GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each question are shown in brackets.

Section A

1. (a) Define the term *thermal coefficient of expansion.* (2)

   (b) A copper ball has a diameter of 40.25 mm at a temperature of 550°C.

   Calculate the temperature at which the ball will just drop through a hole of 40 mm. (6)

   Note: co-efficient of linear expansion of copper = 0.000018/°C

2. (a) State Boyles Law. (2)

   (b) 500 litres of a perfect gas at a pressure of 1 bar has a temperature of 15°C. It was heated until its temperature was 135°C. The pressure remains constant.

   Calculate EACH of the following:

   (i) the mass of the gas; (2)

   (ii) the quantity of heat that was transferred to the gas; (2)

   (iii) the final volume of the gas. (2)

   Note: R = 0.265 kJ/kgK Cp = 1.05kJ/kgK

3. Methane (CH_4) is completely burned in 25% excess air by mass.

   Calculate EACH of the following:

   (a) the mass of carbon dioxide in the exhaust gases per kg of fuel; (5)

   (b) the mass of oxygen in the exhaust gases per kg of fuel. (5)

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4. The following parameters may be determined during the analysis of a diesel engine.

Define EACH of the following terms, stating the formula for calculating the values of such:

(a) indicated power; (2)

(b) brake power; (2)

(c) Power loss to lubricating oil; (2)

(d) Power loss to exhaust. (2)

5. (a) State TWO thermodynamic and TWO general properties of required of a good refrigerant. (2)

(b) For the FOUR key points in a simple refrigeration circuit, state the condition of the refrigerant. (6)

6. (a) Describe how changes of state occur without change in temperature. (2)

(b) A metal component with a mass of 1.15 kg at 600°C is quenched by immersion in 5 kg of water at 20°C. The combined final temperature of the water and metal is 36°C.

Determine the Specific Heat Capacity of the metal. (6)

Note: the Specific Heat Capacity of water is 4.18 kJ/kgK.

Section B

7. (a) Copper is commonly used as a conductor of electricity. In relation to its atomic structure, state why is it a good conductor of electricity. (3)

(b) Cables with copper conductors often have PVC insulation. In relation to its atomic structure, state why PVC is it not a good conductor of electricity. (3)

(c) State why conductors have power losses. (2)

(d) State how can power losses be determined in conductors. (2)

8. (a) List TWO means by which electricity may be produced. (2)

(b) State TWO main effects of an electric current. (2)

(c) Explain which electrical effect is being made use of in:

(i) a cartridge fuse; (2)

(ii) a solenoid. (2)

9. TWO resistors of 20 Ω and 40 Ω respectively are connected in series across a 240V supply

Calculate the supply current when a single 100 Ω resistor is connected in parallel with:

(a) the 20 Ω resistor only; (4)

(b) the 20 Ω and 40 Ω resistors in series. (4)

10. A conductor has an effective length of 300 mm and a diameter of 9.5 mm. The force on the conductor is 18 N when it is carrying a current of 25 A at right angles to a magnetic field.

Calculate EACH of the following:

(a) the flux density; (4)

(b) the magnetic flux. (4)

11. A standard shipping container 12.192 m long x 2.438 m wide x 2.591 m high is lost overboard with a mass of 29 tonnes and floats on its side in sea water of density 1025 kg/m^3.

Calculate the height of the container above the water surface. (8)

12. A mass of 50 tonnes is loaded on board ship 4 m off the centreline creating a heel angle of 1.5°.

Determine the mass of the vessel before the load is added. (8)

Take: KM = 6 m, KG = 4.9 m, and $m \times d = \Delta\, GM \tan\theta$