◗ Thermodynamics Questions

Correct answers are given in **bold**

1. Calculate the efficiency of a reversible heat engine operating between a hot reservoir at 900K and a cold reservoir at 400K.

(a) 33%
(b) 44%
(c) 55%
(d) 66%

2. A perfect gas at a pressure of 50 bar and a temperature of 500K has a density of 50 kg/m3. The ratio of specific heats γ is 1.48. Calculate the adiabatic increase in temperature if the pressure is raised to 60 bar.

(a) 30K
(b) 60K
(c) 90K
(d) 120K

3. Air is heated at a rate of 21kW as it flows at a steady rate through a horizontal duct. The mass flow rate of air is 3kg/s and at inlet, the air velocity is 25m/s. Between the inlet and outlet, the specific enthalpy increases by 6 kJ/kg. Calculate the air velocity at the exit.

(a) 4.7 m/s
(b) 6.3 m/s
(c) 12.6 m/s
(d) 44.7 m/s

4. A flammable gas mixture with a molar mass of 114 kg/kmol is burned in a rigid container with a fixed volume. Initially the pressure in the container is 200kPa and the temperature is 30℃. After the mixture has burned, the temperature is 900℃ and the specific gas constant is 400J/KgK. Calculate the final pressure, assuming the initial gas mixture and the products of combustion behave as perfect gases.

(a) 225 kPa
(b) 425 kPa
(c) 625 kPa
(d) 835 kPa

5. A 1kg aluminium block at 250℃ is quenched in a 10 litre bucket of water at 23℃. Calculate the equilibrium temperature of the water. You may assume that the specific heat capacities of aluminium and water are 900 and 4,187 J/kgK respectively.

(a) 42℃
(b) 63℃
(c) 86℃
(d) 104℃

6. Calculate the specific enthalpy of superheated steam at a pressure of 60bar and a temperature of 430℃, given that at 60bar, values of enthalpy are tabulated for temperatures T_1=400℃ (h_1=3177kJ/kg) and T_2=450℃ (h_2=3301kJ/kg).

(a) 3198 kJ/kg
(b) 3251 kJ/kg
(c) 3281 kJ/kg
(d) 3521 kJ/kg

7. Air flows at a steady rate of 0.2kg/s through an open system from (1) to (2). Gas velocity increases from 20m/s at (1) to 50m/s at (2). The temperature at (1) is 350K and the pressure ratio p_2/p_1 is 1.2. The change in potential energy of the flow is negligible. Treat air as a perfect gas with γ=1.4 and C_P=1005J/KgK.

Calculate the work done on the gas if the process is considered to be a reversible adiabatic process.

(a) 1kJ
(b) 2kJ
(c) 3kJ
(d) 4kJ

8. A 1.325 MW steam turbine receives steam at 6bar at a rate of 150kg/min. Steam leaves the turbine at a pressure of 0.07 bar, dryness fraction 0.9 and velocity of 300 m/s, while water leaves the condenser as a saturated liquid with negligible velocity. Calculate the input steam temperature.

(a) 225℃
(b) 325℃
(c) 425℃
(d) 525℃

9. Calculate the rate of heat loss through a 2m square double glazed window unit. You may assume that the heat transfer coefficient on the room side surface of the glass (h_{room}) is 8W/m2K; on the glass surface exposed to the outside ambient, the heat transfer coefficient (h_{out}) is 15W/m2K. The two glass panes in the double glazed unit are each 7mm thick and have a thermal conductivity of 0.8W/mK. Air fills the gap between the panes of the double glazed unit and this offers negligible resistance to heat transfer across the gap by conduction compared to convective heat transfer resistances at interior glass surfaces. The convective heat transfer coefficient for these surfaces is 5W/m2K. Room temperature in the house is maintained at 20℃ and the outside air temperature is 0℃.

(a) 13.1 W
(b) 65.5 W
(c) 131 W
(d) 655 W

10. Calculate the rate of radiative heat transfer from the moon. You may assume that the surface temperature of the moon is 123℃ and it has a diameter of 3474 km. The Stefan-Boltzmann constant is 56.7×10^{-9} W/m2K4.

(a) 5.28 × 106 W
(b) 5.28 × 108 W
(c) 5.28 ×1012 W
(d) 5.28 × 1016 W