

## GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each question are shown in brackets.

### Section A

1. (a) Explain what is meant by the term specific heat capacity and why are the units J/kgK. (4)
- (b) An iron casting has a mass of 30 kg and a temperature of 400°C. Determine its temperature after losing 1950 kJ of heat energy. (4)

*Note: Specific Heat Capacity of Cast Iron = 477 J/kgK*

2. (a) Explain why metals expand as their temperature rises. (3)
- (b) A copper ball has a diameter of 55.25 mm at a temperature of 595°C.
- Calculate the temperature at which the ball will just drop through a hole of 54.95 mm. (5)

*Note: Co-efficient of linear expansion of copper = 0.0000167/°C*

3. Argon has a volume of 0.7 m<sup>3</sup> at 3.5 bar and a temperature of 25°C. The Argon is now heated in its vessel until the pressure reaches 1.05 MN/m<sup>2</sup> the volume is unchanged.

Determine EACH of the following:

- (a) the mass of Argon; (4)
- (b) the final temperature of the Argon. (4)

*Note: The characteristic gas constant for Argon has a value of 208 J/kgK.*

4. A perfect gas at an initial pressure, temperature and volume of 10 bar, 28°C and 74 litres respectively is compressed according to Boyle's Law until the volume is 26 litres.

Heating then causes an expansion according to Charles's Law until the temperature is 180°C.

Determine EACH of the following:

- (a) the final pressure; (3)
- (b) the final volume; (3)
- (c) the mass of gas. (3)

Note:  $R = 0.29 \text{ kJ/kgK}$

5. A diesel engine uses 28 kg of fuel per hour. The indicated power of the engine is 132 kW and the mechanical efficiency is 91%.

Determine EACH of the following:

- (a) the brake power; (3)
- (b) the indicated specific fuel consumption; (3)
- (c) the brake thermal efficiency. (3)

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

6. (a) State TWO desirable properties of refrigerants. (2)
- (d) In a vapour compression refrigeration plant, state the primary function of EACH of the following:
- (i) the condenser; (2)
  - (ii) the expansion valve; (2)
  - (iii) the evaporator. (2)

**Section B**

7. A circuit consists of three resistors connected in parallel. The resistors have values of 150 ohm, 220 ohm and 180 ohm. The circuit is powered from a battery which has an e.m.f. of 29 volts and an internal resistance of 4 ohms.

Determine EACH of the following:

- (a) the battery terminal voltage; (5)
- (b) the current in EACH resistor. (3)

8. Fig Q8 shows TWO 12 V lamps, EACH of  $4\ \Omega$  resistance connected in parallel across a 20 V supply.

To avoid exceeding the current rating for the lamps a resistor of  $1.33\ \Omega$  is connected in series with the supply.

Determine EACH of the following:

- (a) the power dissipated by each lamp; (5)
- (b) the power dissipated by the  $1.33\ \Omega$  resistor; (2)
- (c) the total energy used by the circuit in 30 minutes. (3)

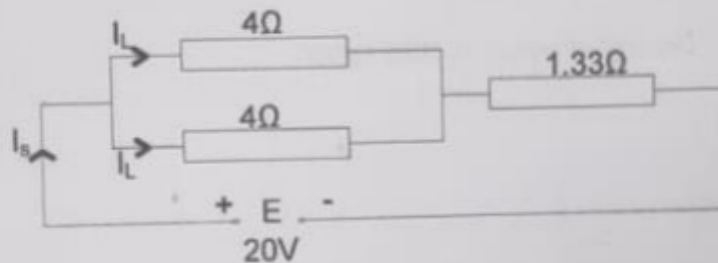


FIG Q8

9. (a) State the THREE main effects of an electric current. (3)
- (b) State TWO practical examples of EACH effect in Q9(a). (3)
- (c) List FOUR means by which electricity may be produced. (2)

10. (a) State Lenz's Law. (3)

(b) A conductor with an effective length of 300 mm creates a magnetic flux of  $250 \mu\text{Wb}$  when carrying a current of 45 A at right angles to a magnetic field. The force on the conductor is 34 N.

Determine the diameter of the conductor. (5)

11. A ship of 10000 tonne displacement has a rectangular fuel tank 15 m long, 12 m wide and 4 m deep. The tank is across the centreline and is full of fuel oil with a density of  $900 \text{ kg/m}^3$  and the tank bottom is 1.2 m above the keel. The KG of the vessel is 6.2 m when the tank is full.

Determine the new KG after all of the oil has been used. (8)

12. (a) State Archimedes principle. (2)

(b) After discharging ballast at a depth of 30 m underwater an ROV can be equated to an empty sphere of 700 mm diameter.

Determine EACH of the following:

(i) the buoyancy force on the ROV; (3)

(ii) the pressure on the ROV. (3)

Note: Density of water is  $1020 \text{ kg/m}^3$