

Day 1: Fundamentals & Working Fluid Properties

Absolute pressure is defined as:

- A. Gage pressure minus atmospheric pressure
- B. Atmospheric pressure minus vacuum pressure**
- C. Barometric reading multiplied by specific gravity
- D. Hydrostatic head divided by fluid density

Specific volume is defined as:

- A. Mass per unit volume
- B. Total weight divided by volume
- C. Volume per unit mass**
- D. Ratio of liquid density to water density

Specific gravity of a gas is referenced against the density of:

- A. Pure water
- B. Standard air**
- C. Mercury
- D. Hydrogen

The internal energy of an ideal gas depends primarily on its:

- A. Volume
- B. Pressure
- C. Temperature**
- D. Elevation

Flow work represents:

- A. The potential energy due to liquid elevation
- B. Molecular kinetic energy caused by heat
- C. Energy required to push fluid across a boundary**
- D. Total heat absorbed across a cycle

Enthalpy is the sum of:

- A. Kinetic energy and potential energy
- B. Internal energy and flow work**
- C. Heat added and entropy
- D. Work output and friction loss

Stagnation enthalpy accounts for ordinary enthalpy plus:

- A. Elevation potential energy
- B. Kinetic energy brought to rest**
- C. Molecular internal energy
- D. Condenser heat rejection

For steady fluid flow in a pipe, the product of cross-sectional area, velocity, and density equals:

- A. Volume flow rate
- B. Total dynamic head
- C. Mass flow rate**
- D. Gage pressure

The Zeroth Law of Thermodynamics establishes the concept of:

- A. Conservation of energy
- B. Direction of heat flow
- C. Temperature measurement**
- D. Absolute entropy

The First Law of Thermodynamics is based on the principle of:

- A. Absolute zero temperature
- B. Conservation of energy**
- C. Degradation of energy
- D. Maximum efficiency

According to the Third Law of Thermodynamics, a pure crystalline substance has zero entropy at:

- A. 0°C
- B. 0°F
- C. 0 K**
- D. Critical temperature

A pure substance is characterized by:

- A. Maintaining a gaseous phase at all times
- B. Fixed chemical composition through phase changes**
- C. Zero viscosity during fluid flow
- D. Incompressible behavior

Hydrostatic pressure exerted by a standing liquid depends on:

- A. Total container surface area
- B. Depth and fluid density**
- C. Pipe roughness
- D. Fluid flow velocity

A pyrometer is an instrument specifically designed to measure:

- A. Very low temperatures
- B. High temperature gases**
- C. Atmospheric moisture
- D. High vacuum pressures

In thermodynamic sign conventions, work done on the system by external surroundings is:

- A. Positive
- B. Negative**
- C. Zero
- D. Undefined

In thermodynamic sign conventions, heat added to a system is:

- A. Positive
- B. Negative
- C. Equal to total entropy
- D. Independent of temperature

Standard atmospheric pressure at sea level in SI units is:

- A. 14.7 kPa
- B. 29.92 kPa
- C. 101.325 kPa
- D. 760 kPa

Boyle's Law describes the behavior of an ideal gas undergoing a:

- A. Constant pressure process
- B. Constant temperature process
- C. Constant volume process
- D. Isentropic process

Charles's Law states that at constant pressure, volume varies:

- A. Inversely with temperature
- B. Directly with absolute temperature
- C. Inversely with density
- D. As the square of pressure

The individual gas constant for any gas is obtained by dividing the universal gas constant by its:

- A. Specific heat ratio
- B. Critical pressure
- C. Molecular weight
- D. Boiling point

A barometer is an instrument primarily used to measure:

- A. Steam quality
- B. Local atmospheric pressure
- C. Flue gas draft head
- D. Static water level

A working substance that remains exclusively in the gaseous state throughout its entire cycle is:

- A. Saturated steam
- B. Compressed liquid
- C. An ideal gas
- D. Subcooled refrigerant

One standard technical atmosphere (1 atm) corresponds to a barometric column height of:

- A. 29.92 in Hg
- B. 14.7 mm Hg
- C. 101.325 in Hg
- D. 760 cm Hg

In the Kelvin absolute temperature scale, water freezes at approximately:

- A. 460 K
- B. 0 K
- C. 273 K
- D. 32 K

The Rankine absolute temperature scale uses as its baseline reference:

- A. Absolute zero with Fahrenheit degree increments
- B. Freezing point of water at sea level
- C. Boiling point of liquid mercury
- D. Ambient standard room temperature

An adiabatic boundary or process is defined by:

- A. Zero boundary work
- B. Perfectly insulated conditions with zero heat transfer
- C. Zero change in fluid pressure
- D. Uncontrolled ambient air leakage

Mass flow rate divided by cross-sectional duct area defines:

- A. Fluid density
- B. Specific volume
- C. Mass flux (mass velocity)
- D. Absolute static head

The continuity equation for steady single-stream flow requires that:

- A. Total velocity remains unchanged
- B. Entering mass equals leaving mass
- C. Entropy generation is zero
- D. Gage pressure equals atmospheric pressure

Temperature difference measured on the Celsius scale is numerically identical to the difference measured in:

- A. Degrees Fahrenheit
- B. Degrees Rankine
- C. Kelvin
- D. Degrees Baumé

In the English engineering system, standard atmospheric pressure at sea level equals:

- A. 29.92 psi
- B. 14.7 psi
- C. 760 psi
- D. 62.4 psi

Day 2: Ideal Gas Processes & Thermodynamic Cycles

1. A reversible adiabatic process is defined by:
 - A. Constant temperature
 - B. Zero work output
 - C. Constant entropy**
 - D. Infinite heat transfer
2. In an isometric process, the boundary work performed is:
 - A. Maximum possible
 - B. Zero**
 - C. Equal to enthalpy change
 - D. Proportional to gas constant
3. An alternative engineering term for a constant volume process is:
 - A. Isobaric
 - B. Isothermal
 - C. Isochoric**
 - D. Isenthalpic
4. During a constant temperature process for an ideal gas, the change in internal energy is:
 - A. Positive
 - B. Negative
 - C. Zero**
 - D. Dependent on pressure ratio
5. In an isobaric expansion of an ideal gas, boundary work equals:
 - A. Zero
 - B. Enthalpy change minus heat
 - C. Pressure times change in volume**
 - D. Universal gas constant times entropy
6. For an ideal gas undergoing a polytropic process, setting the exponent $n = 0$ corresponds to:
 - A. Isothermal process
 - B. Isobaric process**
 - C. Isometric process
 - D. Isentropic process
7. For an ideal gas undergoing a polytropic process, setting the exponent $n = 1$ corresponds to:
 - A. Isothermal process**
 - B. Isobaric process
 - C. Isometric process
 - D. Isentropic process
8. The theoretical thermodynamic cycle possessing the highest possible thermal efficiency between two temperatures is the:
 - A. Otto cycle
 - B. Rankine cycle
 - C. Carnot cycle**
 - D. Diesel cycle
9. Heat addition in a Carnot cycle occurs during:
 - A. Isentropic compression
 - B. Constant pressure expansion
 - C. Constant temperature expansion**
 - D. Constant volume heating
10. In a Carnot cycle, heat rejection occurs during: **A. Isothermal compression**
 - B. Isentropic expansion
 - C. Isobaric cooling
 - D. Polytropic expansion
11. An internal combustion engine operating on the Otto cycle uses what mechanism of ignition?
 - A. Compression ignition
 - B. Spark ignition**
 - C. Glow plug preheating
 - D. External combustion
12. In an Otto cycle, heat addition occurs during a:
 - A. Constant pressure process
 - B. Constant volume process**
 - C. Constant temperature process
 - D. Isentropic process
13. In an Otto cycle, heat rejection occurs during a:
 - A. Constant volume process**
 - B. Constant pressure process
 - C. Constant entropy process
 - D. Throttling process
14. The thermal efficiency of an air-standard Otto cycle depends primarily on:
 - A. Cut-off ratio and fuel type
 - B. Compression ratio and specific heat ratio**
 - C. Condenser pressure and quality
 - D. Maximum cycle work and speed
15. Mean effective pressure is defined as:
 - A. Maximum cylinder pressure
 - B. Net cycle work divided by displacement volume**
 - C. Ratio of clear volume to stroke
 - D. Indicated power minus brake power

16. Compression ratio is defined as the ratio of:
- Clearance volume to total volume
 - Maximum volume to clearance volume
 - Cut-off volume to clearance volume
 - Stroke length to cylinder diameter
17. In a cycle consisting of two constant-temperature and two isentropic processes, the cycle is:
- Otto
 - Brayton
 - Carnot
 - Diesel
18. In an ideal gas, specific heat at constant pressure exceeds specific heat at constant volume by:
- The polytropic index
 - The gas constant
 - The specific volume
 - The compressibility factor
19. In an internal combustion engine, maximum cycle temperature occurs:
- At top dead center before ignition
 - After combustion or before expansion
 - At exhaust valve opening
 - During intake suction
20. A rigid vessel containing an ideal gas receives heat; the thermodynamic process is:
- Isobaric
 - Isometric
 - Isothermal
 - Isentropic
21. On an indicator diagram, a vertical straight line represents an:
- Isobaric process
 - Isometric process
 - Isothermal process
 - Isentropic process
22. On an indicator diagram, a horizontal straight line represents an:
- Isobaric process
 - Isochoric process
 - Isothermal process
 - Isentropic process
23. A reversible process is ideal because it operates without:
- Mass displacement
 - Heat addition
 - Internal friction or mechanical dissipation
 - Fluid velocity
24. A hyperbola on a pressure-volume plot describes an ideal gas undergoing an:
- Isothermal process
 - Isometric process
 - Isobaric process
 - Isentropic process
25. In an air-standard cycle, cold-air standard conditions assume the specific heat ratio (k) of air to be:
- 1.0
 - 1.3
 - 1.4
 - 1.67
26. Clearance volume in a reciprocating cylinder is the space occupied by fluid when the piston is at:
- Bottom dead center
 - Top dead center
 - Half-stroke position
 - The exhaust manifold
27. Total cylinder volume before compression equals:
- Displacement volume plus clearance volume
 - Displacement volume minus clearance volume
 - Bore area times clearance length
 - Stroke length times piston rod area
28. In a Carnot engine, heat is absorbed from a high-temperature thermal reservoir designated as the:
- Temperature sink
 - Temperature source
 - Intercooler
 - Regenerator
29. In a Carnot engine, waste heat is discharged to a low-temperature region designated as the:
- Temperature sink
 - Combustor
 - Superheater
 - Indicator
30. The Otto cycle is bounded entirely on a pressure-volume plane by:
- Two constant-pressure lines and two isentropes
 - Two constant-volume lines and two isentropes
 - Two isotherms and two constant-pressure lines
 - Four polytropic lines

Day 3: Diesel, Brayton Cycles & Gas Mixtures

1. The Diesel cycle differs fundamentally from the Otto cycle because it is:
 - A. Spark-ignition
 - B. Compression-ignition**
 - C. External combustion
 - D. Condensing vapor type
2. In an ideal Diesel cycle, heat addition occurs at:
 - A. Constant volume
 - B. Constant pressure**
 - C. Constant temperature
 - D. Constant entropy
3. Cut-off ratio in a Diesel engine is defined as:
 - A. Volume after combustion divided by clearance volume**
 - B. Total cylinder volume divided by clearance volume
 - C. Displacement volume divided by bore area
 - D. Compression pressure divided by suction pressure
4. The open gas turbine cycle is based on the:
 - A. Rankine cycle
 - B. Brayton cycle**
 - C. Stirling cycle
 - D. Carnot cycle
5. In an open-cycle gas turbine, the compression process occurs within a:
 - A. Nozzle
 - B. Compressor**
 - C. Flasher
 - D. Penstock
6. In a gas turbine combustor, fuel burns with incoming air under:
 - A. Constant pressure**
 - B. Constant volume
 - C. Constant temperature
 - D. Constant entropy
7. Backwork ratio in a gas turbine power plant is defined as:
 - A. Generator output divided by heat added
 - B. Compressor work divided by turbine work**
 - C. Net work divided by indicated power
 - D. Friction power divided by brake power
8. Dalton's Law states that total pressure of a non-reacting gas mixture equals:
 - A. The highest partial pressure present
 - B. The product of individual component pressures
 - C. The sum of the partial pressures of all components**
 - D. Universal gas constant times total volume
9. The partial pressure of a constituent gas in an ideal gas mixture is proportional to its:
 - A. Weight density
 - B. Mole fraction**
 - C. Enthalpy
 - D. Viscosity
10. The mass of air supplied compared to the fuel consumed is called:
 - A. Cut-off ratio
 - B. Equivalence index
 - C. Air-fuel ratio**
 - D. Volumetric displacement
11. Expansion in an ideal Brayton cycle gas turbine occurs:
 - A. Isentropically**
 - B. Isothermally
 - C. Isenthalpically
 - D. Isochorically
12. The expansion ratio in a Diesel cycle is defined as:
 - A. Total volume divided by fuel cut-off volume**
 - B. Clearance volume divided by piston displacement
 - C. Peak cycle pressure divided by exhaust pressure
 - D. Net turbine work divided by compressor work
13. The apparent molecular weight of a gas mixture given percent volume of each gas is calculated from:
 - A. Harmonic mean of molecular weights
 - B. Sum of the products of volume fractions and individual molecular weights**
 - C. Product of all molecular weights divided by total mass
 - D. Standard atmospheric molecular weight
14. The gas constant of a gas mixture is calculated by dividing universal gas constant by:
 - A. Total number of moles
 - B. Apparent molecular weight of the mixture**
 - C. Ratio of specific heats
 - D. Mass fraction of the lightest gas

15. Heat rejection in an ideal Diesel cycle occurs at:
- A. Constant pressure
 - B. Constant temperature
 - C. Constant volume**
 - D. Constant entropy
16. In an ideal Brayton cycle, heat rejection to the environment occurs at:
- A. Constant pressure**
 - B. Constant volume
 - C. Constant temperature
 - D. Constant enthalpy
17. Compression in both the Otto and Diesel cycles takes place under:
- A. Constant pressure
 - B. Isothermal conditions
 - C. Isentropic conditions**
 - D. Constant enthalpy
18. The net work output of a gas turbine system equals:
- A. Turbine work plus compressor work
 - B. Turbine work minus compressor work**
 - C. Total heat input divided by backwork ratio
 - D. Generator output minus cooling water heat
19. In a volumetric analysis of dry air, nitrogen comprises approximately:
- A. 21%
 - B. 50%
 - C. 79%**
 - D. 95%
20. In an ideal gas mixture, the volume percentage of each constituent gas is equal to its:
- A. Partial pressure percentage**
 - B. Gravimetric weight percentage
 - C. Density ratio to water
 - D. Latent heat ratio
21. In a compression-ignition engine, fuel ignition is initiated by:
- A. An electric spark plug
 - B. High temperature resulting from rapid compression**
 - C. Direct burner flame
 - D. Superheated steam injection
22. The ratio of cylinder volume at fuel cut-off to clearance volume in a Diesel cycle is the:
- A. Expansion ratio
 - B. Cut-off ratio**
 - C. Pressure ratio
 - D. Clearance factor
23. Compression pressure ratio (r_p) relates discharge pressure to suction pressure as:
- A. Compression ratio raised to the specific heat ratio**
 - B. Square root of compression ratio
 - C. Cut-off ratio times expansion ratio
 - D. Isentropic work divided by fuel weight
24. An open gas turbine power plant differs from a closed gas turbine plant because it:
- A. Recirculates the identical gas continuously
 - B. Discharges exhaust gas to the atmosphere and takes in fresh air**
 - C. Uses a steam condenser
 - D. Eliminates the expansion turbine
25. Net work delivered by a Brayton cycle equals:
- A. Compressor work divided by turbine work
 - B. Turbine work minus compressor work
 - C. Heat added plus heat rejected
 - D. Enthalpy of fuel divided by air mass
26. In an ideal Brayton gas turbine cycle, the combustion chamber replaces the:
- A. Intercooler
 - B. Constant-pressure heat addition heat exchanger**
 - C. Reciprocating cylinder
 - D. Steam superheater
27. Avogadro's principle establishes that equal volumes of ideal gases at identical temperature and pressure contain:
- A. Equal mass densities
 - B. Equal numbers of moles**
 - C. Identical gas constants
 - D. Equal specific heats
28. The sum of all individual component mole fractions in a gas mixture must always equal:
- A. Zero
 - B. 0.5
 - C. 1.0**
 - D. Universal gas constant
29. The mass fraction of a constituent gas in a mixture equals:
- A. Component mass divided by total mixture mass**
 - B. Partial pressure divided by atmospheric pressure
 - C. Component volume times molecular weight
 - D. Individual gas constant divided by mixture gas constant

30. In an internal combustion engine, maximum cycle pressure occurs:
- A. At bottom dead center during intake
 - B. At the end of combustion (State 3)**
 - C. During exhaust blowdown
 - D. In the intercooler

Day 4: Pure Substances & Rankine Cycle

1. Liquid that is not about to vaporize at its prevailing pressure is termed:
 - A. Saturated liquid
 - B. Superheated vapor
 - C. Subcooled liquid**
 - D. Critical fluid
2. Liquid that is at its boiling temperature and about to vaporize is termed:
 - A. Compressed liquid
 - B. Saturated liquid**
 - C. Wet vapor
 - D. Superheated liquid
3. Vapor that is about to condense upon any heat extraction is termed:
 - A. Saturated vapor**
 - B. Wet mixture
 - C. Superheated vapor
 - D. Subcooled vapor
4. The state where saturated liquid and saturated vapor properties become completely identical is the:
 - A. Triple point
 - B. Critical point**
 - C. Sublimation line
 - D. Dew point
5. Steam quality is defined as the ratio of:
 - A. Liquid mass to total mixture mass
 - B. Mass of vapor to total mass of liquid and vapor**
 - C. Mixture volume to saturated vapor volume
 - D. Enthalpy of vaporization to saturation temperature
6. Moisture content in wet steam is defined as:
 - A. Mass of liquid divided by total mass of liquid and vapor**
 - B. Mass of vapor divided by total mass
 - C. Specific volume divided by critical volume
 - D. Enthalpy of saturated liquid
7. Degrees superheat represents:
 - A. Actual superheated temperature minus saturation temperature**
 - B. Saturation temperature minus subcooled liquid temperature
 - C. Critical temperature minus boiling temperature

- D. Condenser temperature minus ambient temperature
8. Degrees subcooled represents:
 - A. Saturation temperature minus actual liquid temperature**
 - B. Actual steam temperature minus wet bulb temperature
 - C. Feedwater temperature plus boiler temperature
 - D. Ambient temperature minus condenser temperature
 9. A throttling process through an orifice or expansion valve occurs at:
 - A. Constant entropy
 - B. Constant enthalpy**
 - C. Constant temperature
 - D. Constant volume
 10. The primary thermodynamic cycle used in modern steam power plants is the:
 - A. Brayton cycle
 - B. Carnot cycle
 - C. Rankine cycle**
 - D. Otto cycle
 11. In an ideal Rankine cycle, heat addition in the boiler occurs at:
 - A. Constant volume
 - B. Constant pressure**
 - C. Constant temperature
 - D. Constant entropy
 12. Expansion of steam inside an ideal Rankine turbine occurs
 - A. Isentropically**
 - B. Isothermally
 - C. Isenthalpically
 - D. Isochorically
 13. Condensation in the condenser of a Rankine cycle occurs at:
 - A. Constant volume
 - B. Constant pressure**
 - C. Constant entropy
 - D. Isenthalpic conditions
 14. Reheating in a steam power plant involves routing steam back to the boiler after:
 - A. Passing through the condenser
 - B. Partial expansion in a high-pressure turbine**
 - C. Exiting the feedwater pump
 - D. Passing through the cooling tower
 15. Cogeneration efficiency accounts for net turbine work plus:
 - A. Pump work input
 - B. Useful heat rejected or utilized**
 - C. Condenser cooling loss
 - D. Friction power

16. The work required to drive a boiler feed pump operating on liquid water is:
- A. Much greater than turbine work
 - B. Much less than turbine work**
 - C. Equal to generator output
 - D. Negligible only at supercritical pressures
17. For 100% dry saturated vapor, the steam quality is:
- A. 0%
 - B. 50%
 - C. 100%**
 - D. Indeterminate
18. For 100% saturated liquid with no vapor present, steam quality is:
- A. 0%**
 - B. 50%
 - C. 100%
 - D. 1
19. In a surface condenser, heat rejected by condensing steam is absorbed by:
- A. Ambient air drafts
 - B. Cooling water**
 - C. Fuel oil preheaters
 - D. Turbine bearings
20. The primary thermodynamic benefit of reheating steam in a turbine cycle is:
- A. Eliminating the boiler feed pump
 - B. Higher cycle efficiency and reduced moisture at turbine exhaust**
 - C. Decreasing boiler furnace temperatures
 - D. Operating the condenser above atmospheric pressure
21. On a temperature-entropy (T - s) diagram, the region enclosed beneath the saturation dome is the:
- A. Superheated region
 - B. Compressed liquid region
 - C. Wet or mixture region**
 - D. Sublimation zone
22. The boundary line separating the compressed liquid region from the wet mixture region is the:
- A. Saturated liquid line**
 - B. Saturated vapor line
 - C. Isothermal line
 - D. Critical isobar
23. The boundary line separating the wet mixture region from the superheated region is the:
- A. Saturated liquid line
 - B. Saturated vapor line**
 - C. Throttling line
 - D. Subcooled boundary
24. A throttling calorimeter is an instrument used to determine:
- A. Boiler water level
 - B. Quality or moisture content of wet steam**
 - C. Generator speed
 - D. Condenser water flow rate
25. In an ideal Rankine cycle, the working fluid leaving the condenser is in the state of:
- A. Superheated vapor
 - B. Wet mixture with 50% quality
 - C. Saturated liquid**
 - D. High-pressure compressed gas
26. In an ideal Rankine cycle, the fluid entering the boiler feed pump is:
- A. Saturated liquid at condenser pressure**
 - B. Superheated steam
 - C. Wet mixture at boiler pressure
 - D. Subcooled brine
27. Heat input to the steam generator in a Rankine cycle equals:
- A. Enthalpy leaving the boiler minus enthalpy entering from the feed pump**
 - B. Condenser heat rejection minus turbine work
 - C. Generator output times mechanical efficiency
 - D. Latent heat of ice
28. The ideal expansion path on a Mollier (h - s) chart for an unthrottled steam turbine is a:
- A. Horizontal line
 - B. Vertical straight line downwards**
 - C. Hyperbolic curve
 - D. Parabolic curve
29. The ratio of net power plant output to total thermal heat input from fuel is the:
- A. Engine mechanical efficiency
 - B. Overall thermal efficiency**
 - C. Volumetric rating
 - D. Expansion factor
30. In a reheat Rankine cycle, steam is extracted after the high-pressure turbine and returned to the boiler to:
- A. Increase water flow rate
 - B. Increase its temperature at constant pressure**
 - C. Condense into saturated liquid
 - D. Reduce boiler feedwater pressure

Day 5: Fuels, Combustion, Variable Load & Boilers

1. The API gravity scale is universally used to classify:
 - A. Solid coal rank
 - B. Petroleum liquid products**
 - C. Natural gas purity
 - D. Flue gas moisture
2. Complete combustion of pure carbon yields:
 - A. Carbon monoxide
 - B. Carbon dioxide**
 - C. Soot
 - D. Methane
3. Theoretical air is defined as the:
 - A. Excess air supplied by forced draft fans
 - B. Stoichiometric minimum air required for complete combustion**
 - C. Volume of nitrogen entering the burner
 - D. Total moisture present in combustion air
4. Air supplied beyond the theoretical combustion requirement is designated:
 - A. Dilution air
 - B. Excess air**
 - C. Secondary steam
 - D. Flue gas draft
5. Reserve over peak on a power station represents:
 - A. Average load divided by peak load
 - B. Plant capacity minus peak load**
 - C. Connected load minus installed capacity
 - D. Maximum demand plus base load
6. Load factor is mathematically expressed as:
 - A. Average load divided by peak load**
 - B. Peak load divided by installed capacity
 - C. Energy produced divided by fuel energy
 - D. Connected load divided by maximum demand
7. Capacity factor is defined as:
 - A. Actual energy generated divided by maximum potential generation at continuous rated capacity**
 - B. Sum of individual demands divided by coincident maximum demand
 - C. Rated capacity minus reserve
 - D. Fuel energy divided by generator output
8. Demand factor is defined as:
 - A. Actual maximum demand divided by connected load**
 - B. Peak load divided by average load
 - C. Operating hours divided by 8760 hours
 - D. Installed capacity divided by average load
9. Diversity factor is defined as:
 - A. Average load divided by generator rating
 - B. Sum of individual demands divided by maximum simultaneous demand**
 - C. Actual energy output divided by rated capacity
 - D. Base load divided by reserve capacity
10. A diversity factor on an electrical utility grid is normally:
 - A. Less than 0
 - B. Equal to 0
 - C. Greater than 1**
 - D. Exactly 0.5
11. An economizer in a boiler recovers residual heat from flue gas to preheat:
 - A. Primary air
 - B. Pulverized coal
 - C. Boiler feedwater**
 - D. Heavy fuel oil
12. Factor of evaporation is defined as:
 - A. Heat absorbed per unit mass of steam divided by standard heat of vaporization**
 - B. Actual fuel fired divided by steam produced
 - C. Boiler horsepower developed divided by rated horsepower
 - D. Dry flue gas mass divided by ash mass
13. Actual specific evaporation is expressed as:
 - A. kg of steam generated per kg of fuel burned**
 - B. Heat generated by fuel per hour
 - C. Pounds of coal burned per square foot of grate
 - D. Boiler horsepower developed per unit heating surface
14. One developed boiler horsepower corresponds to the evaporation of:
 - A. 100 kg of water per hour
 - B. A standardized heat absorption rate of 35,322 kJ/hr**
 - C. 1,000 pounds of steam per second
 - D. Total furnace volume per megawatt
15. Percent rating of a steam boiler is defined as:
 - A. Developed boiler horsepower divided by rated boiler horsepower**
 - B. Brake power divided by indicated power
 - C. Heat input divided by heating surface
 - D. Fuel flow rate divided by air flow rate
16. In a water-tube boiler, the fluid circulating inside the tubes is:
 - A. Flue gas
 - B. Water and steam**
 - C. Combustion air
 - D. Molten ash
17. In a fire-tube boiler, the medium flowing through the tubes is:
 - A. High-pressure steam
 - B. Feedwater

C. Hot combustion flue gases

D. Pulverized fuel

18. Plant use factor is calculated by dividing actual energy produced by:

A. Total connected electrical load

B. Plant capacity multiplied by actual operating hours

C. Peak load multiplied by 8760 hours

D. Fuel heating value times mass of fuel

19. When computing theoretical combustion of hydrocarbon fuels, atmospheric air is treated gravimetrically as approximately:

A. 21% O₂ and 79% N₂

B. 23.2% O₂ and 76.8% N₂

C. 50% O₂ and 50% N₂

D. 10% O₂ and 90% N₂

20. Equivalent evaporation refers to steam generation standardized:

A. At critical temperature and pressure

B. From and at 100°C under standard atmospheric conditions

C. At peak turbine throttle conditions

D. Under zero excess air combustion

21. The instrument commonly used to measure the specific gravity of liquid fuels is a:

A. Pyrometer

B. Hydrometer (using API/Baumé scales)

C. Calorimeter

D. Manometer

22. Proximate analysis of a solid fuel determines the percentages of:

A. Carbon, hydrogen, oxygen, and nitrogen

B. Moisture, volatile matter, fixed carbon, and ash

C. Specific volume, density, and entropy

D. Carbon monoxide and sulfur dioxide

23. Ultimate analysis of a fuel expresses its composition strictly in terms of:

A. Flue gas volume fractions

B. Chemical elemental percentages (C, H, O, N, S, Ash)

C. Higher and lower heating values

D. Saturated liquid fractions

24. An air preheater in a steam power plant transfers waste heat from flue gases to:

A. Cooling tower water

B. Incoming combustion air

C. Ash handling sluices

D. Generator stator cooling

25. The ratio of the average electrical load over a specific period to the equipment rating is the:

A. Plant factor

B. Diversity factor

C. Connected load factor

D. Reserve ratio

26. The ratio of actual service running hours to the total period of time considered is the:

A. Demand factor

B. Operation factor

C. Diversity factor

D. Percent clearance

27. The total electrical power rating of all consumer appliances connected to a power system is the:

A. Peak load

B. Connected load

C. Reserve margin

D. Equivalent evaporation

28. In an industrial boiler, the steel vessel section where feed water transitions into steam is the:

A. Economizer

B. Steam drum / Evaporating tubes

C. Air preheater

D. Chimney stack

29. When unburned carbon appears in boiler bottom ash, combustion efficiency:

A. Remains unaffected

B. Decreases due to solid combustible loss

C. Increases due to lower gas temperatures

D. Reaches stoichiometric unity

30. Orsat analysis is a laboratory apparatus procedure used to measure volumetric percentages of:

A. Steam quality in superheaters

B. Dry flue gases (CO₂, O₂, CO)

C. Dissolved solids in feedwater

D. Lubricating oil moisture

Day 6: Steam Engines, Turbines, Geothermal & Chimneys

1. In a reciprocating steam engine, volume displacement with piston rod considered accounts for:

A. Clearance volume only

B. Head-end displacement plus crank-end net displacement

C. Flywheel radius and shaft diameter

D. Steam chest volume

2. The indicator diagram of a reciprocating engine records:

A. Speed versus time

B. Pressure versus displacement volume

C. Temperature versus entropy

D. Enthalpy versus moisture

3. Indicated power in a reciprocating steam engine represents:

A. Shaft power delivered at the flywheel

B. Power developed within the cylinder by steam pressure

C. Power lost to bearing friction

D. Generator output

4. Mechanical efficiency of an engine is defined as:

A. Indicated power divided by fuel heat

B. Brake power divided by indicated power

C. Generator output divided by boiler heat

D. Indicated power minus friction power

5. Friction power in a prime mover represents:

A. Indicated power minus brake power

B. Brake power plus generator output

C. Indicated power divided by mechanical efficiency

D. Net plant heat rate

6. A Prony brake is an instrument employed to determine:

A. Boiler evaporative capacity

B. Brake power of an engine

C. Chimney draft head

D. Steam quality at turbine inlet

7. Willan's line defines a linear operating relationship between:

A. Boiler pressure and furnace draft

B. Steam consumption rate and power output

C. Turbine speed and generator poles

D. Chimney height and flue gas temperature

8. The stage efficiency of an expansion turbine stage is defined as:

A. Actual enthalpy drop divided by ideal isentropic enthalpy drop

B. Brake power divided by generator power

C. Feedwater flow divided by steam flow

D. Net power output divided by heat supplied

9. In a geothermal steam plant, the flasher vessel serves to:

A. Pre-cool brine before reinjection

B. Flash hot pressurized geothermal fluid into vapor by pressure reduction

C. Condense exhaust steam using river water

D. Scrub carbon dioxide from ambient air

10. The brine extracted from a geothermal production well is:

A. Discharged into surface rivers

B. Returned underground via reinjection wells

C. Used directly in domestic water mains

D. Converted into cooling tower makeup

11. Natural chimney draft is produced primarily by the:

A. Mechanical chimney draft fans

B. Density difference between hot flue gas and ambient air

C. Turbine exhaust pressure

D. Feedwater economizer coils

12. Draft head developed in a tall chimney depends directly on:

A. Chimney height and air-to-gas density difference

B. Engine stroke length

C. Water tube surface area

D. Turbine rotational speed

13. Brake engine efficiency of a prime mover is defined as:

A. Indicated power divided by fuel energy

B. Brake power divided by ideal isentropic expansion energy

C. Generator output divided by rated capacity

D. Actual steam rate divided by full load steam rate

14. The steam turbine is fundamentally a prime mover that converts:

A. Chemical fuel energy directly into electricity

B. Enthalpy and kinetic energy of expanding steam into shaft work

C. Hydraulic potential head into velocity

D. Low temperature heat into high pressure

15. In a geothermal steam plant using a flash separator, steam separated at the top:

A. Re-enters the production well

B. Directly drives the steam turbine

C. Bypasses the condenser into cooling towers

D. Enters the boiler feed pump

16. The draft required to overcome flow resistance across boiler tubes and ducts is:

A. Static draft

B. Friction draft loss

C. Ambient gage draft

D. Peripheral head

17. If a generator is directly coupled to a steam turbine, the electrical generator efficiency equals:

A. Turbine output divided by brake power

B. Generator electrical output divided by turbine shaft output

C. Heat added divided by generator output

D. Indicated power divided by full-load steam

18. Combined thermal efficiency of a turbo-generator set is:

A. Generator electrical output divided by total heat supplied in steam

B. Indicated power divided by brake power

C. Brake power divided by ideal Rankine work

D. Heat rejected divided by turbine work

19. In a surface condenser, cooling water requirement depends directly on:
- A. Height of the exhaust stack
 - B. Heat rejected by condensing steam and allowable water temperature rise**
 - C. Generator pole pairs
 - D. Bore and stroke of the turbine
20. Flue gas mass exiting a boiler stack equals:
- A. Fuel mass minus ash mass
 - B. Air mass plus fuel mass minus collected solid ash**
 - C. Theoretical oxygen minus moisture
 - D. Total unburned carbon
21. In a reciprocating engine indicator diagram, the area of the closed loop represents:
- A. Net indicated work performed per cycle**
 - B. Total friction loss
 - C. Heat rejected in the radiator
 - D. Swept clearance volume
22. The ratio of indicated power to total chemical heat energy supplied in fuel is the:
- A. Mechanical efficiency
 - B. Indicated thermal efficiency**
 - C. Generator efficiency
 - D. Backwork ratio
23. The ratio of useful brake power to the total chemical heat energy supplied in fuel is the:
- A. Indicated thermal efficiency
 - B. Brake thermal efficiency**
 - C. Volumetric efficiency
 - D. Stage ratio
24. In a steam turbine, the stationary elements designed to accelerate steam and direct it into moving blades are:
- A. Pistons
 - B. Nozzles / Stationary guide vanes**
 - C. Condenser tubes
 - D. Crossheads
25. In an impulse turbine stage, steam pressure drops predominantly across the:
- A. Moving blades
 - B. Stationary nozzles**
 - C. Shaft bearings
 - D. Exhaust hood
26. In a reaction turbine stage, steam expansion and pressure drop occur across:
- A. Only the stationary nozzles
 - B. Both the stationary guide blades and the moving blades**
 - C. The condenser tube bundle

- D. The generator rotor
27. Geothermal power production tapping pressurized underground water that explodes into vapor upon depressurization uses:
- A. A binary closed loop
 - B. A flash steam system**
 - C. An open chimney draft
 - D. A cooling pond ejector
28. In geothermal plants, non-condensable gases (such as H_2S and CO_2) are extracted from the condenser by:
- A. Feed pumps
 - B. Gas ejectors or vacuum pumps**
 - C. The turbine throttle valve
 - D. Mud strainers
29. Forced draft in a boiler installation is supplied by:
- A. A tall natural chimney alone
 - B. A fan positioned upstream pushing fresh air into the furnace**
 - C. Steam condensation inside the drum
 - D. Cooling tower circulating pumps
30. Induced draft in a boiler installation is maintained by:
- A. A fan located near the stack pulling flue gases out of the boiler setting**
 - B. A compressor forcing fuel into burners
 - C. High-pressure water nozzles
 - D. Natural convection alone

Day 7: Diesel Power Plants & Hydroelectric Systems

1. In a four-stroke internal combustion engine, one thermodynamic cycle completes every:
- A. One crankshaft revolution
 - B. Two crankshaft revolutions**
 - C. Four crankshaft revolutions
 - D. Half crankshaft revolution
2. In a two-stroke internal combustion engine, one power stroke occurs every:
- A. One crankshaft revolution**
 - B. Two crankshaft revolutions
 - C. Four crankshaft revolutions
 - D. Three crankshaft revolutions
3. Piston speed of a reciprocating engine is calculated from:
- A. Bore diameter and engine power
 - B. Twice the stroke length multiplied by rotational frequency**
 - C. Mean effective pressure times area
 - D. Volume displacement divided by clearance

4. Volumetric efficiency of a reciprocating engine compares actual inducted air volume to:
 - A. Clearance volume
 - B. Total volume of the cylinder
 - C. Piston displacement volume**
 - D. Fuel volume injected
5. Specific fuel consumption of an engine measures:
 - A. Total fuel burned over engine life
 - B. Fuel mass consumed per unit power produced per unit time**
 - C. Volume of air required per unit fuel
 - D. Ratio of brake power to indicated power
6. Engine heat rate is defined as:
 - A. Heat supplied by fuel per unit power output per hour**
 - B. Heat rejected to the cooling jacket
 - C. Friction power loss per revolution
 - D. Temperature rise across the radiator
7. The synchronous speed of an alternating current generator depends on:
 - A. System frequency and number of magnetic poles**
 - B. Diameter of the penstock
 - C. Total cooling water flow
 - D. Specific fuel gravity
8. Operating a diesel engine at high elevations leads to derating primarily because:
 - A. Gravity decreases significantly
 - B. Ambient air density and pressure decrease**
 - C. Specific heat of air drops to zero
 - D. Friction power increases rapidly
9. A waste heat recovery boiler attached to a diesel engine recovers thermal energy from the:
 - A. Cooling tower sump
 - B. Hot engine exhaust gases**
 - C. Lubricating oil cooler
 - D. Generator armature windings
10. In a hydroelectric installation, gross head is the elevation difference between:
 - A. Headwater level and tailwater level**
 - B. Reservoir top and dam crest
 - C. Surge chamber and turbine runner
 - D. Spiral casing and draft tube throat
11. Net dynamic head supplied to a hydraulic turbine equals gross head minus:
 - A. Atmospheric pressure head
 - B. Penstock friction and hydraulic conduit head losses**
 - C. Velocity head at nozzle exit
 - D. Generator electrical losses
12. Darcy's formula is employed in hydroelectric engineering to calculate:
 - A. Friction head loss in the penstock**
 - B. Runner specific speed
 - C. Water horsepower at the nozzle
 - D. Generator pole requirement
13. For very high hydraulic heads exceeding 1300 feet, the most suitable turbine is the:
 - A. Propeller turbine
 - B. Francis turbine
 - C. Impulse (Pelton) turbine**
 - D. Kaplan turbine
14. For medium hydraulic heads ranging between 110 feet and 800 feet, the standard turbine choice is the:
 - A. Pelton wheel
 - B. Francis turbine**
 - C. Propeller turbine
 - D. Multi-jet impulse wheel
15. For low hydraulic heads below 70 feet, the preferred turbine runner is the:
 - A. Propeller / Kaplan type**
 - B. Multi-stage Pelton
 - C. High-head reaction runner
 - D. Impulse wheel
16. The surge chamber in a hydroelectric power plant protects the penstock from:
 - A. Excessive water silt erosion
 - B. Water hammer overpressures during sudden valve closure**
 - C. Cavitation in the tailrace
 - D. Temperature thermal expansion
17. The draft tube in a reaction turbine recovers kinetic energy from leaving water by:
 - A. Increasing discharge velocity
 - B. Acting as a diffusing conduit that reduces exit velocity head**
 - C. Throttling tailwater back into the casing
 - D. Injecting air into the runner
18. Peripheral coefficient of a hydraulic runner is the ratio of:
 - A. Runner peripheral rim velocity to theoretical water jet velocity**
 - B. Penstock diameter to runner diameter
 - C. Net head to gross head
 - D. Brake power to water horsepower
19. Specific speed of a hydraulic turbine is an index representing the speed of a geometrically similar turbine that produces:
 - A. Maximum possible power under infinite head
 - B. Unit power under unit head**

- C. Zero cavitation under flood conditions
 - D. Constant torque across all heads
20. In an impulse turbine, conversion of total hydraulic head into kinetic velocity occurs in the:

- A. Draft tube
- B. Stationary nozzle**
- C. Runner buckets
- D. Tailrace canal

21. In an internal combustion engine, the mechanical component converting reciprocating linear motion of the piston into rotation is the:

- A. Flywheel
- B. Crankshaft**
- C. Valve lifter
- D. Camshaft

22. Engine displacement volume is determined from:

- A. Clearance volume and cut-off ratio
- B. Cylinder bore area and piston stroke length**
- C. Piston pin diameter and rod thickness
- D. Intake manifold diameter

23. A four-stroke diesel engine completes four distinct piston strokes designated as:

- A. Suction, compression, power, and exhaust**
- B. Admission, condensation, expansion, and reheating
- C. Ignition, vaporization, compression, and throttling
- D. Injection, cut-off, expansion, and blowdown

24. In an electrical AC power plant, standard grid utility frequency across the Philippines is:

- A. 25 Hz
- B. 50 Hz
- C. 60 Hz**
- D. 120 Hz

25. The penstock in a hydroelectric power development is the:

- A. Upper retaining reservoir
- B. High-pressure conduit conducting water from forebay/dam to the hydraulic turbine**
- C. Spillway crest gate
- D. Water discharge canal after the tailrace

26. The trash rack placed at a hydroelectric plant headworks serves to:

- A. Reduce water velocity entering penstocks
- B. Intercept floating debris and prevent it from entering turbines**
- C. Aerate incoming river water

- D. Measure static headwater elevation

27. The tailrace in a hydroelectric plant is the: **A.** Channel conducting discharged water away from the turbine/draft tube into the river

- B. High-pressure nozzle casing
- C. Safety gate on the reservoir spillway
- D. Upper storage forebay

28. A Pelton wheel is an impulse turbine where torque is generated by:

- A. Submerged reaction flow across variable pitch blades
- B. High-velocity water jets striking curved hemispherical buckets**
- C. Suction pressure generated inside a diffuser tube
- D. Siphon lift across a dam crest

29. A Francis turbine is classified hydrodynamically as an:

- A. Pure impulse turbine
- B. Inward-flow reaction turbine**
- C. Axial-flow open propeller
- D. Over-shot water wheel

30. A Kaplan turbine is characterized by:

- A. Fixed impulse buckets operating under heads exceeding 2000 ft
- B. An axial-flow reaction propeller with adjustable runner blades**
- C. High-pressure pelton nozzles
- D. Double-suction centrifugal impellers

Day 8: Machine Foundations & Heat Transfer

1. In machine installation, grouting is the process of:

- A. Excavating native soil beneath footings
- B. Pouring a hardening mixture to fill clearances between bedplate and foundation**
- C. Tightening anchor bolts past yield
- D. Applying paint to prevent corrosion

2. The weight of a concrete machine foundation is commonly designed to be:

- A. Equal to 10% of engine weight
- B. 3 to 5 times the weight of the supported engine**
- C. Exactly equal to bedplate weight
- D. Independent of machine vibration

3. When designing foundation base width, the allowable soil bearing capacity is taken:

- A. With a reduction factor or factor of safety**
- B. At double the ultimate bearing failure limit
- C. Equal to concrete compressive yield
- D. Purely from anchor bolt shear strength

4. Anchor bolts securing heavy reciprocating prime movers should be embedded into concrete at least:
 - A. 5 times bolt diameter
 - B. 10 times bolt diameter
 - C. 30 times bolt diameter**
 - D. 100 times bolt diameter
5. The minimum recommended curing/hardening time for a freshly poured concrete foundation before setting heavy machinery is:
 - A. 24 hours
 - B. 3 days
 - C. 7 days**
 - D. 30 days
6. Thermal conduction through an opaque solid material is governed by:
 - A. Stefan-Boltzmann Law
 - B. Fourier's Law**
 - C. Newton's Law of Cooling
 - D. Dalton's Law
7. Thermal conductivity (k) of a substance measures its:
 - A. Capacity to store electrical charge
 - B. Intrinsic ability to conduct heat**
 - C. Resistance to fluid shear
 - D. Emissivity of radiation
8. Thermal resistance of a flat structural wall is proportional to:
 - A. Wall thickness divided by thermal conductivity**
 - B. Surface convection coefficient times area
 - C. Fourth power of absolute temperature
 - D. Fluid mass flow rate
9. Newton's Law of Cooling governs heat transfer occurring via:
 - A. Conduction across solids
 - B. Convection between a solid surface and an adjacent fluid**
 - C. Radiation through vacuum
 - D. Nuclear fission
10. The Stefan-Boltzmann Law states that radiant heat emitted by a blackbody is proportional to the:
 - A. Natural logarithm of temperature
 - B. Square root of absolute temperature
 - C. Fourth power of absolute temperature**
 - D. First power of surface temperature
11. An ideal physical body that absorbs all incident thermal radiation without reflection is a:
 - A. Gray body
 - B. White body
 - C. Black body**
 - D. Opaque reflector
12. In a heat exchanger, counter-flow configuration compared to parallel-flow configuration provides:
 - A. A higher logarithmic mean temperature difference**
 - B. Reduced heat transfer surface effectiveness
 - C. Parallel fluid outlet temperatures that cannot cross
 - D. Zero thermal efficiency
13. Logarithmic mean temperature difference (LMTD) represents:
 - A. The simple arithmetic average of terminal temperatures
 - B. The true effective average temperature difference along heat exchanger surface**
 - C. The maximum peak temperature inside tubes
 - D. Ambient air temperature minus steam temperature
14. The overall coefficient of heat transfer (U) accounts for:
 - A. Only conductive resistance through metals
 - B. Combined thermal resistances of conductive walls and convective boundary films**
 - C. Radiant emissivity of outer casings
 - D. Tube mechanical vibration friction
15. Reynolds number in fluid heat transfer characterizes the ratio of:
 - A. Conduction to radiation
 - B. Dynamic pressure to head loss
 - C. Inertial forces to viscous forces**
 - D. Tube diameter to wall thickness
16. Thermal insulation materials are engineered primarily to have:
 - A. High mechanical density
 - B. Very low thermal conductivity**
 - C. High electrical conductance
 - D. High solar reflectivity
17. Emissivity of a real physical surface is defined as the ratio of:
 - A. Absorbed heat to transmitted heat
 - B. Radiation emitted by the surface to that emitted by a blackbody at identical temperature**
 - C. Convective film coefficient to conductive coefficient
 - D. Tube perimeter to flow area
18. A composite wall consists of layers in series; the total thermal resistance is the:
 - A. Product of individual resistances
 - B. Sum of individual thermal resistances**
 - C. Difference between inner and outer resistances
 - D. Lowest single layer resistance

19. Fouling resistance or scaling inside heat exchanger tubes causes:
- A. Higher overall heat transfer coefficient
 - B. Additional thermal resistance that degrades heat transfer**
 - C. Lower fluid pressure drops
 - D. Increased fluid turbulence
20. Standard concrete mix specified for structural machine foundations is Class A, having volumetric proportions of:
- A. 1:1:2
 - B. 1:2:4 (cement : sand : stone)**
 - C. 1:3:6
 - D. 2:4:8

21. The main structural purpose of a machine foundation is to:
- A. Elevate the engine for aesthetic display
 - B. Support equipment weight, maintain alignment, and absorb operating vibrations**
 - C. Increase fuel consumption efficiency
 - D. Cool the bottom oil pan

22. Bedplate clearance on a concrete foundation represents:
- A. Total thickness of structural steel reinforcement
 - B. Distance provided between machine bedplate edge and the foundation outer edge**
 - C. Depth of excavation beneath bedrock
 - D. Diameter of flywheel housing

23. Concrete foundation mixtures specify Portland cement, fine aggregate (sand), and coarse aggregate (stone) in proportions measured by:
- A. Volume**
 - B. Specific gravity
 - C. Thermal conductance
 - D. Water pressure

24. Steel rebar reinforcing embedded within a concrete machine foundation resists:
- A. Pure compressive static load only
 - B. Tensile and shear stresses induced by dynamic cyclic forces**
 - C. Foundation concrete evaporation
 - D. Acid corrosion from fuel oil

25. Heat transfer occurring through direct physical contact between molecules without bulk material motion is:
- A. Radiation
 - B. Convection
 - C. Conduction**
 - D. Evaporation

26. Heat transfer accomplished via macroscopic movement of fluid currents is:
- A. Conduction
 - B. Convection**
 - C. Thermal radiation
 - D. Sublimation
27. Heat transfer through electromagnetic waves requiring no intervening physical medium is:
- A. Conduction
 - B. Convection
 - C. Radiation**
 - D. Advection

28. The reciprocal of overall thermal conductance ($1/U$) across a wall equals:
- A. Total thermal resistance**
 - B. Convective film coefficient
 - C. Stefan-Boltzmann constant
 - D. Logarithmic mean area

29. A heat exchanger where hot and cold fluids travel in identical directions along parallel paths is a:
- A. Counter-flow heat exchanger
 - B. Parallel-flow heat exchanger**
 - C. Cross-flow shell bundle
 - D. Regenerative matrix

30. In industrial thermal piping, insulating lagging is wrapped externally to:
- A. Increase convective heat loss
 - B. Minimize parasitic heat loss to the ambient environment**
 - C. Increase internal steam friction
 - D. Eliminate the need for pipe hangers

Day 9: Pumps, Air Compressors, Fans & Blowers

1. A centrifugal pump is best suited for applications requiring:
- A. Very high heads with extremely low discharge
 - B. Relatively high discharge flow at low to moderate heads**
 - C. Pumping molasses and thick pastes
 - D. Positive displacement metering
2. A reciprocating pump belongs to which broad classification:
- A. Roto-dynamic
 - B. Positive displacement**
 - C. Axial-impeller
 - D. Jet-ejector
3. Rotary pumps (such as gear and screw pumps) are preferred for handling:
- A. High-pressure steam

- B. Viscous fluids like lubricating oil and heavy fuels
 - C. Saturated vapor
 - D. Aerated wastewater
4. Water power developed by a pump is defined as:
- A. Electrical power supplied to the motor
 - B. Useful hydraulic power transferred to the pumped fluid
 - C. Shaft power delivered at the coupling
 - D. Power lost to casing friction
5. Pump efficiency is the ratio of:
- A. Water power to brake power input
 - B. Brake power to motor electrical input
 - C. Total dynamic head to suction head
 - D. Theoretical displacement to actual discharge
6. Pump slip in a reciprocating pump is defined as:
- A. Theoretical piston displacement minus actual discharge
 - B. Suction pipe volume plus discharge volume
 - C. Impeller speed minus synchronous speed
 - D. Leakage through stuffing box packing
7. Centrifugal pump affinity laws state that discharge flow rate varies:
- A. Inversely with impeller speed
 - B. Directly with impeller rotational speed
 - C. As the square of rotational speed
 - D. As the cube of rotational speed
8. Centrifugal pump affinity laws state that developed head varies:
- A. Directly with rotational speed
 - B. As the square of impeller rotational speed
 - C. As the cube of rotational speed
 - D. Inversely with impeller diameter
9. Centrifugal pump affinity laws state that power required varies:
- A. Directly with rotational speed
 - B. As the square of rotational speed
 - C. As the cube of impeller rotational speed
 - D. Inversely with fluid density
10. Multi-stage centrifugal pumps (multiple impellers in series) are utilized to:
- A. Handle high solids concentration
 - B. Develop high total discharge head
 - C. Double the flow capacity at zero head
 - D. Eliminate the drive motor
11. Double-suction centrifugal impellers are specifically designed to:
- A. Handle two separate fluids simultaneously
 - B. Handle large discharge flows and balance axial hydraulic thrust

- C. Double discharge pressure in a single stage
 - D. Prevent impeller rotation
12. In a deep well turbine pump, drawdown represents:
- A. Distance from ground to static water level
 - B. Lowering of water level between static and pumping conditions
 - C. Depth of the pump below the well casing bottom
 - D. Diameter of the perforated well strainer
13. The purpose of an intercooler between stages of a multi-stage air compressor is to:
- A. Increase air velocity entering cylinders
 - B. Cool air toward suction temperature to reduce total compression work
 - C. Add moisture to compressed air
 - D. Separate nitrogen from oxygen
14. Volumetric efficiency of a reciprocating air compressor is defined as:
- A. Actual volume of free air drawn at suction divided by swept displacement volume
 - B. Clearance volume divided by piston stroke
 - C. Mass of air delivered divided by fuel burned
 - D. Cylinder bore area divided by discharge pipe area
15. For an ideal multi-stage reciprocating compressor with perfect intercooling, optimal intercooler pressure between stages is the:
- A. Arithmetic mean of suction and discharge pressures
 - B. Geometric mean of suction and discharge pressures
 - C. Difference between discharge and suction pressures
 - D. Ratio of stage specific heats
16. The compression path requiring the minimum possible work input in a gas compressor is:
- A. Isentropic compression
 - B. Polytropic compression with high index
 - C. Isothermal compression
 - D. Adiabatic compression
17. Fan total head is the sum of:
- A. Static pressure head and velocity pressure head
 - B. Barometric pressure and pipe friction
 - C. Chimney draft and ambient head
 - D. Elevation head and pump slip
18. Static efficiency of an industrial fan is defined as:

- A. Static air power divided by mechanical shaft input power
- B. Kinetic air power divided by electric input
- C. Manometer water head divided by duct height
- D. Fan discharge volume divided by impeller blade area

19. Fan affinity laws indicate that when fan speed changes, required driving power varies with the:

- A. First power of speed
- B. Second power of speed
- C. Third power of speed
- D. Square root of speed

20. When gas density increases while fan dimensions and speed remain constant, pressure developed by the fan:

- A. Remains constant
- B. Varies in direct proportion to gas density
- C. Drops to zero
- D. Varies inversely with density

21. In a centrifugal pump, the rotating component equipped with vanes that imparts velocity to liquid is the:

- A. Volute casing
- B. Impeller
- C. Stuffing box
- D. Wear ring

22. The expanding spiral casing of a centrifugal pump designed to convert kinetic velocity head into pressure head is the:

- A. Draft tube
- B. Volute
- C. Impeller eye
- D. Penstock

23. Priming of a centrifugal pump refers to:

- A. Lubricating shaft bearings
- B. Filling suction piping and pump casing with liquid to displace trapped air before starting
- C. Aligning driver coupling bolts
- D. Throttling the discharge check valve

24. Reciprocating pumps are classified as positive displacement machines because they:

- A. Accelerate water via rotating centrifugal vanes
- B. Trap a fixed volume of fluid and physically displace it through valves
- C. Depend strictly on velocity head conversion
- D. Operate only under deep vacuum

25. In an air receiver vessel installed downstream of a reciprocating air

compressor, the primary purpose is to:

- A. Eliminate all oxygen from the gas
- B. Dampen pressure pulsations and provide pressurized reserve storage
- C. Heat compressed air before use
- D. Condense all atmospheric nitrogen

26. An aftercooler installed on a plant air compressor system serves to:

- A. Warm discharge air to prevent pipe freezing
- B. Cool air exiting the final stage and precipitate condensed moisture
- C. Superheat air before pneumatic tools
- D. Control motor synchronous speed

27. Clearance volume in an air compressor cylinder is intentionally provided to:

- A. Allow mechanical clearance and prevent the piston from striking cylinder heads
- B. Double the cylinder volumetric efficiency
- C. Eliminate suction air valves
- D. Increase pressure ratio infinitely

28. Static pressure head developed by a fan represents:

- A. Energy required to accelerate air from rest to discharge velocity
- B. Pressure exerted perpendicularly against duct walls to overcome fluid frictional resistance
- C. Total power input to the electrical motor
- D. Dynamic velocity pressure at the outlet

29. Velocity head developed by an industrial fan or blower is:

- A. Kinetic energy per unit weight of moving air
- B. Pressure measured with a closed static tube
- C. Manometer reading under zero flow
- D. Friction loss along building walls

30. A manometer connected across a duct measuring fluid differential pressure uses:

- A. A bourdon spring element
- B. A balanced column of liquid (such as water or mercury)
- C. An electrical resistance grid
- D. A bimetallic strip

Day 10: Refrigeration, Heat Pumps & Psychrometry

1. One standard ton of refrigeration (TR) is defined as heat extraction equivalent to:

- A. 1,000 kJ/hr
- B. Standard latent heat required to freeze or melt one short ton of ice in 24 hours (3.517 kW)

C. 100 kW continuous cooling

D. 2,000 Btu/hr

2. The coefficient of performance (COP) of a refrigeration system is defined as:

A. Refrigerating effect divided by net work input

B. Condenser heat rejection divided by compressor power

C. Enthalpy of vapor divided by pump work

D. Ambient temperature divided by evaporator load

3. A heat pump differs functionally from a refrigerator because its primary objective is to:

A. Maintain a refrigerated space at sub-zero temperatures

B. Deliver useful heat to a high-temperature conditioned space

C. Generate mechanical shaft work from heat

D. Condense atmospheric moisture

4. The COP of a heat pump operating across identical temperature limits compared to a refrigerator is:

A. Exactly equal

B. Greater by 1

C. Smaller by half

D. Unrelated

5. In a standard vapor-compression cycle, expansion across the expansion valve occurs at:

A. Constant entropy

B. Constant enthalpy

C. Constant volume

D. Constant temperature

6. In a refrigeration cycle, the heat exchanger where refrigerant evaporates and absorbs heat is the:

A. Condenser

B. Evaporator

C. Economizer

D. Intercooler

7. Subcooling liquid refrigerant before it reaches the expansion valve results in:

A. Reduced refrigerating capacity

B. An increased refrigerating effect per unit mass

C. Higher compressor discharge temperature

D. Lower condenser heat rejection

8. Superheating suction vapor before entering the compressor helps ensure that:

A. Condenser pressure drops to vacuum

B. No liquid droplets enter the compressor cylinders to cause mechanical damage

C. Compressor work drops to zero

D. Evaporator pressure reaches critical point

9. A cascade refrigeration system uses two or more separate refrigeration loops to:

A. Eliminate the need for electrical motors

B. Achieve very low temperatures across large overall temperature lifts

C. Operate without any condenser

D. Use pure water as the sole refrigerant

10. Dry-bulb temperature of moist air is measured by:

A. A thermometer with a wetted wick exposed to air flow

B. An ordinary thermometer shielded from moisture and direct radiation

C. An instrument measuring dew condensation pressure

D. A manometer filled with brine

11. Wet-bulb temperature represents the:

A. Boiling temperature of pure liquid refrigerant

B. Dynamic equilibrium temperature indicated by a wetted thermometer in moving air

C. Lowest temperature of the universe

D. Temperature where air density becomes maximum

12. Dew point temperature is defined as the:

A. Temperature at which water vapor in air begins to condense upon cooling at constant pressure

B. Temperature of freezing brine

C. Average of dry-bulb and wet-bulb temperatures

D. Saturation temperature of the compressor refrigerant

13. Relative humidity is defined as the ratio of:

A. Mass of dry air to mass of water vapor

B. Actual partial pressure of water vapor to saturation pressure at dry-bulb temperature

C. Humidity ratio to enthalpy

D. Wet-bulb temperature to dry-bulb temperature

14. Humidity ratio (specific humidity) of moist air is expressed as:

A. Mass of water vapor per unit mass of dry air

B. Volume of vapor divided by total volume

C. Enthalpy of air divided by saturation temperature

D. Percentage of water droplets suspended in air

15. When relative humidity of moist air reaches 100%:

- A. Dry-bulb, wet-bulb, and dew point temperatures are all identical
 - B. Evaporative cooling capacity reaches maximum
 - C. Enthalpy drops to zero
 - D. Partial vapor pressure becomes zero
16. Sensible heating of air refers to a process where:
- A. Moisture is added without temperature change
 - B. Temperature increases while moisture content (humidity ratio) remains constant
 - C. Air is cooled to its dew point
 - D. Enthalpy remains constant while temperature drops
17. Sensible cooling of air without condensation causes relative humidity to:
- A. Drop to zero
 - B. Increase
 - C. Decrease
 - D. Remain unchanged
18. In an evaporative air cooler operating with recirculated spray water, the cooling process follows lines of:
- A. Constant dry-bulb temperature
 - B. Constant wet-bulb temperature (constant enthalpy)
 - C. Constant relative humidity
 - D. Constant specific volume
19. In commercial cold storage calculations, latent heat of fusion of a food product accounts for:
- A. Sensible temperature change above freezing
 - B. Heat removed during freezing of liquid moisture into ice at constant freezing temperature
 - C. Sensible subcooling of frozen food
 - D. Box transmission heat loss
20. The Energy Efficiency Ratio (EER) of a cooling unit represents:
- A. Cooling output in Btu/hr divided by electric power input in Watts
 - B. Coefficient of performance multiplied by 8760
 - C. Kilowatts of cooling per horsepower input
 - D. Sensible heat ratio divided by latent heat
21. In a vapor-compression refrigeration machine, the component that rejects cycle heat to ambient air or cooling water is the:
- A. Evaporator
 - B. Condenser
 - C. Expansion valve
 - D. Liquid accumulator

22. In a vapor-compression refrigeration plant, the component that lowers refrigerant pressure and regulates refrigerant flow into the evaporator is the:
- A. Suction compressor
 - B. Expansion valve (throttling device)
 - C. Oil separator
 - D. Intercooler
23. In an ammonia refrigeration plant, ammonia is designated by chemical refrigerant nomenclature as:
- A. R-12
 - B. R-22
 - C. R-717
 - D. R-134a
24. The psychrometric chart graphically correlates:
- A. Steam quality versus fuel calorific value
 - B. Thermodynamic properties of moist air at a fixed barometric pressure
 - C. Water turbine head versus runner speed
 - D. Engine brake power versus fuel density
25. The horizontal baseline axis on a standard psychrometric chart represents:
- A. Humidity ratio
 - B. Dry-bulb temperature
 - C. Relative humidity
 - D. Barometric elevation
26. The vertical right-hand scale on a standard psychrometric chart indicates:
- A. Dry-bulb temperature
 - B. Humidity ratio (specific humidity)
 - C. Wet-bulb depression
 - D. Fan static power
27. Curved lines running from lower left to upper right across a psychrometric chart indicate:
- A. Constant dry-bulb temperature
 - B. Constant relative humidity
 - C. Constant barometric elevation
 - D. Constant cooling load
28. The curved outer boundary on the far left of a psychrometric chart where relative humidity is 100% is the:
- A. Sensible heat line
 - B. Saturation curve
 - C. Critical isotherm
 - D. Dew point datum
29. Wet-bulb depression is defined as the arithmetic difference between
- A. Dry-bulb temperature and wet-bulb temperature
 - B. Saturation temperature and critical temperature

- C. Condenser temperature and evaporator temperature
- D. Ambient temperature and absolute zero

30. In food refrigeration calculations, specific heat of a food commodity above freezing is:

- A. Equal to specific heat of superheated steam
- B. Greater than its specific heat below freezing**
- C. Always zero
- D. Independent of water moisture content

Day 11: Air-Conditioning, Psychrometry, Cooling Towers & Dryers: Terms Reviewer & Practice Problems

1. Dry-bulb temperature of moist air indicates:

- A. The dew condensation limit
- B. The true thermodynamic sensible temperature measured by an ordinary thermometer**
- C. The moisture content per kg of dry air
- D. The total latent heat of vaporization

2. Wet-bulb depression is defined as:

- A. Dry-bulb temperature minus wet-bulb temperature**
- B. Wet-bulb temperature minus dew-point temperature
- C. Saturation temperature minus ambient temperature
- D. Critical temperature minus boiling temperature

3. On a standard psychrometric chart, horizontal movement directed straight to the left represents:

- A. Pure humidification
- B. Sensible heating
- C. Sensible cooling**
- D. Chemical dehumidification

4. On a standard psychrometric chart, vertical movement directed straight upwards represents:

- A. Sensible cooling
- B. Humidification at constant dry-bulb temperature**
- C. Adiabatic saturation
- D. Chemical dehumidification

5. On a standard psychrometric chart, vertical movement directed straight downwards represents:

- A. Dehumidification at constant dry-bulb temperature**
- B. Sensible heating
- C. Evaporative cooling
- D. Adiabatic mixing

6. An adiabatic saturation process on a psychrometric chart proceeds along lines of:

- A. Constant dry-bulb temperature
- B. Constant wet-bulb temperature or enthalpy**
- C. Constant relative humidity
- D. Constant specific volume

7. When air passes through a typical chilled water cooling coil and undergoes simultaneous cooling and dehumidification, its path on the psychrometric chart moves:

- A. Horizontally to the right
- B. Downward and to the left**
- C. Upward and to the right
- D. Vertically upward

8. Chemical dehumidification of moist air is characterized on a psychrometric chart by:

- A. Decreasing moisture content with an increase in dry-bulb temperature**
- B. Constant dry-bulb temperature and rising relative humidity
- C. Constant wet-bulb temperature with falling dry-bulb temperature
- D. Increasing moisture content with falling enthalpy

9. The saturation line on the far left boundary of a psychrometric chart represents a relative humidity of:

- A. 0%
- B. 50%
- C. 75%
- D. 100%**

10. Total barometric pressure of moist air is equal to:

- A. Partial pressure of dry air plus partial pressure of water vapor**
- B. Saturation pressure multiplied by relative humidity
- C. Enthalpy of saturated vapor divided by gas constant
- D. Absolute humidity times water density

11. Relative humidity is defined as:

- A. Mass of dry air divided by volume of moisture
- B. Actual partial pressure of water vapor divided by saturation pressure at the same dry-bulb temperature**
- C. Humidity ratio divided by enthalpy
- D. Wet-bulb temperature divided by dry-bulb temperature

12. Percent saturation is defined as the ratio of:

- A. Dry-bulb temperature to wet-bulb temperature

- B. Actual humidity ratio to the humidity ratio of saturated air at the same dry-bulb temperature
- C. Partial vapor pressure to total barometric pressure
- D. Enthalpy of air to latent heat of vaporization

13. Sensible heat is defined as thermal energy that:

- A. Produces a phase change at constant temperature
- B. Can be measured by a thermometer and produces a change in temperature
- C. Remains entirely concealed within chemical bonds
- D. Cannot be sensed by touch or temperature instruments

14. Latent heat is defined as thermal energy that:

- A. Directly changes dry-bulb temperature
- B. Produces a change of state without altering temperature
- C. Increases the velocity head of a fluid
- D. Measures fluid flow work

15. Sensible Heat Factor (SHF) is mathematically expressed as:

- A. Sensible heat divided by latent heat
- B. Sensible heat divided by total heat (sensible heat plus latent heat)
- C. Latent heat divided by total heat
- D. Total heat divided by sensible heat

16. The bypass factor of an air conditioning coil measures the:

- A. Fraction of conditioned air bypassing the entire duct
- B. Proportion of air passing through the coil undisturbed without contacting the coil surface
- C. Ratio of sensible heat to latent heat
- D. Rate of refrigerant leakage across expansion valves

17. When two airstreams mix adiabatically without external heat exchange, the resulting mixture temperature lies:

- A. Above the hotter airstream temperature
- B. Below the cooler airstream temperature
- C. Directly on the straight line connecting the two initial states on the psychrometric chart
- D. At absolute zero

18. In cooling tower terminology, "range" is defined as:

- A. The difference between entering warm water temperature and leaving cool water temperature
- B. Leaving water temperature minus entering air wet-bulb temperature

C. Dry-bulb temperature minus wet-bulb temperature

D. Total height of the cooling tower fill

19. In cooling tower terminology, "approach" is defined as:

A. Difference between entering water temperature and leaving water temperature

B. Difference between leaving cool water temperature and entering air wet-bulb temperature

C. Height of the drift eliminators above ground

D. Ambient dry-bulb temperature minus dew-point temperature

20. The theoretical lowest temperature to which circulating water can be cooled in an evaporative cooling tower is the:

A. Ambient dry-bulb temperature

B. Entering air wet-bulb temperature

C. Condenser saturation temperature

D. Ice freezing point

21. Cooling tower efficiency

(effectiveness) is defined as:

A. Range divided by the sum of range and approach

B. Approach divided by range

C. Water flow rate divided by air flow rate

D. Make-up water divided by circulating water

22. Drift eliminators in an evaporative cooling tower serve to:

A. Increase water residence time inside the basin

B. Minimize the loss of entrained liquid water droplets carried away in the discharge air stream

C. Condense ambient water vapor into the sump

D. Filter incoming combustion air

23. Make-up water supplied to an evaporative cooling tower basin is required to replace water lost primarily to:

A. Expansion valve throttling

B. Evaporation into the cooling air stream and drift losses

C. Condensation inside the fill

D. High water pump efficiency

24. Ventilation load in an air-conditioned building represents the thermal energy required to:

A. Reheat air after the fan

B. Condition outside fresh air introduced for air quality down to space conditions

C. Overcome duct friction head

D. Run the compressor drive motor

25. In an industrial drying system, bone-dry weight (BDW) refers to:

- A. The weight of moisture evaporated in the chamber
- B. The constant weight of completely dry solid material free of any moisture**
- C. The total weight of wet feed entering the dryer
- D. The weight of humid air leaving the exhaust

26. Throughout a continuous drying process, the component that remains strictly constant from feed to dried product is the:

- A. Total gross material weight
- B. Mass of dry bone-dry solid material**
- C. Moisture percentage
- D. Temperature of the moist material

27. Moisture content expressed on a "wet basis" is defined as:

- A. Mass of moisture divided by total weight of wet material (solid plus moisture)
- B. Mass of moisture divided strictly by mass of dry solid**
- C. Mass of water vapor divided by mass of dry air
- D. Total dry solid divided by water volume

28. Moisture content expressed on a "dry basis" is defined as:

- A. Mass of moisture divided by total mass of wet feed
- B. Mass of moisture divided strictly by the mass of bone-dry solid**
- C. Percentage of ambient relative humidity
- D. Ratio of latent heat to sensible heat

29. In an ideal adiabatic dryer, the drying air follows a line of:

- A. Constant dry-bulb temperature
- B. Constant enthalpy / wet-bulb temperature while absorbing product moisture**
- C. Constant relative humidity
- D. Constant specific volume

30. In an isothermal drying chamber, the air temperature throughout the evaporation of product moisture:

- A. Drops rapidly along an isentropic curve
- B. Remains constant due to auxiliary heat supplied inside the chamber**
- C. Drops to absolute dew point
- D. Follows a constant humidity ratio line