

Sept 2005

GENERAL ENGINEERING SCIENCE II

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) State the Characteristic Gas Equation for a Perfect Gas. (2)
- (b) State the meaning of EACH of the symbols, with their associated SI unit, used in Q1(a). (5)

2. An aluminium vessel has a mass of 10kg and contains 6kg of water; both are at a temperature of 15°C. A mass of 5kg of water at 35°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* = 0.95kJ/kgK
 the specific heat of water = 4.12kJ/kgK

3. A mass of 1.1 tonne of copper drops in temperature by 86°C.

Calculate EACH of the following:

- (a) the final volume; (6)
- (b) the percentage reduction in volume. (3)

Note: *the coefficient of linear expansion of copper* = 0.000017 / °C
 density of copper = 8800kg/m³

4. Benzene (C₆H₆) is completely burned in 20% excess air.

Calculate EACH of the following:

- (a) the mass of carbon dioxide in the exhaust gases per kg of fuel; (4)
- (b) the mass of nitrogen in the exhaust gases per kg of fuel. (4)

Note: *relative atomic masses*

carbon = 12, hydrogen = 1, oxygen = 16, air contains 23% oxygen by mass

5. A diesel engine uses 25kg of fuel in two hours. The indicated power of the engine is 60kW and the mechanical efficiency is 90%.

Calculate EACH of the following:

- (a) the brake power; (2)
- (b) the indicated specific fuel consumption; (4)
- (c) the brake thermal efficiency. (4)

Note: the calorific value of the fuel = 40MJ/kg

6. (a) 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)

7. A battery of e.m.f. 42 volts and internal resistance 7 ohm feeds a circuit consisting of three resistors connected in parallel. The resistors have values of 2 ohm, 4 ohm and 8 ohm.

- (a) Sketch the circuit diagram. (2)
- (b) Calculate EACH of the following:
- (i) the battery terminal voltage; (4)
- (ii) the current in EACH resistor. (4)

8. (a) State the THREE main factors that an induced voltage across a coiled conductor is dependent upon. (6)
- (b) Calculate the e.m.f. induced in a coil of 200 turns when there is a change of flux of 25mWb linking with it in 50ms. (3)

9. A battery of 80 cells is charged through a fixed resistor from a 240V direct current supply. At the beginning of the charge, the e.m.f. per cell is 1.9V and the charging current is 5A. The internal resistance per cell is 0.06Ω.

Calculate the value of the fixed resistor. (6)

10. Describe the chemical changes that take place during the charging and discharging of a simple lead - acid cell. (7)
11. (a) State Lenz's Law. (2)
- (b) A rectangular coil wound with 42.5 turns of wire has a mean width of 25mm and a mean axial length of 20mm. The coil is placed in a uniform magnetic field of flux density 0.2T and a current of 15mA is supplied.
- Calculate the maximum torque on the field. (8)
12. (a) Describe EACH of the following:
- (i) a shunt; (1)
- (ii) a multiplier. (1)
- (b) Explain how EACH device in Q 12(a) is used in a measuring instrument. (6)