UPPSC-AE 2021

Uttar Pradesh Public Service Commission

Combined State Engineering Services Exam

Assistant Engineer

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 Uttar Pradesh Public Service Commission (UPPSC) for the post of Assistant 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 Mechanical Engineering Practice book for UPPSC-AE 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 UPPSC. 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 UPPSC 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

Uttar Pradesh Public Service Commission
Combined State Engineering Services Examination
Assistant Engineer
Mechanical Engineering

Paper-I

Engineering Mechanics:
Analysis of force systems, friction, centroid and centre of gravity, trusses and beams, principle of virtual work, kinematics and kinetics of particle, kinematics and kinetics of rigid bodies.

Mechanism and Machines:
Velocity and acceleration of links, cams and followers gears and gear trains clutches, belt drives, brakes and dynamometers, Flywheel and governors, balancing of rotating and reciprocating masses, balancing of multi cylinder engines, Free and forced vibration, damped vibration, whirling of shafts.

Mechanics of Solids:
Stresses and strains, compound stresses strains, Torsion of circular shafts, stresses and deflections in beams unsymmetrical bending, curved beams, Thin and thick cylinders and spheres, Buckling of columns, Energy methods, helical and leaf springs.

Design of Machine Elements:
Design for Static and dynamic loading, Theories of failure, fatigue principles of design of riveted, welded and bolted joints, shafts, springs, bearings, brakes, clutches and flywheels.

Engineering Materials:
Crystal systems and crystallography, crystal imperfections, Alloys and phase diagrams, Heat treatment, ferrous and non ferrous metals and alloys, Mechanical properties and testing.

Manufacturing:
Metal casting, metal forming, metal joining, Mechanics of metal cutting, machining and machine tool operations, unconventional machining methods limits, fits and tolerances, inspection: Surface roughness, comparators, computer integrated manufacturing, Flexible manufacturing systems, jigs and fixtures.

Industrial Engineering:
Production, planning and control, inventory control and operation, research, CPM and PERT.

Mechatronics and Robotics:
Microprocessors and microcontrollers, Architecture, Programming, Computer interfacing Programmable logic controller, sensors and actuators, Piezoelectric accelerometers, Hall effect sensors, optical encoder, resolver, Inductosyn, Pneumatic and Hydraulic Actuators, stepper motor, control system, mathematical modeling, control signals, controllability and observability, Robotics: Robot classification, robot specification. Notation: Direct and inverse kinematics homogeneous co-ordinates and arm equation of four axix SCARA Robot.

Paper-II

Thermodynamics:
Thermodynamic systems and processes, properties of pure substances, concepts and applications of zeroth, first and second law of thermodynamics, entropy, availability and irreversibility, detailed analysis of thermodynamic cycles, ideal and real gases, fuels and combustion.

Fluid Mechanics :
Basic concepts and properties of fluids, manometry, fluid statics, buoyancy, equations of motion, Bernoulli's equation and applications, viscous flow of incompressible fluids, laminar and turbulent flows, flow through pipes and head losses in pipes, dimensional analysis, Forces on immersed bodies and boundary layer over a flat plate, isentropic and adiabatic flows, normal shock waves.

Heat Transfer:
Modes of heat transfer, steady and unsteady heat conduction, thermocouple time constant, critical thickness of insulation, heat transfer from fins, momentum and energy equations for boundary layer flow on a flat plate. Free and forced convection, radiation heat transfer, Stefan-Boltzmann law, shape factor, black and grey body radiation heat exchange, boiling and condensation, heat exchanger analysis, LMTD and NTU – effectiveness methods.

Energy conversion:
SI and CI engines, performance characteristics and testing of IC engines, combustion phenomena in SI and CI engines, carburetion and fuel injection systems, emissions and emission control. Reciprocating and rotary pumps, pelton wheel, Francis and Kaplan turbines, velocity diagrams impulse and reaction principles steam and gas turbines; Rankine and Brayton cycles with regeneration and reheat, high pressure boilers, draft, condensers. Unconventional power systems, including nuclear, MHD, biomass, wind and tidal systems, utilization of solar energy; Reciprocating and rotary compressors; theory and applications, Theory of propulsions, pulse jet and ramjet engines.

Environmental control:
Vapour compression, vapour absorption, steam jet and air refrigeration systems, properties of refrigerant and their nomenclature, psychometrics properties and processes, psychrometic relations, use of pschrometic chart, load estimation, supply air conditions, sensible heat factors, air conditioning system layout, comfort chart, comfort and industrial air conditioning.

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Contents

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UNIT 1

Thermodynamics

Q.1 An adiabatic boundary is one which
(a) prevents heat transfer
(b) permits heat transfer
(c) prevents work transfer
(d) permits work transfer

Q.2 Match **List-I** with **List-II** and select the correct answer using the codes given below.

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.3 Match the following **List-I** (Thermometer) with **List-II** (Thermometric property) and select the correct answer using the codes given below.

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.4 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.5 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.6 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.7 Which one of the following represents open thermodynamic system?
(a) Manual ice cream freezer
(b) Centrifugal pump
(c) Pressure cooker
(d) Bomb calorimeter

Q.8 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.9 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.10 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.11 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.12 The fundamental unit of enthalpy is
(a) MLT^{-2} (b) ML^2T^{-1}
(c) ML^2T^{-2} (d) ML^3T^{-2}

Q.13 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.14 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.15 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.16 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.17 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.18 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.19 Match **List-I** with **List-II** and select the correct answer using the codes given below.

List-I
A. Normal boiling point of oxygen
B. Triple point of water
C. Normal boiling point of water
D. Normal melting point of gold

List-II
1. 100°C
2. –183°C
3. 1063°C
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

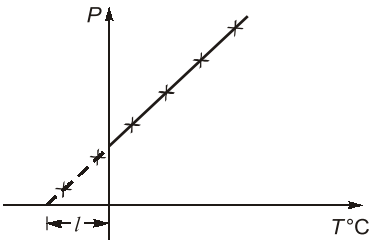
Q.20 Which of the following is used for measuring high temperature beyond 1063°C?
(a) Platinum-platinum/Rhodium thermocouple
(b) Electrical resistance thermometer
(c) Optical method using planck's law of thermal radiation
(d) Constant pressure gas thermometer

Q.21 Zeroth law of thermodynamics form the basis of measurement of
(a) pressure (b) temperature
(c) heat exchanger (d) work

Q.22 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.23 Triple point temperature of water is
(a) 273 K (b) 273.14 K
(c) 273.15 K (d) 273.16 K

Q.24 Experimental data obtained from a constant-volume-gas thermometer is shown is the figure below. The value of I in °C is



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

Q.25 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.26 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.27 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.28 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.29 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.30 Work done is zero for the following process
(a) constant volume (b) free expansion
(c) throttling (d) all of the above

Q.31 In free expansion process
(a) $W_{1-2} = 0$ (b) $Q_{1-2} = 0$
(c) $dU = 0$ (d) All of the above

Q.32 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.33 The cyclic integral of $(\delta Q - \delta W)$ for a process is
(a) positive (b) negative
(c) zero (d) unpredictable

Q.34 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.35 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.36 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.37 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.38 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

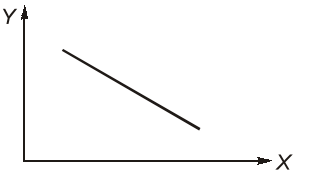
Q.39 In a cyclic process, heat transfer are +15.7 kJ, –26.2 kJ, –4.86 kJ and +31.5 kJ. What is the net work for this cyclic process?

(a) 15.14 kJ (b) 16.41 kJ
(c) 16.14 kJ (d) 15.41 kJ

Q.40 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.41 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

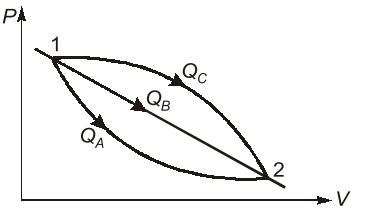
Q.42 A PMM1 is

(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.43 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.44 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) $Q_A > Q_B < Q_C$

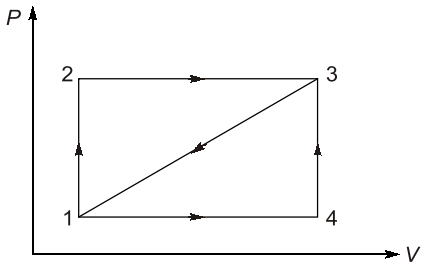
Q.45 Internal energy is defined by

(a) Zeroth law of thermodynamics
(b) First law of thermodynamics
(c) Second law of thermodynamics
(d) Law of entropy

Q.46 Key concept in analyzing the filling of an evacuated tank is

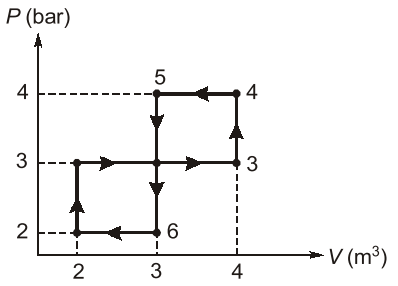
(a) the mass flow rate in the tank remains constant
(b) the enthalpy across the valve remains constant
(c) the internal energy in the tank remains constant
(d) the temperature in the tank remains constant

Q.47 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



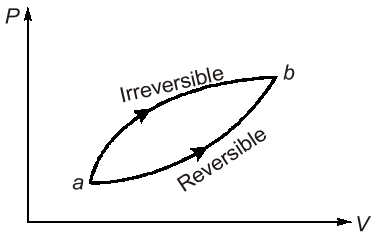
(a) –140 kJ (b) –80 kJ
(c) –40 kJ (d) 60 kJ

Q.48 The net work output for the cycle 1–2–3–4 –5–6–1 shown in figure is



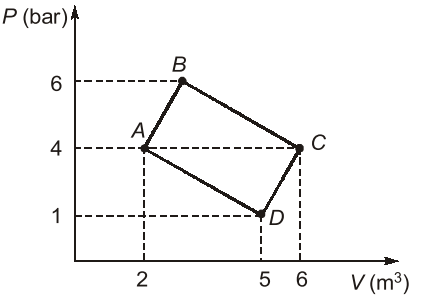
(a) 200 kJ
(b) 1200 kJ
(c) 0 kJ
(d) 1000 kJ

Q.49 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,



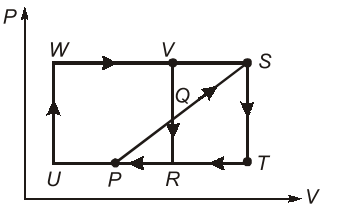
(a) ΔU, Q, W are same
(b) ΔU is same
(c) Q, W are same
(d) ΔU, Q are different

Q.50 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.51 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.52 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.53 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.54 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.55 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.56 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.57 Compressed air coming out from a punctured football
(a) becomes hotter
(b) becomes cooler
(c) remains at same temperature
(d) attains atmospheric temperature

Q.58 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.59 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.60 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.61 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.62 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.

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

Q.63 If a heat engine attains 100% thermal efficiency, it violates
(a) zeroth law of thermodynamics
(b) first law of thermodynamics
(c) second law of thermodynamics
(d) third law of thermodynamics

Q.64 A refrigerator and a heat pump operate between the same temperature limits. If the COP of the refrigerator is 4, the COP of the heat pump would be
(a) 3 (b) 4
(c) 5 (d) 6

Q.65 If the temperature of the source is increased keeping sink temperature fixed, the efficiency of the Carnot engine
(a) increases
(b) decreases
(c) does not change
(d) depends on working fluid

Q.66 The more effective way of increasing the efficiency of a Carnot engine is to
(a) increase higher temperature
(b) decrease higher temperature
(c) increase lower temperature
(d) decrease lower temperature

Q.67 A Carnot engine operates between reservoirs at 20°C and 200°C. If 10 kW of power is produced, the rejected heat rate is nearest
(a) 26.3 kJ/s (b) 20.2 kJ/s
(c) 16.3 kJ/s (d) 12 kJ/s

Q.68 An inventor invents a thermal engine that operates between ocean layers at 27°C and 10°C. It produces 10 kW and discharges 9900 kJ/min of heat. Such an engine is
(a) impossible (b) reversible
(c) possible (d) probable

Q.69 If the time taken by a system to execute a process through a finite gradient is infinitely large, the process
(a) becomes reversible
(b) remains irreversible
(c) becomes isothermal
(d) becomes adiabatic

Q.70 "Heat cannot be transported from a system at low temperature to another system at high temperature without the aid of external agency". This statement of second law is attributed to
(a) Clausius (b) Joule Thomson
(c) Max-Planck (d) Gay Lusac

Q.71 Which aspect is not true in the context of the efficiency of a Carnot cycle engine?
The efficiency of a Carnot cycle engine
(a) depends upon the temperature of source and sink.
(b) is always less than 100 per cent.
(c) is same for all reversible engines working between the same temperature limits.
(d) is dependent on the working fluid.

Q.72 Consider the following statements:
1. It is the second law of thermodynamics which provides criterion as to the probability of various processes.
2. Heat and work are completely inter-changeable forms of energy.
3. Work is high grade energy.
4. The complete conversion of low grade energy into high grade energy in a cycle is impossible.

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

Q.73 The four processes of the Carnot cycle are
(a) two reversible adiabatic and two reversible isobaric processes
(b) two reversible isothermal and two reversible adiabatic processes
(c) all four are isentropic processes
(d) two reversible isochoric processes and two reversible isobaric processes

Q.74 Perpetual motion machine of second kind violates the
(a) First law of thermodynamics
(b) Kelvin-Plank statement
(c) Clausius statement
(d) Third law of thermodynamics

Q.75 The efficiency of a thermodynamic cycle cannot be infinite since it
(a) violates the I law of thermodynamics
(b) violates the II law of thermodynamics
(c) violates the III law of thermodynamics
(d) rejects no heat

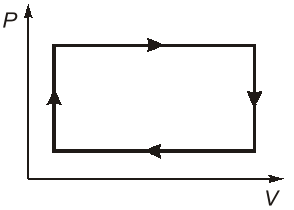
Q.76 Second law of thermodynamics defines
(a) Heat (b) Work
(c) Enthalpy (d) Entropy

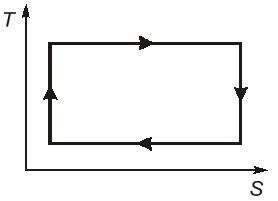
Q.77 Kelvin-plank law deals with
(a) conservation of energy
(b) conservation of heat
(c) conservation of mass
(d) conversion of heat into work

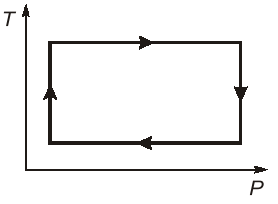
Q.78 The efficiency of the Carnot cycle may be increased by
(a) increasing the highest temperature
(b) decreasing the highest temperature
(c) increasing the lowest temperature
(d) keeping the lowest temperature constant

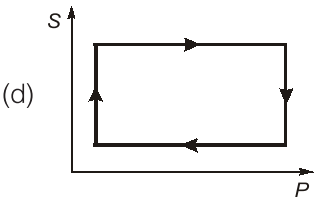
Q.79 In a Carnot engine, when working substance gives heat to the sink
(a) temperature of sink increases
(b) temperature of sink remains same
(c) temperature of source decreases
(d) temperature of both the sink and source decreases

Q.80 Which of the following represents Carnot cycle?

(a)


(b)


(c)


(d)


Q.81 The Carnot cycle is unpredictable because it
(a) requires a perfect gas as the working fluid
(b) necessitates all processes comprising the cycle to be reversible
(c) demands high speed for its working
(d) involves greater pressures and volumes

Q.82 An engine operates between temperature limits of 900 K and T_2 and another between T_2 and 400 K for both to be equally efficient T_2 will be equal to
(a) 600 K (b) 650 K
(c) 625 K (d) 700 K

Q.83 An inventor claims that a heat engine has the following specifications:
Developed = 50 kW
Fuel burned per hour = 3 kg
Heating value of fuel = 7500 kJ/kg
Temperature limit = 627°C and 27°C
Cost of fuel = ₹ 30/kg
Power the performance of his engine is
(a) possible
(b) not possible
(c) economical
(d) uneconomical

Q.84 Three engines *A*, *B* and *C* operating on Carnot cycle respectively use air, steam and Helium as the working fluid. If all the engine operates within the same temperature limit, then which engine will have highest efficiency
(a) Engine *A*
(b) Engine *B*
(c) Engine *C*
(d) All engines will have same efficiency

Q.85 If a heat engine gives an output of 3 kW when the input is 10000J/sec then the thermal efficiency of the engine will be
(a) 20% (b) 30%
(c) 70% (d) 76.7%

Q.86 A heat engine operates at 75% of the maximum possible efficiency. The ratio of the heat source temperature (in K) to the heat sink temperature (in K) is 5/3. The fraction of the heat supplied that is converted to work is

(a) 0.2 (b) 0.3
(c) 0.4 (d) 0.6

Q.87 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.88 A reversible power cycle is used to drive a reversible heat pump cycle. The power cycle takes in Q_1 heat units at T_1 and reflects Q_2 at T_2. The heat pump abstracts Q_4 from sink at T_4 and discharges Q_3 at T_3. The ratio of Q_4/Q_1 (in terms of four temperature) is

(a) $\frac{T_4}{T_1}\left(\frac{T_1 - T_2}{T_3 - T_4}\right)$ (b) $\frac{T_1}{T_4}\left(\frac{T_3 - T_4}{T_1 - T_2}\right)$

(c) $\frac{T_2}{T_3}\left(\frac{T_1 - T_2}{T_3 - T_4}\right)$ (d) $\frac{T_2}{T_3}\left(\frac{T_3 - T_4}{T_1 - T_2}\right)$

Q.89 Two insulated tanks containing ideal gases at different pressures and temperatures are connected to each other and gases are allowed to mix.

The process that occurs can be called

(a) free expansion
(b) constant enthalpy
(c) constant internal energy
(d) reversible adiabatic

Q.90 The equation, $\delta Q = dU + PdV$, is true for

(a) any system, any process
(b) any system, reversible process
(c) closed system, any process
(d) closed system, only reversible process

Q.91 Clausius inequality is stated as

(a) $\oint \delta Q < 0$ (b) $\oint \delta Q = 0$

(c) $\oint \frac{\delta Q}{T} > 0$ (d) $\oint \frac{\delta Q}{T} \le 0$

Q.92 For the isentropic expansion of an ideal gas from the initial conditions P_1, T_1 to the final conditions P_2, T_2, which one of the following relations is valid?

$\left(\gamma = \frac{c_p}{c_v}\right)$

(a) $\left(\frac{P_1}{P_2}\right) = \left(\frac{T_2}{T_1}\right)^{\gamma}$ (b) $\left(\frac{P_1}{P_2}\right) = \left(\frac{T_1}{T_2}\right)^{\frac{\gamma}{\gamma-1}}$

(c) $\left(\frac{P_1}{P_2}\right) = \left(\frac{T_1}{T_2}\right)^{(\gamma-1)}$ (d) $\left(\frac{P_1}{P_2}\right) = \left(\frac{T_1}{T_2}\right)^{\frac{\gamma-1}{\gamma}}$

Q.93 In Rankine temperature scale freezing point of water is 491.670°R and boiling point of water is 671.640°R. The triple point of water in Rankine scale is

(a) 489.67 °R (b) 491.688°R
(c) 493.470°R (d) 494.688 °R

Q.94 Consider the following statements related to state of thermodynamic equilibrium:

1. Consistency of all properties across the system.
2. The properties won't change without some perceivable affect in the surroundings.
3. Thermodynamic equilibrium consists of equality of temperatures only.

Which of these statements are correct?

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

Q.95 Consider the following

1. Intensive property – specific heat.
2. Extensive property – heat capacity.
3. Path function – entropy generation.
4. Open system – human body.

Which of the following items is/are incorrectly matched?

(a) 2 and 4 (b) 2 and 3
(c) 4 only (d) none of the above

Q.96 Helium in a piston cylinder arrangement goes through a polytropic process with heat to work ratio of 0.62. What is the index of polytropic process?

(a) 1.10 (b) 1.15
(c) 1.20 (d) 1.25

Q.97 Two insulated rigid containers are connected through a valve. One of the container contains an ideal gas at P, pressure and T_1 temperature, while the second container is evacuated. When the valve is opened the gas occupies the entire tank. If T_2 is the final temperature of the gas then
(a) $T_1 > T_2$ (b) $T_1 = T_2$
(c) $T_1 < T_2$ (d) more data is required

Q.98 A piston cylinder device contains 5 kg of air at 400 kPa and 30°C. During a quasi-equilibrium isothermal expansion process, 15 kJ of boundary work is done by the system, and 3 kJ of paddle-wheel work is done on the system. The heat transfer during this process is
(a) 12 kJ (b) 18 kJ
(c) 2.4 kJ (d) 3.5 kJ

Q.99 A system which is in thermodynamic equilibrium will
(a) deliver maximum reversible work.
(b) have maximum thermal efficiency
(c) deliver both maximum reversible work and have maximum thermal efficiency
(d) do not deliver anything

Q.100 A system containing air undergoes a change of state from (P_1, v_1) to (P_2, v_2) whose values are (0.5 MPa, 0.287 m^3/kg) and (0.1 MPa, 1.435 m^3/kg) respectively. The process undergone by the system is
(a) isochoric (b) isobaric
(c) isothermal (d) isentropic

Q.101 Steam flows through a machine which causes gain in enthalpy of 0.8 kJ/kg. If the kinetic energy at inlet is 0.2 kJ/s and mass flow rate of steam is 2 kg/s, what is the change in kinetic energy of the steam?
(a) –1.4 kJ/s (b) –1.6 kJ/s
(c) 1.4 kJ/s (d) 1.6 kJ/s

Q.102 Consider the following processes
1. free expansion
2. water flowing down the water fall
3. cooling of hot tea in open air
4. energy storing in flywheel

Which of these are irreversible processes?
(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 2, 3 and 4 (d) all of these

Q.103 Consider the following statements regarding Perpetual Motion Machine of third kind:
1. It is an ideal device which do not contribute to any sort of losses due to relative rubbing of parts.
2. It is an internally as well as externally reversible device.

Which of these statements is/are correct?
(a) 1 only
(b) 2 only
(c) both 1 and 2
(d) none of these

Q.104 Which of the following statements are true?
1. Water vapour can be treated as an ideal gas above 10 kPa.
2. Compressibility factor is defined only for an ideal gas and its value is unity.
3. Free expansion of a gas contained in an insulated chamber is an isenthalpic process.

(a) 1 and 2 only
(b) 1, 2 and 3
(c) 2 and 3 only
(d) none of the above

Q.105 Critical temperature among the substances: Water, Ammonia, Oxygen and Nitrogen is the highest for
(a) Water (b) Ammonia
(c) Oxygen (d) Nitrogen

Q.106 Carnot cycle operates between temperature of 800 K and 400 K. The Carnot efficiency will be 50% if working substance is
(a) Ideal gas
(b) Nitrogen
(c) Ammonia
(d) Any substance

Q.107 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.108 A body of constant heat capacity C_p and initial temperature T_1 is placed in contact with a heat reservoir at temperature T_2 and comes to isothermal equilibrium with it. If $T_2 > T_1$, what is the entropy change of the universe?

(a) $C_p\left[\ln\frac{T_1}{T_2}-\left(1-\frac{T_1}{T_2}\right)\right]$

(b) $C_p\left[\ln\frac{T_2}{T_1}-\left(1-\frac{T_2}{T_1}\right)\right]$

(c) $C_p\left[\ln\frac{T_2}{T_1}-\left(1-\frac{T_1}{T_2}\right)\right]$

(d) $C_p\left[\ln\frac{T_2}{T_1}-\left(\frac{T_1}{T_2}-1\right)\right]$

Q.109 Match **List-I** (Laws of thermodynamics) with **List-II** (Defines) the following:

List-I	List-II
A. First	1. Absolute zero temperature
B. Second	2. Internal energy
C. Zeroth	3. Temperature
D. Third	4. Entropy

Codes:

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

Q.110 Consider the processes:

Process A: A heat source at 800 K loses 2000 kJ of heat to sink at 500 K.

Process B: A heat source at 800 K loses 2000 kJ of heat to sink at 750 K.

Which of the following can be concluded?

(a) Process A is less irreversible.

(b) Process B is less irreversible.

(c) Both processes accompany entropy generation with negative value.

(d) Entropy generation in process B is more than that of process A.

Q.111 The slope of constant pressure line on a *T-s* diagram is given by

(a) $\frac{C_P}{T}$ (b) $\frac{T}{C_P}$

(c) $\frac{s}{T}$ (d) $\frac{T}{s}$

Q.112 The slope of constant volume line on a *T-s* diagram is given by

(a) $\frac{C_v}{T}$ (b) $\frac{T}{C_v}$

(c) $\frac{s}{T}$ (d) $\frac{T}{s}$

Q.113 Entropy change for a closed system depends on

(a) heat transfer

(b) mass transfer

(c) change of temperature

(d) thermodynamic coordinates

Q.114 The value of entropy at 0 K is taken as

(a) 1 (b) 0

(c) –1 (d) any value

Q.115 Which of the following second-law statements is incorrect?

(a) The entropy of an isolated system must remain constant or increase.

(b) The entropy of a hot copper block decreases as it cools.

(c) If ice is melted in water in an insulated container, the net entropy decreases.

(d) Work must be input if energy is transferred from a cold body to a hot body.

Q.116 Energy tends over to gravitate to a lower degree of intensity so long as it undergoes no transformation.

Which law of thermodynamics is related to this statement?

(a) Zeroth law

(b) First law

(c) Second law

(d) Third law

Q.117 Consider the following statements:

In an irreversible process

1. entropy always increases
2. the sum of the entropy of all bodies taking part in a process always increases
3. once created, entropy can not be destroyed

Which among the above are correct?

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

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

Q.118 One kg of water at room temperature is brought into contact with a high temperature thermal reservoir. The entropy change of the universe is
(a) equal to entropy change of the reservoir
(b) equal to entropy change of water
(c) equal to zero
(d) always positive

Q.119 For a thermodynamics cycle to be irreversible, it is necessary that

(a) $\int \frac{\delta Q}{T} = 0$ (b) $\int \frac{\delta Q}{T} < 0$

(c) $\int \frac{\delta Q}{T} > 0$ (d) $\int \frac{\delta Q}{T} \geq 0$

Q.120 Increase in entropy of a system represents
(a) increase in availability of energy
(b) increase in temperature
(c) decrease in pressure
(d) degradation of energy

Q.121 For reversible adiabatic process, change in entropy is
(a) maximum (b) minimum
(c) zero (d) unpredictable

Q.122 Entropy may be expressed as a function of
(a) pressure and temperature
(b) temperature and volume
(c) heat and work
(d) all of above

Q.123 A certain amount of fluid at temperature T_1 is mixed with an equal amount of the same fluid at temperature T_2 in an insulated container with total fluid as the system, consider the following statements
I. Energy of the system is conserved
II. Entropy of the system is conserved
III. Entropy of the system increases
IV. Entropy of the system decreases
Which of the above statements is/are true?
(a) I and II (b) I and III
(c) I and IV (d) I only

Q.124 Which one of the following statements applicable to a perfect gas will also be true for an irreversible process
(a) $\delta Q = dU + PdV$ (b) $\delta Q = TdS$
(c) $TdS = dU + PdV$ (d) None of these

Q.125 Consider two subsystem 1 and 2 containing same fluid and having same mass m; but at Temperature T_1 and $T_2 (T_1 > T_2)$ enclosed in an adiabatic enclosure separate by a partition. If the partition is removed and the fluids are allowed to mix. The entropy change of process is

(a) $\Delta S = 2mc \ln \frac{(T_1 - T_2)/2}{\sqrt{T_1 T_2}}$

(b) $\Delta S = 2mc \ln \frac{(T_1 + T_2)/2}{\sqrt{T_1 T_2}}$

(c) $\Delta S = mc \ln \frac{(T_1 + T_2)/2}{\sqrt{T_1 T_2}}$

(d) $\Delta S = 2mc \ln \frac{\sqrt{T_1 T_2}}{\sqrt{T_1 + T_2}/2}$

Q.126 In a reversible isothermal process, an ideal gas expands to four times its initial volume. The change in entropy is
(a) $R \log_{10} 4$ (b) $R \ln 4$
(c) $C_v \log_{10} 4$ (d) $C_v \ln 4$

Q.127 High pressure steam is expanded adiabatically and reversible through a well insulated turbine which produces some shaft work. If the enthalpy change and entropy change across the turbine are represented by ΔH and ΔS, respectively, for this process:
(a) $\Delta H = 0$ and $\Delta S = 0$
(b) $\Delta H \neq 0$ and $\Delta S = 0$
(c) $\Delta H \neq 0$ and $\Delta S \neq 0$
(d) $\Delta H = 0$ and $\Delta S \neq 0$

Q.128 A system undergo a state change from 1 to 2, according to second law of thermodynamics for the process to be feasible, the entropy change $(S_2 - S_1)$ of the system
(a) is positive or zero
(b) is negative or zero
(c) is zero
(d) can be positive, negative or zero

Q.129 Consider the following statements:
1. Availability is generally conserved
2. Availability can either be negative or positive

3. Availability is the maximum theoretical work obtainable
4. Availability can be destroyed in irreversibility

Which of these statements are correct?

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

Q.130 A reversible power cycle operates with temperature limits of 800 K and 300 K. If it takes 560 kJ of heat, then what would be the unavailable work?

(a) 180 kJ (b) 190 kJ
(c) 200 kJ (d) 210 kJ

Q.131 A heat engine receives heat from a source at 1500 K at a rate of 600 kW and rejects the waste heat to a medium at 350 K. If the power output from the heat engine is 250 kW, the irreversibility rate for the process is

(a) 125 kW (b) 150 kW
(c) 180 kW (d) 210 kW

Q.132 The exergy of an isolated system in a process

(a) can never increase
(b) can never decrease
(c) always remains constant
(d) is always positive

Q.133 Which of the following thermodynamic relation is Keenan function?

(a) $U + PV$ (b) $H - T_0 S$
(c) $E - T_0 S$ (d) $U - T_0 S$

Q.134 The main cause for the irreversibility is

(a) mechanical and fluid friction
(b) unrestricted expansion
(c) heat transfer with a finite temperature difference
(d) all of the above

Q.135 Neglecting change in kinetic energy and potential energy unit mass the availability in a non-flow process becomes $a = \phi - \phi_0$ where ϕ is the availability function of the

(a) open system (b) closed system
(c) isolated System (d) steady flow process

Q.136 The second law efficiency (η_{II}) of a process is defined as (where A_{min} is minimum exergy intake to perform the task, A_{max} is maximum exergy intake to perform the task, A is exergy intake to perform the task)

(a) $\eta_{II} = \frac{A_{min}}{A}$ (b) $\eta_{II} = \frac{A_{max}}{A}$
(c) $\eta_{II} = \frac{A}{A_{min}}$ (d) $\eta_{II} = \frac{A}{A_{max}}$

Q.137 A heat engine receives heat from a source at 1200 K at a rate of 500 kJ/sec and rejects the waste heat to a medium at 300 K. The power output of the heat engine is 180 kW. Then irreversibility rate for this process is

(a) 375 kW (b) 275 kW
(c) 195 kW (d) 125 kW

Q.138 The process of sublimation is found to occur in case of

(a) liquid nitrogen (b) solid carbon dioxide
(c) solid oxygen (d) air

Q.139 In *P-V-T* surface, the zone below the triple point is known as

(a) liquid zone (b) vapour zone
(c) sublimation zone (d) fusion zone

Q.140 The point that connects the saturated liquid line to the saturated vapour line is called

(a) triple point
(b) critical point
(c) superheated point
(d) compressed liquid point

Q.141 At triple point of a pure substance

(a) liquid and vapour phase coexist
(b) solid and vapour phase coexist
(c) liquid and solid phase coexist
(d) solid, liquid and vapour phase coexist

Q.142 Sublimation curve on *P-T* diagram for all substances possesses the following slope

(a) zero (b) infinite
(c) positive (d) negative

Q.143 At critical point the enthalpy of vapourization is

(a) dependent on temperature only
(b) maximum
(c) minimum
(d) zero

Q.144 Triple point is the point in

(a) *p-V* diagram (b) *p-T* diagram
(c) *h-S* diagram (d) *T-s* diagram

Q.145 A substance expands on freezing only if
(a) the slope of sublimation line on *p*-*T* chart is –ve
(b) the slope of sublimation line on *p*-*T* chart is +ve
(c) the slope of fusion line on *p*-*T* chart is –ve
(d) the slope of fusion line on *p*-*T* chart is +ve

Q.146 On a *P*-*V*-*T* surface, the triple point and critical point are seen as respectively
(a) Line, Line (b) Line, Point
(c) Point, Line (d) Point, Point

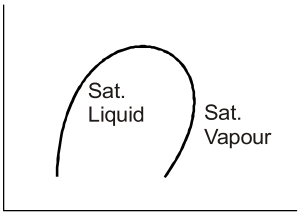
Q.147 In the mollier diagram for steam, dryness fraction lines converge at
(a) triple point (b) critical point
(c) saturation point (d) none of these

Q.148 For a mixture of solid, liquid and vapour phases of a pure substance in equilibrium, what is the number of independent intrinsic properties needed?
(a) 0 (b) 1
(c) 2 (d) 3

Q.149 Which one of the following represents the condensation of a mixture of saturated liquid and saturated vapour on the enthalpy-entropy diagram
(a) a horizontal line
(b) an inclined line of constant slope
(c) a vertical line
(d) a curved line

Q.150 Which of the following are pure substances?
1. Gaseous air
2. A mixture of gaseous air and liquid water
3. A mixture of liquid water and water vapour
4. A mixture of gaseous air and oil
(a) 1 and 2 (b) 2 and 3
(c) 3 and 4 (d) 1 and 3

Q.151 The ordinate and abscissa in the given figure showing the saturated liquid and vapour regions of a pure substance represent.



(a) Temperature and pressure
(b) Enthalpy and entropy
(c) Pressure and volume
(d) Pressure and enthalpy

Q.152 Change of state, e.g., freezing, melting, evaporation and condensation, is an
(a) Adiabatic process
(b) Isobaric process
(c) Isothermal process
(d) Iso-choric process

Q.153 Change in specific entropy for polytropic process is expressed as

(a) $ds = c_v\left(\frac{\gamma - n}{1 - n}\right)\log_e\frac{T_2}{T_1}$

(b) $ds = c_p\left(\frac{\gamma - n}{\gamma - 1}\right)\log_e\frac{T_2}{T_1}$

(c) $ds = \left(\frac{\gamma - n}{\gamma - 1}\right)\log_e\frac{T_2}{T_1}$ (d)

$ds = c_v\left(\frac{\gamma - n}{\gamma - 1}\right)\log_e\frac{V_2}{V_1}$

Q.154 The specific volume of water when heated from 1°C to 50°C
(a) first increases and then decreases
(b) increase steadily
(c) first decreases and then increases
(d) decrease steadily

Q.155 The entropy of fixed amount of an ideal gas
(a) decreases in every isothermal compression
(b) increase in every isothermal compression
(c) remains same in every isothermal compression
(d) may increase or decrease in every isothermal compression

Q.156 Consider the following statements:
1. The direction of the entropy transfer is same as that of the heat transfer.
2. In an adiabatic internally reversible process, entropy remains constant.
3. Entropy of an isolated system can never decrease.
4. If a closed system undergoes a process its entropy always increases.
Which of the above 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.157 What is the loss in the available energy in a cycle where 1000 kJ of heat is transferred to 500 K reservoir from 1000 K reservoir? Take atmospheric temperature to be 32°F.

(a) 3200 kJ (b) 1000 kJ
(c) 305 kJ (d) 273 kJ

Q.158 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.159 In a mixture there are 5 gases present. The degree of freedom of the mixture is

(a) 4 (b) 5
(c) 6 (d) 7

Q.160 Which of the following statements are incorrect?

1. There is no entropy transfer associated with work.
2. There is no entropy transfer associated with heat.
3. There is exergy transfer associated with work.
4. There is no exergy transfer associated with heat.

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

Q.161 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

■■■■

Answers Thermodynamics

1.	(a)	2.	(c)	3.	(d)	4.	(c)	5.	(b)	6.	(c)	7.	(b)	8.	(c)
9.	(d)	10.	(d)	11.	(b)	12.	(c)	13.	(b)	14.	(b)	15.	(d)	16.	(a)
17.	(c)	18.	(d)	19.	(b)	20.	(c)	21.	(b)	22.	(c)	23.	(d)	24.	(d)
25.	(d)	26.	(a)	27.	(a)	28.	(a)	29.	(c)	30.	(d)	31.	(d)	32.	(c)
33.	(c)	34.	(b)	35.	(d)	36.	(b)	37.	(a)	38.	(a)	39.	(c)	40.	(c)
41.	(c)	42.	(d)	43.	(d)	44.	(a)	45.	(b)	46.	(b)	47.	(d)	48.	(c)
49.	(b)	50.	(d)	51.	(c)	52.	(b)	53.	(c)	54.	(d)	55.	(a)	56.	(c)
57.	(b)	58.	(c)	59.	(d)	60.	(c)	61.	(c)	60.	(c)	63.	(c)	64.	(c)
65.	(a)	66.	(d)	67.	(c)	68.	(a)	69.	(c)	70.	(a)	71.	(d)	72.	(b)
73.	(b)	74.	(b)	75.	(b)	76.	(d)	77.	(d)	78.	(a)	79.	(b)	80.	(b)
81.	(b)	82.	(a)	83.	(b)	84.	(d)	85.	(b)	86.	(b)	87.	(b)	88.	(a)

89.	(c)	**90.**	(d)	**91.**	(d)	**92.**	(b)	**93.**	(b)	**94.**	(a)	**95.**	(d)	**96.**	(d)
97.	(b)	**98.**	(a)	**99.**	(d)	**100.**	(c)	**101.**	(b)	**102.**	(a)	**103.**	(c)	**104.**	(d)
105.	(a)	**106.**	(d)	**107.**	(b)	**108.**	(c)	**109.**	(d)	**110.**	(b)	**111.**	(b)	**112.**	(b)
113.	(a)	**114.**	(b)	**115.**	(c)	**116.**	(c)	**117.**	(d)	**118.**	(d)	**119.**	(b)	**120.**	(d)
121.	(c)	**122.**	(a)	**123.**	(b)	**124.**	(c)	**125.**	(b)	**126.**	(b)	**127.**	(b)	**128.**	(d)
129.	(a)	**130.**	(d)	**131.**	(d)	**132.**	(a)	**133.**	(b)	**134.**	(d)	**135.**	(b)	**136.**	(a)
137.	(c)	**138.**	(b)	**139.**	(c)	**140.**	(b)	**141.**	(d)	**142.**	(c)	**143.**	(d)	**144.**	(b)
145.	(a)	**146.**	(b)	**147.**	(b)	**148.**	(a)	**149.**	(b)	**150.**	(d)	**151.**	(d)	**152.**	(c)
153.	(a)	**154.**	(c)	**155.**	(a)	**156.**	(a)	**157.**	(d)	**158.**	(d)	**159.**	(c)	**160.**	(c)
161.	(c)														

Explanations

3. (d)

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

11. (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.

13. (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.

14. (b)

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

19. (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

20. (c)

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

21. (b)

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

26. (a)

Zeroth law gives the concept of temperature.

27. (a)

$$\delta Q = \delta W + \Delta U \quad \text{(As per 1st law)}$$
$$\therefore \quad \delta W = \delta Q - \Delta U$$
$$= 60 + 30 = 90 \text{ kJ}$$

28. (a)

As per first law of thermodynamics:

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

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

$$\Delta U = \delta Q - \delta W$$
$$= -40 + 20 = -20 \text{ kJ/kg}$$

29. (c)

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

30. (d)

For constant volume process

$$W = \int pdV$$

Since, $dV = 0$

$$W = 0$$

For free expansion

$$W = 0$$

Also for throttling process

$$W = 0$$

31. (d)

For free expansion,

$$\delta W = 0$$

No heat interaction takes place,

Hence $\delta Q = 0$

From first law,

$$\delta Q = dU + \delta W$$
$$dU = 0$$

32. (c)

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

33. (c)

For a process

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

34. (b)

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

For constant volume, close system work = 0

Hence, $\delta Q = dU$

35. (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.

36. (b)

From the first law of thermodynamics

$$\delta Q = dU + \delta W$$
$$-1500 = dU - 5000$$
$$dU = 5000 - 1500$$
$$dU = 3500 \text{ kJ}$$

37. (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

$$\delta Q = dh$$

38. (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

39. (c)

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

For the cyclic process,

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

40. (c)

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

41. (c)

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