Diagnostic Exam

Topic IV: Thermodynamics

1. 2 m^3 of an ideal gas is compressed from 100 kPa to 200 kPa. As a result of the process, the internal energy of the gas increases by 10 kJ, and 140 kJ of heat is lost to the surroundings. What is most nearly the work done by the gas during the process?

(A) −150 kJ

(B) −130 kJ

(C) −85 kJ

(D) −45 kJ

2. A cylinder fitted with a frictionless piston contains an ideal gas at temperature T and pressure p. The gas expands isothermally and reversibly until the pressure is $p/3$. Which statement is true regarding the work done by the gas during expansion?

(A) It is equal to the change in enthalpy of the gas.

(B) It is equal to the change in internal energy of the gas.

(C) It is equal to the heat absorbed by the gas.

(D) It is greater than the heat absorbed by the gas.

3. Consider the following balanced actual combustion reaction for propane.

$$C_3H_8 + 14.29(\text{air}) \rightarrow 4H_2O + 3CO + 11.29N_2$$

$3CO_3$

Assume air is 21% oxygen and 79% nitrogen by volume. What is most nearly the percent theoretical air?

(A) 50%

(B) 60%

(C) 68%

(D) 75%

4. In 1 hour, approximately how much black-body radiation escapes a 1 cm × 2 cm rectangular opening in a kiln whose internal temperature is 980°C?

(A) 20 kJ

(B) 100 kJ

(C) 130 kJ

(D) 150 kJ

5. Refrigerant HFC-134a at 0.8 MPa and 70°C is cooled and condensed at constant pressure in a steady-state process until it is a saturated liquid. Cooling water enters the condenser at 20°C and leaves at 30°C. If the mass flow rate of the refrigerant is 0.1 kg/s, the mass flow rate of the cooling water is most nearly

(A) 0.51 kg/s

(B) 0.65 kg/s

(C) 0.70 kg/s

(D) 0.75 kg/s

6. What is most nearly the melting temperature of sodium chloride, given that the latent heat of fusion is 30 kJ/mol, and the associated entropy change is 28 J/mol·K?

(A) 370K

(B) 880K

(C) 930K

(D) 1100K

7. Most nearly, what is the volume of 0.05 kg of refrigerant HFC-134a at 1.3 MPa with a quality of 37.5%?

(A) 9.6×10^{-5} m^3

(B) 1.7×10^{-4} m^3

(C) 3.1×10^{-4} m^3

(D) 2.2×10^{-3} m^3

8. Hot air at an average temperature of 100°C flows through a 3 m long tube with an inside diameter of 60 mm. The temperature of the tube is 20°C along its entire length. The average convective film coefficient is 20.1 $W/m^2 \cdot K$. What is most nearly the rate of convective heat transfer from the air to the tube?

(A) 520 W

(B) 850 W

(C) 910 W

(D) 1100 W