

SECTION I (One hour)

1. (i) When an alternating potential difference is applied to the primary of a transformer, why is an alternating emf. 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 transformer coils wound on an iron core? State an important feature of such a core and a function of this feature (7 marks)

2. Figure 1 shows a graph of stopping potential,  $V_s$ , plotted against frequency,  $f$ , for a certain metal, Z

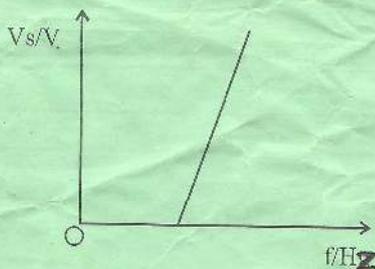


Figure 1

- (i) Calculate the threshold wavelength of the metal, given that the work function is 3.8 electronvolts.
  - (ii) To which region of the electromagnetic spectrum does the wavelength calculated in (a) 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. (7 marks)
3. The voltage sensitivity,  $\theta/V$ , of a moving coil meter is given by
 
$$\frac{\theta}{V} = \frac{BAN}{CR}$$
 Where B is the magnetic field strength, A the area of the coil, N the number of turns of the coil, C the torsional constant and R the resistance of the coil. What are the units of C? (5 marks)
  4. Figure 2, shows the loading and unloading curve for rubber



Figure 2

- (a) Use the graph to estimate the gain of internal energy by the strip of rubber when it is extended to A and unloaded
- (b) Explain why rubber can be stretched to about ten times its original length before its elastic limit is reached (6 marks)
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5. Copper contains about  $10^{29}$  free electrons per cubic metre. 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 =  $1.7 \times 10^{-8} \Omega \text{ m}$ ) (5marks)
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6. The SONEL thermal plant in Limbe supplies SONARA with 1.0 MW at a p.d of  $1.0 \times 10^4 \text{ V}$ . The total resistance between the power station and the factory is  $0.5 \Omega$ .
- (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 (5 marks)
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7. An observer is standing at the bank of a stream. At what velocity will the observe see a boat sailing at  $50 \text{ cm s}^{-1}$  relative to a stream which is flowing at  $10 \text{ cm s}^{-1}$ .
- (i) down stream
- (ii) perpendicular to the flow of the stream (5 marks)

**SECTION II (one and a half hours)**

*Answer all questions*

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

**EITHER 8 (a), (b) and (c)**

8. (a) (i) Differentiate between longitudinal waves 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 (10 marks)
- (b) Light is travelling in glass A with speed  $1.9568 \times 10^8 \text{ m s}^{-1}$ . It reaches an interface with a different glass B, at an angle slightly greater than the critical angle of  $87.60^\circ$  and undergoes total internal reflection.
- (i) Explain with the aid of diagram what is meant by the terms critical angle and total internal reflection
- (ii) Calculate the speed of light glass B. (6 marks)
- (c) An observer travelling with a constant velocity of  $25 \text{ m s}^{-1}$ , passes close to a stationary source of sound and notices that there is a change of frequency of 60 Hz as he passes the source. What is the frequency of the source. (4 marks)

**OR 8 (d, e and f)**

8. (d) (i) Define the specific heat of vaporisation
- (ii) Describe an experiment to determine the specific heat of vaporisation of water. Your description should include a diagram, procedure and precautions, observations, calculations and conclusion. (10 marks)
- (e) An office uses a water tank containing  $1.2 \text{ m}^3$  water as a thermal store. The water in the tank is heated to  $98^\circ\text{C}$  in the night when there is less electrical energy consumption. In the morning when it is very cold, the water is pumped round the office to keep the office warm:

Turn over

- (i) Calculate the energy given out by the water on a day that the temperature drops from  $98^{\circ}\text{C}$  to  $65^{\circ}\text{C}$ . (3 marks)
  - (ii) The four radiators in the office give out an average power of 1.5 kW each. For how long can they all operate at this power before the water temperature drops to  $65^{\circ}\text{C}$ ? (2 marks)
  - (iii) Explain why this heating system operates more effectively in the morning than in afternoon. (2 marks)
- (f) State with reason two thermometric properties. (3 marks)

Answer either 9 (a), (b) and (c) or 9 (d) and (e)

EITHER 9a, b, and c

9. (a) (i) Define capacitance. (6 marks)
- (ii) What are the physical factors on which the capacitance of a parallel plate capacitor depend.
- (iii) How would you relate capacitance to relative permittivity.
- (b) Figure 3 shows a circuit for charging and discharging of a capacitor using a two way switch.

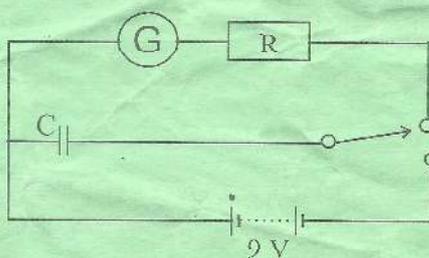


Figure 3

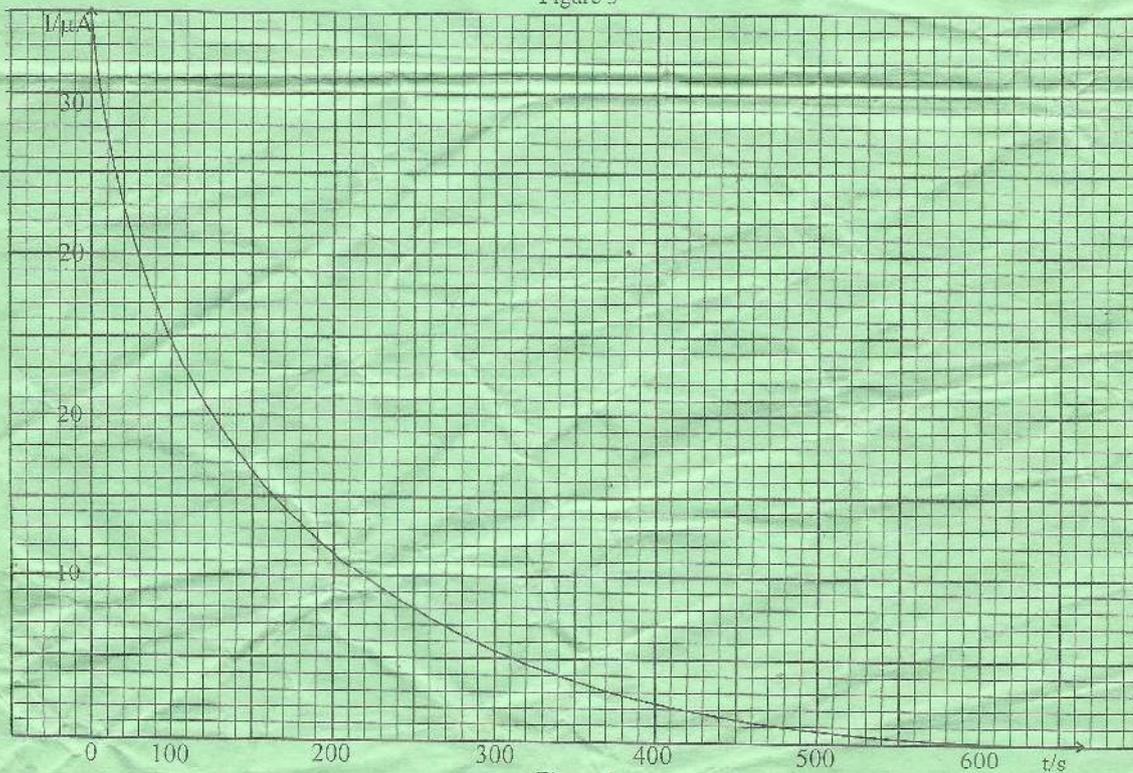


Figure 4

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The graph Figure 4, 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 process
- (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 the  $R$  were increased.

(10 marks)

- (c) A  $5.0 \mu\text{F}$  capacitor and an  $8.0 \mu\text{F}$  capacitor are charged by a  $12 \text{ V}$  battery. The two capacitors are then connected as shown in Figure 5.

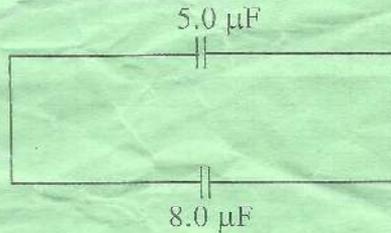


Figure 5

Calculate the charge on the  $5.0 \mu\text{F}$  capacitor, as shown in Figure 5.

(4 marks)

OR 9(d and e)

9. (d) Distinguish between intrinsic and extrinsic semiconductor. (3marks)

- (e) The output characteristics in Figure 7 are for the transistor circuit show in figure 6

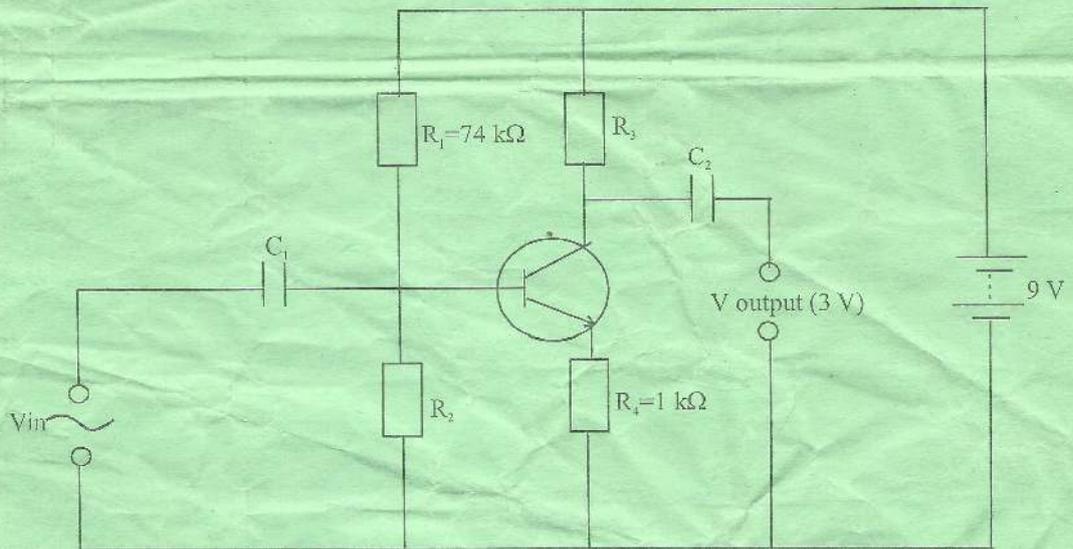


Figure 6

Turn over

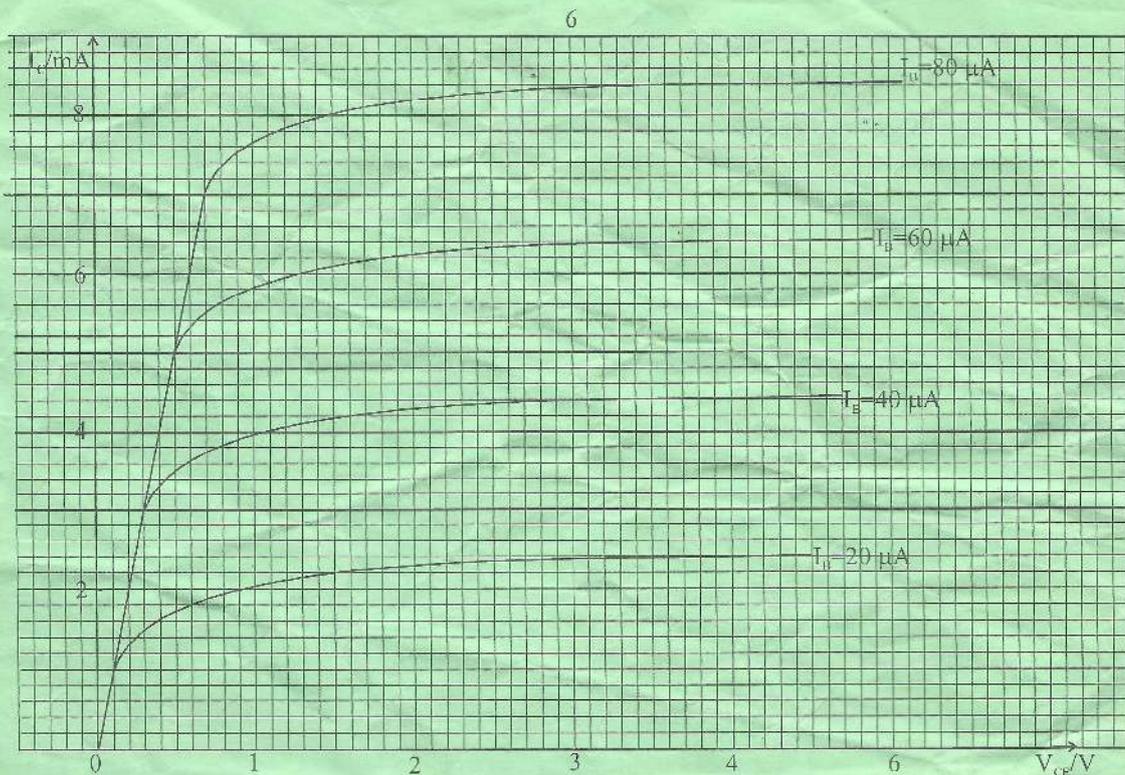


Figure 7

- (i) Construct a table of values which would enable you draw the transfer characteristic at constant  $V_{CE}$  of 3.5V. Hence draw a graph from which you could obtain the current gain  $h_{FE}$  for the transistor. What is the value of  $h_{FE}$ . (7 marks)
- (ii) What are the functions of  $R_3$ ,  $C_1$  and  $C_2$  (3 marks)
- (iii) Calculate  $R_3$  and  $R_2$

Given that current through  $R_4 = 1\text{mA}$ , current through  $R_3 = 1\text{mA}$  and  $V_{BE} = 0.6\text{V}$  (6 marks)

State the type of capacitor used in the circuit (1 mark)

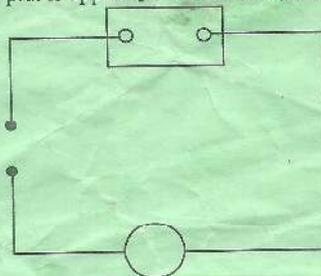
Answer either 10 (a), (b) and (c) or 10 (d), (e) and (f)

EITHER 10 (a), (b) and (c)

10. (a) Explain what is meant by the emf and terminal p.d of a battery. Why is the p.d between the terminals of a battery not always the same as the emf. (4 marks)
- (b) The emf of the electricity supply to a rural farm house is 240V. 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 220V. If the resistance of the cooker is  $40\Omega$ 
  - (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 (7 marks)

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- (c) A semi conductor diode and a resistor of constant resistance are connected in some way inside a 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.

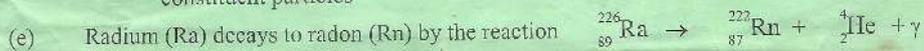


Ammeter  
Figure 8

- (i) What is the most likely arrangement of the resistor and diode? Explain your deduction (3 marks)  
 (ii) Calculate the resistance of the resistor and the forward resistance of the diode (6 marks)

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

- 10 (d) (i) State the observations obtained from the Rutherford  $\alpha$ -scattering experiment with a thin metal foil. What conclusions may be deduced from each of these observations? (6 marks)  
 (ii) Explain how and why the masses of compound differ from the sum of the masses of their constituent particles (2 marks)



- (i) Estimate the energy (in joules) released when an atom of  ${}^{226}\text{Ra}$  decays  
 (ii) Estimate the wavelength of gamma photon emitted during this decay given that 4% of the energy released turns to gamma radiation.  
 (iii) What happens to the remaining 96% of the energy..

The atomic masses are radium =  $3.753 \times 10^{-25}\text{kg}$ , radon =  $3.686 \times 10^{-25}\text{kg}$ , helium =  $0.066 \times 10^{-25}\text{kg}$  (8 marks)

- (f) An  $\alpha$ -particle is accelerated to attain a kinetic energy of  $1.34 \times 10^{-15}\text{kJ}$  collides head-on with a gold nucleus. Calculate the upper limit of the radius of gold nucleus. (The proton number of gold is 79) (4 marks)