JUNE 2006

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

$$F = BIlsin\theta$$

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

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

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

What are the base units of ε_o

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.
3. The maximum 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

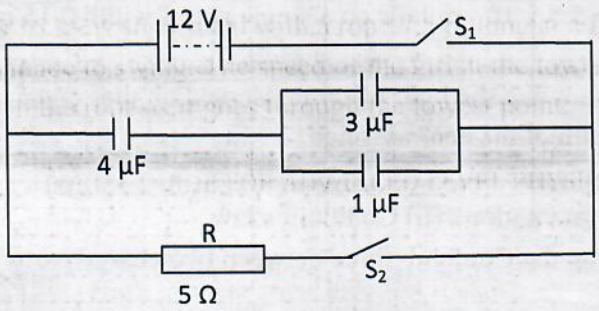
   (i) The work function of the tungsten in eV (ii) The threshold frequency of the tungsten
4. Differentiate between progressive waves and stationary waves in terms of
   i. Amplitude of vibration of the particles of the medium
   ii. Phase of vibration of the particles of the medium
5. A 'supper man' is sitting on a tree 98 m high with a baby has rescued from the claws of a tiger. Unfortunately, the child slips and falls with an initial velocity of zero. 'Supper man' realized what was happening 2 seconds later and flew to catch the child at a constant speed of 39.2 ms^{-1}. Calculate
   i. The time 'supper man' will fly before catching the child
   ii. The distance 'supper man' will fly to catch the child.
6. 

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

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

ii. If S_1 is now opened and S_2 closed, calculate the current through R.

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 the swing is 3 ms^{-1}. Calculate the tension in the rope as it goes through the lowest point.

8. (a) Describe one method you can use to produce a uniform magnetic field in the laboratory.
(b) A beam of electrons are accelerated through a pd V, and enters 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 is the radius of the circular path.
(c) Describe an experiment you would carry out in the laboratory using a beam of electrons following circular path in a magnetic field to determine the specific charge of an electron.
(d) Neon ions each of mass 3.3×10^{-26} kg are accelerated through a pd of 1400 V. the ions then enters 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 enter the B and E fields
   ii. Calculate the magnitude of the electric field for the ions to go through the B and E fields un – deflected. The flux density is 0.4T
(e) Define surface tension
Describe an experiment to measure the surface tension of water at room temperature.
(f) Two drops of mercury – one small and the other large are placed on a smooth polished surface. Sketch and explain the shapes.
(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 60 cm mark. A beaker of liquid is then placed so that the ring just parts the surface. Find the surface tension of the liquid.

9. (a) (i) Explain what is meant by the resistivity of a matrial?
(ii) Sketch on the same set of axes graphs to show how the resistivity of a conductor, semiconductor, and insulator vary with temperature.
(b) The graph in figure 2 shows the results of an experiment to determine the resistivity of a wire of length 80.0 cm.

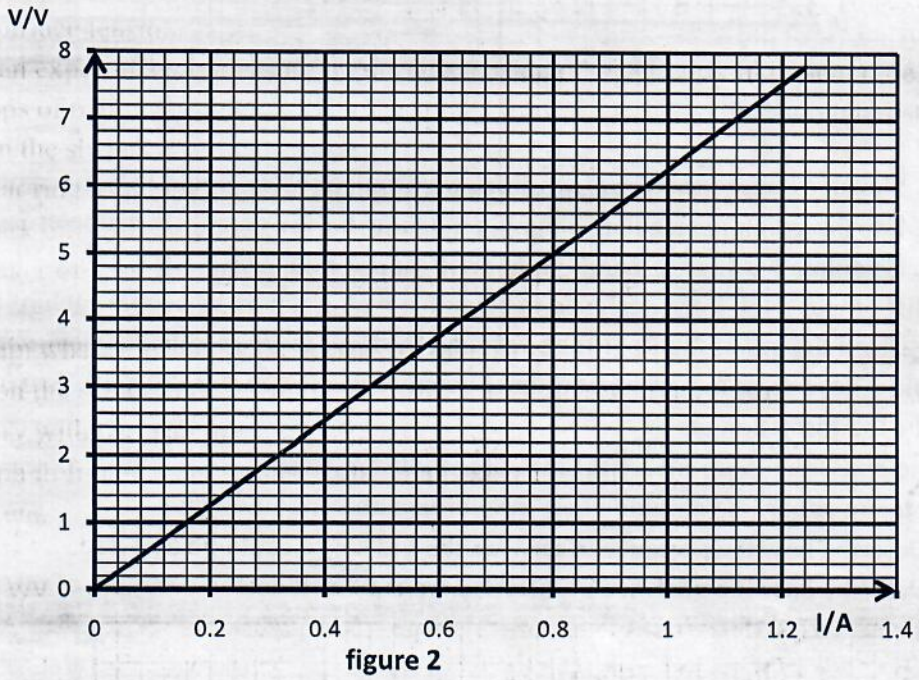


figure 2

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

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

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

(d) (i) Explain what is meant by a material is elastic.

(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 enrgy dissipated can be obtained from your graph.

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

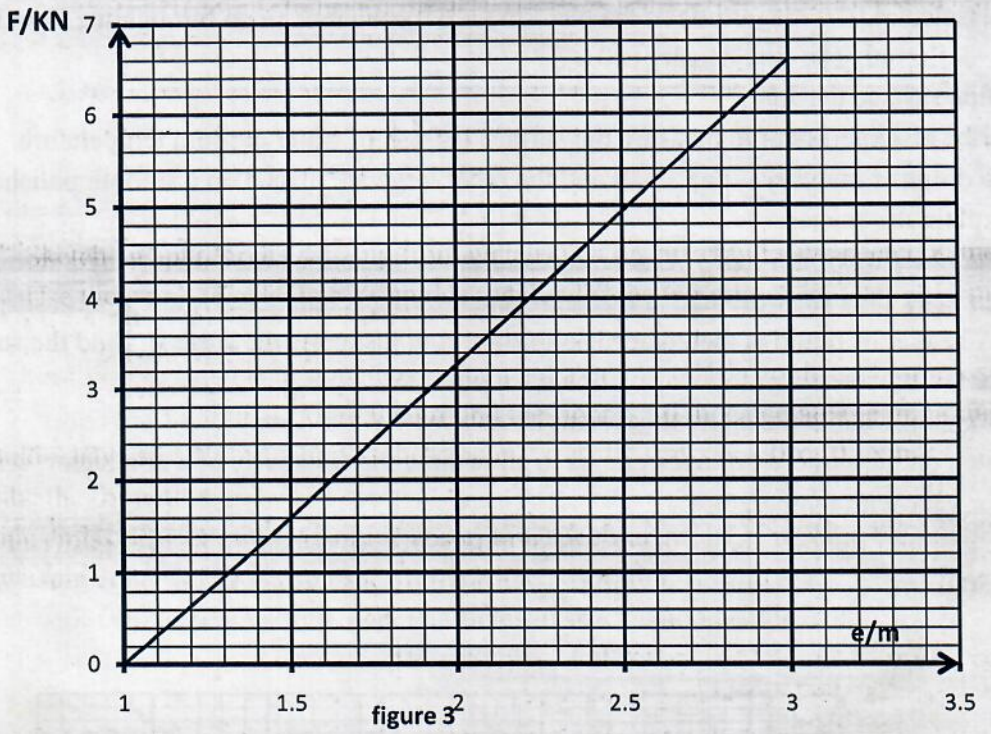


figure 3

i. Sketch an appropriate set – up from which such results could have been obtained

ii. Use the graph to calculate Young's modulus for the wire if its diameter is 15 mm.

iii. Calculate the energy stored in the wire for the extension.

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

10. (a) Describe the formation of

i. Line emission spectrum (ii) Line absorption spectrum

(b) By using either line emission spectrum or line absorption spectra

i. Describe how the presence of any particles in space could be detected

ii. Describe how the presence of different types of elements in a sample of matter could be identified.

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

(c) In a nuclear reactor, the following processes occur – nuclear fission and controlled chain reaction

i. Explain these terms

ii. Draw an energy flow diagram for energy conversion in a nuclear reaction to produce electricity from nuclear fission.

(d) Describe the formation of

i. n-type semiconductor (ii) p-n junction.

(e) (i) What is the effect of temperature change on the conductivity of an intrinsic semiconductor.

(ii) What are the important characteristics that distinguish the depletion layer in p-n junction from the n- and p – regions?

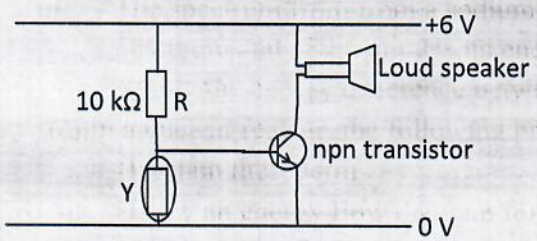


Figure 4

Figure 4 shows a simple alarm circuit.
The device Y could be a
(i) Thermistor (ii) LDR
Explain how each of these could be used to make figure 4 functions as an alarm
The resistance of the LDR in position Y for a given light intensity is 200 Ω. Explain whether the alarm in figure 4 will be on or not.