POSTAL Book Package 2023

Mechanical Engineering

Objective Practice Sets

Thermodynamics

Contents

MADE EASY Publications

3 CHAPTER
First Law of Thermodynamics

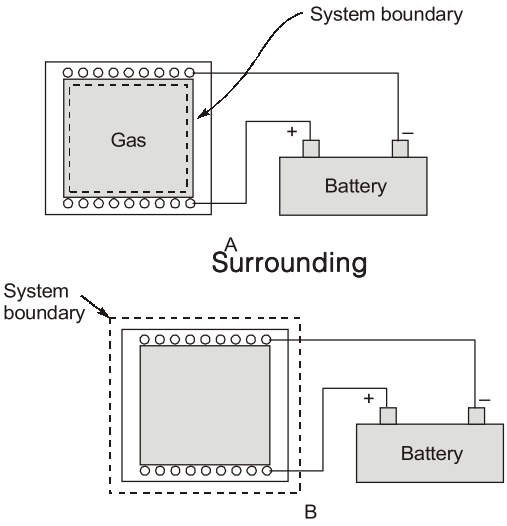
MCQ and NAT Questions

Q.1 Energy of a system is
(a) path function and extensive property
(b) point function and intensive property
(c) path function and intensive property
(d) point function and extensive property

Q.2 Isentropic process is given by $pv^{\gamma}=c$ and polytropic process as $pv^{n} = C$
Consider the following and choose the correct alternative.
(a) γ and n are property of a gas
(b) γ and n depend upon the process
(c) γ is property of gas but n is not
(d) γ is property of a gas

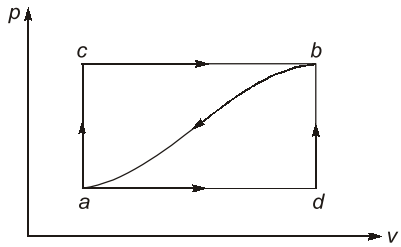
Q.3 Two blocks which are at different states are brought into contact with each other and allowed to reach a final state of thermal equilibrium. The final temperature attained is specified by the
(a) Zeroth law of the thermodynamics
(b) First law of thermodynamics
(c) Second law of thermodynamics
(d) Third law of thermodynamics

Q.4 Consider the two diagram given below



Choose the correct option
(a) Both in (A) and (B) heat and work cross the boundary of the system.
(b) Both in (A) and (B) only heat crosses the boundary of the system.
(c) In A only heat crosses the boundary of the system and in B both heat and work cross the boundary of the system
(d) In A both heat and work cross the boundary of the system while in B only work crosses the boundary of the system (Temperature of the surrounding is greater than that of gas).

Q.5 When a system is taken from state *a* to state *b* as shown in figure below along path acb 74 kJ of heat flows into the system and the system does 34 kJ of work. The amount of heat exchanged by the system along path *adb*, if work done is 8.5 kJ will be



(a) –48.5 KJ (b) 48.5 KJ
(c) 31.5 KJ (d) – 31.5 KJ

Q.6 Internal energy is defined by
(a) Zeroth law of thermodynamics
(b) First law of thermodynamics
(c) Second law of thermodynamics
(d) Law of entropy

Q.7 First law of thermodynamics is valid for
(a) all processes
(b) only reversible processes
(c) only cyclic processes
(d) only cyclic processes that are carried out reversibly

Which of the following statements is/are correct?
(a) Heat interaction in the process is 113.47 kJ.
(b) Work interaction in the process is 246.67 kJ.
(c) Change in internal energy is –26.64 kJ.
(d) Heat interaction in the process is 220 kJ.

Q.47 A fluid is confined in a cylinder by a spring loaded, frictionless piston so that the pressure in the fluid is a linear function of the volume i.e. ($P = a+bV$). The internal energy of the fluid is given by the following equation, $U = 56 + 4.12PV$ where U is in kJ, P in kPa and V in m^3. The fluid changes from an initial state of 170 kPa, 0.03 m^3 to a final state of 400 kPa, 0.06 m^3, with no work other than that done on the piston.
Which of the following statements is/are correct?
(a) The relation between P and V is $P = (–60 + 7666.67\ V)$ kPa.
(b) 8.55 kJ work is done by the system.
(c) 86.42 kJ heat flow into the system during the process.
(d) 86.42 kJ heat flow from the system during the process.

■■■■

Answers First Law of Thermodynamics

1. (d)	2. (c)	3. (b)	4. (c)	5. (b)	6. (b)	7. (a)	8. (b)	9. (c)
10. (d)	11. (c)	12. (c)	13. (b)	14. (a)	15. (d)	16. (b)	17. (c)	18. (b)
19. (d)	20. (d)	21. (c)	22. (a)	23. (a)	24. (d)	25. (c)	26. (b)	27. (b)
28. (b)	29. (b)	30. (c)	31. (c)	32. (d)	33. (b)	34. (a)	35. (c)	36. (c)
37. (c)	38. (a)	39. (a)	40. (2568.4)	41. (9.414)	42. (40)	43. (1835.844)	44. (181.86)	
45. (156.34)		46. (a, b)	47. (a, b, c)					

Explanations First Law of Thermodynamics

1. (d)

It is better to say internal energy instead of energy which is a point function and is extensive property.

2. (c)

γ (Ratio of specific heat) is a property of gas, while n is exponent coefficient of polytropic process and not a property of gas.

3. (b)

It is the first law of thermodynamics, which specifies the final temperature attained when two blocks which are at different states are brought into contact with each other and allowed to reach a final state of thermal equilibrium.

4. (c)

In A, system boundary is inside so no work cross the boundary of the system, while in B both heat and work cross the boundary of the system.

5. (b)

For path acb
$Q = \Delta U + W$
$74 = \Delta U + 34$
$40 = \Delta uU$
For path adb
$Q = 40 + 8.5 = 48.5$ kJ

6. (b)

Zeroth law of thermodynamics — concept of temperature
First law of thermodynamics — concept of internal energy
Second law of thermodynamics — concept of entropy.

7. (a)

- $\bar{d}Q = dE + \bar{d}W$ This equation holds good for any process, reversible or irreversible, and for any system.
- $\bar{d}Q = dU + \bar{d}W$ This equation holds good for process undergone by a closed stationary system.

8. (b)

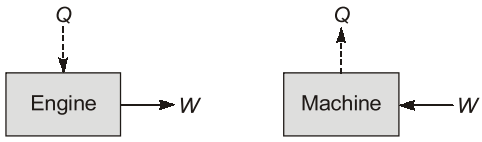
ΔU is a point function and it is independent of the path followed.

9. (c)

Clockwise work is positive and anticlockwise work is negative. Both areas are same in magnitude, but will cancel each other, hence net work output is zero.

10. (d)

There can be no machine which would continuously supply mechanical work without some other form of energy disappearing simultaneously. It is fictitious machine.



A PMM1 The converse of PMM1

11. (c)

$$c_p - c_v = R$$

$$c_p = R + c_v = 0.2 + 0.7 + (2.7 \times 10^{-4})T$$

$$= 0.9 + (2.7 \times 10^{-4})T \text{ kJ/kgK}$$

$$\Delta h = \int_{T_1}^{T_2} c_p dT$$

$$= \int_{300}^{400} \left\{0.9 + (2.7 \times 10^{-4})T\right\} dT$$

$$= 0.9(400 - 300) + \frac{2.7 \times 10^{-4}}{2}(400^2 - 300^2)$$

$$= 99.45 \text{ kJ/kg}$$

12. (c)

$$PV^n = C \quad \text{(Polytropic process)}$$

$$\ln P + n \ln V = C$$

$$X + nY = C$$

$$\frac{X}{C} + \frac{Y}{(C/n)} = 1 \quad \text{(Equation of straight line)}$$

13. (b)

$$R = c_p - c_v = 1.045 - 0.727$$

$$= 0.318 \text{ kJ/kgK}$$

$$V_1 = \frac{mRT_1}{P_1} = \frac{0.25 \times 0.318 \times 293}{1 \times 10^2} = 0.232 \text{ m}^3$$

$$\therefore \quad T_2 = T_1\left(\frac{P_2}{P_1}\right)^{(n-1)/n} = 293(8)^{0.25/1.25} = 444.1 \text{ K}$$

$$\therefore \quad V_2 = V_1\left(\frac{P_2}{P_1}\right)^{1/n} = 0.232\left(\frac{1}{8}\right)^{1/1.25} = 0.0439 \text{ m}^3$$

14. (a)

$$\text{Heat transfer} = \frac{(\gamma - n)}{(\gamma - 1)} \times W \qquad \left[g = \frac{c_p}{c_v}\right]$$

$$= \frac{(\gamma - n)}{(\gamma - 1)}\left\{\frac{P_1V_1 - P_2V_2}{(n-1)}\right\}$$

$$= \left(\frac{1.437 - 1.25}{1.437 - 1}\right)\left\{\frac{1 \times 0.232 - 8 \times 0.04539}{(1.25 - 1)}\right\}100$$

$$= -20.4 \text{ kJ}$$

15. (d)

Engine power,

$$P = T \times \frac{2\pi N}{60} = 10{,}000 \times \frac{2 \times \pi \times 1000}{60}$$

$$= 1046.67 \text{ kW}$$

$$Q = 1000 \times 0.5 \times 4.18 \times \Delta T = \text{Power}$$

$$\therefore \quad \Delta T = \frac{1046.67}{1000 \times 0.5 \times 4.18} = 0.5°\text{C}$$

$$T_e = T_i + \Delta T = 25.5°\text{C}$$

16. (b)

$$\eta = \frac{W_{net}}{Q_s} = \frac{300 + 250 - 100 - 250}{300}$$

$$= \frac{2}{3} \times 100 = 66.67\%$$

$$\text{Work ratio} = \frac{W_{net}}{W_{output}} = \frac{300 + 250 - 100 - 250}{300 + 250}$$

$$= \frac{200}{550} = 0.36$$

17. (c)

for insulated battery, $Q_{1\text{-}2} = 0$

$$\therefore \quad Q_{1-2} = W_{1-2} + U_{1-2} = 0$$

$$\therefore \quad U_{1-2} = -W_{1-2} = -Ei(\Delta\theta) = -3 \times 60 \times (3600)$$

$$= -64.8 \times 10^4 \text{ J} = -64.8 \times 10^4 \text{ J}$$

18. (b)

The first law of thermodynamics takes the form $W = -\Delta H$ when applied to an open system undergoing an adiabatic process with negligible changes in kinetic and potential energies.

$$H_1 + \frac{1}{2}mC_1^2 + mgz_1 + Q$$

$$= H_2 + \frac{1}{2}mC_2^2 + mgz_2 + W$$

$$H_1 = H_2 + W$$