium flame showed two prominent yellow lines of wavelengths 589.0 nm and 589.6 nm. Using an energy level diagram, explain how this is possible. Calculate the energy difference between the sodium lines. **(4 marks)**

(c) In a nuclear reactor the following process occur:
Nuclear fission
Controlled chain reactions
(i) Explain these terms. **(2 marks)**
(ii) Draw an energy flow diagram for energy conversion in a nuclear reactor to produce electricity from nuclear fission **(4 marks)**

(20 marks)

OR 10 (d), (e) and (f).

10 (d) Describe the formation of
(i) n-type semiconductor
(ii) p-n junction. **(6 marks)**

(e) (i). Show the effect of temperature change on the conductivity of an intrinsic semiconductor **(3 marks)**
(ii). What are the important characteristics that distinguish the depletion layer in a p-n junction from the n- and p- regions? **(3 marks)**

(f)

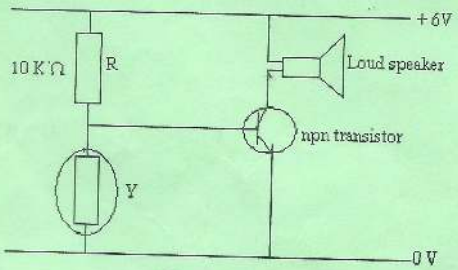

Figure 4.

Figure 4 shows a simple alarm circuit.
The device Y could be a (i). Thermistor (ii) LDR.

Explain how each of these devices could be used to make figure 4 function as an alarm **(4 marks)**

(iii) The resistance of the LDR in the position Y for a given light intensity is 200Ω. Explain whether the alarm in figure 4 will be on or not. **(4 marks)**

(20 marks)