June 2001

GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each part question are shown in brackets

1. An engine cylinder liner has a bore of 170 mm. The overall piston clearance at 25°C is 1.3 mm.

   Determine the temperature at which the piston will just seize in the liner. (8)

   Note: The coefficient of linear expansion of the piston material is 21×10^{-6}/°C
   The coefficient of linear expansion of the liner is 7×10^{-6}/°C

2. An aluminium beaker weighing 0.8 kg contains 2.5 kg 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 90°C.

   Calculate the heat energy required. (8)

   Assume: there are no heat losses
   the specific heat capacity of water is 4.2 kJ/kgK
   the specific heat capacity of aluminium is 0.39kJ/kgK

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

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

   (c) A perfect gas has a specific volume of 0.75 m^3/kg at a temperature of 30°C. Calculate the specific volume when the temperature is raised to 187°C while the pressure remains constant. (6)

4. *(a)* State the chemical formulae for EACH of the following compounds associated with combustion:

   (i) Water; (1)
   (ii) Carbon dioxide; (1)
   (iii) Carbon monoxide; (1)
   (iv) Sulphur dioxide. (1)

   (b) State TWO reasons why it is undesirable to have insufficient air supplied in a combustion process. (4)

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

6. An internal combustion engine develops 500 kW at the output shaft. It has an indicated specific fuel consumption of 160g/kWh and consumes fuel at a rate of 110kg/h.

   Determine EACH of the following:

   (a) the mechanical efficiency of the engine; (5)

   (b) the brake thermal efficiency given that the calorific value of the fuel is 40.8 MJ/kg. (5)

7. *(a)* Describe, with the aid of a labelled sketch, the structure of an atom. (6)

(b) Describe how electric current flows through a metallic conductor. (4)

8. For the circuit shown in Fig. Q.8 determine EACH of the following:

(a) the supply current; (4)

(b) the potential differences across the 19 Ω. and the 4 Ω resistors. (4)

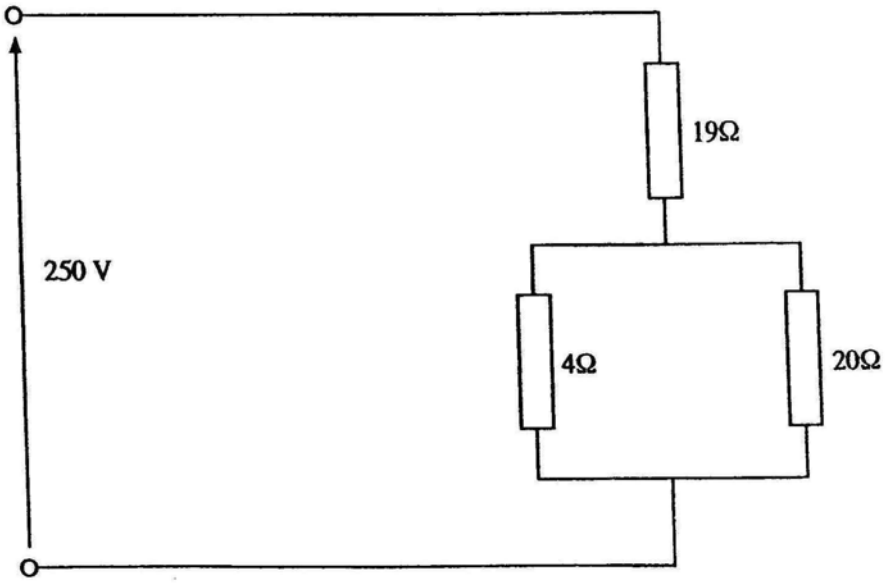

Fig. Q.8

9. The element of an electric heater has a resistance of 28 Ω and is connected to a 220 volt supply for a period of 7 hours.

Determine EACH of the following:

(a) the current flowing; (2)

(b) the power supplied in kW; (3)

(c) the energy consumed in kWh. (3)

10. *(a)* Name THREE effects produced by an electric current. (3)

(b) Describe how the state of charge held in a lead-acid secondary cell is normally measured. (2)

(c) Name the instrument used to take the measurement in *Q.10(b)* and describe how it is used. (3)

11. *(a)* State Lenz's Law. (2)

(b) A magnetic flux of 4mWb is produced by a current carrying coil having 220 turns. The current direction is completely reversed during a time period of 0.25 s.

Calculate the magnitude of the emf induced in the coil. (4)

12. With reference to a moving coil electrical test instrument:

(a) sketch and label the main components; (6)

(b) explain the principle of its operation. (4)