SECTION A: PHYSICAL SCIENCE

*Answer **ONE** question from this section.*

1. (a) Describe the **three** modes of radioactive decay. (6 marks)

(b) Explain how neutron-proton ratio affects the stability of isotopes. (2 marks)

(c) State **five** characteristics of plane progressive waves. (5 marks)

(d) The displacement y of a plane progressive wave is given by $y = 0.03\,Sin\,(200\pi t - 0.5\pi x)$ where y and x are in metres and t is in seconds. Determine the:

(i) amplitude;
(ii) wavelength;
(iii) velocity of the wave.

(7 marks)

2. (a) Draw a labelled pH scale for a universal acid-base indicator. (4 marks)

(b) (i) State Newton's law of cooling.

(ii) The temperature of a body in a room dropped from 32 °C to 27 °C in 3 hours. If the room temperature is kept constant at 20 °C, determine the time it takes the body's temperature to fall from 27 °C to 23 °C.

(7 marks)

(c) Distinguish between damped vibration and forced vibration. (4 marks)

(d) (i) Define the term period as applied to simple harmonic motion.

(ii) Figure 1 shows a mass attached to a horizontal spring and set into a simple harmonic motion. Derive an expression for the periodic time.

(5 marks)

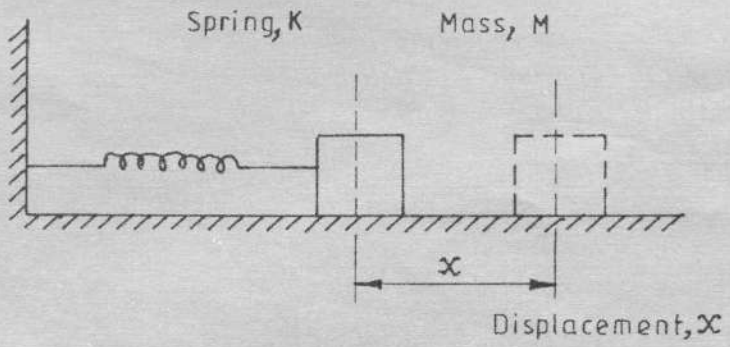

Fig. 1

SECTION B: MECHANICAL SCIENCE

*Answer **ONE** question from this section.*

3. (a) Define the following terms:

(i) work;
(ii) energy;
(iii) power.

(3 marks)

(b) (i) State the principle of conservation of energy.

(ii) Explain the energy conversion occurring when a mass is attached to one end of a helical spring and the system set in vertical oscillation.

(7 marks)

(c) Distinguish between 'principle of moments' and 'moment of a couple' as applied to co-planar forces. (4 marks)

(d) Figure 2 shows a rectangle representing a system of forces. Determine the magnitude of the resultant force. (6 marks)

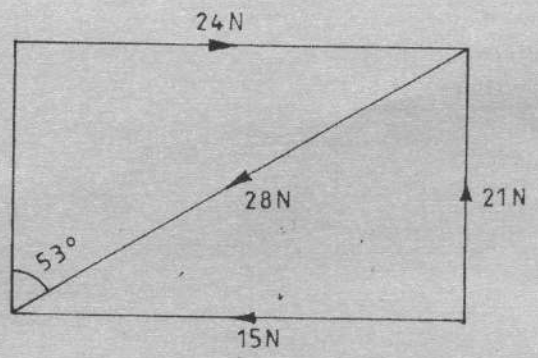

Fig. 2

4. (a) Define the following terms as applied to circular motion:

(i) angular velocity;
(ii) centripetal force;
(iii) centrifugal force.

(6 marks)

(b) With aid of a diagram, describe how U-tube manometer is used to measure gauge pressure of a gas. (5 marks)

(c) (i) State **three** conditions for an ideal heat engine to achieve the Carnot cycle efficiency.

(ii) A steam plant consumes 36.4 tonnes of coal per hour of calorific value 37 MJ/kg. The power output of the turbines is 120 MW. The upper and lower temperatures of the working fluid are 400 °C and 30 °C respectively. Determine:

(I) the overall efficiency of the plant;

(II) the Carnot cycle efficiency. (9 marks)

SECTION C: ELECTRICAL ENGINEERING PRINCIPLES

*Answer **THREE** questions from this section.*

5. (a) Define the following with reference to electric circuits;

(i) Node;

(ii) Branch;

(iii) Loop. (3 marks)

(b) Figure 3 shows a d.c. bridge circuit. Determine the branch currents i_a, i_b and i_c. (6 marks)

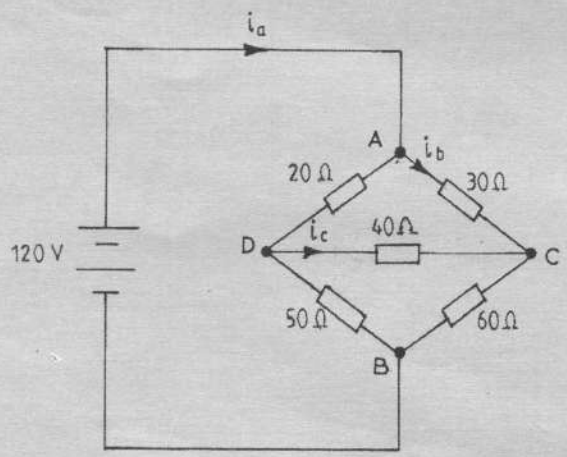

Fig. 3

(c) Write the general expression of a sine-wave and state the meaning of each of the parameters. (5 marks)

(d) A 10 Ω resistor is connected to a 200 V, 50 Hz supply. Determine the:

(i) peak value of current;

(ii) average value of current;

(iii) power dissipated. (6 marks)

6. (a) (i) State the **three** basic SI units and their quantities as used in measurements.

(ii) With aid of a diagram, explain how an ammeter and voltmeter are connected in electric circuits.

(8 marks)

(b) Distinguish between primary and secondary cells. (2 marks)

(c) A primary cell with an e.m.f. of 1.5 V and internal resistance of 0.1 Ω is connected to a circuit of 30 Ω resistance. Determine the:

(i) current flowing in the circuit;

(ii) current in the circuit if supplied from twelve similar cells connected in parallel.

(4 marks)

(d) With aid of a diagram, describe the construction of a lead acid cell. (6 marks)

7. (a) With aid of a circuit diagram explain the operation of a single phase transformer on No-load. (6 marks)

(b) Explain **two** types of iron losses occurring in transformers. (4 marks)

(c) A 400 kVA transformer has primary winding resistance of 0.5 Ω and secondary winding resistance of 0.001 Ω. The iron loss is 2.5 kW, primary and secondary voltages are 5 kV and 320 V respectively. If power factor of the load is 0.85, determine the efficiency of the transformer. (10 marks)

8. (a) Table 1 shows the comparison between electric and magnetic circuits. Complete the table. (5 marks)

Table 1

Electric circuit	Magnetic circuit
$I = E/R$	
	Permanence
Resistivity (ℓ)	
	Magnetic field intensity (B)
Current density $= \frac{\text{Electric field intensity}}{\text{Resistivity}}$	

(b) An air cored toroidal coil has 3000 turns and carries a current of 0.1 A. The length of the magnetic circuit is 15 cm while the cross-sectional area of the coil is 4 cm^2. Determine the:

(i) magnetic field strength;
(ii) total flux in the coil.

(5 marks)

(c) (i) State **four** properties of dielectrics.

(ii) Derive the expression for capacitance of a parallel plate capacitor.

(10 marks)

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