SSC-JE

Staff Selection Commission

Junior Engineer

Mechanical Engineering

Topicwise Objective Solved Questions

Volume-I

Previous Years Solved Papers : 2007-2024

Also useful for ***RRB-JE Mains*** *as well as various* **public sector examinations**
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Preface

B. Singh (Ex. IES)

Staff Selection Commission-Junior Engineer has always been preferred by Engineers due to job stability. SSC-Junior Engineer examination is conducted every year. MADE EASY team has deeply analyzed the previous exam papers and observed that a good percentage of questions are repetitive in nature, therefore it is advisable to solve previous years papers before a candidate takes the exam.

The SSC JE exam is conducted in two stages as shown in table given below.

Papers	Subject	Maximum Marks	Duration
Stage 1: Paper-I : Objective type	(i) General Intelligence & Reasoning (ii) General Awareness (iii) General Engineering : Mechanical	50 Marks 50 Marks 100 Marks	2 hours
Stage 2: Paper-II : Objective Type	General Engineering : Mechanical	300 Marks	2 hours
Note: In Paper-I, every question carry one mark and there is negative marking of ¼ marks for every wrong answer. Candidates shortlisted in Stage 1 are called for Stage 2. On the basis of combined score in Stage 1 and Stage 2, final merit list gets prepared.			

MADE EASY has taken due care to provide complete solution with accuracy. Apart from Staff Selection Commission-Junior Engineer, this book is also useful for Public Sector Examinations and other competitive examinations for engineering graduates.

I have true desire to serve student community by providing good source of study and quality guidance. Any suggestion from the readers for improvement of this book is most welcome.

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

Syllabus of Engineering Subjects

(For both Objective and Conventional Type Papers)

Mechanical Engineering

Theory of Machines and Machine Design: Concept of simple machine, Four bar linkage and link motion, Flywheels and fluctuation of energy, Power transmission by belts – V-belts and Flat belts, Clutches – Plate and Conical clutch, Gears – Type of gears, gear profile and gear ratio calculation, Governors – Principles and classification, Riveted joint, Cams, Bearings, Friction in collars and pivots.

Engineering Mechanics and Strength of Materials: Equilibrium of Forces, Law of motion, Friction, Concepts of stress and strain, Elastic limit and elastic constants, Bending moments and shear force diagram, Stress in composite bars, Torsion of circular shafts, Buckling of columns – Euler's and Rankin's theories, Thin walled pressure vessels

Thermal Engineering: Properties of Pure Substances : p-v & P-T diagrams of pure substance like H2O, Introduction of steam table with respect to steam generation process; definition of saturation, wet & superheated status. Definition of dryness fraction of steam, degree of superheat of steam. h-s chart of steam (Mollier's Chart).
1st Law of Thermodynamics : Definition of stored energy & internal energy, 1st Law of Thermodynamics for cyclic process, Non Flow Energy Equation, Flow Energy & Definition of Enthalpy, Conditions for Steady State Steady Flow; Steady State Steady Flow Energy Equation.
2nd Law of Thermodynamics : Definition of Sink, Source Reservoir of Heat, Heat Engine, Heat Pump & Refrigerator; Thermal Efficiency of Heat Engines & co-efficient of performance of Refrigerators, Kelvin – Planck & Clausius Statements of 2nd Law of Thermodynamics, Absolute or Thermodynamic Scale of temperature, Clausius Integral, Entropy, Entropy change calculation for ideal gas processes. Carnot Cycle & Carnot Efficiency, PMM-2; definition & its impossibility.

Air standard Cycles for IC engines : Otto cycle; plot on P-V, T-S Planes; Thermal Efficiency, Diesel Cycle; Plot on P-V, T-S planes; Thermal efficiency. IC Engine Performance, IC Engine Combustion, IC Engine Cooling & Lubrication.

Rankine cycle of steam : Simple Rankine cycle plot on P-V, T-S, h-s planes, Rankine cycle efficiency with & without pump work. Boilers; Classification; Specification; Fittings & Accessories : Fire Tube & Water Tube Boilers. Air Compressors & their cycles; Refrigeration cycles; Principle of a Refrigeration Plant; Nozzles & Steam Turbines

Fluid Mechanics & Machinery: Properties & Classification of Fluids : ideal & real fluids, Newton's law of viscosity, Newtonian and Non-Newtonian fluids, compressible and incompressible fluids. Fluid Statics : Pressure at a point. Measurement of Fluid Pressure : Manometers, U-tube, Inclined tube. Fluid Kinematics : Stream line, laminar & turbulent flow, external & internal flow, continuity equation. Dynamics of ideal fluids : Bernoulli's equation, Total head; Velocity head; Pressure head; Application of Bernoulli's equitation. Measurement of Flow rate Basic Principles : Venturimeter, Pilot tube, Orifice meter. Hydraulic Turbines: Classifications, Principles. Centrifugal Pumps : Classifications, Principles, Performance.

Production Engineering: Classification of Steels : mild steal & alloy steel, Heat treatment of steel, Welding – Arc Welding, Gas Welding, Resistance Welding, Special Welding Techniques i.e. TIG, MIG, etc. (Brazing & Soldering), Welding Defects & Testing; NDT, Foundry & Casting – methods, defects, different casting processes, Forging, Extrusion, etc, Metal cutting principles, cutting tools, Basic Principles of machining with (i) Lathe (ii) Milling (iii) Drilling (iv) Shaping (v) Grinding, Machines, tools & manufacturing processes.

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SSC-JE : Paper-I

Contents

Mechanical Engineering : Volume-I

Previous Years Objective Solved Papers

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CHAPTER 1

Thermodynamics

1. Basic Concepts & Zeroth Law of Thermodynamics

1.1 According to which law, all perfect gases change in volume by 1/273rd of their original volume at 0°C for every 1°C change in temperature when pressure remains constant?
(a) Joule's law (b) Boyle's law
(c) Gay-Lussac law (d) Charle's law
[SSC-JE : 2007]

1.2 Zeroth law of thermodynamics defines:
(a) internal energy (b) enthalpy
(c) temperature (d) pressure
[SSC-JE : 2008]

1.3 The term NTP stands for
(a) Nominal temperature and pressure
(b) Natural temperature and pressure
(c) Normal temperature and pressure
(d) Normal thermodynamics practice
[SSC-JE : 2010]

1.4 Mixture of ice and water form a
(a) Closed system
(b) Open system
(c) Isolated system
(d) Heterogeneous system [SSC-JE : 2010]

1.5 When neither mass nor energy is allowed to cross the boundary of a system, it is then called:
(a) Open system (b) Isolated system
(c) Universe (d) Closed system
[SSC-JE : 2012]

1.6 In case of Boyle's law, if pressure increases by 1% the percentage decrease in volume is :
(a) $\frac{1}{101}\%$ (b) $\frac{100}{101}\%$
(c) $\frac{1}{100}\%$ (d) 0% [SSC-JE : 2012]

1.7 The boiling and freezing points for water are marked on a temperature scale *P* as 130°P and –20°P respectively. What will be the reading on this scale corresponding to 60°C on Celsius scale?
(a) 60°P (b) 70°P
(c) 90°P (d) 110°P
[SSC-JE : 2014 (E)]

1.8 Which of the following is an extensive property?
(a) temperature (b) pressure
(c) density (d) enthalpy
[SSC-JE : 2014 (M)]

1.9 The sequence of process that eventually returns the working substance to its original state, is known as ______.
(a) Event
(b) Thermodynamic cycle
(c) Thermodynamic property
(d) None of these
[SSC-JE (Forenoon) 1.3.2017]

1.10 According to kinetic theory of gases, at absolute zero ______.
(a) Specific heat of molecules reduces to zero
(b) Kinetic energy of molecules reduces to zero
(c) Volume of gas reduce to zero
(d) Pressure of gas reduce to zero
[SSC-JE (Forenoon) 1.3.2017]

1.11 According to Gay-Lussac's law for perfect gases, the absolute pressure of given mass varies directly as _______.
(a) Temperature
(b) Absolute temperature
(c) Absolute temperature, if volume remains constant
(d) Product of absolute temperature and volume
[SSC-JE (Forenoon) 1.3.2017]

1.12 Three states of matter are distinguished with respect to molecules by the ______.
(a) Atoms in molecules
(b) Number
(c) Orientation
(d) Character of motion
[SSC-JE (Forenoon) 1.3.2017]

1.13 Equal volume of all gases, at the same temperature and pressure, contain equal number of molecules. This is according to _______.
(a) Charle's law (b) Avogadro's law
(c) Joule's law (d) Gay Lussac law
[SSC-JE (Forenoon) 1.3.2017]

1.14 A reversible process _____.
(a) Must pass through a continuous series of equilibrium states
(b) Leaves no history of the events in surroundings
(c) Must pass through the same states on the reversed path as on the forward path
(d) All options are correct
[SSC-JE (Forenoon) 1.3.2017]

1.15 Extensive property of a system is one whose value _____.
(a) depends on the mass of the system, like volume
(b) does not depend on the mass of the system, like temperature, pressure etc.
(c) is not dependent on the path followed but on the state
(d) is dependent on the path followed and not on the state
[SSC-JE : (Afternoon) 1.3.2017]

1.16 Total heat of a substance is also known as _____.
(a) internal energy (b) entropy
(c) thermal capacity (d) enthalpy
[SSC-JE : (Afternoon) 1.3.2017]

1.17 A system will be thermodynamic equilibrium only if it is in _____.
A. Thermal equilibrium
B. Mechanical equilibrium
C. Chemical equilibrium
(a) only A (b) only B
(c) only C (d) A, B and C
[SSC-JE : (Afternoon) 1.3.2017]

1.18 Properties of substances like pressure, temperature and density, in thermodynamic co-ordinates are _____.
(a) path functions
(b) point functions
(c) cyclic functions
(d) real functions
[SSC-JE : (Afternoon) 1.3.2017]

1.19 A football was inflated to a gauge pressure of 1 bar when the ambient temperature was 15°C. When the game started next day, the air temperature at the stadium was 5°C. Assume that the volume of the football remains constant at 2500 cm^3. Gauge pressure of air to which the ball must have been originally inflated so that it would equal 1 bar gauge at the stadium is _____.
(a) 2.23 bar (b) 1.94 bar
(c) 1.07 bar (d) 1 bar
[SSC-JE : (Forenoon) 2.3.2017]

1.20 Which of the following is expected to have highest thermal conductivity?
(a) steam (b) solid ice
(c) melting ice (d) water
[SSC-JE : (Forenoon) 2.3.2017]

1.21 The amount of heat required to raise the temperature of 1 kg of water from 0°C to the saturation temperature T_s °C at a given constant pressure is defined as _____.
(a) Superheat (b) Entropy
(c) Latent heat (d) Sensible heat
[SSC-JE : (Forenoon) 2.3.2017]

1.22 Calories is measure of________
(a) specific heat (b) quantity of heat
(c) thermal capacity (d) entropy
[SSC-JE : (Afternoon) 2.3.2017]

1.23 All gases behave ideally under_______.
(a) vacuum conditions
(b) low pressure conditions
(c) high pressure conditions
(d) high pressure and high temperature conditions
[SSC-JE : (Afternoon) 2.3.2017]

1.24 If a gas vapour is allowed to expand through a very minute aperture, then such a process is known as______.
(a) free expansion
(b) throttling
(c) hyperbolic expansion
(d) parabolic expansion
[SSC-JE : (Forenoon) 3.3.2017]

1.25 A football was inflated to a gauge pressure of 1 bar when the ambient temperature was 15°C. When the game started next day, the air temperature at the stadium was 5°C. Assume that the volume of the football remains constant at 2500 cm^3. The amount of heat lost by the air in the football and the gauge pressure of air in the football at the stadium respectively equal to _____.
(a) 30.6 J and 1.94 bar
(b) 21.8 J and 0.93 bar
(c) 61.1 J and 1.94 bar
(d) 43.7 J and 0.93 bar
[SSC-JE : (Forenoon) 3.3.2017]

1.26 For a thermodynamic process to be reversible, the temperature difference between hot body and working substance should be______.
(a) zero (b) minimum
(c) maximum (d) infinity
[SSC-JE : (Forenoon) 3.3.2017]

1.27 The universal gas constant of a gas is the product of molecular weight of the gas and _____.
(a) Gas constant
(b) Specific heat at constant pressure
(c) Specific heat at constant volume
(d) None of these
[SSC-JE : (Afternoon) 3.3.2017]

1.28 The temperature of a gas is a measure of _____.
(a) Average distance between gas molecules
(b) Average kinetic energy of gas molecules
(c) Average potential energy of gas molecules
(d) None of these
[SSC-JE : (Afternoon) 3.3.2017]

1.29 Thermal equilibrium between two or more bodies exists, when they are brought together, there is no change in _____.
(a) Density (b) Pressure
(c) Temperature (d) All options are correct
[SSC-JE : (Afternoon) 3.3.2017]

1.30 According to the Gay-Lussac law for a perfect gas, the absolute pressure of given mass varies directly as
(a) temperature
(b) absolute temperature
(c) absolute temperature, if volume is kept constant
(d) volume, if temperature is kept constant
[SSC-JE : (Forenoon) 4.3.2017]

1.31 Which of the following can be regarded as gas so that gas laws could be applicable, within the commonly encountered temperature limits.
(a) O_2, N_2, steam, CO_2
(b) O_2, N_2, water vapour
(c) SO_2, NH_3, CO_2, moisture
(d) O_2, N_2, H_2, air
[SSC-JE : (Forenoon) 4.3.2017]

1.32 Temperature of a gas is produced due to
(a) its heating value
(b) kinetic energy of molecules
(c) repulsion of molecules
(d) attraction of molecules
[SSC-JE : (Forenoon) 4.3.2017]

1.33 The pressure of a gas in terms of its mean kinetic energy per unit volume E is equal to
(a) E/3 (b) E/2
(c) 3E/4 (d) 2E/3
[SSC-JE : (Forenoon) 4.3.2017]

1.34 According to Boyle's law for a perfect gas
(a) $T_2/T_1 = P_2/P_1$, if V is kept constant
(b) $T_2/T_1 = V_2/V_1$, if P is kept constant
(c) $P_1/P_2 = V_2/V_1$, if T is kept constant
(d) None of these
[SSC-JE : (Forenoon) 4.3.2017]

1.35 Boyle s law i.e. pV = constant is applicable to gases under
(a) all ranges of pressures
(b) only small range of pressures
(c) high range of pressures
(d) steady change of pressures
[SSC-JE : (Forenoon) 4.3.2017]

1.36 According to which law, all perfect gases change in volume by (1/273)th of their original volume at 0°C for every 1°C change in temperature when pressure remains constant
(a) Joule's law (b) Boyle's law
(c) Regnautt's law (d) Charles' law
[SSC-JE : (Forenoon) 4.3.2017]

1.37 A perfect gas at 27°C was heated until its volume was doubled. The temperature of the gas will now be
(a) 270°C (b) 540°C
(c) 327°C (d) 729°C
[SSC-JE : (Forenoon) 4.3.2017]

1.38 Which of the following laws is applicable for the behavior of a perfect gas?
(a) Boyle's law (b) Charles' law
(c) GayLussac law (d) All options are correct
[SSC-JE : (Afternoon) 4.3.2017]

1.39 According to Dalton's law, the total pressure of the mixture of gases is equal to
(a) greater of the partial pressures of all
(b) average of the partial pressures of all
(c) sum of the partial pressures of all
(d) sum of the partial pressures of all divided by average molecular weight
[SSC-JE : (Afternoon) 4.3.2017]

1.40 A closed system is one in which
(a) mass does not cross boundaries of the system, though energy may do so
(b) mass crosses the boundary but not the energy
(c) neither mass nor energy crosses the boundaries of the system
(d) both energy and mass cross the boundaries of the system
[SSC-JE : (Afternoon) 4.3.2017]

1.41 Kinetic theory of gases assumes that the collisions between the molecules are
(a) perfectly elastic (b) perfectly inelastic
(c) partly elastic (d) partly inelastic
[SSC-JE : (Afternoon) 4.3.2017]

1.42 The condition of perfect vacuum, i.e., absolute zero pressure can be attained at
(a) a temperature of – 273.16°C
(b) a temperature of 0°C
(c) a temperature of 273°K
(d) a negative pressure and 0° C temperature
[SSC-JE : (Afternoon) 4.3.2017]

1.43 An open system is one in which .
(a) mass does not cross boundaries of the system, though energy may do so
(b) neither mass nor energy crosses the boundaries of the system
(c) both energy and mass cross, the boundaries of the system
(d) mass crosses the boundary but not the energy
[SSC-JE : (Afternoon) 4.3.2017]

1.44 If a fluid expands suddenly into vacuum through an orifice of large dimension, then such a process is called
(a) free expansion
(b) hyperbolic expansion
(c) adiabatic expansion
(d) parabolic expansion
[SSC-JE : (Afternoon) 4.3.2017]

1.45 An ideal gas at 27°C is heated at constant pressure till its volume becomes three times. The temperature of gas then will be
(a) 81°C (b) 900°C
(c) 627°C (d) 927°C
[SSC-JE : (Afternoon) 4.3.2017]

1.46 Which of the following is not an extensive property
(a) entropy (b) enthalpy
(c) internal energy (d) density
[SSC-JE : (Afternoon) 4.3.2017]

1.47 What happens during a throttling process?
(a) Steam temperature remains constant
(b) Steam pressure remains constant
(c) Steam entropy remains constant
(d) Steam enthalpy remains constant
[SSC-JE : (Afternoon) 22.1.2018]

1.48 The value of the universal gas constant (R_u) is equal to
(a) 848 m kgf/kg-mol-K
(b) 8.48 m kgf/kg-mol/K
(c) 84.8 m kgf/kg-mol/K
(d) 0.848 m kgf/kg-mol/K
[SSC-JE : (Forenoon) 23.1.2018]

1.49 Liquids have
(a) no specific heat
(b) different values of specific heat at same temperature
(c) only one value of specific heat
(d) two distinct values of specific heat
[SSC-JE : (Forenoon) 23.1.2018]

1.50 In metric system the unit of heat is given as
(a) CHU (b) BTU
(c) kcal (d) kelvin
[SSC-JE : (Forenoon) 23.1.2018]

1.51 What type of slopes does constant pressure line have in the superheated region of the Mollier diagram?
(a) Positive slope
(b) Negative slope
(c) Zero slope
(d) First positive than negative slope
[SSC-JE : (Forenoon) 23.1.2018]

1.52 For a gas with *n* degree of freedom, what will be the value of $\frac{C_P}{C_v}$
(a) $n + 1$ (b) $n - 1$
(c) $1-\frac{2}{n}$ (d) $1+\frac{2}{n}$
[SSC-JE : (Forenoon) 23.1.2018]

1.53 Adiabatic process is
(a) essentially as isentropic process
(b) non-heat transfer process
(c) reversible process
(d) constant temperature process
[SSC-JE : (Afternoon) 23.01.2018]

1.54 What is the temperature at which a system goes under a reversible isothermal process without heat transfer?
(a) Absolute zero temperature
(b) Critical temperature
(c) Reversible temperature
(d) Boiling temperature
[SSC-JE : (Afternoon) 23.01.2018]

1.55 Consider the following properties
1. Entropy 2. Viscosity
3. Temperature
4. Specific heat at constant volume

Which of the above properties of a system is/are extensive?
(a) Only 1 (b) Only 1 and 2
(c) Only 2, 3 and 4 (d) Only 1, 2 and 4
[SSC-JE : (Forenoon) 24.01.2018]

1.56 Constant volume process is
(a) isopiestic process
(b) hyperbolic process
(c) isometric process
(d) polytropic process
[SSC-JE : (Forenoon) 24.01.2018]

1.57 Molar volume is equal to
(a) 22.41 m^3 at NTP (b) 2.241 m^3 at NTP
(c) 29.27 m^3 at NTp (d) 1.03 m^3 at NTp
[SSC-JE : (Forenoon) 24.01.2018]

1.58 The general gas equation is given as
(a) pv = mT (b) p/V = mT
(c) pT = mRT (d) pV = mRT
[SSC-JE : (Forenoon) 24.01.2018]

1.59 Which formula is the CORRECT depiction of slope of adiabatic curve?
(a) $\frac{dP}{dV}=-\gamma\frac{P}{V}$ (b) $\frac{dP}{dV}=\frac{P}{V}$
(c) $\frac{dP}{dV}=-\frac{P}{V}$ (d) $\frac{dP}{dV}=\gamma\frac{P}{V}$
[SSC-JE : (Forenoon) 24.01.2018]

1.60 Which relation clearly depicts the absolute thermodynamic temperature scale?
(a) $\frac{Q_1}{Q_2}=\frac{T_1}{T_2}$
(b) $\frac{Q_2}{Q_1}=\frac{T_1}{T_2}$
(c) $\frac{Q_1}{Q_2}=\frac{T_1}{T_2}$ and $\frac{Q_2}{Q_1}=\frac{T_1}{T_2}$ both
(d) None of these
[SSC-JE : (Forenoon) 24.01.2018]

1.61 Which of the following is the other name of isentropic process?
(a) a reversible isothermal process
(b) a reversible adiabatic process
(c) a reversible isobaric process
(d) a reversible isochoric process
[SSC-JE : (Forenoon) 24.01.2018]

Answers Thermodynamics

1. Basic Concepts & Zeroth Law of Thermodynamics

1.1 (d)	1.2 (c)	1.3 (c)	1.4 (d)	1.5 (b)	1.6 (b)	1.7 (b)	1.8 (d)
1.9 (b)	1.10 (b)	1.11 (c)	1.12 (d)	1.13 (b)	1.14 (d)	1.15 (a)	1.16 (d)
1.17 (d)	1.18 (b)	1.19 (c)	1.20 (b)	1.21 (d)	1.22 (b)	1.23 (b)	1.24 (b)
1.25 (d)	1.26 (a)	1.27 (a)	1.28 (b)	1.29 (c)	1.30 (c)	1.31 (d)	1.32 (b)
1.33 (d)	1.34 (c)	1.35 (b)	1.36 (d)	1.37 (c)	1.38 (d)	1.39 (c)	1.40 (a)
1.41 (a)	1.42 (a)	1.43 (c)	1.44 (a)	1.45 (c)	1.46 (d)	1.47 (d)	1.48 (a)
1.49 (c)	1.50 (c)	1.51 (a)	1.52 (d)	1.53 (b)	1.54 (a)	1.55 (a)	1.56 (c)
1.57 (a)	1.58 (d)	1.59 (a)	1.60 (a)	1.61 (b)	1.62 (a)	1.63 (d)	1.64 (a)
1.65 (b)	1.66 (b)	1.67 (a)	1.68 (c)	1.69 (a)	1.70 (a)	1.71 (b)	1.72 (d)
1.73 (*)	1.74 (c)	1.75 (d)	1.76 (b)	1.77 (c)	1.78 (b)	1.79 (a)	1.80 (c)
1.81 (a)	1.82 (d)	1.83 (b)	1.84 (d)	1.85 (c)	1.86 (b)	1.87 (a)	1.88 (b)
1.89 (c)	1.90 (c)	1.91 (b)	1.92. (d)	1.93 (b)	1.94 (d)	1.95 (c)	1.96 (a)
1.97 (b)	1.98 (b)	1.99 (b)	1.100 (c)	1.101 (c)	1.102 (c)	1.103 (b)	1.104 (d)
1.105 (a)	1.106 (d)	1.107 (b)	1.108 (a)				

2. Energy and Energy Interactions

2.1 (b)	2.2 (a)	2.3 (d)	2.4 (a)	2.5 (c)	2.6 (b)	2.7 (c)	2.8 (b)
2.9 (c)	2.10 (a)	2.11 (c)	2.12 (c)	2.13 (a)	2.14 (a)	2.15 (c)	2.16 (*)
2.17 (b)	2.18 (d)	2.19 (c)	2.20 (d)	2.21 (a)	2.22 (a)	2.23 (a)	2.24 (b)
2.25 (c)	2.26 (c)	2.27 (c)	2.28 (d)	2.29 (c)	2.30 (d)	2.31 (c)	2.32 (d)
2.33 (c)	2.34 (d)	2.35 (d)	2.36 (c)	2.37 (d)	2.38 (d)	2.39 (a)	2.40 (d)
2.41 (a)	2.42 (d)	2.43 (a)	2.44 (c)	2.45 (c)	2.46 (d)	2.47 (c)	2.48 (c)
2.49 (d)	2.50 (d)	2.51 (d)	2.52 (c)	2.53 (d)	2.54. (c)	2.55 (b)	2.56 (d)
2.57 (d)	2.58 (d)	2.59 (b)	2.60 (c)	2.61 (d)	2.62 (a)	2.63 (a)	

3. First Law of Thermodynamics

3.1 (d)	3.2 (b)	3.3 (c)	3.4 (b)	3.5 (b)	3.6 (b)	3.7 (b)	3.8 (c)
3.9 (b)	3.10 (b)	3.11 (a)	3.12 (b)	3.13 (b)	3.14 (c)	3.15 (d)	3.16 (b)
3.17 (c)	3.18 (c)	3.19 (a)	3.20 (d)	3.21 (d)	3.22 (d)	3.23 (c)	3.24 (a)
3.25 (a)	3.26 (c)	3.27 (b)	3.28 (c)	3.29 (c)	3.30 (d)	3.31 (c)	3.32 (c)
3.33 (d)	3.34 (d)	3.35 (c)	3.36 (a)	3.37 (c)	3.38 (d)	3.39 (d)	3.40 (b)
3.41 (*)	3.42 (d)	3.43 (a)	3.44 (b)	3.45 (a)	3.46 (c)	3.47 (c)	3.48 (a)
3.49 (a)	3.50 (b)	3.51 (a)	3.52 (c)	3.53 (a)	3.54 (c)	3.55 (c)	3.56 (c)

3.57	(a)	3.58	(c)	3.59	(b)	3.60	(b)	3.61	(a)	3.62	(*)	3.63	(d)	3.64	(a)
3.65	(a)	3.66	(c)	3.67	(a)	3.68	(b)	3.69	(d)	3.70	(c)	3.71	(d)	3.72	(a)
3.73	(c)	3.74	(c)	3.75	(d)	3.76	(c)	3.77	(b)	3.78	(d)	3.79	(c)	3.80	(d)
3.81	(c)	3.82	(d)	3.83	(c)	3.84	(b)	3.85	(b)	3.86	(a)	3.87	(b)	3.88	(a)
3.89	(a)	3.90	(d)	3.91	(c)	3.92	(d)	3.93	(b)	3.94	(d)	3.95	(d)	3.96	(c)
3.97	(c)														

4. Open System Analysis by First Law

4.1	(c)	4.2	(b)	4.3	(b)	4.4	(d)	4.5	(b)	4.6	(c)	4.7	(a)	4.8	(b)
4.9	(c)	4.10	(b)	4.11	(a)	4.12	(b)	4.13	(c)	4.14	(c)	4.15	(b)	4.16	(a)
4.17	(d)	4.18	(c)	4.19	(c)	4.20	(b)	4.21	(d)	4.22	(d)	4.23	(d)	4.24	(d)
4.25	(c)	4.26	(b)	4.27	(b)	4.28	(c)	4.29	(b)	4.30	(c)	4.31	(a)		

5. Second Law of Thermodynamics

5.1	(d)	5.2	(b)	5.3	(a)	5.4	(b)	5.5	(c)	5.6	(b)	5.7	(a)	5.8	(c)
5.9	(c)	5.10	(d)	5.11	(c)	5.12	(c)	5.13	(c)	5.14	(a)	5.15	(a)	5.16	(c)
5.17	(b)	5.18	(b)	5.19	(c)	5.20	(d)	5.21	(c)	5.22	(b)	5.23	(c)	5.24	(b)
5.25	(d)	5.26	(b)	5.27	(c)	5.28	(c)	5.29	(c)	5.30	(c)	5.31	(c)	5.32	(d)
5.33	(b)	5.34	(b)	5.35	(*)	5.36	(d)	5.37	(b)	5.38	(d)	5.39	(a)	5.40	(c)
5.41	(c)	5.42	(b)	5.43	(b)	5.44	(c)	5.45	(a)	5.46	(b)	5.47	(c)	5.48	(a)
5.49	(c)	5.50	(b)	5.51	(b)	5.52	(c)	5.53	(d)	5.54	(b)	5.55	(b)	5.56	(b)
5.57	(c)	5.58	(d)	5.59	(a)	5.60	(a)	5.61	(a)	5.62	(a)	5.63	(b)	5.64	(a)
5.65	(b)	5.66	(d)	5.67	(a)	5.68	(b)	5.69	(c)	5.70	(d)	5.72	(b)	5.73	(c)
5.74	(a)	5.75	(a)	5.76	(b)	5.77	(d)	5.78	(c)	5.79	(b)	5.80	(b)	5.81	(c)
5.82	(d)	5.83	(d)	5.84	(a)	5.85	(b)	5.86	(a)						

6. Entropy

6.1	(d)	6.2	(d)	6.3	(a)	6.4	(a)	6.5	(d)	6.6	(d)	6.7	(c)	6.8	(b)
6.9	(a)	6.10	(c)	6.11	(a)	6.12	(b)	6.13	(a)	6.14	(d)	6.15	(c)	6.16	(b)
6.17	(b)	6.18	(c)	6.19	(b)	6.20	(d)	6.21	(d)	6.22	(c)	6.23	(b)	6.24	(*)
6.25	(c)	6.26	(a)	6.27	(b)	6.28	(c)	6.29	(a)	6.30	(c)	6.31	(d)	6.32	(b)
6.33	(d)	6.34	(a)	6.35	(b)	6.36	(d)	6.37	(b)	6.38	(d)	6.39	(b)	6.40	(a)
6.41	(d)	6.42	(a)	6.43	(a)	6.44	(b)	6.45	(c)	6.46	(c)	6.47	(a)	6.48.	(c)
6.49	(a)	6.50	(a)	6.51	(c)	6.52	(d)	6.53	(d)	6.54	(d)	6.55	(b)	6.56	(c)

7. Properties of Pure Substances

7.1	(d)	7.2	(a)	7.3	(c)	7.4	(d)	7.5	(c)	7.6	(a)	7.7	(d)	7.8	(b)
7.9	(c)	7.10	(a)	7.11	(b)	7.12	(c)	7.13	(c)	7.14	(b)	7.15	(a)	7.16	(b)
7.17	(a)	7.18	(b)	7.19	(b)	7.20	(c)	7.21	(d)	7.22	(b)	7.23	(d)	7.24	(b)
7.25	(b)	7.26	(d)	7.27	(d)	7.28	(d)	7.29	(d)	7.30	(b)	7.31	(d)	7.32	(a)
7.33	(d)	7.34	(b)	7.35	(c)	7.36	(c)	7.37	(a)	7.38	(d)	7.39	(b)	7.40	(d)
7.41	(c)	7.42	(b)	7.43	(a)	7.44	(d)	7.45	(b)	7.46	(b)	7.47	(a)	7.48	(c)
7.49	(d)	7.50	(b)	7.51	(d)	7.52	(d)	7.53	(a)	7.54	(a)	7.55	(a)	7.56	(b)
7.57	(d)	7.58	(d)	7.59	(a)	7.60	(a)	7.61	(a)	7.62	(a)	7.63	(b)	7.64	(d)
7.65	(d)	7.66	(a)	7.67	(d)	7.68	(b)	7.69	(a)	7.70	(c)	7.71	(b)	7.72	(d)
7.73	(c)	7.74	(a)	7.75	(c)	7.76	(c)	7.77	(b)	7.78	(a)	7.79	(d)	7.80	(c)
7.81	(b)	7.82	(c)	7.83	(b)	7.84	(b)	7.85	(b)	7.86	(c)	7.87	(d)	7.88	(a)
7.89	(a)	7.90	(a)	7.91	(d)	7.92	(c)	7.93	(c)	7.94	(a)	7.95	(c)	7.96	(d)
7.97	(a)	7.98.	(a)	7.99	(d)	7.100	(d)	7.101	(b)	7.102	(d)	7.103	(a)	7.104	(c)
7.105	(a)	7.106	(d)	7.107	(a)	7.108	(c)	7.109	(b)	7.110	(b)	7.111	(b)	7.112	(b)
7.113	(a)	7.114	(a)	7.115	(d)	7.116	(b)	7.117	(a)	7.118	(a)	7.119	(d)		

Explanations Thermodynamics

1. Basic Concepts & Zeroth Law of Thermodynamics

1.1 (d)

According to Charle's law, the pressure remains constant.

i.e., $V \propto T$

$$\frac{V_2}{V_1} = \frac{T_2}{T_1}$$

$$\frac{\Delta V}{V_1} = \frac{\Delta T}{T_1}$$

$$\Rightarrow \quad \frac{\Delta V}{V_1} = \frac{1}{273}$$

1.2 (c)

The temperature is associated with the ability to distinguish hot from cold.

The zeroth law is a consequence of thermal equilibrium and allows us to conclude that temperature is a well defined physical quantity.

1.3 (c)

The term NTP stands for normal temperature and pressure. NTP is defined as air at 20°C (293.15K) and 1 atm (101.325 kPa) pressure.

Note: STP stands for standard temperature and pressure and defined for air at 0°C temperature and 1 bar pressure.

1.4 (d)

- A homogeneous system is defined as the one whose chemical composition and physical properties are the same in all parts of the system, or change continuously from one point to another.
- A heterogeneous system is defined as one consisting of two or more homogeneous bodies (phases). Each phase is separated from other phases by interfaces or, boundaries and in passing over such a boundary the chemical composition of the substance or its physical properties abruptly change. An example of heterogeneous system is water with ice floating in it. This system has two homogeneous bodies, water and ice.

1.5 (b)

Isolated system is one in which there is no interaction between the system and surrounding whether it is mass or energy.

1.6 (b)

Boyle's law states that the absolute pressure exerted by a given mass of an ideal gas is inversely proportional to the volume it occupies if the temperature and amount of gas remains unchanged within a closed system.

i.e. $P \propto \frac{1}{V}$ or $PV = k$

or, $P_1 V_1 = P_2 V_2$

$$P_1 V_1 = 1.01\, P_1 V_2$$

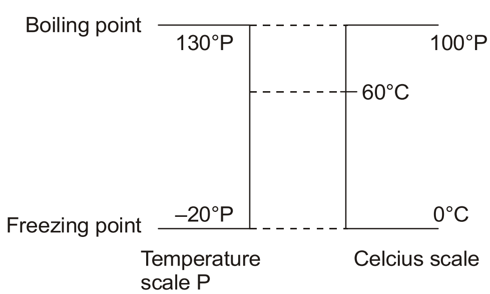
$$V_2 = \frac{1}{1.01} V_1 = \frac{100}{101} V_1$$

$$\% \text{ decrease in volume} = \frac{V_1 - V_2}{V_1} \times 100$$

$$= \frac{V_1 - \frac{100}{101} V_1}{V_1} \times 100 = \frac{100}{101}\%$$

1.7 (b)

Method-I



Let us have a scale :

$$°P = a\,°C + b$$

$$130 = a\,(100) + b$$

$$-20 = a\,(0) + b$$

$$150 = a\,(100)$$

$$\Rightarrow \quad °P = 1.5\,(°C) - 20$$

$$°P = 1.5 \times (60) - 20$$

$$= 90 - 20$$

$$°P = 70$$

Method-II

According to zeroth law,

$$\left(\frac{t - t_F}{t_B - t_F}\right)_{°C} = \left(\frac{t - t_F}{t_B - t_F}\right)_{°P}$$

$$\frac{60 - 0}{100 - 0} = \frac{t - (-20)}{130 - (-20)}$$

$$\frac{3}{5} = \frac{t + 20}{150}$$

$$\Rightarrow \quad t = 70°P$$

1.8 (d)

Enthalpy is an extensive property.

Extensive properties are those which depend upon the mass of the system.

1.9 (b)

The sequence of process that eventually returns the original state is known as thermodynamic cycle. It may also be defined as series of state changes such that the final state is identical with initial state.

1.10 (b)

Absolute zero is the point where all the molecules have no kinetic energy.

According to Kinematic theory of gases,

$$C_{rms} = \sqrt{\frac{3RT}{M}}$$

where, C_{rms} = Root mean square velocity of molecules

R = Characteristic gas constant

T = Temperature

M = Molecular weight

When temperature is zero, C_{rms} becomes zero when velocity is zero then kinetic energy of molecules is zero as kinetic energy is function of velocity.

1.11 (c)

According to Gay-Lussac's law for perfect gases, at constant volume the absolute pressure of given mass varies directly proportional to absolute temperature.

1.12 (d)

Three states of matter are distinguished with respect to molecules by character motion of molecules. In other words, it can also be defined as how the molecules of matter move.

Example: Motion of molecules in gas is more than that of liquids and solids.

1.13 (b)

Avogadro's law states that equal volume of all gases at the same temperature and pressure have the same number of molecules.

1.15 (a)

The properties which depends upon mass is called extensive properties. Example: Volume, entropy, enthalpy etc.

1.16 (d)

Enthalpy is the heat content of the system or the amount of energy within a substance, both kinetic and potential.

1.17 (d)

Thermodynamic equilibrium exists only when all the following types of equilibriums are satisfied:

1. Thermal equilibrium: It is equality of temperature.
2. Mechanical equilibrium: It is equality of forces.
3. Chemical equilibrium: No chemical change should take place with time.
4. Phase equilibrium: Mass of each phase should not change with time.

1.18 (b)

Point function: These depend on the state only and not on how a system reaches that state. Eg. pressure, temperature, density etc.

Path function: Their magnitudes depend on the path followed during a process as well as the end states.

Eg. heat, work, etc.

1.19 (c)

Let initial pressure inside ball = P_1

Final pressure inside ball = P_2 (on next day)

$$T_1 = 15°C = 288\text{ K} ;\ T_2 = 5°C = 278\text{ K}$$

$$V = 2500\text{ cm}^3 = \text{constant}$$

$$P_{atm} = 1.01\text{ bar}$$

$$(P_2)_{gauge} = 1\text{ bar}$$

$$P_2 = (P_2)_{gauge} + P_{atm} = 1 + 1.01 = 2.01\text{ bar}$$

Assuming air as an ideal gas

$$PV = mRT$$

$$\frac{P}{T} = \frac{mR}{V} = \text{constant} \ (\because V = \text{constant})$$

Hence, $$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\Rightarrow \frac{P_1}{288} = \frac{2.01}{278}$$

$$\Rightarrow P_1 = 2.08\text{ bar}$$

$$(P_1)_{gauge} = P_1 - P_{atm} = 2.08 - 1.01 = 1.07\text{ bar}$$

1.20 (b)

$k_{solid} > k_{liquid} > k_{gas}$

1.21 (d)

Sensible heat is heat exchanged by a body in which exchange of heat changes the temperature of the body or system without changing the phase of system. It is associated with random motion of molecules.

1.22 (b)

1 Calorie = 4.184 Joule

1.23 (b)

Favourable conditions for a gas to be ideal gas are

1. High temperature
2. Low pressure
3. Low density
4. Inter molecular forces should be negligible.

1.24 (b)

1. Throttling is a process in which no change in enthalpy is observed from one state to another.
2. No work is done ($\delta W = 0$)
3. Process is adiabatic ($\delta Q = 0$)

1.25 (d)

$$(P_1)_{gauge} = 1\text{ bar} = 100\text{ kPa}$$

$$T_1 = 15°C = 288\text{ K}$$

$$T_2 = 5°C = 278\text{ K}$$

$$P_{atm} = 1.01\text{ bar}$$

$$P_1 = P_{atm} + (P_1)_{gauge}$$

$$P_1 = 1.01 + 1 = 2.01\text{ bar}$$

$$V = 2500\text{ cm}^3 = \text{Constant}$$

Assuming air as an ideal gas

$$PV = mRT$$

$$\frac{P_1}{P_2} = \frac{T_1}{T_2} \quad \text{[For } V = \text{constant]}$$

$$P_2 = \frac{T_2}{T_1} \times P_1 = \frac{278}{288} \times 2.01$$

$$= 1.94 \text{ bar}$$

$$(P_2)_{gauge} = P_2 - P_{atm} = 1.94 - 1.01$$

$$= 0.93 \text{ bar}$$

Now,Heat lost, $\Delta Q = mc_V \Delta T$

where, $$m = \frac{P_1V_1}{RT_1} = \frac{(100) \times (2500 \times 10^{-6})}{(0.287) \times (288)}$$

$$= 6.08 \times 10^{-3} \text{ kg}$$

$$\Delta Q = (6.08 \times 10^{-3}) \times (0.718) \times (15 - 5)$$

$$= 0.0437 \text{ kJ} = 43.7 \text{ J}$$

1.26 (a)

A process will be reversible when it is performed in such a way that system is all times infinitesimally near a state of thermodynamic equilibrium.

1.27 (a)

Universal gas constant, $\bar{R}$ = 8.314 kJ/kmol-K
Characteristic gas constant of a gas = R
Molecular weight of gas = M

$$R = \frac{\bar{R}}{M} \quad \Rightarrow \bar{R} = MR$$

1.28 (b)

Temperature of gas is a measure of its average kinetic energy.

$\frac{1}{2}mV^2 = \frac{3}{2}kT$ [where k is boltzmann constant]

1.29 (c)

This is according to Zeroth law of thermodynamics.

1.30 (c)

Gay-Lussac's Law is an Ideal gas law where at constant volume, the pressure of an ideal gas is directly proportional to its absolute temperature.

1.31 (d)

Water vapour and steam do not behave like an ideal gas. Therefore gas laws cannot be applied to them.

1.32 (b)

According to kinetic theory of gases, the molecules of gases are in continuous random motion and during this random motion, they collide with each other. Hence the temperature is associated with the random velocity of colliding molecules i.e., kinetic energy of molecules.

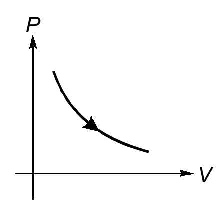
1.33 (d)

Mean kinetic energy per unit volume is

$$E = \frac{3}{2}(nRT) = \frac{3}{2}P \quad \Rightarrow P = \frac{2}{3}E$$

1.34 (c)

According to Boyle's law for a fixed amount of an ideal gas kept at a fixed temperature, pressure and volume are inversely proportional



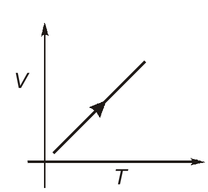
$$P \propto \frac{1}{V} \quad \Rightarrow PV = \text{const.}$$

1.35 (b)

Boyle's law holds true only if the number of molecules and temperature both are constant.

1.36 (d)

According to Charle's law when the pressure on a sample of dry gas is held constant the absolute temperature of the gas is directly proportional to the volume of gas.



1.37 (c)

Consider pressure is constant. Then according to charle's law

$$V \propto T$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$T_2 = T_1 \times \left(\frac{V_2}{V_1}\right) = 300 \times 2 = 600 \text{ K}$$

$$T_2 = 600 - 273 = 327°C$$

1.38 (d)

Boyle's law: when temperature is constant $\left(P \propto \frac{1}{V}\right)$.

Charle's law: when pressure is constant ($T \propto V$)

GayLussac's law: This states that "the ratio between the volume of gaseous reactants and products can be expressed in simple whole number".

For example: In the following reaction the ratio of volumes of H_2, Cl and HCl is 1 : 1 : 2 (a simple ratio).

H_2 + Cl2 → 2 HCl
(1 vol.) (1 vol.) (2 vol.)

1.39 (c)

Dalton's law of partial pressure states that in mixture of non reacting gases the total pressure exerted is equal to the sum of the partial pressures of the individual gases.

1.40 (a)

Close system is the system in which only energy interaction takes place between system and surrounding. There is no mass interaction takes place in closed system.

Example : Piston cylinder arrangement without valves.

1.41 (a)

The assumptions of kinetic theory of gases are given below :

(i) The gas is composed of large number of identical molecules moving in random directions, separated by distances that are large compared to their size.

(ii) The molecules undergo perfectly elastic collision (no energy loss) with each other.

(iii) The transfer of kinetic energy between molecules is heat.

1.42 (a)

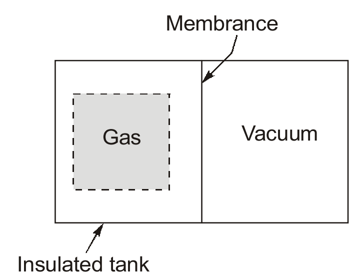
The condition of perfect vacuum i.e., absolute zero pressure can be attained at 0 K. i.e., –273.15°C.

1.43 (c)

It is the system in which mass as well as energy interaction takes place between system and surrounding.

Example : Boiler, turbine, pump etc.

1.44 (a)



The expansion of gas against vacuum is called free or unresisted expansion process.

Salient aspects of free expansion are

(i) Highly irreversible
(ii) Work done is zero
(iii) Adiabatic [Heat transfer = 0]
(iv) Change in internal energy is zero
(v) Entropy of system increases

1.45 (c)

At constant pressure. According to Charle's law

$$V \propto T$$

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

$$T_2 = \left(\frac{V_2}{V_1}\right)T_1 \qquad [V_2 = 3V_1]$$

$$= 3T_1 = 3(27 + 273)$$

$$T_2 = 900 \text{ K} = 627°C$$

1.46 (d)

Properties represents the characteristics of the system. Properties which depend on mass is called extensive or extrinsic properties.

Example : Mass, volume, entropy, enthalpy, internal energy.

1.47 (d)

During throttling in any system
1. The steam enthalpy remains constant
2. The steam pressure decreases
3. The dryness of steam increases
4. The entropy of system increases

1.48 (a)

We know, $R_u = 8.314$ kJ/kgmol-K

and 1 kgf = 9.81 N

$R_u = 8314$ J/kgmol-K

$\because$ 1 J = 1 N-m

$$= \frac{8.314 \times 10^3}{9.81} \text{kgf-m/kg-mol-K}$$

= 848 m kgf/kgmol-K

1.49 (c)

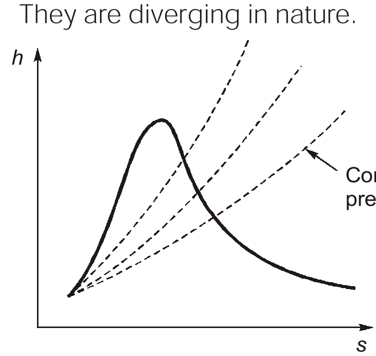
The liquids have only one value of specific heats because they are incompressible in nature.

1.50 (c)

kcal is unit of heat in metric system.
Joule is unit of heat in SI system.
BTU is unit of heat in FPS system.

1.51 (a)

They are diverging in nature.



1.52 (d)

Total energy associated with a grain molecule of the gas is given by

$$E = n \times \frac{1}{2} kT = \frac{n}{2} RT$$

where, n = Total number of molecules;
R = Universal gas constant = nk;
k = Boltzmann constant

Specific heat at constant volume,

$$C_V = \frac{dE}{dT} = \frac{nR}{2}$$

Also, $$C_P = C_V + R = \frac{nR}{2} + R = R\left(\frac{n}{2} + 1\right)$$

Now, $$\frac{C_P}{C_V} = \frac{\frac{n}{2} + 1}{\frac{n}{2}} = 1 + \frac{2}{n}$$

1.54 (a)

According to the definition of Kelvin scale

$$\frac{Q}{Q_t} = \frac{T}{T_t}$$

$$T = 273.16 \frac{Q}{Q_t}$$

From the above equation, it is clear that the heat transferred isothermally between two adiabatic bodies decreases if temperature decreases. Here, Q_t is the thermometric property. Therefore from the above equation if Q is having smaller value than T also lowers. The smallest possible value of Q is zero and corresponding T is 0.
Thus, the temperature at which a system undergoes a reversible isothermal process without transfer of heat is called as absolute zero. At absolute zero, an isotherm and adiabatic are identical.

1.55 (a)

Extensive property: An extensive property is a physical quantity whose value is proportional to the size of system it describes, or to the quantity of matter in the system.

1.56 (c)

Constant volume process is also known as isochoric, isovolumetric and isometric process.

1.57 (a)

At NTP, the temperature and pressure is 20°C and 1 atm. respectively and corresponding to this, the molar volume is 22.41 m^3.

1.58 (d)

According to ideal gas equation,

$$PV = mRT$$