

10/12/21

## GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each question are shown in brackets

All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer

### Section A

1. An aluminium vessel has a mass of 3 kg and contains 2 kg of water at a temperature of 12°C. A further 5 kg of water at 40°C is added to the vessel and there are no heat losses.

Calculate the final temperature of the vessel and water. (8)

*Note: the specific heat of aluminium = 0.95 kJ/kgK  
the specific heat of water = 4.18 kJ/kgK*

2. A iron casting has a volume of 0.422 m<sup>3</sup> at 812°C. Its temperature falls to 10°C.

Calculate EACH of the following:

(a) the final volume; (4)

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

*Note: the coefficient of linear expansion of cast iron = 0.000011/°C.*

3. A perfect gas at an initial pressure, temperature and volume of 1 bar, 18°C and 35 litres respectively is compressed according to Boyles Law until the volume is 15 litres. Heating then causes an expansion according to Charles Law until the temperature is 160°C.

Calculate EACH of the following:

(a) the final pressure; (3)

(b) the final volume; (3)

(c) the mass of gas. (3)

*Note: R = 0.29 kJ/kgK*

4. (a) In combustion explain what is meant by the Stoichiometric air to fuel ratio. (3)
- (b) With reference to internal combustion engines describe the effect of supplying:
- (i) inadequate air; (3)
- (ii) excess air. (3)

5. A 4 stroke diesel engine is tested over a 24 hour period and uses 18.2 tonnes of fuel. The power of the engine is tested using a dynamometer which gives a steady state torque reading of 48 kNm at 800 rpm. The mechanical efficiency was later found to be 87%.

Calculate EACH of the following:

- (a) the brake power; (4)
- (b) the indicated specific fuel consumption. (4)

*Note: the calorific value of the fuel = 44 MJ/kg*

6. (a) With the aid of a P-h diagram, describe the condition of the refrigerant fluid as it flows around the basic vapour compression plant. (4)
- (b) List the energy changes that occur across EACH item of plant in the basic refrigeration system of Q6(a). (4)

**Section B**

7. The circuit shown in Fig Q7 is connected across a 36 V supply. The power dissipated in the network is 540 W.

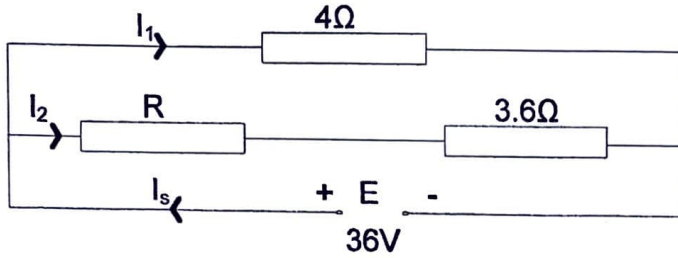


Fig Q7

Calculate EACH of the following:

- (a) the value of the unknown resistor R; (5)
  - (b) the power dissipated by this resistor; (2)
  - (c) the total energy consumed by the circuit in 2 hours (2)
8. An electric fire operated from a 230 V supply has a heating element comprising of two  $25\ \Omega$  coils. The coils may be connected in series to give a low setting, or in parallel to give a high setting.

Calculate EACH of the following:

- (a) the power output for the low setting; (4)
- (b) the power output for the high setting. (4)

9. The circuit in FIG Q9 has a voltmeter as shown. When the switch is open the reading on the voltmeter is 30 V, when the switch is closed the voltage drops to 26.67 V.

(a) Explain the reason for the change in the voltmeter readings. (4)

(b) Determine the resistance of the cell. (4)

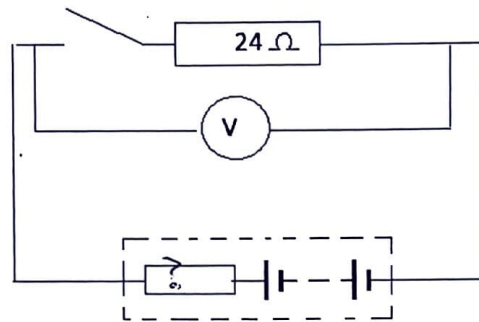


FIG Q9

10. (a) Define the resistivity of a material. (3)

(b) The resistance of 1.9 km of copper wire of 0.5 mm diameter is 170 ohms.

Calculate the resistance of 1 km of iron wire of 1 mm diameter. (5)

*Note: the resistivity of iron = 5.9 x resistivity of copper.*

11. A rectangular river dam is 30 m wide and is flooded to its top edge, on one side only, with water of density  $1005 \text{ kg/m}^3$ .

Calculate EACH of the following:

(a) the height of the dam, if the thrust under the flooded condition is 30MN; (5)

(b) the pressure at a point 2.24 m above the base of the dam. (4)

12. A ship has a displacement volume of  $3440 \text{ m}^3$  in sea water.

Calculate the mass,  $m$ , which when loaded on the centre line at a Kg of 4.8 m will cause a change of + 0.25 m in the position of the ship's centre of gravity. (8)

*Note: KG = 3.5 m and density of sea water =  $1025 \text{ kg/m}^3$*