

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)
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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)

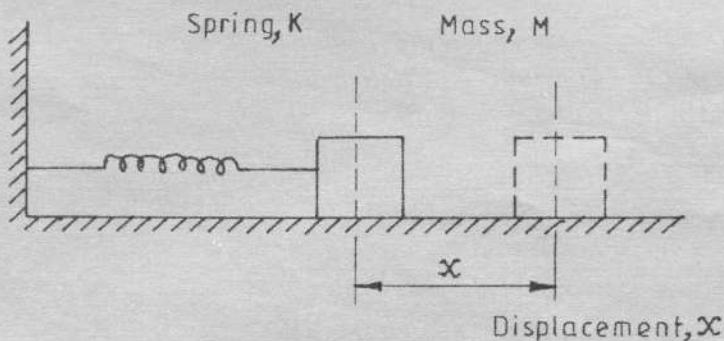


Fig. 1

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)

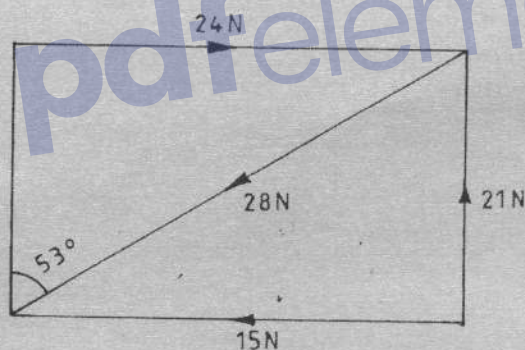


Fig. 2

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)

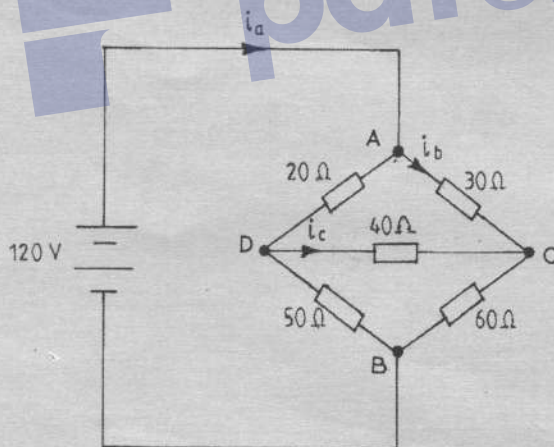


Fig. 3

- (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. (8 marks)
- (ii) With aid of a diagram, explain how an ammeter and voltmeter are connected in electric circuits. (2 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 0.1Ω is connected to a circuit of 30Ω resistance. Determine the:
- (i) current flowing in the circuit;
- (ii) current in the circuit if supplied from ¹² 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 0.5Ω and secondary winding resistance of 0.001Ω . 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
$I = \frac{E}{R}$	
	Permanence
Resistivity (ℓ)	
	Magnetic field intensity (B)
Current density Electric field intensity $= \frac{\text{Electric field intensity}}{\text{Resistivity}}$	

- (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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