GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each part question are shown in brackets

1. An aluminium beaker weighing 0.68kg contains 2.5kg of pure water. Initially the combined mass of water and aluminium is at a temperature of 18°C. Heating takes place until the combined mass is at a new temperature of 90°C.

   Calculate the heat energy input required to cause this temperature rise. (8)

   Note: there are no heat energy losses during heating;
   the specific heat capacity of water is 4.2kJ/kgK;
   the specific heat capacity of aluminium is 0.9kJ/kgK.

2. *(a)* State Charles' law for a perfect gas. (2)

   (b) Express Charles' law as an equation, stating the units used. (2)

   (c) A perfect gas has a specific volume of $0.75m^3/kg$ at a temperature of 25°C.

   Calculate the new value of specific volume when the temperature is raised to 155°C while the pressure remains constant. (6)

3. *(a)* State what is meant by *combustion.* (1)

   (b) List THREE conditions necessary for combustion to occur. (3)

   (c) Calculate the mass of *air* needed to completely burn EACH of the following:

   (i) 0.8 kg Carbon; (3)
   (ii) 0.15 kg Hydrogen. (3)

   Note: Relative atomic masses: Oxygen 16; Hydrogen 1; Carbon 12.

   Air contains 23% oxygen by mass.

4. An oil engine developing an indicated power of 40 kW uses 10 kg of oil per hour.

   The brake power is 32 kW. Calculate EACH of the following:

   (a) the brake specific fuel consumption of the engine; (3)

   (b) the mechanical efficiency of the engine. (3)

5. With reference to refrigeration plant, state SIX desirable properties of an effective refrigerant fluid. (6)

6. A steel ball bearing race has a nominal diameter of 80 mm at 20°C. Its diameter must be reduced by 0.03 mm in order to assemble it in a housing.

   Determine the temperature to which it must be cooled for assembly. (8)

   Note: The coefficient of linear expansion of steel is $12 \times 10^{-6}/°C$

7. *(a)* State the THREE main effects of an electric current. (3)

(b) State TWO practical applications of EACH effect in Q.7(a). (6)

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)

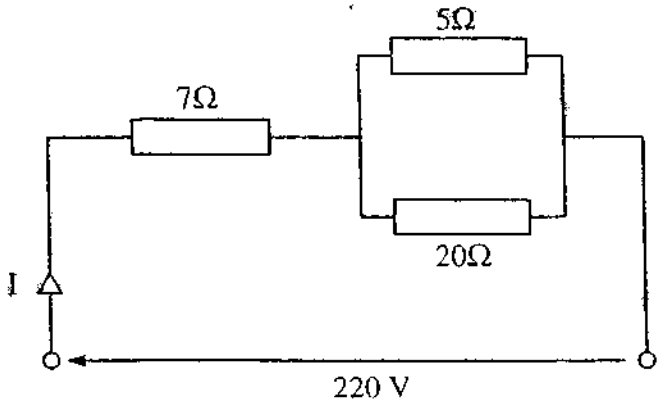

Fig. Q.8

9. *(a)* State what is meant by the *temperature coefficient of resistance* of a material. (4)

(b) A copper rod is 0.6m long, 3.0mm in diameter and has a resistance of 750 μΩ.

Calculate the *resistivity* of the wire. (4)

10. *(a)* Fig. Q.10 illustrates an electrical relay circuit used in an engineering control system. Describe the operation of the relay when Switch S is closed. (6)

(b) State a practical application for a moving iron device. (2)

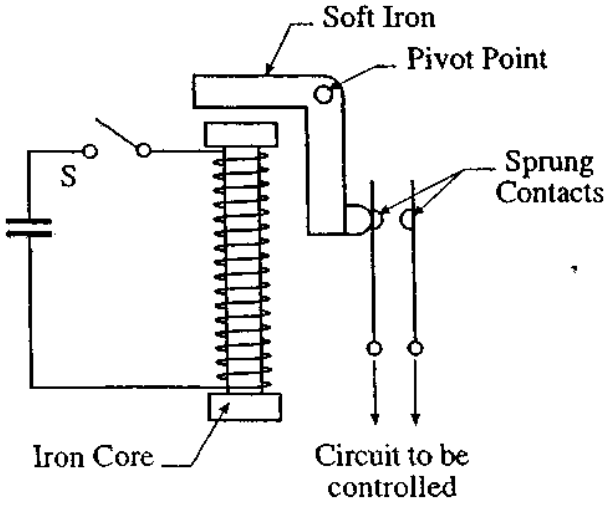

Fig. Q.10