UNIT I BASIC CONCEPTS AND FIRST LAW

TOPIC 1.1 BASIC CONCEPTS - CONCEPT OF CONTINUUM, COMPARISON OF MICROSCOPIC AND MACROSCOPIC APPROACH.

1. Energy is a
a) point function
b) property of the system
c) extensive property
d) all of the mentioned

Answer: d
Explanation: Energy has a definite value for every state of the system.

2. The specific energy, e=E/m is an extensive property.
a) true
b) false

Answer: b
Explanation: The specific energy is an intensive property.

3. (m*V*V)/2 gives the
a) macroscopic kinetic energy
b) microscopic kinetic energy
c) macroscopic potential energy
d) microscopic potential energy

Answer: a
Explanation: The formula gives the macroscopic kinetic energy of the fluid element by virtue of its motion.

4. (m*g*z) gives the
a) macroscopic kinetic energy
b) microscopic kinetic energy
c) macroscopic potential energy
d) microscopic potential energy

Answer: c
Explanation: The above formula gives the macroscopic potential energy of the fluid element by virtue of its position.

5. Which of the following types of energy can be present in molecules?
a) translational and rotational kinetic energy
b) electronic energy and vibrational energy
c) chemical energy and nuclear energy
d) all of the mentioned

Answer: d
Explanation: The molecules may be subjected to rotation as well as vibration due to a collision.

6. The total internal energy of the system is given by
a) $U=N/\varepsilon$
b) $U=N\varepsilon$
c) $U=\varepsilon/N$
d) none of the mentioned

Answer: b
Explanation: $U=N\varepsilon$ where N is the total number of molecules in the system and ε represents the energy of one molecule.

7. In an ideal gas there are no intermolecular forces of attraction and repulsion, and the internal energy is a function of temperature only.
a) true
b) false

Answer: a
Explanation: For an ideal gas U depends only on T.

8. Which of the following is true in regard to the energy of an isolated system?
a) $dQ\neq0$
b) $dW\neq0$

c) E=constant
d) all of the mentioned

Answer: c
Explanation: For an isolated system, dQ=dW=0 and hence, dE=0 by first law.

9. A perpetual motion machine of first kind
a) is a fictitious machine
b) can supply mechanical work without dissipating energy
c) violates first law
d) all of the mentioned

Answer: d
Explanation: There cannot be any machine which would continuously supply mechanical energy without other form of energy being dissipated.

10. The limitation of the first law is
a) does not indicate the possibility of a spontaneous process proceeding in a definite direction
b) it assigns a quality to different forms of energy
c) indicates the direction of any spontaneous process
d) none of the mentioned

Answer: a
Explanation: This is the main limitation of first law and the second law overcomes it.

TOPIC 1.2 PATH AND POINT FUNCTIONS. INTENSIVE AND EXTENSIVE, TOTAL AND SPECIFIC QUANTITIES. SYSTEM AND THEIR TYPES.

1. Integral of dQ/T is independent of reversible path connecting between two points.
a) true
b) false

Answer: a
Explanation: For two reversible paths, dQ/T doesn't depend on the path taken.

2. Integral of dQ/T of a reversible path is given by
a) Si-Sf
b) Sf-Si
c) Si+Sf
d) -Si-Sf

Answer: b
Explanation: Integral of dQ/T is = Sf-Si where i=initial equilibrium state and f=final equilibrium state.

3. Entropy is a
a) path function, intensive property
b) path function, extensive property
c) point function, intensive property
d) point function, extensive property

Answer: d
Explanation: Fact about entropy and unit of entropy is J/K.

4. Specific entropy is given by(where m is the mass)
a) Sm
b) m/S
c) S/m
d) none of the mentioned

Answer: c
Explanation: s=S/m with unit J/kg K.

5. For any process which is undergone by a system
a) dQ/T>=ds
b) dQ/T<=ds
c) dQ/T≠ds
d) none of the mentioned

Answer: b
Explanation: For any process dQ/T<=ds and this comes from Clausius theorem.

6. For a reversible process,
a) dS=dQ/T

b) dS>dQ/T
c) dS<dQ/T
d) none of the mentioned

Answer: a
Explanation: For a reversible process, dQ/T is equal to the net change in entropy.

7. For an irreversible process,
a) dS=dQ/T
b) dS>dQ/T
c) dS<dQ/T
d) none of the mentioned

Answer: b
Explanation: For a irreversible process, change in entropy is greater than dQ/T.

8. For two different paths between same two points, entropy change is
a) depends on path taken
b) different
c) same
d) none of the mentioned

Answer: c
Explanation: This is because entropy is a property.

9. For the general case, we can write
a) S2-S1<=dQ/T for a path
b) S2-S1>=dQ/T for a path
c) S2-S1≠dQ/T for a path
d) none of the mentioned

Answer: b
Explanation: The equality sign holds good for a reversible process and the inequality sign for an irreversible process.

10. When two equilibrium states are infinitesimally near,
a) dQ/T=dS
b) dQ/T>dS
c) dQ/T<dS
d) none of the mentioned

Answer: a
Explanation: dS is an exact differential because S is a point function and a property.

TOPIC 1.3 THERMODYNAMIC EQUILIBRIUM STATE, PATH AND PROCESS. QUASI-STATIC, REVERSIBLE AND IRREVERSIBLE PROCESSES.

1. A reversible process is performed in such a way that
a) at the conclusion of process, both system and surroundings can be restored to their initial states without producing any change
b) it should not leave any trace to show that the process had ever occurred
c) it is carried out infinitely slowly
d) all of the mentioned

Answer: d
Explanation: These are some basic concepts of a reversible process.

2. A reversible process coincides with a quasi-static process.
a) true
b) false

Answer: a
Explanation: A reversible process is carried out very slowly and every state it passes through is an equilibrium state.

3. Irreversibility of a process may be due to
a) lack of equilibrium during the process
b) involvement of dissipative effects
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These two are the major causes of irreversibility.

4. A heat transfer process approaches reversibility as the temperature difference between two bodies approaches
a) infinity

b) zero
c) -1
d) 1

Answer: b
Explanation: For heat transfer to be reversible, heat must be transferred through an infinitesimal temperature difference.

5. All actual heat transfer processes are
a) irreversible
b) take place through a finite temperature difference
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: An infinitesimal temperature difference is not easy to attain.

6. Free expansion is irreversible.
a) true
b) false

Answer: a
Explanation: It can be demonstrated by the second law.

7. Which of the following can be a cause of irreversibility?
a) friction, viscosity
b) inelasticity
c) electrical resistance, magnetic hysteresis
d) all of the mentioned

Answer: d
Explanation: These effects are known as dissipative effects.

8. The continual motion of a movable device in the complete absence of friction is known as
a) PMM2
b) PMM3
c) PMM1
d) PMM0

Answer: b
Explanation: This is not possible since lubrication cannot be completely eliminated.

9. The friction present in moving devices makes a process reversible.
a) true
b) false

Answer: b
Explanation: Friction lakes the process irreversible.

10. Which of the following is irreversible?
a) stirring work
b) friction work in moving devices
c) current flowing through a wire
d) all of the mentioned

Answer: d
Explanation: All these processes includes a particular cause of irreversibility.

11. A process will be reversible if it has
a) no dissipative effects
b) dissipative effects
c) depends on the given conditions
d) none of the mentioned

Answer: a
Explanation: Without any dissipative effects, a process can perform in a reversible manner.

12. Irreversibility can be distinguished in how many types?
a) 0
b) 1
c) 2
d) 3

Answer: c
Explanation: Tow types of irreversibility are internal and external irreversibility.

13. Internal irreversibility is caused by
a) internal dissipative effects
b) friction, turbulence
c) electrical resistance, magnetic hysteresis
d) all of the mentioned

Answer: d
Explanation: Internal dissipative effects are the major cause of internal irreversibility.

14. The external irreversibility occurs at the system boundary.
a) true
b) false

Answer: a
Explanation: This mainly includes heat interaction with the surroundings due to a finite temperature gradient.

15. Which of the following is true?
a) mechanical irreversibility is due to finite pressure gradient
b) thermal irreversibility is due to finite temperature gradient
c) chemical irreversibility is due to finite concentration gradient
d) all of the mentioned

Answer: d
Explanation: These are some other distinctions of irreversibility.

TOPIC 1.4 HEAT AND WORK TRANSFER, DEFINITION AND COMPARISON, SIGN CONVENTION. DISPLACEMENT WORK AND OTHER MODES OF WORK

1. The magnitude of mechanical work is the
a) product of the force and distance travelled perpendicular to the force
b) product of the force and distance travelled parallel to the force
c) sum of the force and distance travelled perpendicular to the force
d) sum of the force and distance travelled parallel to the force

Answer: b
Explanation: The work is done by a force as it acts upon a body moving in the direction of the force.

2. Work done by a system is taken to be
a) positive
b) negative
c) zero
d) varies according to situation

Answer: a
Explanation: In thermodynamics, work done by a system is take to be positive.

3. Work done on a system is taken to be
a) positive
b) negative
c) zero
d) varies according to situation

Answer: b
Explanation: In thermodynamics, work done on a system is take to be negative.

4. Work is a
a) point function
b) path function
c) depends on the state
d) none of the mentioned

Answer: b
Explanation: Amount of work done depends on the path the system follows.

5. Thermodynamic properties are
a) point function
b) path function
c) depends on the state
d) none of the mentioned

Answer: a
Explanation: For a given state there is a definite value for each property.

6. The differentials of point functions are
a) perfect differentials
b) exact differentials
c) all of the mentioned
d) none of the mentioned

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Answer: c
Explanation: Change in thermodynamic property is independent of path and depends only on initial and final states of the system.

7. In the equation dV=(1/p)dW, (1/p) is known as
a) volume factor
b) pressure factor
c) differential factor
d) integration factor

Answer: d
Explanation: Used to convert inexact differential dW into exact differential dV.

8. Cyclic integral of a property is always
a) zero
b) one
c) infinite value
d) none of the mentioned

Answer: a
Explanation: The initial and final states of the system for a cyclic process are the same.

9. Constant pressure process is also known as
a) isopiestic process
b) isobaric process
c) all of the mentioned
d) none of the mentioned

Answer: c
Explanation: Isobaric and isopiestic means pressure being constant.

10. Work done in a quasi-static process
a) depends on the path followed
b) independent of the path followed
c) depends only on the initial and final states
d) none of the mentioned

Answer: a
Explanation: This is because work done is a path function.

TOPIC 1.5 P-V DIAGRAM.

1. Which of the following is a property of a pure substance?
a) it has constant chemical composition throughout its mass
b) it is a one-component system
c) it may exist in one or more phases
d) all of the mentioned

Answer: d
Explanation: These are some of the properties of a pure substance.

2. For water, as temperature increases, volume always increases?
a) true
b) false

Answer: b
Explanation: From 0 degree Celsius to 4 degree Celsius as temperature increases, volume of water decreases which is a peculiarity of water.

3. A saturation state is a state from which a change of phase may occur
a) without a change of pressure or temperature
b) with a change of pressure or temperature
c) both of the mentioned
d) none of the mentioned

Answer: a
Explanation: For example, water at 0 degree Celsius and at 100 degree Celsius.

4. In which of the following state does water exist?
a) saturated solid state
b) saturated liquid state
c) saturated vapour state
d) all of the mentioned

Answer: d
Explanation: Water exists in these states at 0 degree Celsius and at 100 degree Celsius.

5. Which of the following exists in a p-V diagram for water?

a) saturated solid line
b) saturated liquid lines
c) saturated vapour line
d) all of the mentioned

Answer: d
Explanation: The p-V diagram for water has all these three lines.

6. The triple point is a line on the p-V diagram, where all the three phases, solid, liquid and gas exist.
a) true
b) false

Answer: a
Explanation: At triple point, all these three phases exists in equilibrium.

7. At a pressure below the triple point line,
a) the substance cannot exist in the liquid phase
b) the substance when heated transforms from solid to vapour
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: This phenomenon is known as sublimation and takes place by absorbing the latent heat of sublimation from the surroundings.

8. Which of the following statement is true?
a) to the left of saturated solid line is the solid region
b) between saturated solid line and saturated liquid line with respect to solidification there exists the solid-liquid mixture region
c) between two saturated liquid lines is the compressed liquid region
d) all of the mentioned

Answer: d
Explanation: These statements come from the p-V diagram for a pure substance.

9. The isotherm passing through the critical point is called the critical isotherm.
a) true
b) false

Answer: a
Explanation: At critical point, all the quantities like pressure, temperature and volume attain their critical values.

10. The greater the temperature, the_____is the vapour pressure.
a) lower
b) higher
c) depends on the substance
d) none of the mentioned

Answer: b
Explanation: The vapour pressure mainly depends on the temperature.

11. Phase change occurs at
a) constant pressure
b) constant temperature
c) constant pressure and temperature
d) none of the mentioned

Answer: c
Explanation: For phase change, pressure and temperature must be constant like water at 0 degree Celsius and at 100 degree Celsius.

12. Which of the following statement is true?
a) saturation temperature is a function of pressure
b) saturation pressure is a function of temperature
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: At saturation temperature, a pure liquid transforms into vapour and at saturation pressure, the liquid boils.

TOPIC 1.6 ZEROTH LAW OF THERMODYNAMICS -

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CONCEPT OF TEMPERATURE AND THERMAL EQUILIBRIUM-RELATIONSHIP BETWEEN TEMPERATURE SCALES -NEW TEMPERATURE SCALES.

1. It is necessary to have a temperature difference to obtain work of any cycle.
a) true
b) false

Answer: a
Explanation: It comes from the second law of thermodynamics.

2. The absolute thermodynamic temperature scale is also known as
a) celsius scale
b) kelvin scale
c) fahrenheit scale
d) none of the mentioned

Answer: b
Explanation: It was proposed by Kelvin.

3. In defining the temperature scale, the standard reference point is taken as
a) zero kelvin
b) boiling point of water
c) triple point of water
d) none of the mentioned

Answer: c
Explanation: Triple point of water is taken as the standard reference point.

4. When the heat transferred isothermally between the given_____decreases, the temperature _____
a) isotherms, increases
b) isotherms, decreases
c) adiabatics, increases
d) adiabatics, decreases

Answer: d
Explanation: This comes from the equation, T=(273.16)(Q/Q1).

5. If a system undergoes a reversible isothermal process without transfer of heat, the temperature at which this process takes place is called
a) absolute zero
b) triple point of water
c) boiling point of water
d) none of the mentioned

Answer: a
Explanation: The smallest possible value of Q which is the amount of heat supply is zero and the corresponding temperature is zero.

6. At absolute zero, an isotherm and an adiabatic are identical.
a) true
b) false

Answer: a
Explanation: At absolute zero, there is no heat transfer.

7. A definite zero point____on the absolute temperature scale but this point____be reached____violation of the second law.
a) doesnot, can, without
b) exists, cannot, without
c) exists, can, with
d) none of the mentioned

Answer: b
Explanation: When the heat rejected approaches zero, the temperature of heat rejection approaches zero as a limit.

8. Which law is stated here, "It is impossible to reduce any system to the absolute zero of temperature in a finite number of operations.
a) first law of thermodynamics
b) second law of thermodynamics
c) third law of thermodynamics
d) none of the mentioned

Answer: c
Explanation: Any attainable value of absolute temperature is always greater than zero.

9. The statement of third law is also called the Fowler-Guggenheim statement of the third law.
a) true
b) false

Answer: a
Explanation: This is a fact about third law of thermodynamics.

10. The Kelvin temperature is numerically equal to the_____and may be measured by means of a _____
a) gas temperature, liquid thermometer
b) ideal gas temperature, gas thermometer
c) ideal gas temperature, liquid thermometer
d) none of the mentioned

Answer: b
Explanation: θ=T=273.16K .

TOPIC 1.7 FIRST LAW OF THERMODYNAMICS - APPLICATION TO CLOSED AND OPEN SYSTEMS - STEADY AND UNSTEADY FLOW PROCESSES.

1. First law of thermodynamics deals with _____
a) Conservation of mass
b) Conservation of momentum
c) Conservation of energy
d) Conservation of pressure

Answer: c
Explanation: First law corresponds to the law of conservation of energy. It states that energy can neither be created nor destroyed, but can be transformed from one form to the other. It follows the principle of heat transfer and energy transfer.

2. Equation of the first law of thermodynamics is _____
a) Internal Energy= Heat added into work done
b) Internal Energy= Heat rejected into work done
c) Internal Energy= Heat added divided by work done
d) Internal Energy=Heat added plus work done

Answer: d
Explanation: It is a thermodynamic expression which gives a relationship between internal energy, heat and work done. Work done on the system is positive, and work done by the system is negative. The standard unit of all these quantities is Joule.

3. During a fluid flow, the temperature is developed due to_____
a) Increase in density
b) Change in pressure
c) Translational Kinetic Energy
d) Fluid level

Answer: c
Explanation: When there is a high rate of fluid flow, the molecules tend to collide with each other. At this state, the average translational kinetic energy of the particles increases. The temperature developed due to this is called as Kinetic temperature.

4. The equation for the average kinetic energy is_
a) 0.5 KT
b) 1.5 KT
c) 2.5 KT
d) 3.5 KT

Answer: b
Explanation: The equation for kinetic energy is $0.5mv^2$, where m= mass and v= velocity. This equation corresponds to 1.5 KT, where K=Boltzmann's constant and R= Gas constant.

5. An increase in enthalpy leads to an increase in _____
a) Increase in pressure

b) Increase in volume
c) Increase in internal energy
d) Increase in mass

Answer: c
Explanation: When the temperature increases, the amount of molecular interactions also increases. Using the equation from the first law of thermodynamics, internal energy also increases with the increase in temperature. Thus, increase in enthalpy leads to an increase in internal energy.

6. Entropy occurs due to _____
a) Change in macroscopic variables
b) Volumetric changes only
c) Mass changes only
d) Temperature only

Answer: a
Explanation: Entropy is related to a number of microscopic configurations. It can have some of the most specified macroscopic variables. These macroscopic variables undergo changes, which lead to a disorder or randomness.

7. What is the equation of entropy?
a) Ratio of reversible transfer of heat to absolute temperature
b) Ratio of absolute temperature to reversible heat transfer
c) Ratio of adiabatic heat to macroscopic variables
d) Ratio of macroscopic variables to adiabatic heat

Answer: a
Explanation: This equation was defined by Rudolf Clausius, who defined entropy as a ratio of reversible heat transfer to that of its absolute temperature. This definition is also called the macroscopic definition of entropy.

8. SI unit of enthalpy is_____
a) Joule/kgK
b) Joule/K
c) Joule/kg
d) K/kg

Answer: c
Explanation: Enthalpy is defined as a measurement of energy in a thermodynamic system. It is equal to the internal energy plus the product of volume and pressure. Thus, giving a unit of Joule/kg.

9. Which among this is not an exothermic reaction?
a) Combustion reaction
b) Neutralization reaction
c) Thermite reaction
d) Evaporating liquid water

Answer: d
Explanation: Exothermic reaction is a reaction that releases energy by either light or heat. It is the opposite of endothermic reactions. In this case, evaporating liquid water is an endothermic reaction. Endothermic reaction is a reaction in which the system absorbs heat from its surroundings.

10. What reaction takes place during photosynthesis?
a) Exothermic reaction
b) Endothermic reaction
c) Redox reaction
d) Combustion reaction

Answer: b
Explanation: Photosynthesis takes place by absorbing heat and energy from the surroundings. Since, endothermic reaction is a reaction in which the system absorbs heat from its surroundings, the reaction that takes place during photosynthesis is an endothermic reaction.

UNIT II SECOND LAW AND AVAILABILITY

ANALYSIS

TOPIC 2.1 HEAT RESERVOIR, SOURCE AND SINK. HEAT ENGINE, REFRIGERATOR, HEAT PUMP.

1. The first law of thermodynamics doesn't tell us whether a thermodynamic process is feasible or not.
a) true
b) false

Answer: a
Explanation: The second law of thermodynamics provides criterion as to the probability of a process.

2. According to Joule's experiments,
a) heat can be completely converted into work
b) work can be completely converted into heat
c) both heat and work are completely interchangeable
d) all of the mentioned

Answer: b
Explanation: Work transfer -> internal

energy increase -> heat transfer.

3. Which of the following is true?
a) work is a high grade energy
b) heat is a low grade energy
c) complete conversion of low grade energy into high grade energy in a cycle is impossible
d) all of the mentioned

Answer: d
Explanation: These facts are in accordance with Joule's work and underlies the work of Carnot.

4. In a cyclic heat engine there is
a) net heat transfer to the system and net work transfer from the system
b) net heat transfer from the system and net work transfer to the system
c) depends on the conditions of cycle
d) none of the mentioned

Answer: a
Explanation: This is the basic concept of cycle heat engine.

5. Boiler, turbine, condenser and pump together constitute a heat engine.
a) true
b) false

Answer: a
Explanation: It is an example for a cyclic heat engine.

6. In a heat engine cycle, which of the following process occurs?
a) heat is transferred from furnace to boiler
b) work is produced in turbine rotor
c) steam is condensed in condenser
d) all of the mentioned

Answer: d
Explanation: These are the basic processes occurring in a heat engine cycle comprising of furnace, boiler condenser and a turbine.

7. The function of a heat engine cycle is to

_____continuously at the expense of _____ to the system.
a) heat input, produce work
b) produce work, heat input
c) can be both of the mentioned
d) none of the mentioned

Answer: b
Explanation: Net work and heat input are of primary interest in a cycle.

8. Efficiency of a heat engine is defined as
a) total heat output / net work input
b) total heat input / net work output
c) net work output / total heat input
d) net work input / total heat output

Answer: c
Explanation: Basic definition of efficiency.

9. A thermal energy reservoir is a large body of
a) small heat capacity
b) large heat capacity
c) infinite heat capacity
d) none of the mentioned

Answer: c
Explanation: Basic fact about TER.

10. Processes inside a thermal energy reservoir are quasi-static.
a) true
b) false

Answer: a
Explanation: The changes taking place in TER are very slow and minute.

11. A TER which transfers heat to system is called_____and one which receives heat is called _____
a) source, sink
b) sink, source
c) sink, sink
d) source, source

Answer: a
Explanation: A source transfers heat while a sink receives heat.

12. Which if the following statements are true for a mechanical energy reservoir(MER)?
a) it is a large body enclosed by an adiabatic impermeable wall
b) stores work as KE or PE
c) all processes within an MER are quasi-static
d) all of the mentioned

Answer: d
Explanation: These are some important features of an MER.

TOPIC 2.2 STATEMENTS OF SECOND LAW AND ITS COROLLARIES. CARNOT CYCLE REVERSED CARNOT CYCLE, PERFORMANCE. CLAUSIUS INEQUALITY.

1. Carnot cycle is a reversible cycle.
a) true
b) false

Answer: a
Explanation: A reversible cycle is an ideal hypothetical cycle in which all processes are reversible.

2. A reversible cycle has following processes.
a) 4 isothermal processes
b) 4 adiabatic processes
c) 2 isothermal and 2 adiabatic processes
d) none of the mentioned

Answer: c
Explanation: Two reversible isotherms and two reversible adiabatics constitute a Carnot cycle.

3. The correct sequence of the processes taking place in a carnot cycle is
a) adiabatic -> adiabatic -> isothermal -> isothermal
b) adiabatic -> isothermal -> adiabatic -> isothermal
c) isothermal -> isothermal -> adiabatic -> adiabatic
d) isothermal -> adiabatic -> isothermal -> adiabatic

Answer: d
Explanation: Carnot cycle consists if these four processes in succession.

4. The reversed heat engine takes heat from a ____temperature body, then discharges it to a ____temperature body and____an inward flow of network.

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a) high, low, receives
b) low, high, receives
c) high, low, gives
d) low, high, gives

Answer: b
Explanation: In reversed heat engine, the magnitude of energy transfers remains same and only directions change.

5. Example of reversed heat engine is
a) heat pump
b) refrigerator
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: Heat pump and refrigerator are the types of reversed heat engine.

6. According to Carnot's theorem, all heat engines operating between a given constant temperature source and sink, none has a higher efficiency than a reversible engine.
a) true
b) false

Answer: a
Explanation: This is the statement of Carnot's theorem .

7. The efficiency of all reversible heat engines operating between the same heat reservoirs is
a) same
b) independent of the nature of working substance
c) independent of the amount of working substance
d) all of the mentioned

Answer: d
Explanation: This statement is a corollary of Carnot's theorem.

8. Efficiency of a reversible heat engine is given by
a) 1-(T1/T2)
b) 1-(T2/T1)
c) (T1/T2)-1
d) (T2/T1)-1

Answer: b
Explanation: Efficiency=1-(Q2/Q1) and T2,T1 are temperatures at which heat is rejected and received.

9. For a reversible refrigerator, Coefficient of Performance is given by
a) T2/(T1-T2)
b) T1/(T1-T2)
c) T2/(T2-T1)
d) T1/(T2-T1)

Answer: a
Explanation: For a reversible refrigerator, (Q1/Q2)=(T1/T2).

10. For a reversible heat pump, COP is given by
a) T2/(T1-T2)
b) T1/(T1-T2)
c) T2/(T2-T1)
d) T1/(T2-T1)

Answer: b
Explanation: For a reversible heat pump we have, (Q1/Q2)=(T1/T2).

TOPIC 2.3 CONCEPT OF ENTROPY, T-S DIAGRAM, TDS EQUATIONS, ENTROPY CHANGE FOR - PURE SUBSTANCE, IDEAL GASES - DIFFERENT PROCESSES, PRINCIPLE OF INCREASE IN ENTROPY.

1. Which of the following is true?
a) for an isolated system, dS>=0
b) for a reversible process, dS=0
c) for an irreversible process, dS>0
d) all of the mentioned

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Answer: d
Explanation: For an isolated system which does not undergo any energy interaction with the surroundings, dQ=0 and also dS>=dQ/T.

2. The entropy of an isolated system can never _____
a) increase
b) decrease
c) be zero
d) none of the mentioned

Answer: b
Explanation: The entropy of an isolated system always increases and remains constant only when the process is reversible.

3. According to entropy principle, the entropy of an isolated system can never decrease and remains constant only when the process is reversible.
a) true
b) false

Answer: a
Explanation: This is the statement for the principle of increase of entropy.

4. Entropy may decrease locally at some region within the isolated system. How can this statement be justified?
a) this cannot be possible
b) this is possible because entropy of an isolated system can decrease.
c) it must be compensated by a greater increase of entropy somewhere within the system.
d) none of the mentioned

Answer: c
Explanation: The net effect of an irreversible process is an entropy increase of the whole system.

5. Clausius summarized the first and second laws of thermodynamics as
a) the energy of the world is constant
b) the entropy of the world tends towards a maximum
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These two statements were given by Clausius.

6. The entropy of an isolated system always _____and becomes a_____at the state of equilibrium.
a) decreases, minimum
b) increases, maximum
c) increases, minimum
d) decreases, maximum

Answer: b
Explanation: If entropy of an isolated system varies with some parameter, then there is a certain value of that parameter which maximizes the entropy.

7. Entropy principle is the quantitative statement of the second law of thermodynamics.
a) true
b) false

Answer: a
Explanation: This is a general fact about entropy principle.

8. Which of the following can be considered as an application of entropy principle?
a) transfer of heat through a finite temperature difference
b) mixing of two fluids
c) maximum temperature obtainable from two finite bodies
d) all of the mentioned

Answer: d
Explanation: These are some basic applications of entropy principle.

9. The final temperatures of two bodies, initially at T1 and T2 can range from
a) (T1-T2)/2 to sqrt(T1*T2)

b) (T1+T2)/2 to sqrt(T1*T2)
c) (T1+T2)/2 to (T1*T2)
d) (T1-T2)/2 to (T1*T2)

Answer: b
Explanation: (T1+T2)/2 is the temperature when there is no delivery of work and sqrt(T1*T2) is the temperature with maximum delivery of work.

10. Which of the following processes exhibit external mechanical irreversibility?
a) isothermal dissipation of work
b) adiabatic dissipation of work
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These processes exhibit external mechanical irreversibility.

TOPIC 2.4 APPLICATIONS OF II LAW. HIGH AND LOW GRADE ENERGY.

1. Which of the following is a type of energy?
a) high grade energy
b) low grade energy
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These are two types in which the sources of energy can be divided into.

2. Which of the following is an example of high grade energy?
a) mechanical work
b) electrical energy
c) water power and wind power
d) all of the mentioned

Answer: d
Explanation: These are some examples of the high grade energy.

3. The complete conversion of heat into shaft-work is impossible.
a) true
b) false

Answer: a
Explanation: This statement can be proved by the second law of thermodynamics.

4. Which of the following is an example of low grade energy?
a) heat or thermal energy
b) heat from nuclear fission or fusion
c) heat from combustion of fossil fuel
d) all of the mentioned

Answer: d
Explanation: These are few examples of low grade energy.

5. The part of_____available for conversion is referred to _____
a) high grade energy, available energy
b) low grade energy, available energy
c) low grade energy, unavailable energy
d) high grade energy, unavailable energy

Answer: b
Explanation: Only some part of low grade energy is available for conversion.

6. The_____obtainable from a certain heat input in a cyclic heat engine is called _____
a) minimum work output, available energy
b) maximum work output, available energy
c) minimum work input, unavailable energy
d) none of the mentioned

Answer: b
Explanation: Q1=AE+UE and the minimum energy that has to be rejected is called the unavailable energy.

7. The unavailable energy is the product of the lowest temperature of heat rejection and the change of entropy of system during the process of supplying heat.

a) true
b) false

Answer: a
Explanation: U.E.=T0*(change in entropy).

8. The lowest practicable temperature of heat rejected is the
a) given temperature
b) 0K
c) temperature of surroundings
d) 273K

Answer: c
Explanation: Work done and hence efficiency will be maximum when heat is rejected at the temperature of surroundings.

9. The available energy is known as_____and the unavailable energy is known as _____
a) energy, exergy
b) exergy, energy
c) both are called exergy
d) both are called energy

Answer: b
Explanation: Rant was the one who coined these terms.

10. Whenever heat is transferred through a finite temperature difference, there is always a decrease in the availability of energy so transferred.
a) true
b) false

Answer: a
Explanation: This is because of exergy lost due to irreversible heat transfer.

11. Exergy is lost due to
a) irreversible heat transfer
b) through finite temperature difference
c) during the process of heat addition
d) all of the mentioned

Answer: d
Explanation: The decrease in exergy is given by the product of lowest feasible temperature of heat rejection and the additional entropy change in the system.

12. Energy is said to be degraded each time it flows through a finite temperature difference.
a) true
b) false

Answer: a
Explanation: The exergy is mainly lost due to irreversible heat transfer through a finite temperature difference.

13. When considering a finite energy source, its working fluid expands,
a) reversibly
b) adiabatically
c) reversibly and adiabatically
d) none of the mentioned

Answer: c
Explanation: For a finite energy source, expansion of working fluid is reversibly and adiabatically.

TOPIC 2.5 AVAILABLE AND NON-AVAILABLE ENERGY OF A SOURCE AND FINITE BODY.

1. Which of the following is a type of energy?
a) high grade energy
b) low grade energy
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These are two types in which the sources of energy can be divided into.

2. Which of the following is an example of high grade energy?
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d) all of the mentioned

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d) high grade energy, unavailable energy

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c) minimum work input, unavailable energy
d) none of the mentioned

Answer: b
Explanation: Q1=AE+UE and the minimum energy that has to be rejected is called the unavailable energy.

7. The unavailable energy is the product of the lowest temperature of heat rejection and the change of entropy of system during the process of supplying heat.
a) true
b) false

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Explanation: U.E.=T0*(change in entropy).

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12. Energy is said to be degraded each time it flows through a finite temperature difference.
a) true
b) false

Answer: a
Explanation: The exergy is mainly lost due to irreversible heat transfer through a finite temperature difference.

13. When considering a finite energy source, its working fluid expands,
a) reversibly
b) adiabatically
c) reversibly and adiabatically
d) none of the mentioned

Answer: c
Explanation: For a finite energy source, expansion of working fluid is reversibly and adiabatically.

TOPIC 2.6 ENERGY AND IRREVERSIBILITY. EXPRESSIONS FOR THE ENERGY OF A CLOSED SYSTEM AND OPEN SYSTEMS.

1. The entropy of any closed system can increase in which if the following way?
a) by heat interaction in which there is entropy transfer
b) dissipative effects or internal irreversibilities
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These two processes increase the entropy of a closed system.

2. Entropy increase dS of the system can be expressed as
a) dS=dS(due to external heat interaction)-dS(due to internal irreversibility)
b) dS=dS(due to external heat interaction)+dS(due to internal irreversibility)
c) dS=-dS(due to external heat interaction)-dS(due to internal irreversibility)
d) dS=-dS(due to external heat interaction)+dS(due to internal irreversibility)

Answer: b
Explanation: Total entropy increase of the system is the sum of these two entropies.

3. The entropy increase due to internal irreversibility is also called entropy production or entropy generation.
a) true
b) false

Answer: a
Explanation: This entropy is generated during the process within the system.

4. Which of the following statement is true?
a) if the isentropic process is reversible, it must be adiabatic
b) if the isentropic process is adiabatic, it cannot but be reversible
c) if the process is adiabatic and reversible, it must be isentropic
d) all of the mentioned

Answer: d
Explanation: An adiabatic process need not be isentropic, since entropy can also increase due to friction.

5. Lost work is given by
a) pdV-dW
b) pdV+dW
c) -pdV-dW
d) pdV*dW

Answer: a
Explanation: The lost work d(LW) indicates the work that is lost due to irreversibility.

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6. The amount of entropy generation is given by
a) S2+S1+∫(dQ/T)
b) S2-S1+∫(dQ/T)
c) S2-S1-∫(dQ/T)
d) none of the mentioned

Answer: c
Explanation: Here (S2-S1) is the entropy change of the system and ∫(dQ/T) is the entropy transfer.

7. Any thermodynamic process is accompanied by entropy generation.
a) true
b) false

Answer: a
Explanation: This comes from the second law.

8. Which of the following statement is false?
a) for a reversible process, entropy generation is zero
b) the entropy generation does not depend on the path the system follows
c) for an irreversible process, entropy generation is greater than zero
d) none of the mentioned

Answer: b
Explanation: Entropy generation is not a thermodynamic property and depends on the path that system follows.

9. If the path A causes more entropy generation than path B, then
a) path A is more irreversible than path B
b) path A involves more lost work
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: The amount of entropy generation quantifies the intrinsic irreversibility of the process.

10. In an open system, there is a transfer of which of the following quantity?
a) mass
b) energy
c) entropy
d) all of the mentioned

Answer: d
Explanation: In an open system, there is a transfer of all these three quantities.

11. The rate of entropy increase of the control volume_____or_____the net rate of entropy transfer to it.
a) exceeds or is less than
b) exceeds, is equal to
c) is less than, or equal to
d) none of the mentioned

Answer: b
Explanation: The difference is the entropy generated within the control volume due to irreversibility.

12. Mass and energy are conserved quantities, but entropy is generally not conserved.
a) true
b) false

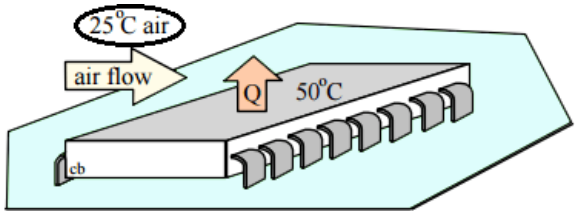
Answer: a
Explanation: This is a basic fact about entropy.

13. The rate at which entropy is transferred out must_____the rate at which entropy enters the control volume.
a) be less than
b) equal to
c) exceed
d) none of the mentioned

Answer: c
Explanation: The difference is the rate of entropy generated within the control volume owing to irreversibilities.

14. A chip dissipates 2 kJ of electric work and rejects it as heat transfer from its surface

which is at 50°C to 25°C air. How much entropy is generated in the chip?



a) 4.19 J/K
b) 5.19 J/K
c) 6.19 J/K
d) 7.19 J/K

Answer: c
Explanation: C.V.1 Chip with surface at 50°C, we assume chip state is constant.
U2 – U1 = 0 = 1Q2 – 1W2 = W(electrical,in) – Q(out,1)
S2 – S1 = 0 = – [Q(out,1)]/[T(surf)] + 1S2(gen1)
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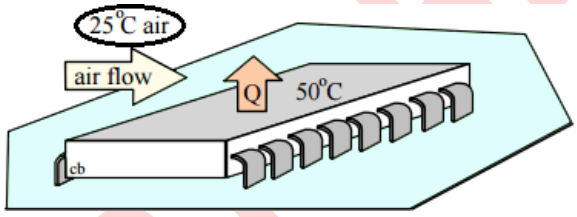

a) 0.419 J/K
b) 0.519 J/K
c) 0.619 J/K
d) 0.719 J/K

Answer: b
Explanation: C.V.2 From chip surface at 50°C to air at 25°C, assume constant state.
U2 – U1 = 0 = 1Q2 – 1W2 = Q(out,1) – Q(out,2)
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TOPIC 2.7 ENERGY BALANCE AND ENTROPY GENERATION.

1. The entropy of any closed system can increase in which if the following way?
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b) dissipative effects or internal irreversibilities
c) both of the mentioned
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Explanation: These two processes increase the entropy of a closed system.

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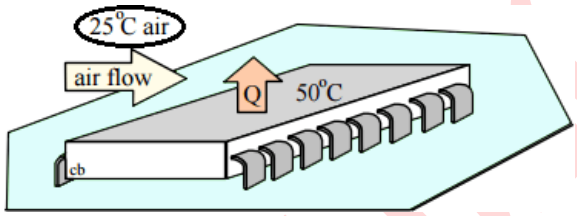

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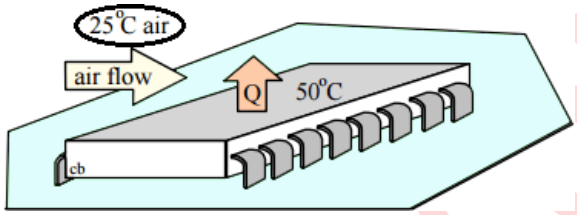

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1S2(gen2) = [Q(out,2) / T(air)] – [Q(out,1) / T(surf)] = (2/298.15) – (2/323.15) = 0.519 J/K.

TOPIC 2.8 I AND II LAW OF EFFICIENCY.

1. The first law efficiency is defined as the ratio of the output energy to the input energy.
a) true
b) false

Answer: a
Explanation: First law efficiency = output energy / input energy.

2. Which of the following statement is true about the first law?
a) it is concerned only with the quantities of energy
b) it disregards the form in which the energy exists
c) it does not discriminate between the

energies available at different temperatures
d) all of the mentioned

Answer: d
Explanation: It is the second law which provides a means of assigning a quality index to energy.

3. With the concept of exergy available, which of the following is possible?
a) to analyse means of minimizing the consumption of available energy to perform a given process
b) to ensure most efficient possible conversion of energy
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These statements tell us why the concept of exergy is so important.

4. Second law efficiency is defined as
a) actual exergy intake / minimum exergy intake
b) minimum exergy intake / actual exergy intake
c) actual exergy intake / maximum exergy intake
d) maximum exergy intake / minimum exergy intake

Answer: b
Explanation: It is the ratio of minimum exergy which must be consumed to do a task divided by the actual amount of exergy consumed in performing the task.

5. For a power plant, second law efficiency can be given by desired output(W) / available energy(Wmax).
a) true
b) false

Answer: a
Explanation: Here, A=Wmax and Amin=W, hence second law efficiency = Amin/A = W/Wmax.

6. Second law efficiency can also be given as
a) 1 / (first law efficiency * Carnot efficiency)
b) Carnot efficiency * first law efficiency
c) Carnot efficiency / first law efficiency
d) first law efficiency / Carnot efficiency

Answer: d
Explanation: First law efficiency = W/Q1 = (W/Wmax)*(Wmax/Q1) = second law efficiency * Carnot efficiency.

7. If work is involved, Amin=_____and if heat is involved, Amin= _____
a) w, Q(1+To/T)
b) W, Q(1-To/T)
c) Q(1+To/T), W
d) Q(1-To/T), W

Answer: b
Explanation: This is because, Wmax=Q1(1-To/T).

8. If solar energy Qr is available at a reservoir storage temperature of Tr and if quantity of heat Qa is transferred by the solar collector at temperature Ta, then which of the following is true?
a) first law efficiency = Qa/Qr
b) second law efficiency = exergy output / exergy input
c) second law efficiency = (first law efficiency)*(1-To/Ta)/(1-To/Tr)
d) all of the mentioned

Answer: d
Explanation: Second law efficiency = first law efficiency / Carnot efficiency.

9. In case of a heat pump, second law efficiency is given as
a) (first law efficiency)*(1-Ta/To)
b) (first law efficiency)*(1+To/Ta)
c) (first law efficiency)*(1-To/Ta)
d) none of the mentioned

Answer: c
Explanation: First law efficiency = Qa/Wi

and second law efficiency = Qa*(1-To/Ta)/Wi.

10. Both first law efficiency and second law efficiency indicate how effectively the input has been converted into the product.
a) true
b) false

Answer: a
Explanation: First law of efficiency does this on energy basis and second law efficiency does it on exergy basis.

11. For proper utilization of exergy, it is desirable to make first law efficiency _____ and the source and use temperatures should _____
a) as close to unity, be different
b) as close to unity, match
c) as close to zero, match
d) as close to zero, be different

Answer: b
Explanation: If first law efficiency is close to unity, the all the energy carried in by heat transfer is used and no heat is lost to the surroundings.

UNIT III PROPERTIES OF PURE SUBSTANCE AND STEAM POWER CYCLE

TOPIC 3.1 FORMATION OF STEAM AND ITS THERMODYNAMIC PROPERTIES, P-V, P-T, T-V, T-S, H-S DIAGRAMS.

1. Which of the following curves meet at triple point?
a) fusion curve and vaporization curve
b) fusion curve and sublimation curve
c) vaporization curve and sublimation curve
d) fusion curve and vaporization curve and sublimation curve

Answer: d
Explanation: At triple point, all these three curves meet.

2. The slopes of sublimation and vaporization curves for all substances are
a) negative
b) positive
c) zero
d) none of the mentioned

Answer: b
Explanation: This is true for all substances.

3. The slope of the fusion curve for water is
a) negative
b) positive
c) zero
d) none of the mentioned

Answer: a
Explanation: The slope of fusion curve for most substances is positive but for water it is negative.

4. The temperature at which a liquid boils is very sensitive to pressure but the temperature at which a solid melts is not such a strong function of pressure.
a) true
b) false

Answer: a
Explanation: The slope of the fusion curve is small.

5. Which of the following statement is true?
a) the triple point of water is 273.16 K
b) the triple point of CO2 is 216.55 K
c) when solid CO2 is exposed to 1atm pressure, it gets transformed into vapour directly
d) all of the mentioned

Answer: d
Explanation: The solid CO2 absorbs the latent heat of sublimation from the surroundings which gets cooled.

6. The equation which forms the basis of the Mollier diagram is
a) Tds=-dh+vdp
b) Tds=dh+vdp
c) Tds=dh-vdp
d) none of the mentioned

Answer: c
Explanation: This equation form the basis of the h-s diagram of a pure substance also called the Mollier diagram.

7. Which of the following statements is true?
a) the slope of an isobar on h-s coordinates is equal to the absolute saturation temperature at that pressure
b) is the temperature remains constant, the slope will also remain constant
c) if the temperature increases, the slope of the isobar will also increase
d) all of the mentioned

Answer: d
Explanation: Here absolute saturation temperature is given by Tsat+273.

8. Which of the following represents the latent heat of vaporization at a particular pressure.
a) Hf-Hg
b) Hg-Hf
c) Hf+Hg
d) none of the mentioned

Answer: b
Explanation: Here Hg is the specific enthalpy of the saturated vapour and Hf is the specific enthalpy of the saturated water.

9. At critical pressure, value of Hg-Hf is
a) two
b) one
c) zero
d) infinity

Answer: c
Explanation: As pressure increases, there is a decrease in Hg-Hf and at critical pressure its value becomes zero.

10.In the Mollier diagram, the constant pressure lines diverge from one another.
a) true
b) false

Answer: a
Explanation: As the pressure increases, the saturation temperature also increases, increasing the slope of the isobar.

TOPIC 3.2 P-V-T SURFACE.

1. Which of the following is a property of a pure substance?
a) it has constant chemical composition throughout its mass
b) it is a one-component system
c) it may exist in one or more phases
d) all of the mentioned

Answer: d
Explanation: These are some of the properties of a pure substance.

2. For water, as temperature increases, volume always increases?
a) true
b) false

Answer: b
Explanation: From 0 degree Celsius to 4 degree Celsius as temperature increases, volume of water decreases which is a peculiarity of water.

3. A saturation state is a state from which a change of phase may occur
a) without a change of pressure or temperature

b) with a change of pressure or temperature
c) both of the mentioned
d) none of the mentioned

Answer: a
Explanation: For example, water at 0 degree Celsius and at 100 degree Celsius.

4. In which of the following state does water exist?
a) saturated solid state
b) saturated liquid state
c) saturated vapour state
d) all of the mentioned

Answer: d
Explanation: Water exists in these states at 0 degree Celsius and at 100 degree Celsius.

5. Which of the following exists in a p-V diagram for water?
a) saturated solid line
b) saturated liquid lines
c) saturated vapour line
d) all of the mentioned

Answer: d
Explanation: The p-V diagram for water has all these three lines.

6. The triple point is a line on the p-V diagram, where all the three phases, solid, liquid and gas exist.
a) true
b) false

Answer: a
Explanation: At triple point, all these three phases exists in equilibrium.

7. At a pressure below the triple point line,
a) the substance cannot exist in the liquid phase
b) the substance when heated transforms from solid to vapour
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: This phenomenon is known as sublimation and takes place by absorbing the latent heat of sublimation from the surroundings.

8. Which of the following statement is true?
a) to the left of saturated solid line is the solid region
b) between saturated solid line and saturated liquid line with respect to solidification there exists the solid-liquid mixture region
c) between two saturated liquid lines is the compressed liquid region
d) all of the mentioned

Answer: d
Explanation: These statements come from the p-V diagram for a pure substance.

9. The isotherm passing through the critical point is called the critical isotherm.
a) true
b) false

Answer: a
Explanation: At critical point, all the quantities like pressure, temperature and volume attain their critical values.

10. The greater the temperature, the_____is the vapour pressure.
a) lower
b) higher
c) depends on the substance
d) none of the mentioned

Answer: b
Explanation: The vapour pressure mainly depends on the temperature.

11. Phase change occurs at
a) constant pressure
b) constant temperature
c) constant pressure and temperature
d) none of the mentioned

Answer: c
Explanation: For phase change, pressure and temperature must be constant like water at 0 degree Celsius and at 100 degree Celsius.

12. Which of the following statement is true?
a) saturation temperature is a function of pressure
b) saturation pressure is a function of temperature
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: At saturation temperature, a pure liquid transforms into vapour and at saturation pressure, the liquid boils.

TOPIC 3.3 USE OF STEAM TABLE AND MOLLIER CHART.

1. The properties of water are arranged in the steam tables as functions of
a) pressure
b) temperature
c) pressure and temperature
d) none of the mentioned

Answer: c
Explanation: The properties of water are arranged in steam tables as functions of both pressure and temperature.

2. The internal energy of saturated water at the triple point is
a) 1
b) 0
c) -1
d) infinity

Answer: b
Explanation: This value is arbitrarily chosen.

3. The entropy of saturated water is chosen to be zero at triple point.
a) true
b) false

Answer: a
Explanation: This is arbitrarily chosen and form the basic assumptions for steam tables.

4. When a liquid and its vapour are in equilibrium at a certain pressure and temperature, then which of the following is required to identify the saturation state.
a) pressure
b) temperature
c) both pressure and temperature
d) pressure or temperature

Answer: d
Explanation: If one of the quantity is given, then other gets fixed.

5. Saturated liquid or the saturated vapour has how many independent variables?
a) one
b) two
c) three
d) none of the mentioned

Answer: a
Explanation: Only one property is required to be known to fix up the state.

6. If data are required for intermediate temperatures or pressures, linear interpolation is normally accurate.
a) true
b) false

Answer: a
Explanation: To reduce the amount of interpolation required, two tables are provided.

7. For a liquid-vapour mixture, which of the following can give us all the properties of the mixture?
a) p or t and the quality of the mixture are given
b) p or t and any one of the property is given
c) both of the mentioned
d) none of the mentioned

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Answer: c
Explanation: In first case, properties can be directly evaluated and in second case we can find the quality first and then evaluate all other properties.

8. When does a vapour become superheated?
a) when the temperature of vapour is less than the saturation temperature at given pressure
b) when the temperature of vapour is more than the saturation temperature at given pressure
c) when the temperature of vapour is equal to the saturation temperature at given pressure
d) none of the mentioned

Answer: b
Explanation: For a superheated vapour, temperature of vapour must be greater than the saturation temperature.

9. The superheat or degree of superheat is given by
a) difference between the temperature of saturated liquid and saturation temperature
b) difference between the temperature of superheated vapour and saturation temperature
c) sum of the temperature of superheated vapour and saturation temperature
d) none of the mentioned

Answer: b
Explanation: Superheat= T1(temperature of superheated vapour) – T(saturated).

10. When the temperature of a liquid is less than the saturation temperature at the given pressure, the liquid is called compressed liquid.
a) true
b) false

Answer: a
Explanation: For a compressed liquid, temperature of liquid must be less than the saturation temperature.

11. The properties of liquid_____with pressure.
a) do not vary
b) vary largely
c) vary little
d) none of the mentioned

Answer: c
Explanation: This is the reason why properties are taken from the saturation tables at the temperature of the compressed liquid.

12. Which of the following statement is true?
a) a subcooled liquid is one which is cooled below its saturation temperature at a certain pressure
b) subcooling is the difference between the saturation temperature and the actual liquid temperature
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: This is what a subcooled liquid means.

TOPIC 3.4 DETERMINATION OF DRYNESS FRACTION.

1. The product of steam rate & network when the steam rate is expressed in kg/kWh is equal to?
a) 36
b) 360
c) 3600
d) 60

Answer: c
Explanation: The Steam Rate in terms of kJ/kWh is given by the expression,
Steam Rate = $(3600/W_{net})$ kg/kWh.

2. The product of heat rate & efficiency when the heat rate is expressed in kJ/kWh is equal to?
a) 60
b) 36

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c) 360
d) 3600

Answer: d
Explanation: The heat rate in terms of kJ/kWh is given by the expression,
Heat Rate = (3600/n) kJ/kWh
where, n = efficiency.

3. What is the effect of reheat pressure on mean temperature of heat addition T_{ml}?
a) Reheat pressure is directly proportional to T_{ml}
b) Reheat pressure is inversely proportional to T_{ml}
c) Reheat pressure is equal to T_{ml}
d) T_{ml} is independent of reheat pressure

Answer: a
Explanation: As cycle efficiency is reduced with a decrease in reheat pressure. Hence, the mean temperature of heat addition also decreases.

4. Why is the steam not allowed to expand deep into the two phase region before it is taken to reheating?
a) to control flow rate
b) to control phase change
c) to protect reheat tubes
d) none of the mentioned

Answer: c
Explanation: The steam is not allowed to expand deep into the two phase region before it is taken to reheating, because the moisture particles in the steam while evaporating would leave behind solid deposits in the form of scale which is difficult to remove. Hence, when the steam expands, the reheat tubes are damaged.

5. Net Work output of the plant _____ with reheat.
a) decreases
b) increases
c) remains same
d) none of the mentioned

Answer: b
Explanation: With reheat, the area under the curve increases in comparison to what it was without reheat. Hence, Net Work output of the plant increases.

6. Which of the following problems are posed by increasing the number of reheats?
a) Cost & Fabrication problems arise
b) Heat transfer problems arise
c) Frictional losses arise
d) None of the mentioned

Answer: a
Explanation: Higher the number of Reheats, still higher steam pressures could be used, but mechanical stresses increase at a higher proportion than the increase in pressure, because of the prevailing high temperature. The cost & fabrication difficulties will also increase.

7. What is the effect of decrease of reheat pressure on the quality of steam at turbine exhaust?
a) decreases
b) increases
c) remains same
d) none of the mentioned

Answer: b
Explanation: For too low a reheat pressure, the exhaust steam may even be in the superheated state which isn't good.

8. The optimum reheat pressure for most of the power plants is how many times of the initial steam pressure?
a) 0.1-0.15
b) 0.2-0.20
c) 0.2-0.25
d) 0.1-0.10

Answer: c
Explanation: The efficiency increases as the

reheat pressure is lowered & reaches a peak at a pressure ratio between 0.2-0.25.

9. What is the most preferable dryness fraction of the exhaust steam?
a) 0.99
b) 0.77
c) 0.66
d) 0.88

Answer: d
Explanation: The dryness fraction of the exhaust steam is in the range of 0.86-0.88 for modern turbines.

10. For pressure ratio = 1, efficiency = 0, then?
a) reheat is used
b) reheat is not used
c) only reheat is used
d) none of the mentioned

Answer: b
Explanation: There cannot be any reheat cycle employed when the cycle efficiency is zero and the pressure ratio is equal to 1.

TOPIC 3.5 APPLICATION OF I AND II LAW FOR PURE SUBSTANCES.

1. Which of the following represents the specific volume during phase transition.
a) Vf-Vg
b) Vg-Vf
c) Vf+Vg
d) none of the mentioned

Answer: b
Explanation: Here Vg is the specific volume of the saturated vapour and Vf is the specific volume of the saturated liquid.

2. At critical point, value of Vg-Vf is
a) two
b) one
c) zero
d) infinity

Answer: c
Explanation: As pressure increases, there is a decrease in Vg-Vf and at critical point its value becomes zero.

3. Above the critical point, the isotherms are continuous curves.
a) true
b) false

Answer: a
Explanation: These continuous curves approach equilateral hyperbolas at large volumes and low pressures.

4. A rigid tank contains 50 kg of saturated liquid water at 90°C. Determine the pressure in the tank and the volume of the tank.
a) 0.0518 m^3
b) 0.0618 m^3
c) 0.0718 m^3
d) 0.0818 m^3

Answer: a
Explanation: P = C = 70.183 kPa
v = C = 0.001036 m^3/kg
Total volume of the tank = mv = (50kg)(0.001036 m^3/kg)
= 0.0518 m^3.

5. A piston –cylinder device contains 0.06m^3 of saturated water vapour at 350 kPa pressure. Determine the temperature and mass of the vapour inside the cylinder.
a) 0.104 kg
b) 0.124 kg
c) 0.134 kg
d) 0.114 kg

Answer: d
Explanation: T = = 138.86°C

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v = = 0.52422 m^3/kg
m = V/v = 0.06 m^3/0.52422 m^3/kg = 0.114 kg.

6. A rigid tank contains 10 kg of water at 90°C. If 8 kg of the water is in the liquid form and the rest is in the vapour form, determine the pressure in the tank.
a) 60.183 kPa
b) 70.183 kPa
c) 80.183 kPa
d) 90.183 kPa

Answer: b
Explanation: P = °C = 70.183 kPa.

7. A rigid tank contains 10 kg of water at 90°C. If 8 kg of the water is in the liquid form and the rest is in the vapour form, determine the volume of the tank.
a) 1.73 m^3
b) 2.73 m^3
c) 3.73 m^3
d) 4.73 m^3

Answer: d
Explanation: P = °C = 70.183 kPa
@ 90°C, vf = 0.001036 m^3/kg and vg = 2.3593 m^3/kg
V = Vf + Vg = mf vf + mg vg = 4.73 m^3.

8. An 80 litre vessel contains 4 kg of R-134a at a pressure of 160 kPa. Determine the temperature.
a) -10.60°C
b) -13.60°C
c) -15.60°C
d) -19.60°C

Answer: c
Explanation: v = V/m = 0.080 m^3/4 kg = 0.02 m^3/kg
@ 160kPa, vf = 0.0007437 m^3/kg; vg = 0.12348 m^3/kg
vf < v < vg Therefore T = = -15.60°C.

9. An 80 litre vessel contains 4 kg of R-134a at a pressure of 160 kPa. Determine the quality.
a) 0.127
b) 0.137
c) 0.147
d) 0.157

Answer: d
Explanation: v = V/m = 0.080 m^3/4 kg = 0.02 m^3/kg
@ 160kPa, vf = 0.0007437 m^3/kg; vg = 0.12348 m^3/kg.
vf < v < vg
x = (v –vf)/ vfg = 0.157.

10. An 80 litre vessel contains 4 kg of R-134a at a pressure of 160 kPa. Determine the volume occupied by the vapour phase.
a) 0.0775 m^3
b) 0.0575 m^3
c) 0.0975 m^3
d) 0.0375 m^3

Answer: a
Explanation: v = V/m = 0.080 m^3/4 kg = 0.02 m^3/kg
@ 160kPa, vf = 0.0007437 m^3/kg; vg = 0.12348 m^3/kg
vf < v < vg
x = (v –vf)/ vfg = 0.157
mg = x*m(total) = 0.628kg
Vg = mg*vg = 0.0775 m^3 or 77.5 litre.

11. Determine the specific volume of R-134a at 1 MPa and 50°C, using ideal gas equation of state.
a) 0.022325 m^3/kg
b) 0.024325 m^3/kg

c) 0.025325 m^3/kg
d) 0.026325 m^3/kg

Answer: b
Explanation: v = RT/P = (0.0815 kJ/kg.K)* (323 K)/(1000 kPa)
= 0.026325 m^3/kg.

TOPIC 3.6 IDEAL AND ACTUAL RANKINE CYCLES

1. What is the unit of Heat rate?
a) kJ/KW
b) KW/kJ
c) kJ
d) KW

Answer: a
Explanation: Heat rate is the rate of input required to produce unit shaft output.

2. Rankine cycle operating on low pressure limit of p1 and high pressure limit of p2 _____
a) has higher thermal efficiency than the Carnot cycle operating between same pressure limits
b) has lower thermal efficiency than Carnot cycle operating between same pressure limits
c) has same thermal efficiency as Carnot cycle operating between same pressure limits
d) may be more or less depending upon the magnitudes of p1 and p2

Answer: a
Explanation: Area under P-V curve for Rankine will be more as compared to Carnot cycle.

3. Rankine efficiency of a Steam Power Plant _____
a) improves in Summer as compared to that in Winter
b) improves in Winter as compared to that in Summer
c) is unaffected by climatic conditions
d) none of the mentioned

Answer: b
Explanation: In winters, the temperature of cooling water is low, which increases Condenser's efficiency.

4. Rankine cycle comprises of _____
a) two isentropic processes and two constant volume processes
b) two isentropic processes and two constant pressure processes
c) two isothermal processes and two constant pressure processes
d) none of the mentioned

Answer: b
Explanation: Rankine cycle is a reversible cycle which have two constant pressure and two constant temperature processes.

5. In Rankine cycle, the work output from the turbine is given by _____
a) change of internal energy between inlet and outlet
b) change of enthalpy between inlet and outlet
c) change of entropy between inlet and outlet
d) change of temperature between inlet and outlet

Answer: b
Explanation: Work output(turbine) = h1 – h2.

6. Which of the following contributes to the improvement of efficiency of Rankine cycle in a Thermal Power Plant?
a) reheating of steam at intermediate stage
b) regeneration use of steam for heating Boiler feed water
c) use of high pressures
d) all of the mentioned

Answer: d
Explanation: The regenerative features effectively raise the nominal cycle heat input

temperature, by reducing the addition of heat from the Boiler/fuel source at the relatively low feedwater temperatures that would exist without regenerative feedwater heating.

7. Match the following:

i) Boiler	A. reversible adiabatic expansion of steam
ii) turbine	B. constant pressure heat heat addition
iii) Condenser	C. reversible adiabatic compression
iv) pump	D. constant pressure heat rejection

a) i-B ii-A iii-D iv-C
b) i-A ii-C iii-D iv-A
c) i-B ii-D iii-C iv-A
d) i-A ii-D iii-B iv-C

Answer: a
Explanation: Working fluid in Rankine cycle undergoes 4 processes, expansion in turbine, heat addition in Boiler, heat rejection in Condenser and compression in pump.

8. What is the actual turbine inlet temperature in Rankine cycle?
a) 700C
b) 800C
c) 550C
d) 1150C

Answer: c
Explanation: The TIT(Turbine Inlet Temperature) is of the range 500-570C.

9. Rankine cycle efficiency of a good Steam Power Plant may be in the range of?
a) 15 to 20%
b) 35 to 45%
c) 70 to 80%
d) 90 to 95%

Answer: b
Explanation: Efficiency of Rankine cycle in actual working condition is found to be between 35 to 45%.

10. A simple Rankine cycle operates the Boiler at 3 MPa with an outlet temperature of 350°C and the Condenser at 50 kPa. Assuming ideal operation and processes, what is the thermal efficiency of this cycle?
a) 7.7
b) 17.7
c) 27.7
d) 37.7

Answer: c
Explanation: Fixing the states; h1 = 340.5 kJ/kg, h2 = h1 + v1 (P2 – P1) = 343.5 kJ/kg, h3 = 3115.3 kJ/kg, s3 = 6.7428 kJ/kg – K, x4 = 0.869, and h4 = 2343.9 kJ/kg. Thus, $\eta = 1 - Q_{out} / Q_{in} = 1 - (h4 - h1) / (h3 - h2) =$ 27.7%.

11. A simple Rankine cycle produces 40 MW of power, 50 MW of process heat and rejects 60 MW of heat to the surroundings. What is the utilization factor of this co generation cycle neglecting the pump work?
a) 50
b) 60
c) 70
d) 80

Answer: b
Explanation: Application of the first law to the entire cycle gives Qin = Qp + Qreject + W = 150 MW. The utilization factor is then = (Qp + W) / Qin = 60%.

TOPIC 3.7 CYCLE IMPROVEMENT METHODS - REHEAT AND REGENERATIVE CYCLES, ECONOMISER, PREHEATER, BINARY AND COMBINED CYCLES.

1. The reheating of steam is used when the vaporization pressure is_____.
a) low
b) high

c) both when low or high
d) always

Answer: b
Explanation: When vaporization pressure is high, the reheating of steam is adopted.

2. Why both reheating and regeneration is used together?
a) the effect of reheat alone on efficiency is very small
b) regeneration has a marked effect on efficiency
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: Thus a modern steam power plant has both reheating and regeneration.

3. How many types of feedwater heaters are present?
a) one
b) two
c) three
d) four

Answer: b
Explanation: The two types are open heaters and closed heaters.

4. Which of the following statement is true?
a) open heater is also known as contact-type heater
b) in an open type heater the extracted or bled steam is allowed to mix with the feedwater
c) in a closed heater, the fluids are not allowed to mix together
d) all of the mentioned

Answer: d
Explanation: These are the details of open and closed type heater.

5. The temperature of feedwater leaving a heater is_____the saturation temperature at steam extraction pressure.
a) less than
b) equal to
c) more than
d) none of the mentioned

Answer: a
Explanation: Their difference is known as the terminal temperature difference of heater.

6. Which of the following is true for an open heater?
a) it is simple, has low cost and low heat transfer capacity
b) a pump is required at each heater
c) both of the mentioned
d) none of the mentioned

Answer: b
Explanation: The open heater has high heat transfer capacity.

7. Deaerator is a type of open heater.
a) true
b) false

Answer: a
Explanation: In steam power plants, closed heaters are favoured but one open heater is used for the purpose of feedwater deaeration.

8. Which of the following is true for a closed heater?
a) it requires a single pump regardless of the number of heaters
b) it is costly
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: Closed heaters may not give as high feedwater temperature as do open heaters.

9. The higher the number of heaters used, the _____will be the cycle efficiency.
a) lower
b) higher
c) efficiency does not depend on number of

heaters
d) none of the mentioned

Answer: b
Explanation: The cycle efficiency varies according to the number of heaters.

10. If n heaters are used, the greatest gain in efficiency occurs when overall temperature rise is_____times the difference between condenser and boiler saturation temperatures.
a) (n-1) / n
b) (n+1) / n
c) n / (n-1)
d) n / (n+1)

Answer: d
Explanation: This gives us the greatest gain in efficiency.

11. The efficiency gain follows the law of diminishing return with the increase in the number of heaters.
a) true
b) false

Answer: a
Explanation: This is because the cycle efficiency is proportional to the temperature rise of feedwater.

12. Which of the following statement is true?
a) in some cases, an increase in feedwater temperature may reduce the boiler efficiency
b) number of heaters are optimized
c) most often, five points of extraction are used
d) all of the mentioned

Answer: d
Explanation: The number of heaters get fixed by the exergy balance of the whole plant.

13. The thermal irreversibility should be _____ to improve the performance.
a) reduced
b) increased
c) kept constant
d) none of the mentioned

Answer: a
Explanation: The major exergy destruction due to irreversibility takes place in the steam generation.

UNIT IV IDEAL AND REAL GASES, THERMODYNAMIC RELATIONS

TOPIC 4.1 PROPERTIES OF IDEAL GAS- IDEAL AND REAL GAS COMPARISON- EQUATIONS OF STATE FOR IDEAL AND REAL GASES- REDUCED PROPERTIES.

1. For the ideal gas equation, what assumptions are made?
a) there is little or no attraction between the molecules of the gas
b) the volume occupied by the molecules is negligibly small compared to the volume of the gas
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: The ideal gas equation pv=RT is established from the postulates of the kinetic theory of gases considering these two assumptions.

2. When does a real gas obey the ideal gas equation closely?
a) at high pressure and low temperature
b) at low pressure and high temperature

c) at low pressure and temperature
d) at high pressure and temperature

Answer: b
Explanation: At low pressure and high temperature, the intermolecular attraction and the volume of the molecules compared to the total volume of the gas are not of much significance.

3. The real gases deviate from the ideal gas equation when the pressure increases.
a) true
b) false

Answer: a
Explanation: With increase in pressure, the intermolecular forces of attraction and repulsion increase, and also the volume of the molecules becomes appreciable compared to the gas volume.

4. The corrected gas equation is given by
a) $(p+a/(v^2))(v+b)=RT$
b) $(p-a/(v^2))(v-b)=RT$
c) $(p-a/(v^2))(v+b)=RT$
d) $(p+a/(v^2))(v-b)=RT$

Answer: d
Explanation: The two correction terms were introduced by van der Waals.

5. Which of the following statement is true about the correction terms?
a) the coefficient a was introduced to account for the existence of mutual attraction between the molecules
b) the term $a/(v^2)$ is called the force of cohesion
c) the coefficient b was introduced to account for the volumes of the molecules and is known as co-volume
d) all of the mentioned

Answer: d
Explanation: These coefficients were also introduced by van der Waals.

6. Real gases conform more closely with the van der Waals equation of state than the ideal gas equation of state.
a) true
b) false

Answer: a
Explanation: This happens particularly at higher pressures.

7. The following also gave two-constant equations of state.
a) Berthelot
b) Dieterici
c) Redlich-Kwong
d) all of the mentioned

Answer: d
Explanation: These are also two-constant equations of state other than the van der Waals equation.

8. Compressibility factor Z is given by
a) RT/pv
b) pv/RT
c) $(RT/pv)^2$
d) $(pv/RT)^2$

Answer: b
Explanation: This ratio is known as compressibility factor.

9. For an ideal gas, Z has the value
a) 0
b) 2
c) 1
d) infinity

Answer: c
Explanation: For an ideal gas, pv=RT hence Z=1.

10. The magnitude of Z at a particular pressure and temperature indicates the extent of deviation of the gas from the ideal gas behaviour.
a) true
b) false

Answer: a
Explanation: This is a basic fact about the compressibility factor.

TOPIC 4.2 COMPRESSIBILITY FACTOR-.PRINCIPLE OF CORRESPONDING STATES. - GENERALISED

1. For the ideal gas equation, what assumptions are made?
a) there is little or no attraction between the molecules of the gas
b) the volume occupied by the molecules is negligibly small compared to the volume of the gas
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: The ideal gas equation pv=RT is established from the postulates of the kinetic theory of gases considering these two assumptions.

2. When does a real gas obey the ideal gas equation closely?
a) at high pressure and low temperature
b) at low pressure and high temperature
c) at low pressure and temperature
d) at high pressure and temperature

Answer: b
Explanation: At low pressure and high temperature, the intermolecular attraction and the volume of the molecules compared to the total volume of the gas are not of much significance.

3. The real gases deviate from the ideal gas equation when the pressure increases.
a) true
b) false

Answer: a
Explanation: With increase in pressure, the intermolecular forces of attraction and repulsion increase, and also the volume of the molecules becomes appreciable compared to the gas volume.

4. The corrected gas equation is given by
a) $(p+a/(v^2))(v+b)=RT$
b) $(p-a/(v^2))(v-b)=RT$
c) $(p-a/(v^2))(v+b)=RT$
d) $(p+a/(v^2))(v-b)=RT$

Answer: d
Explanation: The two correction terms were introduced by van der Waals.

5. Which of the following statement is true about the correction terms?
a) the coefficient a was introduced to account for the existence of mutual attraction between the molecules
b) the term $a/(v^2)$ is called the force of cohesion
c) the coefficient b was introduced to account for the volumes of the molecules and is known as co-volume
d) all of the mentioned

Answer: d
Explanation: These coefficients were also introduced by van der Waals.

6. Real gases conform more closely with the van der Waals equation of state than the ideal gas equation of state.
a) true
b) false

Answer: a
Explanation: This happens particularly at higher pressures.

7. The following also gave two-constant equations of state.
a) Berthelot
b) Dieterici
c) Redlich-Kwong
d) all of the mentioned

Answer: d
Explanation: These are also two-constant equations of state other than the van der Waals equation.

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a) RT/pv
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d) $(pv/RT)^2$

Answer: b
Explanation: This ratio is known as compressibility factor.

9. For an ideal gas, Z has the value
a) 0
b) 2
c) 1
d) infinity

Answer: c
Explanation: For an ideal gas, pv=RT hence Z=1.

10. The magnitude of Z at a particular pressure and temperature indicates the extent of deviation of the gas from the ideal gas behaviour.
a) true
b) false

Answer: a
Explanation: This is a basic fact about the compressibility factor.

TOPIC 4.3 COMPRESSIBILITY CHART AND ITS USE

1. What is the compressibility of ideal gases?
a) 1
b) 2
c) 3
d) 4
View answer

Answer: a
Explanation: Compressibility = PV/nRT, but for ideal gases PV = nRT, => Compressibility = 1.

2. Which of the following is true about compressibility of real gases?
a) Z = 1
b) Z < 1
c) Z > 1
d) Both Z < 1 and Z > 1
View answer

Answer: d
Explanation: For any value of compressibility except 1, the gas is real.

3. What is the pressure of CO_2 gas with compressibility z = 0.8, if the ideal gas pressure of CO_2 is 10 Pa, all other variables are same?
a) 5
b) 8
c) 10
d) 14
View answer

Answer: b
Explanation: Pressure of CO_2 = 0.8*10 = 8 Pa.

4. What is the pressure of H_2 with compressibility 0.6, molar volume 5 liter/mole at 27^oC?
a) 2.9 atm
b) 5.4 atm
c) 9.6 atm
d) 14.5 atm
View answer

Answer: a
Explanation: P = znRT/V, => P = 0.6*0.0821*300/5 = 2.9 atm.

5. At what temperature, does SO_2 with compressibility 2 has pressure 5 atm and molar volume 10 mole/s?

a) 300.5 K
b) 304.5 K
c) 310 K
d) 312.5 K
View answer

Answer: b
Explanation: T = PV/zR = 5*10/(2*0.0821) = 304.5 K.

6. What is the compressibility factor of water with density 1 g/liter at 27^{o}C and 1 atm?
a) 0.25
b) 0.59
c) 0.73
d) 0.91
View answer

Answer: c
Explanation: z = PM/dRT = 1*18/(1*0.0821*300) = 0.73.

7. What is the compressibility factor of a liquid of molar mass 90 g and density 10 g/liter at 27^{o}C and 2 atm?
a) 0.14
b) 0.39
c) 0.51
d) 0.73
View answer

Answer: d
Explanation: z = PM/dRT = 2*90/(10*0.0821*300) = 0.73.

8. What is the pressure of 80 grams of CH_4 with compressibility 5, with 10 liter volume at 27^{o}C?
a) 10.5 atm
b) 28.9 atm
c) 44.2 atm
d) 61.5 atm
View answer

Answer: d
Explanation: P = 5*5*0.0821*300/10 = 61.5 atm.

9. What is the compressibility of methane with density 10 g/liter at 27^{o}C and 500 atm?
a) 32.5
b) 34.8
c) 39.6
d) 44.1
View answer

Answer: a
Explanation: z = PM/dRT = 500*16/(10*0.0821*300) = 32.5.

10. What is the compressibility of neon (molar mass = 20) with density 20 g/liter at 27^{o}C and 100 atm?
a) 2.1
b) 3.5
c) 4
d) 6.8
View answer

Answer: c
Explanation: z = PM/dRT = 100*20/(20*0.0821*300) = 4.

11. 90 g glucose is filled in a container at 10 atm, if the volume of container is 2 liter, what is the temperature of glucose (z = 1.5)?
a) 25.4^{o}C
b) 51.7^{o}C
c) 76.9^{o}C
d) 103.5^{o}C
View answer

Answer: b
Explanation: T = PV/znR = 10*2/(1.5*0.5*0.0821) = 324.8 K = 51.7^{o}C.

12. How many grams of C_2H_6 (z = 1.4) is present in the container at 27^{o}C and 5 atm and with volume 10 liter?
a) 20 g
b) 30.4 g
c) 40.6 g
d) 50.8 g
View answer

Answer: c
Explanation: n = 5*10/(1.4*0.0821*300) = 1.45, mass of C_2H_6 = 1.45*28 = 40.6 g.

13. What is the volume of 21 g of propane (z = 1.9) at 1 atm and 27^oC?
a) 23.4 liter
b) 37.5 liter
c) 42.1 liter
d) 59.6 liter
View answer

Answer: a
Explanation: V = 1.9*0.5*0.0821*300/1 = 23.4 liter.

14. 1 mole of cyclohexane (z = 1.2) is filled in a container at 27^oC and 4 atm, what is the volume of container?
a) 3.8 liter
b) 4.4 liter
c) 5.6 liter
d) 7.4 liter
View answer

Answer: d
Explanation: V = 1.2*1*0.0821*300/4 = 7.4 liter.

15. 39 grams of benzene (z = 1.4) is filled in a container of volume 10 liter at 27^oC, what is the pressure of container?
a) 1.7 atm
b) 1.9 atm
c) 2.2 atm
d) 2.5 atm
View answer

Answer: a
Explanation: P = 1.4*0.5*0.0821*300/10 = 1.7 atm.

TOPIC 4.4 MAXWELL RELATIONS, TDS EQUATIONS, DIFFERENCE AND RATIO OF HEAT CAPACITIES, ENERGY EQUATION

1. If a relation exists among variables x,y,z then z may be expressed as a function of x and y as, dz=Mdx+Ndy .
a) true
b) false

Answer: a
Explanation: Here, M,N and z are functions of x and y.

2. A pure substance which exists in a single phase has_____independent variables.
a) zero
b) one
c) two
d) three

Answer: c
Explanation: Of all the quantities, any one can be expressed as a function of any two others.

3. Which of the following relation is correct?
a) dU=TdS-pdV
b) dH=TdS+Vdp
c) dG=Vdp-SdT
d) all of the mentioned

Answer: d
Explanation: These relations are true for a pure substance which undergoes an infinitesimal reversible process.

4. Maxwell's equations consists of _____ equations.
a) four
b) three
c) two
d) one

Answer: a
Explanation: Maxwell's equations consists of four equations.

5. Which of the following is not a Maxwell equation?
a) $(\partial T/\partial V) = -(\partial p/\partial S)$
b) $(\partial T/\partial p) = -(\partial V/\partial S)$
c) $(\partial p/\partial T) = (\partial S/\partial V)$
d) $(\partial V/\partial T) = -(\partial S/\partial p)$

Answer: b
Explanation: The correct equation is $(\partial T/\partial p) = (\partial V/\partial S)$.

6. The condition for exact differential is
a) $(\partial N/\partial y) = (\partial M/\partial x)$
b) $(\partial M/\partial y) = (\partial N/\partial x)$
c) $(\partial M/\partial y) = -(\partial N/\partial x)$
d) all of the mentioned

Answer: b
Explanation: This is the condition for perfect or exact differential and here M and N are the functions of x and y.

7. The first TdS equation is
a) $TdS=Cv*dT + T(\partial T/\partial p)dV$
b) $TdS=Cv*dT – T(\partial p/\partial T)dV$
c) $TdS=Cv*dT + T(\partial p/\partial T)dV$
d) $TdS=Cv*dT – T(\partial T/\partial p)dV$

Answer: c
Explanation: This equation comes when entropy is defined as a function of T and V and using Cv and Maxwell's third equation.

8. The second TdS equation is
a) $TdS=Cp*dT + T(\partial V/\partial T)dp$
b) $TdS=Cp*dT – T(\partial V/\partial T)dp$
c) $TdS=Cp*dT + T(\partial T/\partial V)dp$
d) $TdS=Cp*dT – T(\partial T/\partial V)dp$

Answer: b
Explanation: This equation comes when entropy is defined as a function of T and p and using Cp and Maxwell's fourth equation.

9. Which of the following is true?
a) $(\partial p/\partial V)*(\partial V/\partial T)*(\partial T/\partial p)=$ infinity
b) $(\partial p/\partial V)*(\partial V/\partial T)*(\partial T/\partial p)= 0$
c) $(\partial p/\partial V)*(\partial V/\partial T)*(\partial T/\partial p)= 1$
d) $(\partial p/\partial V)*(\partial V/\partial T)*(\partial T/\partial p)= -1$

Answer: d
Explanation: This is the relation between the thermodynamic variables, p,V and T.

10. For getting TdS equations, we assume entropy to be a function of T and V and also of T and p.
a) true
b) false

Answer: a
Explanation: For first TdS equation, we assume entropy as a function of T and V and for second TdS equation, we assume entropy as a function of T and p .

TOPIC 4.5 JOULE-THOMSON COEFFICIENT, CLAUSIUS CLAPEYRON EQUATION, PHASE CHANGE PROCESSES.

1. During phase transitions like vaporization, melting and sublimation
a) pressure and temperature remains constant
b) volume and entropy changes
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: This is what happens during a phase transition.

2. Which of the following requirement is satisfied by a phase change of the first order?
a) there are changes of volume and entropy
b) the first-order derivative of the Gibbs function changes discontinuously
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These requirements must be satisfied for a phase change to be of first order.

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3. The Clausius-Clapeyron equation is given by
a) dp/dT = l / T(vf+vi)
b) dp/dT = l / T(vf-vi)
c) dT/dp = l / T(vf+vi)
d) dT/dp = l / T(vf-vi)

Answer: b
Explanation: Here vf is the final specific volume and vi is the initial specific volume and l is the latent heat.

4. Water_____on melting and has the fusion curve with a_____slope.
a) contracts, negative
b) contracts, positive
c) expands, negative
d) expands, positive

Answer: a
Explanation: Unlike other substances which expands on melting, water contracts on melting and hence the slope of the fusion curve is negative.

5. The vapour pressure curve is of the form ln(p) = A + B/T + C*lnT + DT.
a) true
b) false

Answer: a
Explanation: This is the form of vapour pressure curve where A,B,C, and D are constants.

6. According to Trouton's rule, the ratio of latent heat of vaporization to the boiling point at 1.013 bar is
a) 77 kJ/kgmol K
b) 88 kJ/kgmol K
c) 99 kJ/kgmol K
d) 100 kJ/kgmol K

Answer: b
Explanation: This is the statement of Trouton's rule.

7. The vapour pressure p in kPa at temperature T can be given by the relation
a) p = 101.325 exp (88/R)(1+T/Tb)
b) p = 101.325 exp (88/R)(1+Tb/T)
c) p = 101.325 exp (88/R)(1-T/Tb)
d) p = 101.325 exp (88/R)(1-Tb/T)

Answer: d
Explanation: Here Tb is the boiling point at 1.013 bar and this relation comes from the latent heat of vaporization and Trouton's rule.

8. At the triple point, l(sublimation) = l(vaporization) – l(fusion).
a) true
b) false

Answer: b
Explanation: At the triple point, l(sublimation) = l(vaporization) + l(fusion), where l is the latent heat.

9. The slope of sublimation curve is_____the slope of the vaporization curve at triple point.
a) equal to
b) less than
c) greater than
d) none of the mentioned

Answer: c
Explanation: This is because at triple point, l(sublimation) > l(vaporization).

10. Latent heat of sublimation is given by
a) l(sublimation) = -2.303*(R)*(d(1/T)/d(log p))
b) l(sublimation) = +2.303*(R)*(d(log p)/d(1/T))
c) l(sublimation) = +2.303*(R)*(d(1/T)/d(log p))
d) l(sublimation) = -2.303*(R)*(d(log p)/d(1/T))

Answer: d
Explanation: This is the expression for finding the latent heat of sublimation.

11. An application requires R-12 at −140°C. The triple-point temperature is −157°C. Find the pressure of the saturated vapour at the required condition.
a) 0.0058 kPa
b) 0.0098 kPa
c) 0.0068 kPa
d) 0.0088 kPa

Answer: b
Explanation: The lowest temperature for R-12 is -90°C, so it must be extended to -140°C using the Clapeyron equation.
at T1= -90°C = 183.2 K, P1 = 2.8 kPa
R = 8.3145/120.914 = 0.068 76 kJ/kg K
ln P/P1 = (hfg/R)(T-T1)/(T*T1)
= (189.748/0.068 76)[(133.2 – 183.2)/(133.2 × 183.2)] = -5.6543
P = 2.8 exp(-5.6543) = 0.0098 kPa.

12. Ice (solid water) at −3°C and 100 kPa, is compressed isothermally until it becomes liquid. Find the required pressure.
a) 20461 kPa
b) 30461 kPa
c) 40461 kPa
d) 50461 kPa

Answer: c
Explanation: Water, triple point T = 0.01°C, P = 0.6113 kPa, vf = 0.001 m^3/kg, hf = 0.01 kJ/kg, vi= 0.001 0908 m^3/kg, hi = -333.4 kJ/kg
dPif/dT = (hf – hi)/[(vf – vi)T] = 333.4/(-0.0000908 × 273.16) = -13442 kPa/K
ΔP = (dPif/dT)*ΔT = -13442(-3 – 0.01) = 40460 kPa
P = P(tp) + ΔP = 40461 kPa.

13. Estimate the freezing temperature of liquid water at a pressure of 30 MPa.
a) -2.2°C
b) 0°C
c) -0.2°C
d) -1.2°C

Answer: a
Explanation: At the triple point,
vif = vf – vi = 0.001000 – 0.0010908 = -0.0000908 m^3/kg
hif = hf – hi = 0.01 – (-333.40) = 333.41 kJ/kg
dPif/dT = 333.41/[(273.16)(-0.0000908)] = -13 442 kPa/K
at P = 30 MPa, T = 0.01 + (30 000-0.6)/(-13 442) = = -2.2°C.

UNIT V GAS MIXTURES AND PSYCHROMETRY

TOPIC 5.1 MOLE AND MASS FRACTION, DALTON'S AND AMAGATS LAW.

1. The expression which represents the pressure exerted by a gas is
a) nVRT
b) nRT/V
c) V/nRT
d) 1/nVRT

Answer: b
Explanation: This expression comes from the gas equation where V is the volume occupied by the gas at temperature T.

2. The expression nRT/V is called the partial pressure of a gas.
a) true
b) false

Answer: a
Explanation: This is the partial pressure that a gas exerts.

3. According to the Dalton's law of partial pressures, the total pressure of a mixture of ideal gases is equal to the
a) difference of the highest and lowest pressure
b) product of the partial pressures

c) sum of the partial pressures
d) none of the mentioned

Answer: c
Explanation: According to the Dalton's law of partial pressures, p=p1+p2+p3+…..+pc.

4. Which of the following relation is correct?
a) mole fraction of the Kth gas = moles of the Kth gas / total number of moles of gas
b) partial pressure of Kth gas = (mole fraction of the Kth gas)*(sum of the partial pressures)
c) sum of mole fractions of all the gases is unity
d) all of the mentioned

Answer: d
Explanation: All these statements come from the Dalton's law of partial pressures.

5. The gas constant of the mixture is the _____ of the gas constants of the components.
a) average
b) weighted mean
c) sum
d) difference of the highest and the lowest

Answer: b
Explanation: It can be found from the Dalton's law and gas equation.

6. A quantity called partial volume of a component of mixture is used.
a) true
b) false

Answer: a
Explanation: It is the volume which the component alone would occupy at the pressure and temperature of the mixture.

7. Which of the following statement is true?
a) V=V1+V2+….+Vc , where V is the partial volume of the component
b) 1/v = 1/(v1) + 1/(v2) +..... + 1/(vc) , where v is the specific volume of the component
c) total density is equal to the sum of the densities of the components
d) all of the mentioned

Answer: d
Explanation: these relations come from the Dalton's law and the gas equation.

8. The total entropy of a mixture of gases is the_____of the partial entropies.
a) average
b) weighted mean
c) sum
d) difference of the highest and the lowest

Answer: c
Explanation: This is given by the Gibbs theorem.

9. When gases which are at equal pressure and temperature are mixed adiabatically without work, then
a) internal energy of the gaseous system remains constant
b) heat transfer of the gaseous system remains constant
c) entropy of the gaseous system remains constant
d) all of the mentioned

Answer: a
Explanation: This is because of the first law.

10. The fact that internal energy of a mixture is equal to the sum of the partial internal energies of the gases can also be applied to properties like H,Cv,Cp,S,F, and G.
a) true
b) false

Answer: a
Explanation: This statement comes from the Gibbs theorem.

TOPIC 5.2 PROPERTIES OF GAS MIXTURE - MOLAR MASS, GAS CONSTANT, DENSITY, CHANGE IN INTERNAL ENERGY,

ENTHALPY, ENTROPY AND GIBBS FUNCTION. PSYCHROMETRIC PROPERTIES, PSYCHROMETRIC CHARTS.

1. Which of the following statement is true?
a) the chart is plotted for pressure equal to 760mm Hg
b) the constant wbt line represents adiabatic saturation process
c) the constant wbt line coincides with constant enthalpy line
d) all of the mentioned

Answer: d
Explanation: All these come from the psychrometric chart.

2. In sensible heating or cooling,
a) work done remains constant
b) dry bulb temperature or air remains constant
c) both of the mentioned
d) none of the mentioned

Answer: a
Explanation: The dry bulb temperature of air changes.

3. When humidity ratio of air_____air is said to be dehumidified.
a) increases
b) decreases
c) remains constant
d) none of the mentioned

Answer: b
Explanation: when it increases, air is said to be humidified.

4. Air can be cooled and dehumidified by
a) circulating chilled water in tube across air flow
b) placing evaporator coil across air flow
c) spraying chilled water to air
d) all of the mentioned

Answer: d
Explanation: These are the ways of cooling and dehumidifying air.

5. Cooling and dehumidification of air is done in summer air conditioning.
a) true
b) false

Answer: a
Explanation: This is a common process in summer air conditioning.

6. Heating and humidification is done in
a) summer air conditioning
b) winter air conditioning
c) both of the mentioned
d) none of the mentioned

Answer: b
Explanation: This is opposite to summer air conditioning.

7. Which of the following is an absorbent?
a) silica gel
b) activated alumina
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: Both of these are examples of absorbents.

8. When air passes through silica gel,
a) it absorbs water vapour molecules
b) latent heat of condensation is released
c) dbt of air increases
d) all of the mentioned

Answer: d
Explanation: This process is called chemical dehumidification.

9. In adiabatic evaporative cooling, heat transfer between chamber and surroundings is _____
a) zero
b) high

c) low
d) none of the mentioned

Answer: a
Explanation: No heat transfer takes place between chamber and surroundings in adiabatic evaporative cooling.

10. The cooling tower uses the phenomenon of evaporative cooling to cool warm water above the dbt of air.
a) true
b) false

Answer: b
Explanation: The cooling tower uses the phenomenon of evaporative cooling to cool warm water below the dbt of air.

11. Cooling towers are rated in terms of
a) approach
b) range
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: These are the two factors considered.

TOPIC 5.3 PROPERTY CALCULATIONS OF AIR VAPOUR MIXTURES BY USING CHART AND EXPRESSIONS.

1. Dry air consists of
a) oxygen, nitrogen
b) carbon dioxide
c) hydrogen, argon
d) all of the mentioned

Answer: d
Explanation: Dry air is a mixture of all these gases.

2. Complete dry air exists in nature.
a) true
b) false

Answer: b
Explanation: Complete dry air does not exist in nature.

3. Which of the following is true?(here pa=partial pressure of dry air, pw=partial pressure of water vapour, p=atmospheric pressure)
a) p=pw
b) p=pa
c) p=pw + pa
d) all of the mentioned

Answer: c
Explanation: This comes by Dalton's law of partial pressures.

4. In a mixture of dry air and water vapour,
a) mole fraction of dry air = pa/p
b) mole fraction of water vapour = pw/p
c) both of the mentioned
d) none of the mentioned

Answer: c
Explanation: This comes from the concepts of Dalton's law of partial pressures.

5. When pw is very small,
a) saturation temperature of water vapour at pw is less than atmospheric temperature
b) water vapour in air exists in superheated state
c) air is said to be in unsaturated state
d) all of the mentioned

Answer: d
Explanation: Mostly partial pressure of water vapour is very small.

6. Relative humidity is defined as
a) (saturation pressure of pure water) / pw
b) pw / (saturation pressure of pure water)
c) (saturation pressure of pure water) / p
d) p / (saturation pressure of pure water)

Answer: b
Explanation: Here pw is the partial pressure of water vapour and ps is the saturation

pressure of pure water at same temperature of mixture.

7. For saturated air, relative humidity is 0%.
a) true
b) false

Answer: b
Explanation: For saturated air, relative humidity is 100%.

8. If water is injected into a container with has unsaturated air,
a) water will evaporate
b) moisture content of air will decrease
c) pw will decrease
d) all of the mentioned

Answer: a
Explanation: The moisture content of air will increase and pw will increase.

9. Humidity ratio is given by the ratio of
a) (mass of dry air per unit mass of water vapour)^2
b) 1/(mass of dry air * mass of water vapour)
c) water vapour mass per unit mass of dry air
d) mass of dry air per unit mass of water vapour

Answer: c
Explanation: Humidity ratio is also called specific humidity.

10. The degree of saturation is the ratio of
a) (saturated specific humidity / actual specific humidity)^2
b) 1/(saturated specific humidity * actual specific humidity)
c) saturated specific humidity / actual specific humidity
d) actual specific humidity / saturated specific humidity

Answer: d
Explanation: Here both saturated specific humidity and specific humidity are at same temperature.

11. The degree of saturation varies between -1 and 0.
a) true
b) false

Answer: b
Explanation: The degree of saturation varies between 0 and 1.

12. Which of the following statement is true?
a) dew point temperature is the temperature at which water vapour starts condensing
b) dry bulb temperature is recorded by thermometer with dry bulb
c) wet bulb temperature is recorded by thermometer when bulb is covered with a cotton wick which is saturated with water
d) all of the mentioned

Answer: d
Explanation: These are the definitions of dew point temperature, dry bulb temperature and wet bulb temperature.

13. The wet bulb temperature is the _____ temperature recorded by moistened bulb.
a) lowest
b) highest
c) atmospheric
d) none of the mentioned

Answer: a
Explanation: This is a property of wet bulb temperature.

14. At any dbt, the_the difference of wbt reading below below dbt,____is the amountof water vapour held in mixture.
a) smaller, smaller
b) greater, greater
c) greater, smaller
d) smaller, greater

Answer: c
Explanation: This is an important property of dbt and wbt.

15. When unsaturated air flows over a sheet of water in an insulated chamber
a) specific humidity of air decreases
b) the water evaporates
c) both air and water are cooled during evaporation
d) all of the mentioned

Answer: a
Explanation: The specific humidity of air increases during this process.

TOPIC 5.4 PSYCHROMETRIC PROCESS - ADIABATIC SATURATION, SENSIBLE HEATING AND COOLING, HUMIDIFICATION, DEHUMIDIFICATION, EVAPORATIVE COOLING AND ADIABATIC MIXING.

1. Which of the following statement is true?
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