JUNE 2013

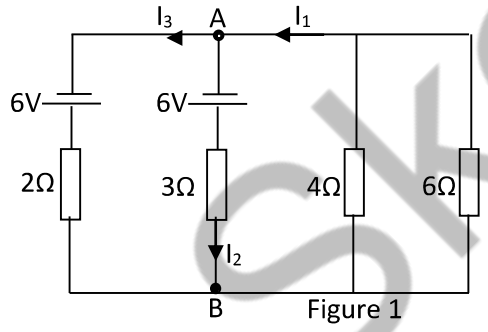
1. The equation $R_T = R_o(1+\alpha T+\beta T^2)$, where α and β are constants, describes the variation of the resistance of a wire with temperature T. This equation is homogeneous.
   (i) Explain the meaning of the underlined word
   (ii) What are the units of αT and βT^2?
   (iii) What are the units of α and β?
2. (a) What is meant by the term "moment of a force"?
   (b) If three forces are in equilibrium they must be coplanar and concurrent. Explain the meaning of the word "coplanar"
   (c) A uniform metal bar of length 4.0 m and mass 80 kg rest with its upper end against a smooth vertical wall and with its lower end on a rough surface of coefficient of friction 0.32. What is the maximum angle made with the horizontal to which the bar can be inclined without sliding?
3. (a) Compare the image formed by a diverging lens and a converging lens, both of focal length 20 cm, if an object is placed 12 cm from each.
   (b) Why is a frequency modulated signal preferred to an amplitude modulated signal system in communication?
4. A 1500 μF capacitor is fully charged using a 100 V d.c power supply. It is disconnected from the power supply and connected to an unchanged 1000 μF capacitor.
   (a) Calculate the p.d across the terminals of the capacitor
   (b) Calculate the initial and final energy stored in the capacitors
   (c) Why is there a loss in energy?
5. 

Figure 1

In figure 1, determine
(i) The current I_1 and I_2
(ii) The p.d between AB

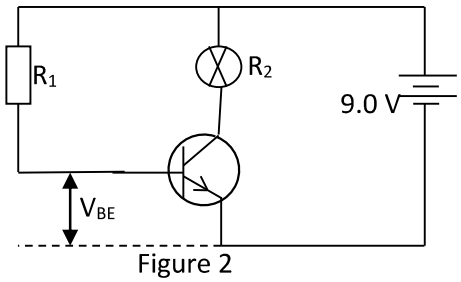
6. 

Figure 2

(i) What is a p – type semiconductor?
Figure 2 shows a transistor in the common emitter mode. The transistor has the following characteristics $V_{BE} = 0.62$ V, $h_{fe} = 100$. The input resistance R_1=60 kΩ and the load resistance R_2 = 600 Ω
(ii) Calculate the current through the load
(iii) Calculate V_{CE}

7. Distinguish between liquids and gases using
   (i) Intermolecular force (ii) The kinetic theory of matter
8. (a) (i) Explain what is meant by the thermometric property of a substance?
   (ii) State two qualities which can make the thermometric property suitable for temperature measurements.

(iii) The melting point of a metal is measured using a resistance thermometer and a constant volume gas thermometer. Explain whether the values obtained would be the same or different.

(b) Describe an experiment to determine the specific latent heat of vaporization of water. Your description should include a diagram, procedure, precautions, observations and conclusions.

(c) (i) A piece of metal block of mass 0.8 kg and specific heat capacity 455 $Jkg^{-1}K^{-1}$ is initially heated in a furnace. The block is then immersed in 1.2 kg ice in an ice container and equilibrium temperature of 48°C is obtained. Calculate the initial temperature of the block.

(ii) Explain whether all electrical insulators are necessarily good thermal conductors.

(d) (i) State the laws of electromagnetic induction.

(ii) An electron of charge, e, and mass, m, enters a uniform magnetic field B of value 2.0 x 10^{-3} T as shown in figure 3 and moves with a speed, v.

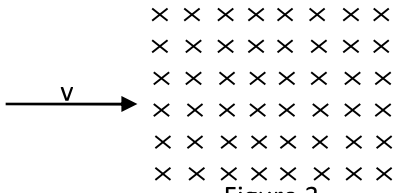


Figure 3

Copy figure 3 into your paper and indicate the path of the electron in the field.

(iii) Calculate the number of revolutions per second made by the electrons.

(e) Describe an experiment to determine the specific charge of an electron. Your account should include a diagram, procedure, observations and conclusions.

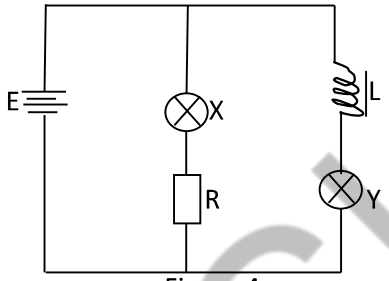


Figure 4

Figure 4 shows two bulbs X and Y connected to a supply E. The inductance of L is 6.0 x 10^{-3} H, the resistance of R is 2.0 Ω, while the resistance of X and Y are each 2.0Ω.

(i) Calculate the current in Y when it is fully lighted.

(ii) Sketch, on the same axes, graphs to show how the p.d across X and Y vary with time

9. (a) Define stopping potential

(b) Use Einstein photoelectric equation to explain

(i) Why for a particular metal, electrons are emitted only when the frequency of the incident radiation is greater than a certain value.

(ii) Why the maximum speed of the emitted electrons is independent of the intensity of the incident radiation.

(c) Figure shows how the frequency (f) of incident radiation on a metal surface varies with the energy of the emitted photoelectrons

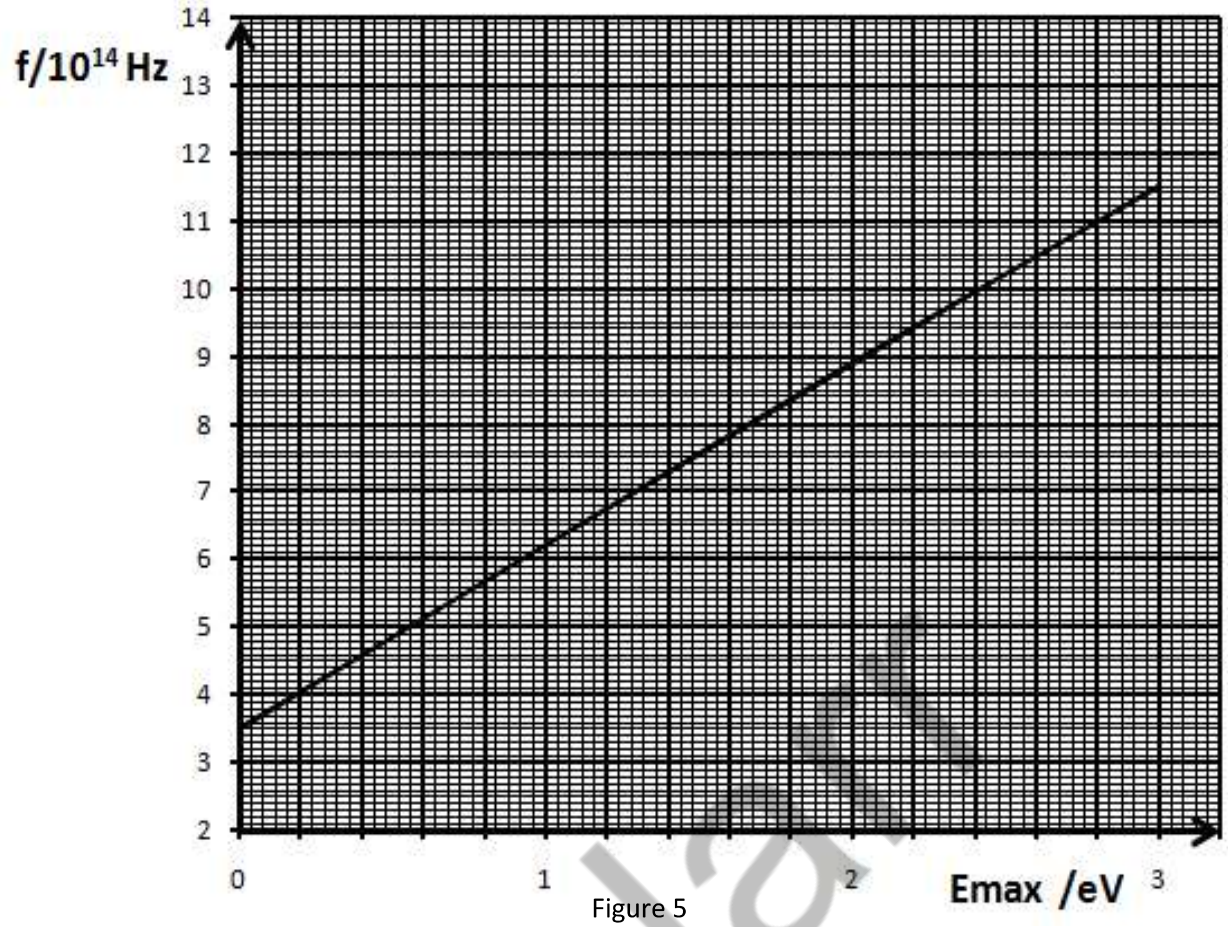


Figure 5

i) From the graph, determine the threshold frequency and calculate the maximum wavelength of the emitted electrons.

(ii) Calculate values for: the plank constant and the work function

(d) An X – ray photon has wavelength of 3.0×10^{-10} m. Calculate the values for

(i) The momentum (ii) The energy

(iii) The mass of the particle associated with the proton which moves at the speed of light.

(e) (i) Define time constant.

Figure 6 shows how a resistor R and a capacitor may be connected in a circuit.

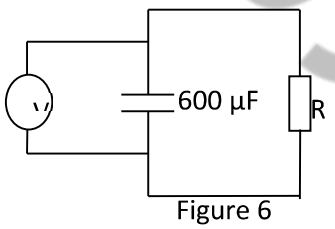


Figure 6

The capacitor is fully charged and connected to the resistor R and the reading on the voltmeter falls by half in 60 s.

(ii) Calculate the time constant and explain how its value could be increased

(f) Figure 7 shows the displacement time graph for a vibrating system.

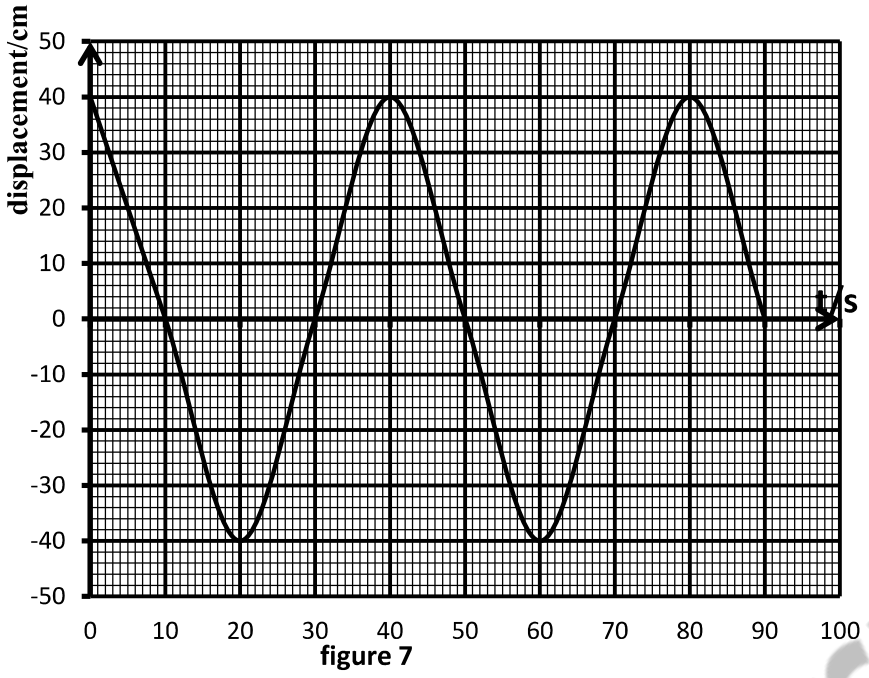


figure 7

(i) Explain whether the motion is simple harmonic or not.
Use the graph to calculate
(ii) The amplitude and frequency of oscillation
(iii) Write the wave equation for the motion described in in figure 7

(g) (i) Sketch a graph to show how the velocity changes with time for the motion above.
(ii) Compare nuclear fission and nuclear fusion as sources of energy.

10. The table below gives the force, F, between a pair of molecules in a solid at various separations, r.

Force, $F/10^{-7}$ N	Separation, $r/10^{-10}$ m
8.8	0.1
5.6	0.26
0.8	0.34
-2.0	0.42
-0.8	1.8
-0.4	1.9

(a) Draw a graph of F against r for a pair of molecule
(b) (i) From your graph, determine the molecular spacing for the molecules at equilibrium separation.
(ii) Calculate the energy used to separate the molecules completely
(iii) What is the physical significance of the energy calculated in (ii)
(c) How can your graph be used to explain that at some point
(i) Hooke's law is slightly obeyed
(ii) The vibration of the molecules is simple harmonic