June 2002

GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each part question are shown in brackets

1. *(a)* Explain the essential requirement for heat energy transfer to take place. (2)

   (b) State the unit in which heat energy is measured. (1)

   (c) Calculate the quantity of heat required to increase the temperature of 2.25 kg of a substance by 220°C. (5)

   Note: the specific heat capacity of the substance is 0.394 kJ/kg K.

2. *(a)* Define Charles' Law for a perfect gas. (3)

   (b) The specific volume of a certain gas is $0.625 m^3/kg$ at 20°C.

   (i) Determine the specific volume when the temperature is raised to 150^{C}C, if the pressure remains constant. (4)

   (ii) Determine the work done on the surroundings, per kilogram of gas, if the expansion was carried out at a pressure of 12 bar. (3)

3. An iron casting has a volume of $0.42 m^3$ at 100°C. Its temperature falls to 12°C.

   Determine EACH of the following:

   (a) the final volume; (5)

   (b) the percentage reduction in volume. (4)

   Note: The coefficient of linear expansion of cast iron is 0.000011/°C.

4. A carbon block of mass 0.75 kg is completely burnt in a furnace to form carbon dioxide. In the process 15% excess air was used.

   Determine the mass of air actually supplied. (8)

   Note: Air contains 23% oxygen by mass. Atomic mass: carbon =12; oxygen = 16.

5. *(a)* State the formula for calculating the *Indicated Power* of an engine unit, defining EACH of the symbols and units used. (4)

   (b) A two-cylinder two-stroke single-acting engine develops an indicated power of 12.8 kW at a speed of 2300 rev/min. The piston diameter of the engine is 80 mm and the length of the engine stroke is 120 mm.

   Calculate the mean effective cylinder pressure *in bar*. (6)

6. State FIVE desirable properties of a refrigerant fluid. (5)

7. *(a)* Describe the general structure of an atom. (5)

(b) Explain, with the aid of sketches, how an electric current flows through a metallic conductor. (5)

8. For the circuit diagram shown in Fig. Q.8, calculate EACH of the following:

(a) the pd across the 7 Ω resistance; (5)

(b) the current through each resistor. (4)

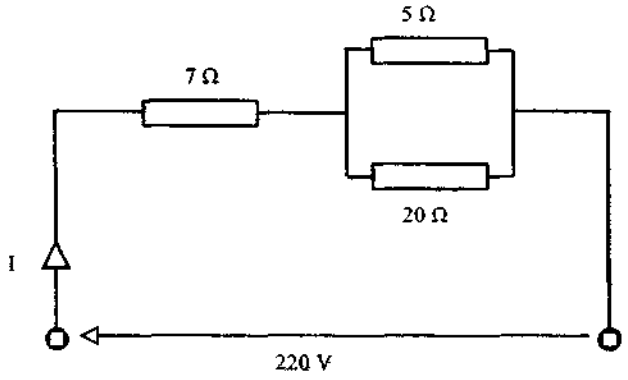

Fig. Q.8

9. *(a)* State what is meant by the *temperature coefficient of resistance* of a material. (3)

(b) A copper rod is 0.4 m long, 4.0 mm in diameter and has a resistance of 55 Ω at room temperature 20°C.

Calculate the *resistivity* of the wire at that temperature. (6)

10. *(a)* Explain the term *internal resistance* of an electric cell, stating the effect it has on the terminal voltage of the cell. (4)

(b) The emf of a cell is 1.5 V and its terminal voltage is 1.3 V when delivering a current of 0.8 A.

Calculate the internal resistance of the cell. (5)

11. *(a)* State *Faraday's Law* of electromagnetic induction. (3)

(b) A steady current flowing in a coil of 1500 turns produces a magnetic flux of 2.5 mWb.

Calculate the average value of the emf induced in the coil when the current is reversed in 0.2 seconds. (4)

12. Explain, with the aid of circuit diagrams, how a moving coil test meter can be adapted to measure EACH of the following:

(a) larger currents; (3)

(b) larger voltages. (3)