RRB-JE (CBT-2) 2024

Railway Recruitment Board

Junior Engineer Examination

2000 MCQs

Fully solved multiple choice questions
with detailed explanations

Practice Book

Mechanical Engineering

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PREFACE

B. Singh (Ex. IES)

With the announcement of vacancies by Railway Recruitment Board (RRB) for the post of Junior Engineer, it has given hope for many engineers between jobs. MADE EASY has always been a success partner for engineers right from the onset of engineering education up to they get a formal tag of engineer.

Owing to needs of students to utilise this opportunity in a fruitful way, it gives me great happiness to introduce the first edition of the Mechanical Engineering Practice book for RRB-JE Examination. While preparing this book utmost care has been taken to cover all the chapters and variety of concepts which may be asked in the exam. It contains more than 2000 multiple choice questions with answer key and detailed explanations, segregated in subject wise manner to disseminate all kind of exposure to students in terms of quick learning. Attempt has been made to bring out all kind of probable competitive questions for the aspirants preparing for RRB-JE. This book also help every student to perform in an extraordinary way.

Full efforts have been made by MADE EASY team to provide error free solutions and explanations. The book not only covers the syllabus of RRB-JE but also useful for other examinations conducted by various Public Service Commissions.

Our team has made their best efforts to make the book error-free. Nonetheless, we would highly appreciate and acknowledge if you find and share any printing/conceptual error. It is impossible to thank all individuals who helped us, but I would like to sincerely acknowledge all the authors, editors and reviewers for putting in their efforts to publish this book.

B. Singh (Ex. IES)
Chairman and Managing Director
MADE EASY Group

Syllabus for Mechanical & Allied Engineering Exam Group – JE

S.No.	Subject
1.	**Engineering Mechanics:** Resolution of forces, Equilibrium and Equilibrant, parallelogram law of forces, triangle law of forces, polygon law of forces and Lami's theorem, couple and moment of a couple, condition for equilibrium of rigid body subjected to number of coplanar non-concurrent forces, definition of static friction, dynamic friction, derivation of limiting angle of friction and angle of repose, resolution of forces considering friction when a body moves on horizontal plane and inclined plane, calculation of moment of inertia and radius of gyration of : (a) I-Section (b) channel section (c) T-Section (d) L-Section (Equal & unequal lengths) (e) Z-Section (f) Built up sections (simple cases only), Newton's laws of motion (without derivation), motion of projectile, D'Alembert's principle, definition law of conservation of energy, law of conservation of momentum.
2.	**Material Science:** Mechanical properties of engineering materials – tensile strength, compressive strength, ductility, malleability, hardness, toughness, brittleness, impact strength, fatigue, creep resistance. Classification of steels, mild steel and alloy steels. Importance of heat treatment. Heat treatment processes – annealing, normalizing, hardening, tempering, carburizing, nitriding and cyaniding.
3.	**Strength of Materials:** Stress, strain, stress strain diagram, factor of safety, thermal stresses, strain energy, proof resilience and modules of resilience. Shear force and bending moment diagram – cant leaver beam, simply supported beam, continuous beam, fixed beam. Torsion in shafts and springs, thin cylinder shells.
4.	**Machining:** Working principle of lathe. Types of lathes – Engine lathe – construction details and specifications. Nomenclature of single point cutting tool, geometry, tool signature, functions of tool angles. General and special operations – (Turning, facing, taper turning thread cutting, knurling, forming, drilling, boring, reaming, key way cutting), cutting fluids, coolants and lubricants. Introduction to shaper, slotter, plainer, broaching, milling and manufacture of gears, heat treatment process applied to gears.
5.	**Welding:** Welding – Introduction, classification of welding processes, advantages and limitations of welding, principles of arc welding, arc welding equipment, choice of electrodes for different metals, principle of gas (oxy-acetylene) welding, equipment of gas welding, welding procedures (arc & gas), soldering and brazing techniques, types and applications of solders and fluxes, various flame cutting processes, advantages and limitations of flame cutting, defects in welding, testing and inspection modern welding methods, (submerged, CO2, atomic – hydrogen, ultrasonic welding), brief description of MIG & TIG welding.
6.	**Grinding & Finishing Process:** Principles of metal removal by grinding, abrasives, natural and artificial, bonds and binding processes, vitrified, silicate, shellac rubber, grinding machines, classification: cylindrical, surface, tool & cutter grinding machine, construction details, relative merits, principles of centreless grinding, advantages & limitations of centreless grinding work, holding devices, wheel maintenance, balancing of wheels, coolants used, finishing by grinding, honing, lapping, super finishing, electroplating, basic principles – plating metals, applications, hot dipping, galvanizing tin coating, parkerising, anodizing, metal spraying, wire process, powder process and applications, organic coatings, oil base paint, lacquer base enamels, bituminous paints, rubber base coating.
7.	**Metrology:** Linear measurement – Slip gauges and dial indicators, angle measurements, bevel protractor, sine bar, angle slip gauges, comparators (a) mechanical (b) electrical (c) optical (d) pneumatic. Measurement of surface roughness; methods of measurements by comparison, tracer instruments and by interferometry, collimators, measuring microscope, interferometer, inspection of machine parts using the concepts of shadow projection and profile projection.
8.	**Fluid Mechanics & Hydraulic Machinery:** Properties of fluid, density, specific weight, specific gravity, viscosity, surface tension, compressibility capillarity, Pascal's law, measurement of pressures, concept of buoyancy. Concept of Reynold's number, pressure, potential and kinetic energy of liquids, total energy, laws of conservation, mass, energy and momentum, velocity of liquids and discharge, Bernoulli's equation and assumptions, venturimeters, pitottube, current meters. Working principle & constructional details of

centrifugal pump, efficiencies – manometric efficiency, volumetric efficiency, mechanical efficiency and overall efficiency, cavitation and its effect, working principle of jet & submersible pumps with line diagrams.

9. **Industrial Management:** Job analysis, motivation, different theories, satisfaction, performance reward systems, production, planning and control, relation with other departments, routing, scheduling, dispatching, PERT and CPM, simple problems. Materials in industry, inventory control model, ABC Analysis, Safety stock, re-order, level, economic ordering quantity, break even analysis, stores layout, stores equipment, stores records, purchasing procedures, purchase records, Bin card, Cardex, Material handling, Manual lifting, hoist, cranes, conveyors, trucks, fork trucks.

10. **Thermal Engineering:** Laws of thermo dynamics, conversion of heat into work vice versa , laws of perfect gases, thermo dynamic processes – isochoric, isobaric, isothermal hyperbolic, isentropic, polytrophic and throttling, modes of heat transfer, thermal conductivity, convective heat transfer coefficient, Stefan Boltzman law by radiation and overall heat transfer coefficient. Air standards cycles – Carnot cycle, Otto cycle, Diesel cycle, construction and working of internal combustion engines, comparison of diesel engine and petrol engine. Systems of internal combustion engine, performance of internal combustion engines. Air compressors their cycles refrigeration cycles, principle of a refrigeration plant.

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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	List-II
A. Centrifugal fan	1. Open system
B. Control volume	2. Internal energy
C. Intensive property	3. Filling a tire at air station
D. Microscopic property	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

(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:

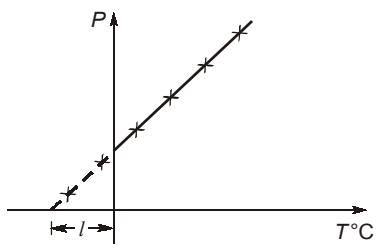
	A	B	C	D
(a)	1	4	2	3
(b)	3	2	4	1
(c)	1	2	4	3
(d)	3	4	2	1

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 displacment 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 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 Gibb's function

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.145 A rigid tank contains 10 kg of water at 90°C. If 8 kg of the water is in the liquid form and the rest is in the vapour form. The pressure (in kPa) and volume (in m^3) of tank are, respectively:

P(kPa)	T(°C)	v_f(m^3/kg)	v_g(m^3/kg)	v_{fg}(m^3/kg)
70.183	90	0.001036	2.3593	2.35826

Given: P_{atm} = 101.325 kPa

(a) 101.325, 4.73 (b) 101.325, 6.7

(c) 171.508, 6.7 (d) 70.183, 4.73

Q.146 Internal energy change of an ideal gas is expressed as

(a) $du = c_v dT$

(b) $du = c_p dT$

(c) $du = (c_p - c_v)\,dT$

(d) $du = c_v dT + \left(\frac{\partial u}{\partial v}\right)_T dv$

Q.147 Critical temperature among the substances: Water, Ammonia, Oxygen and Nitrogen is the highest for

(a) Water (b) Ammonia

(c) Oxygen (d) Nitrogen

Q.148 Carnot cycle operates between temperature of 800K and 400K. The Carnot efficiency will be 50% if working substance is

(a) Ideal gas (b) Nitrogen

(c) Ammonia (d) Any substance

Q.149 Consider the following processes in thermodynamics cycles:

1. Constant pressure
2. Constant volume
3. Adiabatic
4. Isothermal

Which of the above processes are involved in Stirling cycle?

(a) 1 and 2 (b) 2 and 4

(c) 2 and 3 (d) 3 and 4

Q.150 Which of the following statements are **TRUE** with respect to heat and work?

1. They are path function.
2. They are point function.
3. They are inexact differentials.
4. They are boundary phenomenon.

(a) 1 and 4 (b) 1, 3 and 4

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

■■■■

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.**	(a)	**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.	(b)	**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.**	(b)	**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)		

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

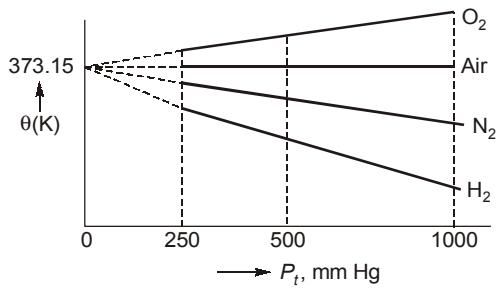
Isolated system:

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

$$W = \int p dV$$

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. (b)

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

For constant volume, close system work = 0

Hence, $\delta Q = dU$

58. (c)

$W = \int_1^2 pdV$

Change in extensive property

Intensive 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

$$TdS = dh - VdP$$
$$TdS = \delta Q \quad \text{(for reversible process)}$$
$$\delta Q = dh \quad \text{when } dP = 0$$

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)

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

For the cyclic process,

$$\Delta U = 0$$
$$\therefore \quad \int \delta W = \int \delta Q$$
$$\therefore \quad W = 15.7 - 26.2 - 4.86 + 31.5$$
$$= 16.14 \text{ kJ}$$

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)

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