

UNIT 1

MCQ:

1. Purest form natural water is:
 - (a) River water
 - (b) **Rain water**
 - (c) Sea water
 - (d) Lake water
2. Permanent hardness in water is caused by presence of:
 - (a) Calcium chloride
 - (b) Magnesium sulphate
 - (c) **Both of them**
 - (d) None of these
3. Hardness in water is caused by presence of:
 - (a) Sodium chloride
 - (b) Sodium carbonate
 - (c) **Calcium chloride**
 - (d) Potassium nitrate
4. Temporary hardness in water can be removed by:
 - (a) Filtration
 - (b) **Boiling**
 - (c) Sedimentation
 - (d) None of these
5. Scale formation in boilers causes:
 - (a) No loss of heat
 - (b) **Wastage of heat**
 - (c) Increase in efficiency
 - (d) None of Above
6. Blow-down operation causes removal of:
 - (a) **Scales**
 - (b) Sodium carbonate
 - (c) Both (a) & (b)
 - (d) Hot water only
7. Solubility calcium sulphate in water:
 - (a) Increase with rise of temperature
 - (b) **Decrease with rise of temperature**
 - (c) Remains unaltered with rise of temperature
 - (d) Does not follow any definite pattern with rise of temperature
8. Internal treatment of boiler-feed water means:
 - (a) **Treating water during evaporation itself**
 - (b) Treating water before boiler-feeding it
 - (c) Treating chemically the steam formed
 - (d) Treating after some internal change in boiler designs
9. Permanent hardness of water cannot be removed by:
 - (a) Adding soda
 - (b) Distillation
 - (c) **Boiling**
 - (d) Adding lime-soda
10. Hard water is unfit for boilers for "steam raising" because:
 - (a) Its the boiling point is higher
 - (b) Steam is generated at a high pressure
 - (c) **It leads to scale formation inside the boiler**
 - (d) Water undergoes decomposition into oxygen and hydrogen
11. The exhausted permit (zeolite) is regenerated by percolating through it a solution of:
 - (a) Calcium chloride
 - (b) Zinc chloride
 - (c) Magnesium chloride
 - (d) **Sodium chloride**
12. Water matching distilled water is obtained by using:
 - (a) Permutit process
 - (b) **Ion exchange process**
 - (c) Lime soda process
 - (d) Boiling
13. Hard water may be softened by passing it through:
 - (a) Limestone
 - (b) **Ion exchange process**
 - (c) Calgon
 - (d) Rock salt
14. Water is hard, when it contains:
 - (a) Acid solution
 - (b) Precipitates in suspension
 - (c) Dissolved sodium salt
 - (d) **Both (b) and (c)**
15. Coagulants help in the settling of:
 - (a) Suspended impurities only
 - (b) Fine suspended matter only
 - (c) Colloidal particles only
 - (d) **Dissolved Ca and Mg salt**
16. Hardness of water is due to the presence of Ca and Mg salts. Temporary hardness in water can be removed by:
 - (a) Filtration
 - (b) **Boiling**
 - (c) Sedimentation
 - (d) None of these

Short Questions with Answers:

- 1. Name the chief sources of water.**
 - Sea water, rain water, ground water and surface water.
- 2. Why is rain water a purest form of natural waters?**
 - Because rain water is obtained by the process of distillation.
- 3. What is the cause for alkanity of natural waters?**
 - Due to the presence of dissolved bicarbonates of Ca and Mg in water.
- 4. Name any two coagulants.**
 - Alum $[K_2SO_4 \cdot Al_2O(SO_4)_3 \cdot 24 H_2O]$ and Sodium aluminate $[NaAlO_2]$.
- 5. Name the impurities present in natural water.**
 - Suspended, colloidal and dissolved impurities.
- 6. Name the gases dissolved in water that cause corrosion.**
 - Oxygen, carbon dioxide and sulphur dioxide.
- 7. How are exhausted ion exchange resins regenerated?**
 - Exhausted cation and anion exchangers are regenerated by passing through their bed strong acid solution and strong base solution respectively.
- 8. Mention the common units used for expressing hardness of water.**
 - Parts per million (ppm) and milligram per litre (mg/L).
- 9. Differentiate between scale and sludge.**
 - Sludge is soft, loose, slimy deposit formed inside the boiler; while scale is hard, sticky, adherent deposit formed on the inner surface of the boiler.
- 10. What is degree of hardness of water?**
 - It is the parts of calcium carbonate equivalent hardness per a particular numbers of parts of water, depending upon the unit employed.
- 11. Distinguish between hard water and soft water.**
 - Hard water is one which does not produce lather with soap solution readily, but forms a white curd; while soft water gives lather easily on shaking it with soap solution. Alternatively, hard water contains dissolved calcium and magnesium salts; while soft water does not contain dissolved calcium and magnesium salts in it.
- 12. Why do we express hardness of water in terms of calcium carbonate equivalent?**
 - This mode permits easy addition and subtraction of concentrations of hardness causing constituents, since its molecular mass is 100. Moreover, it has been adopted as standard for expressing hardness.
- 13. What are the salts responsible for the temporary and permanent hardness of water?**
 - Temporary hardness: $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$.
Permanent hardness: $CaCl_2$, $MgCl_2$, $CaSO_4$, $MgSO_4$, $FeSO_4$, $Al_2(SO_4)_3$ etc.
- 14. Why is hot lime soda process better than the cold process?**
 - Because hot lime soda process: (1) is very economical, (2) requires no coagulant, (3) is very faster, (4) precipitates sludge settles down rapidly (5) produces water of comparatively lower residual hardness.
- 15. What is Zeolite?**
 - It is hydrated sodium alumina-silicate of formula $Na_2O \cdot Al_2O_3 \cdot xSiO_2 \cdot yH_2O$, where $x = 2 - 10$ and $y = 2 - 6$. It is capable of exchanging reversibly Na^+ ions for hardness-producing ions in water.
- 16. Why does hard water consumes lot of soap?**
 - Hard water contains soluble salt of calcium and magnesium. When hard water is used for washing and bathing purposes, it does not lather freely with soap, but produces sticky precipitates of calcium and magnesium soaps. The formation of such insoluble precipitates consumes soap, till hardness is completely precipitated. Hence, this cause wastage of a lot of soap being used.
- 17. Why is water softened before using in boiler?**
 - Water used for steam generation should be sufficiently pure (particularly with respect to hardness), otherwise it would cause boiler problem like scale and sludge formation, priming, foaming and boiler corrosion etc. Hence, water is softened (hardness removed from it) before feeding it to boiler.

18. Why natural water should is not be fed to boiler?

- Natural water contains hardness, due to the presence soluble calcium and magnesium salt in it. If natural water is directly fed to boiler, the hardness causing salts get precipitated in the form of scale and sludge inside the boiler. Moreover, hardness also causes priming, foaming and corrosion in boiler. Hence, in order to avoid these boiler problems, natural water should not be fed to boiler, rather it should be softened before using in boiler.

19. Why are coagulants not used in hot lime-soda process?

- Since during hot lime-soda process, the reactions proceeds faster and the precipitate and sludge get settle down rapidly so no coagulants are needed.

20. State two harmful effects of silica present in water.

- Presence of silica even in small quantities, in water causes the formation of very firmly sticky deposits of calcium silicate and magnesium silicate scales in the boiler. These scales are very difficult to remove.

21. Why is sedimentation with coagulants?

- The process of removing fine suspended and colloidal impurities by adding the requisite amount of coagulant to water before sedimentation.

Long question

1. Write note on
 - a. Sources of water
 - b. Common impurities present in natural water
 - c. Equivalent of calcium carbonate
 - d. Scale formation
 - e. Corrosion
 - f. Sedimentation and coagulation
2. With the help of suitable example explain effect of water on rocks and mineral
3. Define carry over and explain priming and foaming in detail
4. With the help of labelled diagram explain
 - a. Hot lime soda process
 - b. Zeolite process
 - c. Deionizer process
5. Explain about feed water conditioning.
6. All the examples given in study material

UNIT 2**MCQ:**

- A good fuel should possess:
 - High ignition temperature
 - Moderate ignition temperature
 - High calorific value
 - Both (b) and (c)**
- Ignition temperature of fuel is the:
 - A temperature at which the fuel can be stored safely
 - Lowest temperature at which the fuel must be pre-heated so that it starts burning smoothly**
 - Temperature attained with the fuel is burnt
 - Temperature at which the fuel ignites for moment, but does not burn after then
- Which of the following is not an advantage of gaseous fuels over solid and liquid fuels?
 - They can easily be conveyed through pipelines to the actual place of use
 - They can be lighted at moment's notice
 - They cannot be pre-heated by the heat of the hot waste gases**
 - Their combustion can readily be controlled
- Which of the following statements is true?
 - Coke possesses better strength than coal
 - Coke burns with long flame
 - Coke burns with short flame**
 - Sulphur content of coke is higher than that of coal from which it is obtained
- The maximum temperature reached, when coal is completely burnt in the theoretical amount of air, called:
 - Fusion temperature
 - Calorific intensity**
 - Ignition temperature
 - None of these
- Bomb calorimeter is used for determining the calorific value of:
 - Solid fuel
 - Liquid fuel
 - Gaseous fuel
 - Both (a) and (b)**
- Bomb calorimeter is used to determine:
 - HCV at constant pressure
 - LCV at constant pressure
 - HCV at constant volume**
 - LCV at constant volume
- Which of the following gas is used for the fire extinguishers?
 - Nitrogen
 - Oxygen
 - Carbon dioxide**
 - Hydrogen
- Which of the following gas is used as neutralizing agent?
 - Nitrogen
 - Oxygen
 - Gaseous carbon dioxide**
 - Hydrogen
- Which of the following gas is used in making tungsten filaments for electric lamps?
 - N₂
 - O₂
 - Mixture of N₂ and H₂**
 - CO₂

Short Questions with Answers:

- Define a chemical fuel.**
 - A combustible substance containing carbon as the main constituent, which on proper burning liberates large amount of heat, which can be used economically for domestic as well as industrial purpose.
- What is meant by chemical value of fuel?**
 - It is a total quantity of heat liberated when unit mass (or volume) of the fuel is burnt completely in presence of sufficient quantity of air/oxygen.
- What is meant by ignition temperature?**
 - The lowest temperature at which the fuel must be preheated so that it starts burning smoothly.
- Why should an ideal fuel have moderate ignition temperature?**
 - Low ignition temperature can cause fire hazard and involves danger in fuel storage and transport; while high ignition temperature causes difficulty in starting ignition of fuel. Hence, an ideal fuel should have moderate ignition temperature.
- Arrange wood, peat, lignite, bituminous coal and anthracite in decreasing order of their calorific values.**
 - Wood < peat < lignite < bituminous coal < anthracite.

6. Arrange wood, peat, lignite, bituminous coal and anthracite in increasing order of their calorific values.

- Anthracite < bituminous coal < lignite < peat < wood.

7. Write the composition of gases in atmospheric air.

- Oxygen-20.99%, Nitrogen-78.01%, Carbon dioxide-0.03-0.07%, Argon-0.94%, Neon-0.0015%, Hydrogen-0.01%, Helium and Krypton-0.01-0.02%

8. Write the industrial applications of following gases

1. Carbon dioxide

- As solid CO₂ in refrigeration process
- Liquid CO₂ is needed in carbonated.
- Used in creating inert atmosphere.
- As fire extinguisher
- Gaseous CO₂ used as a neutralizing agent
- Gaseous CO₂ is the basic raw material for production of Na₂CO₃, NaHCO₃.

2. Oxygen

- It is used to produce oxyacetylene flame to cutting and welding the metals
- Used in L. D. process for steel production
- Used for artificial respiration in case of patients
- Used for mountain climbers and high attitude aero planes flights

3. Nitrogen

- Used in manufacture of synthetic ammonia, nitric acid
- Used in manufacture organic nitrates like propellants and explosives,
- Synthetically produced nitrates are key ingredients of industrial fertilizers
- Used in producing nitrogen oxide.
- Applied to create inert atmosphere.

4. Hydrogen

- In fertilizer industries to produce NH₃ which is converted into (NH₄)₂SO₄, urea and HNO₃
- In hydrogenation of oils to make fats or in hardening of fatty oils
- In hydrogenating coal, low temperature carbonization tar and water gas to produce gasoline
- In hydrogenating water gas to produce methanol
- In production of HCl, which is used in large quantity in industries
- For filling in metrological balloons which are essential for upper air observation to guide the air flights
- In making oxy-hydrogen flame used for melting of platinum, quartz and in auto welding of lead
- In producing an inert media and in making tungsten filaments for electric lamps, mixture of nitrogen and hydrogen is used

9. Define critical temperature.

- When by decreasing the distance the molecules of a gas are brought close together the gas assumes the liquid form provided the repulsive tendency has been diminished beyond a certain point known as critical temperature which is different for different gases.
- Critical temperature is the temperature below which any gas can be liquefied by increasing the pressure. Above the critical temperature any gas cannot be liquefied by compression.

10. Define critical pressure.

- Above critical temperature the gas will never liquefy under any pressure. The minimum pressure under which gas liquefies at the critical temperature is called as critical pressure.

Long question

1. Define fuel. Explain classification of fuel in detail
2. Explain advantages of solid, liquid and gaseous fuels over each other.
3. Explain characteristic of good fuel
4. With the help of labelled diagram explain construction and working of bomb calorimeter.
5. Write explanatory note on heating and cooling mediums
6. Write note on
 - a. Analysis of air
 - b. Application/uses of
 1. Oxygen
 2. Nitrogen
 3. Hydrogen
 4. Carbon dioxide

UNIT 3**MCQ:**

1. A refrigerant compressor is used to
 - (a) Raise the pressure of the refrigerant
 - (b) Raise the temperature of the refrigerant
 - (c) Circulate the refrigerant through the refrigerating system
 - (d) **All of the above**
2. The refrigerant supplied to compressor must be:
 - (a) **Superheated vapour refrigerant**
 - (b) Dry saturated liquid refrigerant
 - (c) A mixture of liquid and vapour refrigerant
 - (d) None of these
3. The pressure at the inlet of a refrigerant compressor is called:
 - (a) **Suction pressure**
 - (b) Discharge pressure
 - (c) Critical pressure
 - (d) Back pressure
4. The pressure at the outlet of a refrigerant compressor is called:
 - (a) Suction pressure
 - (b) **Discharge pressure**
 - (c) Critical pressure
 - (d) Back pressure
5. The reciprocating compressor are very suitable for:
 - (a) Small displacements and low condensing pressures
 - (b) Large displacements and high condensing pressures
 - (c) **Small displacements and high condensing pressures**
 - (d) Large displacements and low condensing pressures
6. The work requirement for a reciprocating compressor is minimum when the compression process is:
 - (a) **Isothermal**
 - (b) Isentropic
 - (c) Polytropic
 - (d) Adiabatic
7. The heat removing capacity of one tonne refrigerator is equal to
 - (a) 21 kJ/min
 - (b) **210 kJ/min**
 - (c) 420 kJ/min
 - (d) 620 kJ/min
8. The coefficient of performance is always..... one.
 - (a) Equal to one
 - (b) Less than
 - (c) **Greater than**
 - (d) None of these
9. The ratio of heat extracted in the refrigerator to work done on the refrigerant is called
 - (a) **Coefficient of performance of refrigeration**
 - (b) Coefficient of performance of heat pump
 - (c) Relative coefficient of performance
 - (d) Refrigerating efficiency
10. If the condenser and evaporator temperature are 312 K and 273 K respectively, then reversed Carnot C.O.P. is
 - (a) 5
 - (b) **7**
 - (c) 9
 - (d) 10
11. The efficiency of Carnot heat engine is 80%. The C.O.P. of a refrigerator operating on the reversed Carnot cycle is equal to
 - (a) **0.25**
 - (b) 0.60
 - (c) 0.40
 - (d) 0.80
12. The Freon group of refrigerants are:
 - (a) **Halo-carbon refrigerants**
 - (b) Azeotrope refrigerants
 - (c) Inorganic refrigerants
 - (d) Hydro-carbon refrigerants
13. Which of the following refrigerants has the lowest freezing point?
 - (a) R-11
 - (b) R-12
 - (c) **R-22**
 - (d) Ammonia
14. A refrigerants with the highest critical pressure is
 - (a) R-11
 - (b) R-12
 - (c) R-22
 - (d) **Ammonia**
15. Which of the following is an azeotrope refrigerant?
 - (a) R-11
 - (b) R-40
 - (c) R-114
 - (d) **R-502**

SHORT QUESTIONS:

1. Enlist the classification of compressors.
2. Define the following terms:
 - Suction pressure
 - Suction volume
 - Discharge pressure
 - Stroke volume
 - Clearance factor
 - Compression ratio
 - Refrigeration
 - Relative C.O.P.
 - Volumetric efficiency
 - Compressor capacity
 - Isothermal compression process
 - Isothermal expansion process
 - Isentropic expansion process
3. Enlist the factors affecting volumetric efficiency of a reciprocating compressor.
4. Enlist disadvantages of single stage compressors.
5. Give the advantages of multi-stage compression over single stage compression.
6. Enlist the desirable properties of an ideal refrigerant.
7. Enlist the various types of refrigerants.
8. Enlist the advantages of the vapour compression refrigeration system over air refrigeration system.
9. Enlist the advantages of the air refrigeration system over vapour compression refrigeration system.
10. Enlist name of any four inorganic refrigerants
11. Enlist name of any four halocarbon refrigerants
12. Enlist name of any four azeotrope refrigerants
13. Enlist name of any four hydrocarbon refrigerants

Long question

1. Explain various classification of compressor
2. Explain with the help of neat sketch, work done by single stage, single acting reciprocating compressor without clearance volume
3. With the help of p-v diagram explain work done by reciprocating compressor with clearance volume
4. Write note on
 - a. Power required to drive single stage reciprocating compressor
 - b. Volumetric efficiency of reciprocating compressor
 - c. Multi-stage compressor
 - d. Desirable properties of ideal refrigerant.
 - e. R-12, dichlorodifluoromethane
 - f. R-717, ammonia
 - g. R-729, air
 - h. R-744, carbon dioxide
5. What is multi-stage compressor? Give its advantages.
6. What is difference between heat engine, refrigerator and heat pump?
7. Derive an equation of COP for air refrigerator working on reversed Carnot cycle
8. Derive an equation of work done by air refrigeration system working on Bell-Coleman cycle.
9. Explain mechanism of simple vapour compression refrigeration system.

UNIT 4**MCQ:**

1. Which of the following is not a fire tube boiler?
(a) Simple vertical (b) Locomotive
(c) Lancashire (d) Cochran
2. Which of the following is not a water tube boiler?
(a) Simple vertical (b) Babcock
(c) Lancashire (d) Wilcox
3. Which of the following is vertical boiler?
(a) Cochran (b) Babcock
(c) Lancashire (d) Wilcox
4. Which of the following is horizontal boiler?
(a) Locomotive (b) Babcock
(c) Lancashire **(d) All of these**
5. Which of the following is high pressure boiler?
(a) Cochran **(b) Babcock**
(c) Lancashire (d) Locomotive
6. Which of the following is single tube boiler?
(a) Cornish (b) Locomotive (c) Lancashire (d) Babcock
7. Locomotive type of boiler.
(a) Stationary (b) Marine **(c) Portable** (d) None of these
8. Efficiency of petrol engine is:
(a) 25-35% (b) 20-30% **(c) 25-30%** (d) 15-25%
9. Which boiler is used when furnace of boiler is placed inside the drum?
(a) Simple vertical **(b) Babcock** (c) Lancashire (d) Cochran
10. Which of the following affects the selection of boiler?
(a) No. of tubes (b) Working pressure
(c) Initial cost **(d) All of these**
11. Efficiency of external combustion engine is:
(a) High (b) Medium **(c) Low** (d) Very high
12. Efficiency of internal combustion engine is:
(a) High (b) Medium (c) Low (d) Very high
13. The Engine which uses petrol as a fuel is known as.....
(a) Otto Engine (b) Steam Engine
(c) Diesel Engine (d) Gas Engine
14. The Engine which uses air as cooling media is known as.....
(a) Water cooled engine (b) Oil cooled engine
(c) Air cooled engine (d) none of these
15. The engine which uses water as cooling media is known as.....
(a) Air cooled engine (b) Oil cooled engine
(c) Water cooled engine (d) none of these
16. Which of the following is an external combustion engine?
(a) Steam Power Plant (b) Diesel engine
(c) Petrol engine (d) None of these
17. The efficiency of Diesel engine is _____
(a) 70 to 75 % **(b) up to 45 %**
(c) 50 to 60 % (d) None of these
18. The Operation life of petrol engine is _____
(a) Long **(b) Short**
(c) Medium (d) None of these
19. The Operation life of Diesel engine is _____
(a) Long (b) Short
(c) Medium (d) None of these
20. The thermal efficiency of Carnot engine is given by.....
(a) $\eta = 1 - (T_c/T_H)$ (b) $\eta = 1 - (T_H / T_c)$
(c) $\eta = 1 - r$ (d) None of these

SHORT QUESTIONS:

1. Define internal combustion engine.
2. Enlist the various types of fuel used in internal combustion engine.
3. Give the comparison between external and internal combustion engine.
4. Enlist the difference between petrol engine and diesel engine.
5. Enlist the functions of boiler.
6. Compare the water tube boiler and fire tube boiler.
7. Enlist the factors affecting the selection of boiler.
8. Give the function of safety valve in boiler.
9. Define following terms:
 - Saturated steam
 - Dry saturated steam
 - Wet steam
 - Superheated steam
 - Priming
 - Latent heat of vaporization
 - Sensible heat
 - Non-IBR boiler
 - Enthalpy of liquids
 - Enthalpy of dry saturated steam
 - Enthalpy of wet steam
 - Enthalpy of superheated steam
 - Degree of superheat
 - Specific volume of steam

LONG QUESTIONS:

1. Explain about various classification of internal combustion engine.
2. Differentiate between internal combustion engine and external combustion engine.
3. Explain the boiler or steam generator with its principle and function in detail.
4. With the help of neat and labelled diagram explain construction and working of simple vertical boiler.
5. Write note on steam power plant. Explain in detail about working and efficiency of steam power plant working on following cycle
 - a. Carnot cycle
 - b. Rankine cycle
 - c. Simple practical power cycle
6. Derive an equation of efficiency of otto engine
7. Differentiate between
 - a. Petrol engine and diesel engine
 - b. Water tube boiler and fire tube boiler
8. Explain the classification of boilers.
9. Write note on
 1. Boiler mountains
 2. Accessories of boiler
 3. Specific volume of steam