Mechanical Engineering

PRACTICE BOOK

for

Junior Engineer

2300 MCQs

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2300 MCQs for Junior Engineer : Mechanical Engineering Practice Book

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Contents

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UNIT 1

Thermodynamics

Q.1 The study of thermodynamics provides answer to the followings:

1. whether a process is feasible or not
2. to quantify the energy required for a process
3. rate or speed with which a process occurs
4. extent to which a reaction/process takes place

Which of the above statements are correct?

(a) 1, 2 and 3 (b) 1 and 2
(c) 1, 2 and 4 (d) 2, 3 and 4

Q.2 Consider the following statements:

1. Thermodynamic properties are the macroscopic coordinates significant only for systems existing in states of thermodynamic equilibrium.
2. Engineering thermodynamic studies about transfer and transformation of energy.
3. Engineering thermodynamics studies about storage, transfer and transformation of energy.

Which of the above is/are correct?

(a) 3 only (b) 1 and 3
(c) 2 only (d) 1 and 2

Q.3 An adiabatic boundary is one which

(a) prevents heat transfer
(b) permits heat transfer
(c) prevents work transfer
(d) permits work transfer

Q.4 Match the following **List-I** with **List-II**:

List-I

A. Centrifugal fan
B. Control volume
C. Intensive property
D. Microscopic property

List-II

1. Open system
2. Internal energy
3. Filling a tire at air station
4. Specific energy

Codes:

	A	B	C	D
(a)	4	2	1	3
(b)	1	4	3	2
(c)	1	3	4	2
(d)	3	1	2	4

Q.5 Match the following **List-I** (Thermometer) with **List-II** (Thermometric property):

List-I	List-II
A. Mercury-in-glass gas	**1.** Volume
B. Constant pressure gas	**2.** Length
C. Constant volume gas	**3.** EMF
D. Thermocouple	**4.** Pressure

Codes:

	A	B	C	D
(a)	4	3	2	1
(b)	2	4	1	3
(c)	1	3	2	4
(d)	2	1	4	3

Q.6 In a quasi-equilibrium process, the pressure in a system

(a) remains constant
(b) varies with temperature
(c) is everywhere constant at an instant
(d) increase if volume increases

Q.7 Convert the following readings of pressure to kPa, assuming that the barometer reads 760 mm of Hg and match the **List-I** with **List-II**:

List-I	List-II
A. 50 cm Hg vacuum	**1.** 113 kPa
B. 80 cm Hg gauge	**2.** 34.68 kPa
C. 1.2 m of H_2O gauge	**3.** 208 kPa

Codes:

	A	B	C
(a)	1	3	2
(b)	1	2	3
(c)	2	3	1
(d)	3	1	2

Q.8 Ice kept in a well insulated thermo-flask is an example of which system?
(a) closed system
(b) isolated system
(c) open system
(d) non-flow adiabatic system

Q.9 For an isolated system executing a process
1. no heat transfer takes place
2. no work is done
3. no mass crosses the boundary
4. no chemical reaction takes place within the system

Which of the above statement are correct?
(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 2, 3 and 4 (d) all of the above

Q.10 Which of the following aspect is not true regarding microscopic properties of thermodynamic system?
(a) a knowledge of the structure of matter is essential.
(b) a limited number of variables/properties are needed to describe the state of matter.
(c) the values of these variables cannot be measured.
(d) statistical averaging is adopted to predict the behaviour of individual fluid particles.

Q.11 Choose the correct statement among the following:
(a) temperature is an extensive property
(b) mass remains same in an open system
(c) the system boundaries are collapsible and expandable
(d) an isolated system allows exchange of energy in the form of heat only

Q.12 Match **List-I** with **List-II** and select the correct answer:

List-I
A. Interchange of matter is not possible in a
B. Any processes in which the system returns to its original condition or state is called
C. Interchange of matter is possible in a
D. The quantity of matter under consideration in thermodynamics is called

List-II
1. Open system
2. System
3. Closed system
4. Cycle

Codes:

	A	B	C	D
(a)	2	1	4	3
(b)	3	1	4	2
(c)	2	4	1	3
(d)	3	4	1	2

Q.13 Which one of the following represents open thermodynamic system?
(a) Manual ice cream freezer
(b) Centrifugal pump
(c) Pressure cooker
(d) Bomb calorimeter

Q.14 A thermodynamic system is considered to be an isolated one if
(a) mass transfer and entropy change are zero
(b) entropy change and energy transfer are zero
(c) energy transfer and mass transfer are zero
(d) mass transfer and volume change are zero

Q.15 A control volume is
(a) an isolated system
(b) a closed system but heat and work can cross the boundary
(c) a specific amount of mass in space
(d) a fixed region in space where mass, heat and work can cross the boundary of that region

Q.16 A thermodynamic system refers to
(a) any defined region in space
(b) a specified mass in fluid flow
(c) a specified region of constant volume
(d) a prescribed and identifiable quantity of matter

Q.17 In highly rarefied gases, the concept of this loses validity
(a) thermodynamic equilibrium
(b) continuum
(c) stability
(d) macroscopic viewpoint

Q.18 Which of the following is an example of heterogeneous system?
(a) Atmospheric air
(b) Mixture of hydrogen and oxygen
(c) Cooling fluid in a radiator
(d) Mixture of ice, water and steam

Q.19 Consider the following:
1. Temperature 2. Viscosity
3. Specific entropy 4. Thermal conductivity

Which of the above are intensive property?
(a) 1 only (b) 2 and 3 only
(c) 2, 3 and 4 only (d) 1, 2, 3 and 4

Q.20 The sequence of processes that eventually returns the working substance to its original state is known as
(a) event
(b) process
(c) thermodynamic property
(d) thermodynamic cycle

Q.21 A system and its environment put together constitute
(a) an adiabatic system
(b) an isolated system
(c) a segregated system
(d) a homogeneous system

Q.22 Which one of the following is extensive property of a thermodynamics system
(a) Volume (b) Pressure
(c) Temperature (d) Density

Q.23 Which of the following quantities is not the property of the system
(a) Pressure (b) Temperature
(c) Density (d) Heat

Q.24 The fundamental unit of enthalpy is
(a) MLT^{-2} (b) ML^2T^{-1}
(c) ML^2T^{-2} (d) ML^3T^{-2}

Q.25 A closed thermodynamic system is one in which
(a) there is no energy or mass transfer across the boundary
(b) there is no mass transfer, but energy transfer exists
(c) there is no energy transfer, but mass transfer exists
(d) both energy and mass transfer takes place across the boundary but the mass transfer is controlled by valves

Q.26 The value of an extensive property is extensively dependent on
(a) mass or extend of the system
(b) interaction of the system with its surroundings
(c) path followed by the system in going from one state to another
(d) nature of boundaries, rigid or flexible

Q.27 A diathermic wall is one which
(a) prevents thermal interaction
(b) permits thermal interaction
(c) encourages thermal interaction
(d) discourages thermal interaction

Q.28 Which of the following are intensive properties
1. Kinetic energy 2. Specific enthalpy
3. Pressure 4. Entropy

Codes:
(a) 1 and 3 (b) 2 and 3
(c) 1, 3 and 4 (d) 2 and 4

Q.29 For a system to be in thermal equilibrium the system and its surroundings are to be in
(a) Thermal equilibrium
(b) Chemical equilibrium
(c) Mechanical equilibrium
(d) Thermal, chemical and mechanical equilibrium

Q.30 Which of the following statements regarding the concept of continuum are correct?
1. Large number of molecules enable meaningful statistical averaging and assignment of property values
2. Mean free path of the molecules is order of magnitude higher than system dimensions
3. Behaviour of individual molecules is disregarded
4. Mean free path of the molecules approaches the order of magnitude of the system dimensions

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

Q.31 The energy of an isolated system in a process
(a) can never increase
(b) can never decrease
(c) always remains constant
(d) is always positive

Q.32 Which one of the following is not the correct statement about control volume?
(a) Matter flows continuously in and out
(b) Heat and work flows across the control surface
(c) Control volume must be stationary
(d) Focuses an definite volume and volume is enclosed by control surface

Q.33 Zeroth law of thermodynamics states that:
(a) two thermodynamic systems are always in thermal equilibrium with each other.
(b) if two systems are in thermal equilibrium, then the third system will also be in thermal equilibrium.
(c) two systems not in thermal equilibrium with a third system are also not in thermal equilibrium with each other.
(d) when two systems are in thermal equilibrium with a third system, they are in thermal equilibrium with each other.

Q.34 The Kelvin temperature of a system can be measured by a
(a) mercury-in-glass thermometer
(b) thermocouple
(c) constant-volume gas thermometer
(d) resistance thermometer

Q.35 As per international practice, the temperature interval from oxygen point to gold point is divided into three main parts. Which of the following temperature interval is not correct?
(a) 0 to 560°C (b) 0 to 660°C
(c) –190 to 0°C (d) 660 to 1093°C

Q.36 Match **List-I** with **List-II** the following:

List-I	List-II
A. Normal boiling point of oxygen	1. 100°C
B. Triple point of water	2. –183°C
C. Normal boiling point of water	3. 1063°C
D. Normal melting point of gold	4. 0.01°C
	5. 0.001°C

Codes:

	A	B	C	D
(a)	2	5	3	1
(b)	2	4	1	3
(c)	2	5	1	3
(d)	3	4	1	2

Q.37 Which of the following is used for measuring high temperature beyond 1063°C?
(a) Platinum-platinum/Rhodium thermocouple
(b) Electrical resistance thermometer
(c) Optical method using planck's law of thermal radiation
(d) Constant pressure gas thermometer

Q.38 Match **List-I** (Type of thermometer) **List-II** (Thermometric property) the following:

List-I
A. Mercury-in-glass
B. Thermocouple
C. Thermistor
D. Constant volume gas

List-II
1. Pressure
2. Electrical resistance
3. Volume
4. Induced electric voltage

Codes:

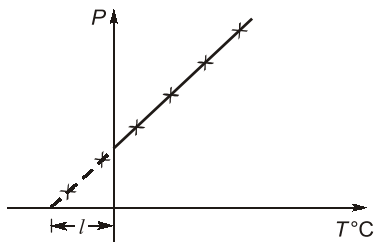
	A	B	C	D
(a)	1	4	2	3
(b)	3	2	4	1
(c)	1	2	4	3
(d)	3	4	2	1

Q.39 Zeroth law of thermodynamics form the basis of measurement of
(a) pressure (b) temperature
(c) heat exchanger (d) work

Q.40 The standard fixed point of thermometry is
(a) Ice point
(b) Sulphur point
(c) Triple point of water
(d) Normal boiling point of water

Q.41 Triple point temperature of water is
(a) 273 K (b) 273.14 K
(c) 273.15 K (d) 273.16 K

Q.42 Experimental data obtained from a constant-volume-gas thermometer is shown is the figure below. The value of l in °C is



(a) 273.15 (b) 1.0
(c) –100 (d) –273.15

Q.43 In new temperature scale say °ρ the boiling and freezing points of water at one atmosphere are 100°ρ and 300°ρ respectively, correlate this scale with centigrade scale. The reading of 0°ρ on the centigrade scale is
(a) 0°C (b) 50°C
(c) 100°C (d) 150°C

Q.44 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 temperature is specified by the
(a) Zeroth law of thermodynamics
(b) First law of thermodynamics
(c) Second law of thermodynamics
(d) Third law of thermodynamics

Q.45 A closed system receives 60 kJ heat but its internal energy decreases by 30 kJ. Then the work done by the system is
(a) 90 kJ (b) 30 kJ
(c) –30 kJ (d) –90 kJ

Q.46 If the work done on a closed system is 20 kJ/kg, and 40 kJ/kg heat is rejected from the system, its internal energy decreases by
(a) 20 kJ/kg (b) 60 kJ/kg
(c) –20 kJ/kg (d) –60 kJ/kg

Q.47 The integrating factor of quasi-static displacement work is
(a) $\frac{1}{T}$ (b) $\frac{1}{P}$
(c) $\frac{1}{V}$ (d) $\frac{P}{V}$

Q.48 The integrating factor of reversible heat transfer is
(a) $\frac{1}{T}$ (b) $\frac{1}{P}$
(c) $\frac{1}{V}$ (d) $\frac{P}{T}$

Q.49 Heat transferred to a closed stationary system at constant volume is equal to
(a) work transfer
(b) increase in internal energy
(c) increase in enthalpy
(d) increase in Gibbs function

Q.50 Which among the following is not a boundary phenomenon?
(a) Work transfer
(b) Heat transfer
(c) Mass transfer
(d) Change of temperature

Q.51 In a general compression process, 2 kJ of mechanical work is supplied to 4 kg of fluid and 800 J of heat is rejected to the cooling jacket. The change in specific internal energy would be
(a) 100 J/kg (b) 200 J/kg
(c) 300 J/kg (d) 400 J/kg

Q.52 Which among the following is not true?
(a) Heat and work transfer are the energy interactions.
(b) Both heat and work transfer are path functions and exact differentials.
(c) Heat transfer is the energy interaction due to temperature difference only.
(d) Work and heat transfer are boundary phenomenon.

Q.53 Work done is zero for the following process
(a) constant volume (b) free expansion
(c) throttling (d) all of the above

Q.54 In free expansion process
(a) $W_{1-2} = 0$ (b) $Q_{1-2} = 0$
(c) $dU = 0$ (d) All of the above

Q.55 Which one of the following thermodynamic process approximates the steaming of food in a pressure cooker?
(a) Isenthalpic (b) Isobaric
(c) Isochoric (d) Isothermal

Q.56 The cyclic integral of $(\delta Q - \delta W)$ for a process is
(a) positive (b) negative
(c) zero (d) unpredictable

Q.57 An isothermal process undergone by air increases its volume from 0.28 m^3 to 1.12 m^3. The change in specific entropy of the system (air) is
(a) 398 J/kgK (b) 387 J/kgK
(c) 199 J/kgK (d) 693 J/kgK

Q.58 Thermodynamic work is the product of
(a) two intensive properties
(b) two extensive properties
(c) an intensive property and change in an extensive property
(d) an extensive property and change in an intensive property

Q.59 The maximum amount of mechanical energy that can be converted into heat in any process
(a) depends on source and sink temperature
(b) depends on friction present
(c) depends on nature of mechanical energy
(d) is 100%

Q.60 The expression for work done during a process $\int p dV$ is applicable for
(a) reversible process only
(b) irreversible process only
(c) polytropic process only
(d) any process

Q.61 A paddle wheel used for stirring a liquid contained in a tank supplied 5000 kJ of work and during the stirring operation the tank lost 1500 kJ of heat to the surroundings. If the tank and liquid are considered as a system the change in its internal energy will be
(a) 1500 kJ (b) 3500 kJ
(c) 5000 kJ (d) 6500 kJ

Q.62 The change in enthalpy of a closed system is equal to the heat transferred, if the reversible process takes place at constant
(a) Pressure (b) Temperature
(c) Volume (d) Entropy

Q.63 Which one of the following statement holds good for the equation
$$\delta Q = dE + \delta W$$
(a) any process undergone by a closed stationary system
(b) any process, reversible and irreversible and for any system
(c) a closed system when only pdV work is present
(d) only reversible process

Q.64 Change in internal energy in a reversible process occurring in a closed system is equal to the heat transferred, if the process occurs at constant
(a) pressure (b) volume
(c) temperature (d) enthalpy

Q.65 Match **List-I** with **List-II** and select the correct answer using the codes given below.

List-I
A. Work done
B. Thermal equilibrium
C. Internal energy
D. No work and heat interaction

List-II
1. Point function
2. Path function
3. Isolated system
4. Equality of temperature

Codes:

	A	B	C	D
(a)	2	4	1	3
(b)	2	3	4	2
(c)	3	1	2	4
(d)	4	2	3	1

Q.66 Which one of the following statements is true?
(a) Heat can be fully converted into work
(b) Work cannot be fully converted into heat
(c) The efficiency of a heat engine increases as the temperature of the heat source is increased while keeping the temperature of the heat sink fixed
(d) A cyclic process can be devised whose sole effect is to transfer heat from a lower temperature to higher temperature

Q.67 Match the following:

A. Heat	**I.** State function
B. Internal energy	**II.** Path function
C. Work	
D. Entropy	

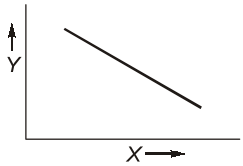
(a) A-I, B-I, C-I, D-I
(b) A-II, B-I, C-II, D-II
(c) A-I, B-II, C-I, D-I
(d) A-II, B-I, C-II, D-I

Q.68 In a cyclic process, heat transfer are +15.7 kJ, –26.2 kJ, –4.86 kJ and +31.5 kJ. What is the net work for this cyclic process?
(a) 15.14 kJ (b) 16.41 kJ
(c) 16.14 kJ (d) 15.41 kJ

Q.69 A stationary mass of gas is compressed without friction from an initial state of 0.3 m^3 and 0.1 MPa to a final state of 0.15 m^3 and 0.1 MPa, the pressure remaining constant during the process. There is a transfer of 40 kJ of heat from the gas during the process. What is the change in internal energy of the gas?
(a) –5 kJ (b) +25 kJ
(c) –25 kJ (d) +15 kJ

Q.70 The first law of thermodynamics is the law of
(a) conservation of mass
(b) conservation of energy
(c) conservation of momentum
(d) conservation of temperature

Q.71 The polytropic process is represented by a straight line in the following figure. What is X and Y respectively?

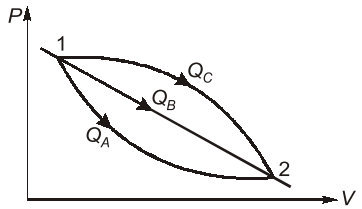


(a) $\ln V$ and $\ln P$
(b) V and P
(c) $\ln P$ and $\ln V$
(d) P and V

Q.72 A PMM1 is
(a) A thermodynamic machine
(b) A hypothetical machine
(c) A real machine
(d) A hypothetical machine whose operation would violate the first law of thermodynamics

Q.73 Energy is added to 5 kg of air with a paddle wheel until $\Delta T = 100°C$. What is the paddle wheel work if the rigid volume is insulated?
(a) 203 kJ (b) 482 kJ
(c) 412 kJ (d) 359 kJ

Q.74 An ideal gas of mass m at state 1 expands to state 2 via three paths. If Q_A, Q_B and Q_C represent the heat absorbed by the gas along three paths, then



(a) $Q_A < Q_B < Q_C$ (b) $Q_A > Q_B > Q_C$
(c) $Q_A < Q_B > Q_C$ (d) $Q_A > Q_B < Q_C$

Q.75 According to first law of thermodynamics
(a) total internal energy of a system during a process remains constant
(b) total energy of a system remains constant
(c) work done by a system is equal to the heat transferred by the system
(d) internal energy, enthalpy and entropy during a process remains constant hence it is an Isochoric process.

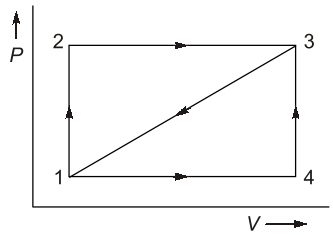
Q.76 Internal energy is defined by
(a) Zeroth law of thermodynamics
(b) First law of thermodynamics
(c) Second law of thermodynamics
(d) Law of entropy

Q.77 Key concept in analyzing the filling of an evacuated tank is
(a) the mass flow rate in the tank remains constant
(b) the enthalpy across the valve remains constant
(c) the internal energy in the tank remains constant
(d) the temperature in the tank remains constant

Q.78 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

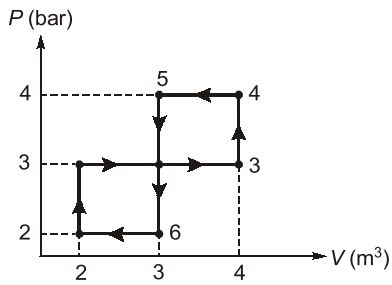
Q.79 During a thermodynamic process, 84 kJ of heat flows into the system and the work done by the system is 32 kJ. The increase in internal energy of the system is
(a) +52 kJ (b) –52 kJ
(c) +116 kJ (d) –116 kJ

Q.80 Given that along the path 1-2-3 a system absorbs 100 kJ as heat and does 60 kJ work while along the path 1-4-3 it does 20 kJ work (see figure given). The heat absorbed during the cycle 1-4-3 is



(a) –140 kJ (b) –80 kJ
(c) –40 kJ (d) 60 kJ

Q.81 The net work output for the cycle 1–2–3–4–5–6–1 shown in figure is



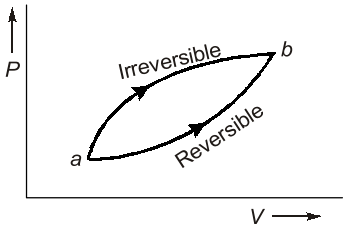
(a) 200 kJ (b) 1200 kJ
(c) 0 kJ (d) 1000 kJ

Q.82 The state of an ideal gas is changed from (T_1, P_1) to (T_2, P_2) in a constant volume process. To calculate the change in enthalpy, (Δh) all of the following properties/variables are required.

(a) c_v, P_1, P_2 (b) c_p, T_1, T_2

(c) c_p, T_1, T_2, P_1, P_2 (d) c_v, P_1, P_2, T_1, T_2

Q.83 For the two paths as shown in the figure, one reversible and one irreversible, to change the state of the system from a to b,



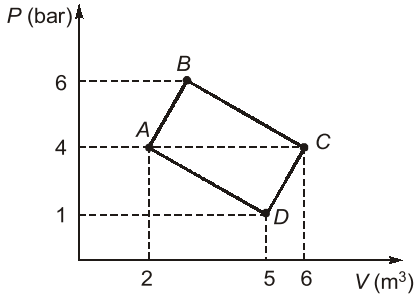
(a) ΔU, Q, W are same

(b) ΔU is same

(c) Q, W are same

(d) ΔU, Q are different

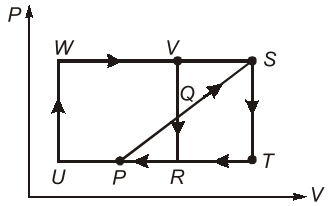
Q.84 The net work done for the closed system shown in the given pressure-volume diagram is



(a) 600 kN-m (b) 700 kN-m

(c) 900 kN-m (d) 1000 kN-m

Q.85 Two ideal heat engine cycles are represented in the given figure. Assume $VQ = QR$; $PQ = QS$ and $UP = PR = RT$. If the work interaction for the rectangular cycle ($WVRU$) is 48 Nm, then the work interaction for the other cycle PST is



(a) 12 Nm (b) 18 Nm

(c) 24 Nm (d) 36 Nm

Q.86 Neglecting changes in potential and kinetic energies, the shaft work during a steady flow process is given by

(a) $\int P\,dV$ (b) $\int V\,dP$

(c) Pv (d) $-\Delta h$

Q.87 Consider the following statements about steady flow process:

1. The rate of flow of mass energy across the control surface are constant.
2. Thermodynamic properties vary along space as well as time coordinates.
3. Any thermodynamic property will have a fixed value at a particular location and will not alter with time.

Which of the above are correct?

(a) 1 and 2 (b) 1 and 3

(c) 2 and 3 (d) 1, 2 and 3

Q.88 Consider following comparative points of S.F.E.E with Bernoulli's equation:

1. These two have several terms in common.
2. Both Bernoulli's equation and S.F.E.E is valid for viscous compressible fluids.
3. The Bernoulli's equation is a special limiting case of S.F.E.E.

Which of the above is/are correct?

(a) 1 only (b) 1 and 3

(c) 1 and 2 (d) 1, 2 and 3

Q.89 Neglecting changes in kinetic and potential energies, the identity $-\int_1^2 v\,dp = h_1 - h_2$ for the shaft work during a steady flow process is valid for

(a) constant volume process

(b) reversible isothermal process

(c) reversible adiabatic process

(d) reversible polytropic process

Q.90 The term Δh in a control volume equation $Q - W = \Delta h$

(a) Accounts for the rate of change in energy of the control volume.

(b) Represents the rate of change of energy between the inlet and outlet.

(c) Is often neglected in control-volume applications?

(d) Includes the work rate due to the pressure forces.

Q.91 Consider the following statements:
1. Triple point is the point at which three states of matter can be in equilibrium.
2. Critical point is the state at which liquid and vapour phase are in equilibrium.
3. Helium does not have a triple point.

Which of these statements is/are correct?
(a) 1 and 2 (b) 2 and 3
(c) 3 only (d) 1, 2 and 3

Q.92 Match **List-I** (Devices) with **List-II** (Thermodynamics equations) and select the correct answer using the codes given below the lists:

List-I	List-II
A. Turbine	1. $w = h_2 - h_1$
B. Nozzle	2. $h_1 = h_2$
C. Valve	3. $h_1 = h_2 + \frac{V_2^2}{2}$
D. Compressor	4. $w = h_1 - h_2$

Codes:

	A	B	C	D
(a)	4	3	2	1
(b)	2	3	1	4
(c)	1	2	3	4
(d)	3	2	4	1

Q.93 If steam is throttled its
(a) pressure and enthalpy remain unchanged
(b) temperature and entropy remain unchanged
(c) enthalpy remains unchanged but the other property change
(d) enthalpy remains unchanged but pressure may or may not change

Q.94 Which one of the following expression is correct for reversible work done by the system (steady flow) between state 1 and 2?
(a) $\int_1^2 PdV$ (b) $-\int_1^2 VdP$
(c) $-\int_1^2 PdV$ (d) $\int_1^2 VdP$

Q.95 Compressed air coming out from a punctured football
(a) becomes hotter
(b) becomes cooler
(c) remains at same temperature
(d) attains atmospheric temperature

Q.96 Work output from a system is at the expense of internal energy in a non-flow process carried out
(a) at constant pressure
(b) at constant volume
(c) adiabatically
(d) polytropically

Q.97 Assumptions made in steady-state flow process are
1. Control volume does not move relative to the coordinate frame.
2. Control volume moves relative to the coordinate frame.
3. The state of the mass at each point in the control volume vary with time.
4. The state of the mass at each discrete area of flow on the control surface do not vary with time. The rate at which heat and work cross the control surface remain constant.

(a) 1 and 4 are correct
(b) 1, 3 and 4 are correct
(c) 2, 3 and 4 are correct
(d) 2 and 4 are correct

Q.98 According to first law of thermodynamics, Δ(energy of system) + Δ(energy of surroundings) is equal to
(a) positive (b) negative
(c) zero (d) none of these

Q.99 Select the Kelvin-Plank statement of the second law:
(a) an engine cannot produce more heat than the heat it receives.
(b) a refrigerator cannot transfer heat from a low-temperature reservoir to a high temperature reservoir without work.
(c) an engine cannot produce work without discharging heat.
(d) an engine discharges heat if the work is less than the heat it receives.

Q.100 According to the Clausius statement of the second law:
1. heat flows from cold surface to hot surface, unaided.
2. heat flows from hot surface to cold surface, unaided.
3. heat can flow from cold surface to hot surface with the aid of external work.

Q.228 Consider the following statements regarding irreversibility

1. Internal irreversibility is due to dissipative effect like internal fluid friction.
2. Internal irreversibility occurs at system boundary.
3. Mechanical irreversibility is due to finite pressure gradient.
4. Chemical irreversibility is due to finite chemical potential (concentration gradient)

Which of these statements are correct?

(a) 1, 2 and 3 (b) 2, 3 and 4
(c) 1, 3 and 4 (d) 1, 2, 3 and 4

Q.229 In a Brayton cycle power plant, 1.5 kg/s of air passes through gas turbine with an enthalpy of 2900 kJ/kg and leaves at 2400 kJ/kg. The work obtained in expansion is 525 kW and heat lost to the surrounding is 175 kW. The irreversibility of the process is

(a) 25 kW (b) 50 kW
(c) 75 kW (d) 100 kW

Q.230 Superheated steam at a mass flow rate of 1 kg/s undergoes expansion to a pressure of 10 kPa. The initial conditions of steam are $P = 3.3$ MPa, $T = 650°C$, $h = 3428$ kJ/kg, $s = 7.2810$ kJ/kgK. The irreversibility associated with expansion is 300 kW. Take ambient temperature to be 27°C. What is the entropy at the end of expansion?

(a) 7.2810 kJ/kgK (b) 7.4808 kJ/kgK
(c) 7.8423 kJ/kgK (d) 8.2810 kJ/kgK

■■■■

Answers Thermodynamics

1.	(c)	2.	(b)	3.	(a)	4.	(c)	5.	(d)	6.	(c)	7.	(c)	8.	(b)
9.	(a)	10.	(b)	11.	(c)	12.	(d)	13.	(b)	14.	(c)	15.	(d)	16.	(d)
17.	(b)	18.	(d)	19.	(d)	20.	(d)	21.	(b)	22.	(a)	23.	(d)	24.	(c)
25.	(b)	26.	(a)	27.	(b)	28.	(b)	29.	(d)	30.	(c)	31.	(c)	32.	(c)
33.	(d)	34.	(c)	35.	(a)	36.	(b)	37.	(c)	38.	(d)	39.	(b)	40.	(c)
41.	(d)	42.	(d)	43.	(d)	44.	(a)	45.	(a)	46.	(a)	47.	(b)	48.	(a)
49.	(a)	50.	(d)	51.	(c)	52.	(b)	53.	(d)	54.	(d)	55.	(c)	56.	(c)
57.	(a)	58.	(c)	59.	(d)	60.	(a)	61.	(b)	62.	(a)	63.	(b)	64.	(b)
65.	(a)	66.	(c)	67.	(d)	68.	(c)	69.	(c)	70.	(b)	71.	(c)	72.	(d)
73.	(d)	74.	(a)	75.	(b)	76.	(b)	77.	(b)	78.	(a)	79.	(a)	80.	(d)
81.	(c)	82.	(b)	83.	(b)	84.	(d)	85.	(c)	86.	(b)	87.	(b)	88.	(b)
89.	(c)	90.	(d)	91.	(d)	92.	(a)	93.	(c)	94.	(b)	95.	(b)	96.	(c)
97.	(d)	98.	(c)	99.	(c)	100.	(c)	101.	(c)	102.	(c)	103.	(a)	104.	(d)
105.	(c)	106.	(a)	107.	(c)	108.	(a)	109.	(d)	110.	(b)	111.	(b)	112.	(b)
113.	(b)	114.	(d)	115.	(d)	116.	(a)	117.	(b)	118.	(b)	119.	(b)	120.	(a)
121.	(b)	122.	(d)	123.	(b)	124.	(b)	125.	(c)	126.	(a)	127.	(c)	128.	(d)
129.	(d)	130.	(b)	131.	(b)	132.	(a)	133.	(d)	134.	(d)	135.	(b)	136.	(a)

137. (d)	**138.** (d)	**139.** (c)	**140.** (b)	**141.** (a)	**142.** (c)	**143.** (a)	**144.** (d)
145. (d)	**146.** (a)	**147.** (a)	**148.** (d)	**149.** (b)	**150.** (b)	**151.** (c)	**152.** (b)
153. (d)	**154.** (b)	**155.** (b)	**156.** (b)	**157.** (a)	**158.** (b)	**159.** (c)	**160.** (c)
161. (c)	**162.** (d)	**163.** (c)	**164.** (d)	**165.** (d)	**166.** (b)	**167.** (d)	**168.** (d)
169. (c)	**170.** (c)	**171.** (d)	**172.** (a)	**173.** (b)	**174.** (c)	**175.** (c)	**176.** (b)
177. (a)	**178.** (b)	**179.** (b)	**180.** (d)	**181.** (a)	**182.** (a)	**183.** (d)	**184.** (d)
185. (d)	**186.** (a)	**187.** (b)	**188.** (c)	**189.** (d)	**190.** (b)	**191.** (b)	**192.** (d)
193. (a)	**194.** (c)	**195.** (b)	**196.** (b)	**197.** (c)	**198.** (c)	**199.** (d)	**200.** (b)
201. (d)	**202.** (d)	**203.** (c)	**204.** (d)	**205.** (b)	**206.** (c)	**207.** (b)	**208.** (b)
209. (a)	**210.** (b)	**211.** (d)	**212.** (d)	**213.** (c)	**214.** (d)	**215.** (b)	**216.** (a)
217. (c)	**218.** (a)	**219.** (c)	**220.** (a)	**221.** (a)	**222.** (b)	**223.** (d)	**224.** (d)
225. (d)	**226.** (c)	**227.** (c)	**228.** (c)	**229.** (b)	**230.** (d)		

Explanations

5. (d)

Mercury-in-glass	:	Length
Radiation	:	Black body radiation
Thermocouple	:	EMF
Constant volume gas	:	Pressure
Constant pressure gas	:	Volume

7. (c)

50 cm Hg vacuum:

$$P_{vacuum} = \rho gh$$
$$= 13.6 \times 10^3 \times 9.81 \times 50 \times 10^{-2}$$
$$= 66.70 \text{ kPa}$$
$$P_{abs} = P_{atm} - P_{vac}$$
$$= (760 - 500) \times 9.81 \times 13.6$$
$$= 34.68 \text{ kPa}$$

80 cm Hg gauge:

$$P_{abs} = P_{atm} + P_{guage}$$
$$= (760 + 800) \times 9.81 \times 13.6$$
$$= 208 \text{ kPa}$$

1.2 m of H_2O guage:

$$P_{abs} = P_{atm} + P_{guage}$$
$$= 101.325 + 1.2 \times 9.81 = 113 \text{ kPa}$$

16. (d)

A certain quantity of matter or a region in space upon which attention is focused in the analysis of a problem is called a system.

17. (b)

The concept of continuum loses validity when the mean free path of the molecules approaches the order of magnitude of the dimension of the vessel. So, in highly rarefied gases the concept of continuum loses its validity.

20. (d)

Thermodynamic cycle can be defined as a series of state changes such that the final and initial state is identical.

21. (b)

An isolated system is one in which there is no interaction of system with the surrounding.

for isolated system

$$\delta Q = 0$$
$$\delta W = 0$$

The first law gives

$$\delta Q = dU + \delta W$$
$$dU = 0$$
$$U = \text{constant}$$

The energy of isolated system is constant.

22. (a)

Since volume depends on mass hence it is extensive property.

23. (d)

Since heat transfer is the path function hence it is not the property of the system.

25. (b)

Open system: Both mass and energy transfer takes place

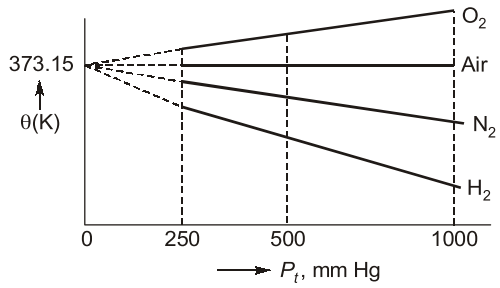
Closed system: No mass transfer, energy transfer may takes place

Isolated system:
Neither energy nor mass transfer takes place.

28. (b)

Specific enthalpy (enthalpy per unit mass) and pressure is intensive property.

34. (c)



36. (b)

Temperature of fixed points	
Point	Temperature (°C)
Normal boiling point of oxygen	–182.97
Standard triple point of water	0.01
Normal boiling point of water	100.00
Normal boiling point of sulphur	444.6
Normal melting point of antimony	630.5
Normal melting point of silver	960.8
Normal melting point of gold	1063

37. (c)

0 – 660°C → Platinum resistance thermocouple
–190 to 0°C → Platinum-platinum/Rhodium Thermocouple > 1063°C → Planck's law of thermal radiation.

39. (b)

- Zeroth law – concept of temperature
- First law – concept of internal energy
- Second law – concept of entropy

44. (a)

Zeroth law gives the concept of temperature.

45. (a)

$$\delta Q = \delta W + \Delta U \quad \text{(As per 1st law)}$$

$$\therefore \quad \delta W = \delta Q - \Delta U$$

$$= 60 + 30 = 90 \text{ kJ}$$

46. (a)

As per first law of thermodynamics:

$$\delta Q = \delta W + \Delta U$$

($\because \delta W = -20$ kJ/kg, $\delta Q = -40$ kJ/kg)

$$\Delta U = \delta Q - \delta W$$

$$= -40 + 20 = -20 \text{ kJ/kg}$$

47. (b)

Quasistatic work,

$$\delta W = P\,dV$$

$$dV = \frac{1}{P}\delta W$$

An inexact different dW when multiplied by an integrating factor $1/P$ becomes an exact differential dV.

(Point function) = (Integrating factor) ×(Path function)

48. (a)

$$\frac{\delta Q}{T} = ds$$

49. (a)

$$\delta W = 0$$

(for constant volume process)

$$\therefore \quad \delta Q = \delta W + \Delta U = 0 + \Delta U$$

$$\therefore \quad \delta Q = \Delta U$$

51. (c)

$\delta Q = -800$ J, $\delta W = -2000$ J

53. (d)

For constant volume process

$$W = \int pdV$$

Since, $dV = 0$

$$W = 0$$

For free expansion

$$W = 0$$

Also for throttling process

$$W = 0$$

54. (d)

For free expansion,

$$\delta W = 0$$

No heat interaction takes place,

Hence $\delta Q = 0$

From first law,

$$\delta Q = dU + \delta W$$

$$dU = 0$$

55. (c)

Since volume of pressure cooker is constant hence it is an Isochoric process.

56. (c)

For a process

$$\oint(\delta Q - \delta W) = 0$$

57. (a)

for isothermal process

$$\Delta S = R\ln\frac{V_2}{V_1} = 287 \times \ln\left(\frac{1.12}{0.28}\right) = 287 \times \ln 4$$

$= 287 \times 2 \times 0.693 = 397.9$ J/kgK

58. (c)

$W = \int_1^2 pdV$

Intensive property

Change in extensive property

59. (d)

Since mechanical energy is high grade energy and heat is low grade energy, 100% conversion of high grade energy into low grade energy is possible.

61. (b)

From the first law of thermodynamics

$$\delta Q = dU + \delta W$$

$$-1500 = dU - 5000$$

$$dU = 5000 - 1500$$

$$dU = 3500 \text{ kJ}$$

62. (a)

From *T-dS* equation

$$TdS = dh - VdP$$

$TdS = \delta Q$ (for reversible process)

$\delta Q = dh$ when $dP = 0$

Hence for constant pressure process

$$\delta Q = dh$$

63. (b)

$$\delta Q = dU + PdV$$

This equation holds good for any process reversible or irreversible.

64. (b)

$$\delta Q = dU + PdV$$

for constant volume process $dV = 0$

$$\delta Q = dU$$

65. (a)

Work done : Path function (Given by area under *P-v* plot)

Internal energy : Point function (Not depend on the path followed)

Isolated system : No work and Heat Interaction (e.g. Universe)

Thermal equilibrium : Equality of temperature

66. (c)

The efficiency of a heat engine increases as the temperature of the heat source is increased while keeping the temperature of the heat sink fixed.

67. (d)

Heat is a path function

Internal energy is a state function

Work is a path function

Entropy is a state function

68. (c)

$\delta Q = \delta W + \Delta U$ (As per first law)

For the cyclic process,

$\Delta U = 0$

$\therefore \quad \int \delta W = \int \delta Q$

$\therefore \quad W = 15.7 - 26.2 - 4.86 + 31.5$

$= 16.14$ kJ

69. (c)

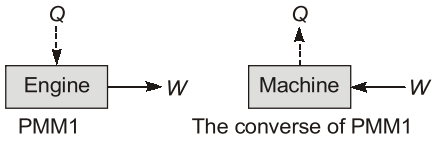
$$Q = \Delta U + W$$
$$Q_{1-2} = U_2 - U_1 + W_{1-2}$$
$$W_{1-2} = \int_1^2 P\,dV = P(V_2 - V_1)$$
$$= 0.1\,(0.15 - 0.3) = -15 \text{ kJ}$$
$$Q_{1-2} = -40 \text{ kJ}$$
$$\therefore \quad \Delta U = Q_{1-2} - W_{1-2} = -40 + 15 = -25 \text{ kJ}$$

71. (c)

$$PV^n = C \quad \text{(Polytropic process)}$$
$$\ln P + n \ln V = C$$
$$X + nY = C$$
$$\frac{X}{C} + \frac{Y}{(C/n)} = 1 \qquad \text{(Equation of straight line)}$$

72. (d)

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



74. (a)

$$Q_A = W_A + \Delta U; \qquad Q_B = W_B + \Delta U$$
$$Q_C = W_C + \Delta U$$

75. (b)

Since first law of thermodynamics defined as law of conservation of energy hence total energy of a system remains constant.

76. (b)

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

79. (a)

From first law of thermodynamics
$\delta Q = dU + \delta W \qquad 84 = dU + 32$
$dU = 52$ kJ

80. (d)

$Q_{1-3} = 100$ kJ; $\qquad W_{1-3} = 60$ kJ
From the first law of thermodynamics
$\delta Q = dU + \delta W \qquad 100 = (U_3 - U_1) + 60$
$U_3 - U_1 = 40$ kJ
Via point (4)
$W_{1-3} = 20$ kJ; $\qquad U_{3-1} = 40$ kJ
$\delta Q = 40 + 20 = 60$ kJ

82. (b)

$$c_p = \frac{dh}{dt}$$

83. (b)

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

86. (b)

Work in steady flow process $= -\int V dP$
Work in non-flow process $= \int P dV$

87. (b)

Thermodynamic properties may vary along space coordinates but do not vary with time.

88. (b)

Bernoulli's equation valid for frictionless incompressible fluids. S.F.E.E. valid for viscous compressible fluids.

90. (d)

S.F.E.E:

$$Q - W_x = \Delta\left[u + Pv + \frac{V^2}{2} + gz\right]$$
$$Q - W_x = \Delta\left[h + \frac{V^2}{2} + gz\right]$$

Δh accounts for internal energy and pressure forces.

91. (d)

When we cool helium to near absolute zero, it shows some strange behavior and converts into a Super-fluid, and has two different fluid phases. This point is called the Lambda point . But it never becomes a solid no matter how close we go to absolute zero.