JUNE 2012

1. (i) When an alternating potential difference is applied to the primary of a transformer, why is an alternating emf is produced (induced) in the secondary.
   (ii) State with reasons the output of the secondary, if the alternating voltage of the primary were replaced with direct current voltage.
   (iii) Why are transformers coils wound on an iron core? State an important feature of such a core and the function of the feature
2. Figure 1 shows a graph of stopping potential, V, plotted against frequency, for a certain metal, Z

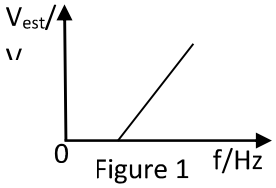


Figure 1

   (i) Calculate the threshold frequency of the metal, given that the work function is 3.8 eV.
   (ii) To which region of the electromagnetic spectrum does the wavelength calculated in (i) belong

   (iii) Of what significance is the gradient of the graph in figure 1. Draw a set – up from which the results above could have been obtained.

3. The voltage sensitivity, $\theta/_V$, of a moving coil meter is given by

$$\theta/_V = \frac{BAN}{CR}$$

   Where B is the magnetic field strength, A is the area of the coil, N is the number of turns of the coil, C is the torsional constant and R is the resistance of the coil. What are the units of C?
4. Figure 2 shows the loading and unloading curve for rubber

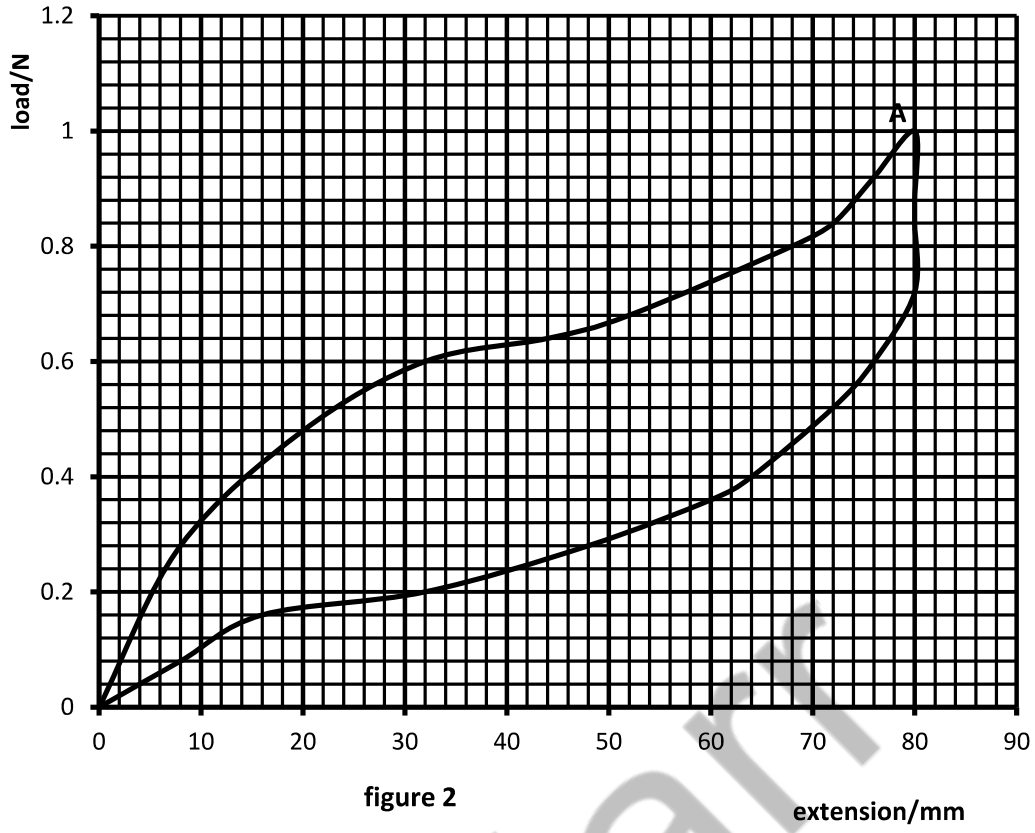


figure 2

(a) Use the graph to estimate the gain in the internal energy by the strip of rubber when it is extended to A and unloaded.

(a) Explain why the rubber can be stretched to about ten times its original length before its elastic limit is reached.

5. Copper contains about 10^{29} free electrons per unit volume. Determine the average drift velocity of the free electrons in a uniform copper wire of length 0.5 m when a p.d of 1.5 V is applied across it. (Resistivity of copper = 1.7×10^{-8} Ωm)
6. The SONEL thermal plant in Limbe supplies SONARA with 1.0MW at a pd of 1.0×10^4 V. The resistance between the power station and the factory is 0.5 Ω.
   (a) What is the power output of the thermal plant
   (b) Explain why the power station output voltage is always stepped up before transmission over a long distance.
7. An observer is standing at the bank of a stream. At what speed will the observer see a boat sailing at 50 cms^{-1} relative to a stream which is flowing at 10 cms^{-1}
   (i) Downstream (ii) perpendicular to the flow of the stream.
8. (a) (i) Differentiate between longitudinal and transverse waves
   (ii) Describe an experiment to measure the speed of sound in free air from measurements of frequency and wavelength using progressive wave. Your description should include a diagram, procedure and precaution(s), observations, calculations and conclusion.
   (b) Light is travelling in glass A with speed 1.9568×10^8 ms^{-1}. It reaches an interface with a different glass B, at an angle slightly greater than the critical angle of 87.60^0 and undergoes total internal reflection.
   (i) Explain with the aid of a diagram what is meant by critical and total internal reflection.
   (ii) Calculate the speed of light in B.

(c) An observer travelling with constant velocity of 25 ms^{-1} passes close to a stationary sound and noticed that there is a change of frequency of 60 Hz as he passes the source. What is the frequency of the source?

(d) (i) Define the specific heat of vaporization

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

(e) An office uses a water tank containing 1.2 m^3 of water as a thermal store. The water in the tank is heated to 98^0 C in the night when there is less electrical energy consumption. In the morning when there it is very cold , the water is pumped round the office to keep the office warm.

(i) Calculate the energy given out by the water on a day that the temperature drops from 98^0 C to 65^0 C.

(ii) The radiators in the office gives out an average power of 1.5 KW each. For how long can they operate at this power before the water temperature drops to 65^0 C.

(iii) Explain why this heating system operates more efficiently in the morning than in the afternoon.

(f) State with reasons two thermometric properties.

9. (a) (i) Define capacitance

(ii) What are the physical factors on which the capacitance of a parallel plate capacitor depends?

(iii) How would you relate capacitance to permittivity?

(b) Figure 3 shows a circuit for charging and discharging of a capacitor using a two way switch.

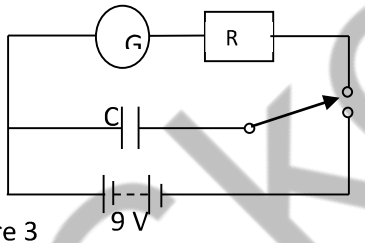


Figure 3

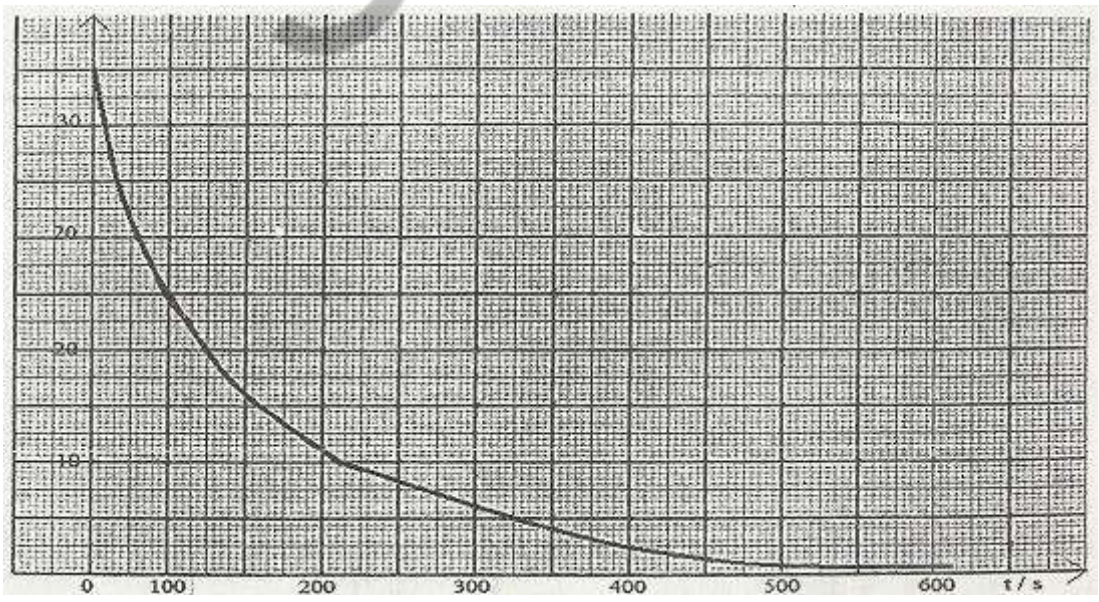


Figure 4

The graph in figure shows how the current varies with time during the discharge. Use the graph to

(i) Calculate the value of the resistance R

(ii) Estimate the charge stored on the capacitor at the start of the discharge

(iii) Find the energy stored at the start of the discharge

(iv) Calculate the capacitance of the capacitor

(v) What would be the effect on the shape of the graph if the value of R were increased?

(c) A 5.0 μF capacitor and 8.0 μF capacitor are charged by a 12 V battery. The two capacitors are then connected as shown in figure 5

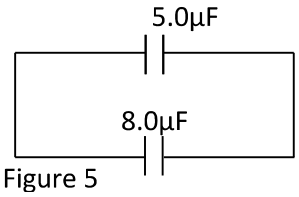


Figure 5

Calculate the charge on the 5.0μF capacitor as shown in figure 5

(d) Distinguish between intrinsic and extrinsic semiconductors

(e) The output characteristics in figure 7 are for the transistor circuit shown in figure 6

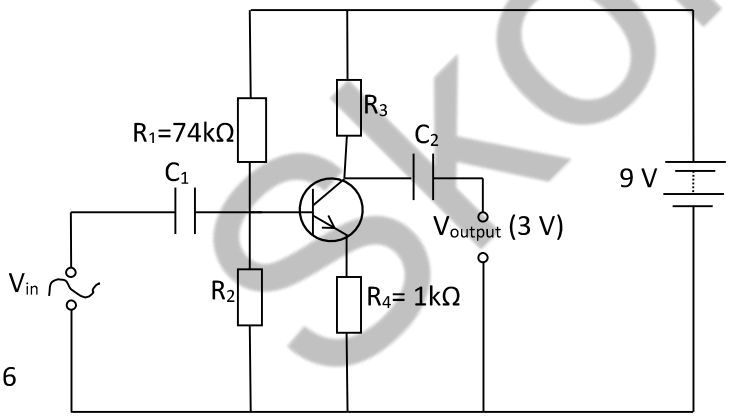
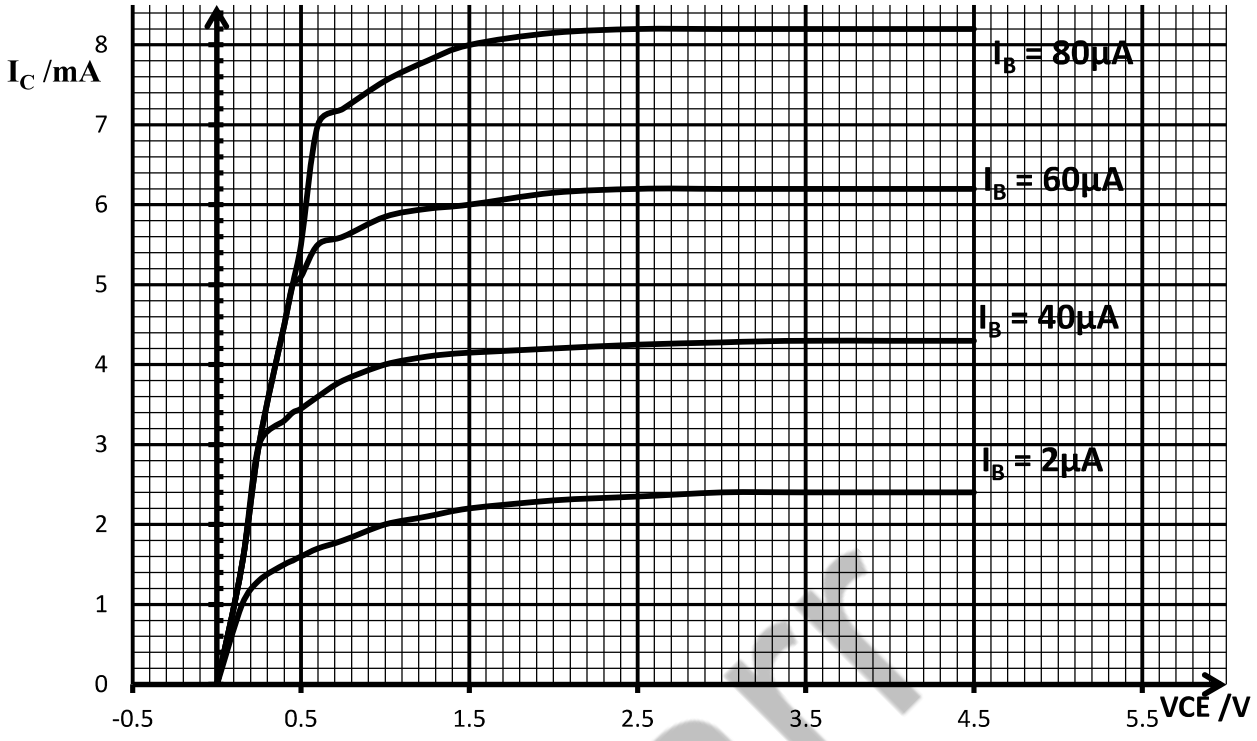


Figure 6



(i) Construct a table of vaules which would enable you to draw the transfer characteristic at constant V_{CE} of 3.5 V. hence draw a graph from which the you could obtain the current gain h_{fe} for the transistor. What is the value of h_{fe}.

(ii) What are the functions of R_3, C_1 and C_2 (iii) Calculate R_1 and R_2

Given that the current through R_4 = 1 mA, current through R_3 = 1mA and V_{CE}=0.6 V

10. (a) Explain what is meant by the emf and terminal pd of a battery. Why is the pd between the terminals of a battery not always the same as the emf?

(b) The emf of the electricity supply to a rural farm house is 240 V. The resistance of the cables to the farm house may be considered as the internal resistance of the supply. When an electric cooker is used in the farm house the measured voltage across the cooker is 220. If the resistance of the cooker is 40 Ω,

(i) Calculate the power of the cooker.

(ii) Calculate the resistance of the cables to the farm house

(iii) Explain why the voltage measured at the cooker is less than the supply voltage when the cooker is in use.

(iv) Suggest one disadvantage of this power supply.

(c) A semiconductor diode and a resistor of constant resistance are connected in some way inside the box having two external terminals (figure 8). When a p.d of 4.0 V is applied across the terminals, the ammeter reads 100 mA. If the same p.d is applied in the reverse direction, the ammeter reads 200 A

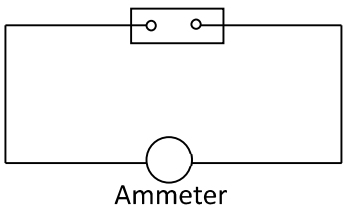


Figure 8

(i) What is the most likely arrangement of the resistor and diode? Explain your deduction

(ii) Calculate the resistance of the resistor and the forward bias resistance of the diode.

(d) (i) State the observations obtained from the Rutherford α – scattering experiment with a thin gold foil. What conclusions may be deduced from each of these observations?
(ii) Explain how and why the masses of compounds differ from the sum of the masses of their constituent particles.
(e) Radium (Ra) decays to radon (Rn) by the reaction

$$^{226}_{89}\text{Ra} \rightarrow {}^{222}_{87}\text{Rn} + {}^{4}_{2}\text{He} + \gamma$$

(i) Estimate the energy (in joules) released when an atom of $^{226}_{89}$Ra decays
(ii) Estimate the wavelength of gamma photon emitted during this decay given that 4 % of the energy turns to gamma radiations.
(iii) What happens to 96 % of the energy?
The atomic masses are radium = 3.7533 x 10^{-25} kg, radon = 3.686 x 10^{-25} kg, helium = 0.066 x 10^{-25} kg.
(f) An α – particle is accelerated to attained a kinetic energy of 1.34 x 10^{-15} KJ, collides head – on with a gold nucleus. Calculate the upper limit of the radius of the gold nucleus. Proton number of gold is 79

STUDENT'S PROPOSED ANSWERS TO JUNE 2012