JUNE 2007

1. The speed of light, c is related to the permeability μ_o and the permittivity, ε_o by the expression

$$c = \frac{1}{\sqrt{\mu_o \varepsilon_o}}$$

   i. Show that this equation is homogeneous
   ii. Calculate the magnitude of ε_o

2. In figure 1 below, the current in the 3 Ω resistor and R are 1.5 A and 0.5 A respectively.

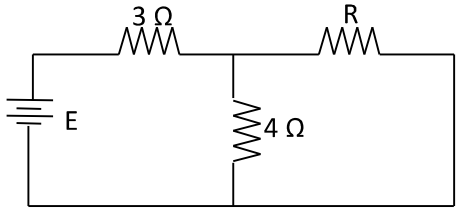

Figure 1

Calculate
   i. The emf of the battery
   ii. The resistance of R

3. (i) Explain why it is preferable to describe elastic behavior of materials in terms of stress – strain rather than force extension.
   (ii) Figure 2 is a graph of the extension and contraction of a rubber band. Calculate the work done in this process.

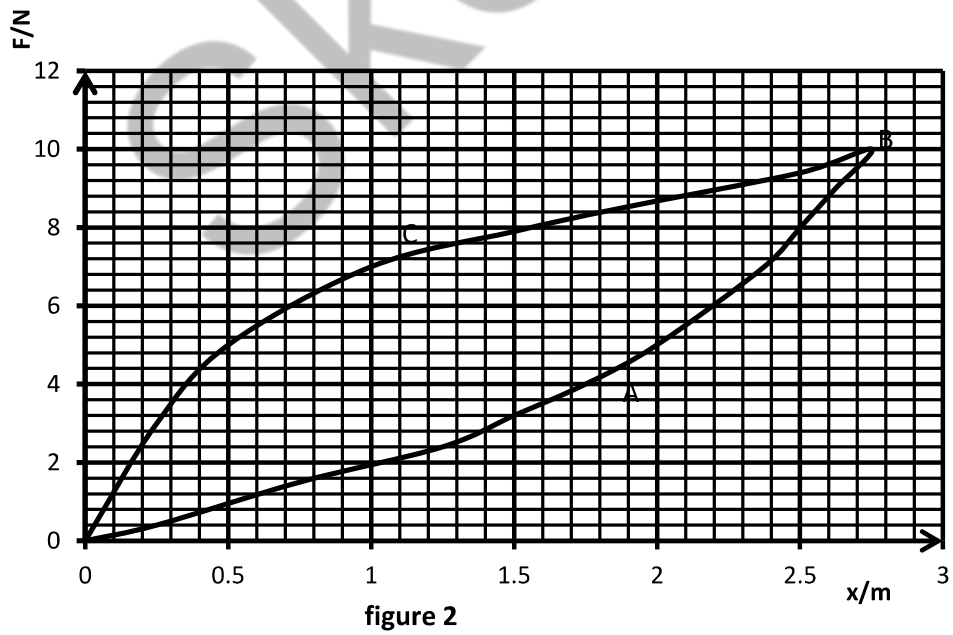

figure 2

4. A drill using a current of 1.5 A when connected to a mains supply of 240 V makes a round hole in a piece of iron of mass M. in one minute 75 % of the electrical energy is converted to internal energy of the iron which cause a rise in temperature of 20^0C. if the specific heat capacity of iron is 460 $Jkg^{-1}K^{-1}$

i. Calculate the mass M of the piece of iron (ii)State any assumption

5. (a) sketch
   i. The transfer (ii) The input (iii) The output
   Characteristic for an npn transistor.
6. Figure 3 shows the path a ray of light would follow in an optical fibre whose core has a refractive index n_1 and the cladding has refractive index n_2

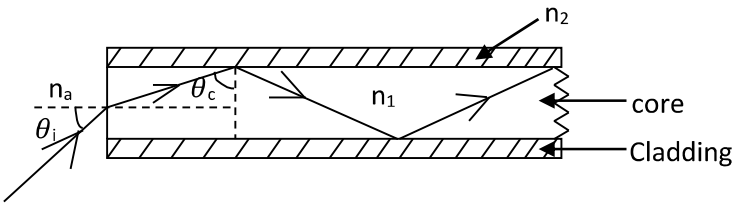

Figure 3

The angle of incidence and the critical angles are respectively θ_i and θ_c

i. What is meant by critical angle?
ii. State and explain whether n_1 is less than or greater than n_2
iii. The refractive index for glass is 1.5, calculate θ_c

7. The mercury in glass thermometer and the constant volume gas thermometer can be used to measure temperature.
   i. Explain why the constant volume gas thermometer could give readings in degree Celsius and mercury in glass thermometer in degree Celsius too.
   ii. The two thermometers may give different readings when immersed in a volume of liquid. Explain why?
8. (a) Describe an experiment to show that for a constant force, the mass of a body is inversely proportional to its acceleration. State clearly how you would minimize errors in measurements and how you would arrive at the required results from your measurements

   (b) A ball X of mass 400 g travelling at 2.5 ms^{-1} makes elastic and head on collision with a second identical, stationary ball Y. they remain in physical contact for 60 μs.

   (i) What does elastic collision mean?

   (ii) Calculate the velocities of X and Y after the collision

   (iii) Find the average force exerted by X during the collision.

   (c) Figure 4 shows a ball propelled from a point A. the ball moves with constant velocity of, hits a wall a B and moves back to A with the same velocity. The ball is in physical contact with the wall for a time intervalΔt. Sketch a graph of the momentum of the ball against time for the movement of the ball.

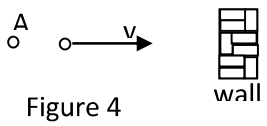

Figure 4

(d) Describe how you would measure the specific heat capacity of a liquid. Describe the procedure you would use to make allowance for heat losses, and how you would derive the specific heat capacity from you measurements.

(e) The kinetic theory of ideal gases leads to the equation

$$P = \frac{1}{3}\rho\overline{c^2}$$

Where P is the pressure, ρ is the density and $\overline{c^2}$ is the mean square speed of the molecules.

(i) State the assumptions used to derive this result.

(ii) Hence derive the equation

9. (a) A radioactive source emits both alpha and beta radiations.

(i) What does it mean for a substance to be radioactive?

(ii) State and explain how you would distinguish between the two types of radiations

(b) Figure 5 shows a graph of the natural logarithm of the activity of a radioactive element plotted against time in minutes. Sketch the set – up from which such results would have been obtained.

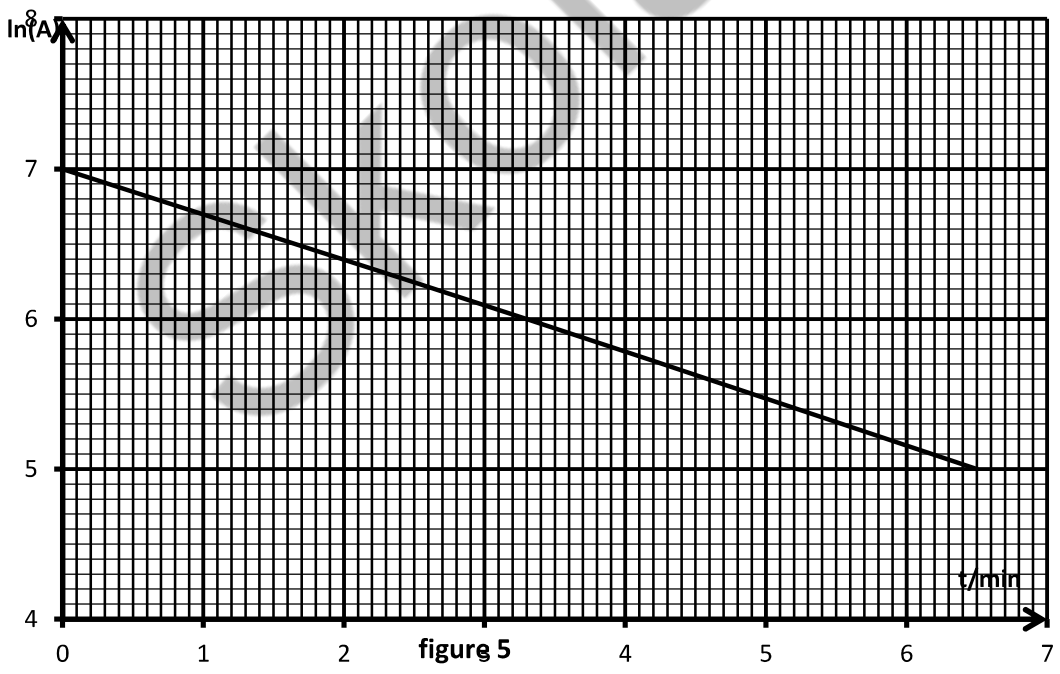

figure 5

(c) (i) Use the graph to obtain a value for the half – life of the sample

(ii) Use the graph to calculate the initial activity of the sample

(d)(i) What is a capacitor?

(ii) In what ways is a capacitor?

(a) Similar to a diode.

(b) Different from a diode.

(e) A capacitor, charged fully with a battery of 10 V is discharged through a resistor. Figure 6 shoows how the current varies with time.

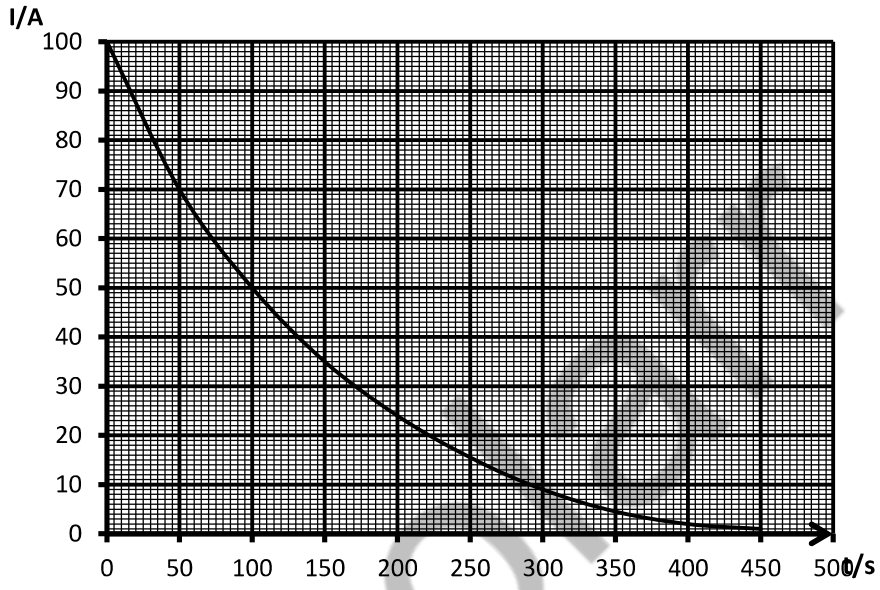

figure 6

(i) Sketch an electric circuit from which such results would have been obtained

(ii) Use the graph to estimate the initial charge on the capacitor and hence, or otherwise, estimate its capacitance.

(iii) Calculate the time constant for the capacitor.

(f) How will the graph be affected if the resistance R in the circuit is doubled? Explain your answer.

10. (a) Explain what is meant by the terms:

(i) Displacement,

(ii) Wave speed for a mechanical wave

(b) Distinguish clearly between stationary wave and progressive wave with reference to the following characteristics of the wave

(i) Amplitude (ii) Frequency (iii) Wavelength (iv) phase (v) wave form (vi) Energy transmitted

Diffraction and interference are phenomena exhibited by wave. State clearly the difference between these phenomena

(c) A laser is used to produce young fringes with slits separated by 0.05 mm. The screen is 1.0 m from the slits and 10 fringe separations occupy 12.5 mm. What is the wavelength of the laser light?

(d) Electrons can be emitted from the surface of zinc by ultraviolet light.

(i) Explain why visible light cannot cause electrons to be emitted from the surface of zinc whereas ultraviolet light does?

(ii) If both metals were illuminated with ultraviolet light of the same frequency, how will the energies of electrons emitted from the zinc and potassium surfaces differ?

(e) Explain each of the following

(i) If the intensity of the ultraviolet light directed at a piece of zinc is doubled, the number of electrons leaving the surface per second also doubles but the maximum kinetic energy is unchanged.

(ii) The maximum kinetic energy of photoelectrons is directly proportional to the difference between the frequency of light falling on the surface and the threshold frequency of that metal.

(iii) Gamma photons are more harmful to people than infrared photons.

(f) Calculate the wavelength of photons emitted when an electron makes a quantum jump from n = 3 state to the ground state of the hydrogen atom. The energy at the state n = 3 is -1.5 ev and the ground state energy is – 13.6 eV.

STUDENT'S PROPOSED ANSWERS TO JUNE 2007