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Q. no. 1

(i) System:

In thermodynamics the system is defined as a definite space or area on which the study of energy transfer is made.

(ii) Surrounding:

Anything outside of the system which effects the behaviour of the system is called surrounding.
Example: Radiator, Air etc.

(iii) Adiabatic System:

Adiabatic system is a system in which no heat transfer occurs across the system boundary.

(iv) Isolated System:

A system in which no heat or mass transfer occurs

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across the boundary system is called Isolated system.

(v) Extensive Property:

Extensive Properties are those that change with the size of the system. If the size of the system double then value of extensive property doubles.

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Q: no. 2

Given data:

$P = 7\,bar$, $\hat{H} = 2600\,KJ/kg$.

$\hat{V} = ?$, $\hat{U} = ?$

Sol:

$$\hat{H} = h_f + x h_{fg}$$

$$2600 = 697.1 + x(2064.9)$$

$$2600 - 697.1 = x(2064.9)$$

$$x = \frac{1902.9}{2064.9}$$

$$\boxed{x = 0.921}$$

$$\hat{V} = V_f + x V_{fg}$$

$$= 0.001108 + (0.92)(0.273 - 0.001108)$$

$$= 0.001108 + (0.92)(0.271892)$$

$$= 0.001108 + 0.25041$$

$$\boxed{\hat{V} = 0.2515\ m^3/kg}$$

$$\hat{U} = U_f + x U_{fg}$$

$$= 696.3 + (0.921)(2571.1 - 696.3)$$

$$= 696.3 + (0.921)(1874.8)$$

$$\boxed{\hat{U} = 2420\ KJ/kg}$$

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Q. no. 3:

Given data:

$m = 10.0 kg$, $P_1 = 20 bar$, $V_1 = 1.0 m^3$

$P_2 = 100 bar$, $PV^{1.5} = const.$

Sol: $\hat{W} = ?$ $\hat{Q} = ?$

$$P_2 = \frac{100\ bar}{} \bigg| \frac{100\ kPa}{1\ bar}$$

$$= 10,000\ kPa = 10\ MPa.$$

$\hat{V}_2 = ?$

$$P_1\hat{V}_1^{1.5} = P_2\hat{V}_2^{1.5}$$

$$\hat{V}_2^{1.5} = \frac{P_1\hat{V}_1^{1.5}}{P_2}$$

$$\hat{V}_2 = \left(\frac{P_1\hat{V}_1^{1.5}}{P_2}\right)^{\frac{1}{1.5}}$$

$$\hat{V}_2 = \left[\frac{2MPa}{} \bigg| \left(\frac{0.1m^3}{kg}\right)^{1.5} \bigg| \frac{1}{10MPa}\right]^{\frac{1}{1.5}}$$

$$\hat{V}_2 = \left(0.2 \times (0.1)^{1.5}\right)^{\frac{1}{1.5}} m^3/kg$$

$$= (0.2 \times 0.0316)^{\frac{1}{1.5}}$$

$$= (0.2 \times 0.0516)^{0.667}$$

$$\hat{V}_2 = 0.0342\ m^3/kg$$

Now: $\Delta U = \hat{Q} + \hat{W}$

At this state $P_1 = 2MPa$, $T_1 = 213.6C$

$u = ?$

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U_1 (kJ/kg)	T (°C)
2600.3	212.4
U_1	213.6
2628.3	225

$$U_1 = 2602.97 \text{ kJ/kg}$$

Now at State 2:

$$P_2 = 10\text{MPa}, \quad \hat{V}_2 = 0.0342 \text{ m}^3/\text{kg}$$

$\hat{U}_2$ (kJ/kg)	$\hat{V}_2$ (m³/kg)
3045.8	0.0328
$\hat{U}_2$	0.0342
3144.5	0.0356

$$\hat{U}_2 = 3095.15 \text{ kJ/kg}$$

Now:

$$\hat{W} = -\int_{0.1}^{0.0342} P_E \, d\hat{V} = -\int_{0.1}^{0.0342} P \, d\hat{V}$$

$$P\hat{V}^{1.5} = P_1 \hat{V}_1^{1.5} \Rightarrow P = \frac{P_1 \hat{V}_1^{1.5}}{\hat{V}^{1.5}}$$

$$P = 2\text{MPa} \left| \left(\frac{0.1 \cancel{m^3}}{\cancel{kg}}\right)^{1.5} \right| \left(\frac{\cancel{kg}}{\hat{V} \cancel{m^3}}\right)^{1.5}$$

$$P = \frac{0.0632}{\hat{V}^{1.5}} \text{ MPa}$$

$$\hat{W} = -\int_{0.1}^{0.0342} \frac{0.0632}{\hat{V}^{1.5}} \, d\hat{V}$$

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$$= -\frac{0.0632}{-0.5}\left|\frac{1}{V^{0.5}}\right|_{0.1}^{0.0342}$$

$$= \frac{0.0632}{0.5}\left[\frac{1}{(0.0342)^{0.5}} - \frac{1}{(0.1)^{0.5}}\right]$$

$$\cancel{\hat{W} = 2602.97\ kJ/kg}$$

$$\boxed{\hat{W} = 283.8\ kJ/kg}$$

Now:

$$\Delta\hat{U} = \hat{U}_2 - \hat{U}_1$$

$$= (3095.15 - 2602.97)\ kJ/kg$$

$$\Delta\hat{U} = 492.18\ kJ/kg.$$

$$\Delta\hat{U} = \hat{q} + W$$

$$\hat{q} = \Delta\hat{U} - \hat{W}$$

$$\hat{q} = (492.18 - 283.8)\ kJ/kg$$

$$\boxed{\hat{q} = 208.38\ kJ/kg}$$