ME-Objective-Paper-I

1. Along the 'triple line' in a p–v diagram showing all three phases of water, which one of the following statements is correct?

(A) A substance has the same pressure and temperature but different specific volume

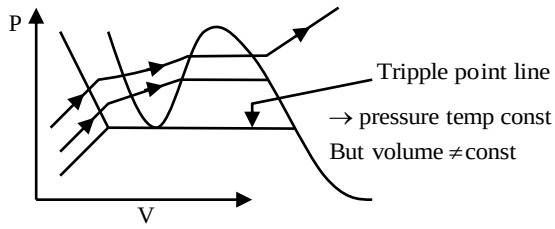
(B) A substance has same temperature and specific volume but different pressure

(C) A substance has same specific volume and pressure but different temperature

(D) A substance has same specific volume, pressure and temperature

Key: (A)

Exp:



2. Internal energy of a system is dependent on the following aspects:

1. Molecular weight
2. Molecular structure
3. Degree of molecular activity

Which of the above are correct?

(A) 1 and 2 only (B) 1 and 3 only

(C) 2 and 3 only (D) 1, 2 and 3

Key: (D)

Exp: Internal energy is a function of molecular weight, structure (Bonding energy) and molecular activity.

(translation, rotation, vibration etc.)

3. In a cyclic process, the heat transfer are $+30\,\text{J}, -50\,\text{J}, -10\,\text{J}$ and $+60\,\text{J}$. The net work for the cyclic process is

(A) 30 Nm (B) 40 Nm (C) 50 Nm (D) 60 Nm

Key: (A)

Exp: $\oint \delta Q = \oint \delta W \Rightarrow W_{net} = 30 - 50 - 10 + 60 = 30$

4. A researcher claims that he has developed an engine, which while working between source and sink temperatures of 377°C and 27°C rejects only 50% of absorbed heat. What will his engine be?

(A) An impossible engine (B) A Stirling engine

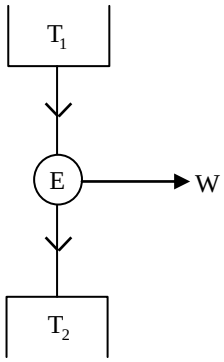
(C) A reversible engine (D) A practical engine

Key: (D)

Exp: $\text{Carnot efficiency}(\eta_c) = 1 - \frac{T_2}{T_1} = 1 - \frac{27+273}{377+273} = 53.84\%$

$\text{Engine efficiency}(\eta_e) = 1 - \frac{Q_2}{Q_1} = 50\%$

$\eta_c > \eta_e = \text{Practical engine}$



5. A reversible engine works between temperature limits of 260°C and 60°C. To improve the performance, we have to

(A) Raise the source temperature to 300°C

(B) Lower the sink temperature to 30°C

(C) Insulate the engine

(D) None of the above

Key: (B)

Exp: Increase in efficiency by lowering sink temp is more than raising source temperature

6. In a real gas equation pv = zRT, depending on the values of pressure and temperature of the real gas, the value of z

(A) Should always be less than 1

(B) May be less than 1, may be greater than 1 or equal to 1

(C) Should always be greater than 1

(D) Should always be equal to 1

Key: (A)

Exp: $PV = ZRT \Rightarrow \underbrace{\left(P + \frac{a}{V^2}\right)}\underbrace{(V-b)} = RT$

$PV \times Z^1 = RT \quad \& \; Z^1 \text{ is greater than } 1$

$\text{so } Z = \frac{1}{Z^1} = < 1$

7. A system executes a cyclic process during which there are two processes as given below:

$_1Q_2 = 460\,\text{kJ}$, $_2Q_1 = -100\,\text{kJ}$, and $_1W_2 = 210\,\text{kJ}$

What will be work interaction in process $_2W_1$?

(A) 100 kJ (B) –210 kJ (C) 150 kJ (D) –150 kJ

Key: (C)

Exp: $_1Q_2 + {}_2Q_1 = {}_1W_2 + {}_2W_1$

$_2W_1 = 150\,kJ$

8. For the same compression ratio, the efficiency of an air standard Otto cycle is

(A) More than the efficiency of an air standard Diesel cycle

(B) Less than the efficiency of an air standard Diesel cycle

(C) Equal to the efficiency of an air standard Diesel cycle

(D) None of the above

Key: (A)

Exp: Efficiency of otto cycle $(\eta_o) = 1 - \frac{1}{r^{\gamma-1}}$

Efficiency of diesel cycle $(\eta_d) = 1 - \chi\left(\frac{r^{1/\chi} - 1}{\gamma - 1}\right)$ r = comp ratio

$\chi = c_p / c_v$

$r > 1$ always

so for same r, $\eta_{otto} > \eta_{diesel}$

9. A Carnot engine operates between 37°C and 347°C. If the engine produces 620 kJ of work, the entropy change during heat addition is

(A) 1 kJ/K (B) 2 kJ/K (C) 3 kJ/K (D) 4 kJ/K

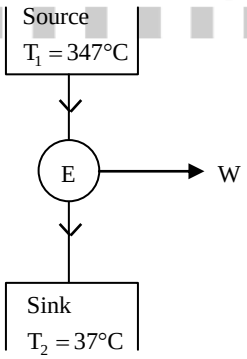
Key: (B)

Exp: $\eta = 1 - \frac{(37+273)}{(347+273)} = \frac{W}{Q_1} = \frac{620}{W + Q_2}$

$\Rightarrow Q_2 = 620\ kJ = Q_{rejected}$

$T_s \Delta s = Q_{rej}$

$\Delta s = \frac{620}{(37+273)} = 2\ kJ/K$



10. An amount of 1000 kJ of heat is added to a system during a constant pressure vapourization process at a temperature of 227°C. The available energy added to the system, if the temperature of the surroundings is 27°C, is

(A) 600 kJ (B) 500 kJ (C) 400 kJ (D) 300 kJ

Key: (C)

Exp: As, A = Q-I

Where A = available energy

Q = Total energy

I = Irreversibility

$$I = T_0 \Delta S = T_0 \frac{Q}{T}$$

$$\text{hence } T_0 = 27°C = 300K$$

$$T = 227°C = 500K$$

$$\therefore I = \frac{300 \times 1000}{500} = 600\,kJ$$

$$\therefore A = Q - I = 1000 - 600 = 400\,kJ$$

11. Consider the following statements:

1. In an ideal gas, there are no inter molecular forces of attraction and repulsion
2. At very low pressure, all gases and vapours approach ideal gas behaviour
3. Enthalpy of an ideal gas depends only on temperature

Which of the above statements are correct?

(A) 1, 2 and 3 (B) 1 and 2 only (C) 1 and 3 only (D) 2 and 3 only

Key: (D)

Exp: Ideal gas assumption states that there is no intermolecular forces

All real gases show deviation from the ideal gas law

i.e., $\frac{PV}{nRT}$ values are not close to 1. But for velocity

Low pressure $P \to 0$ OR very high temperature there values approach towards unity

Enthalpy of ideal gas $H = \underset{\text{fixed}}{\downarrow} mc_p \underset{\text{fixed}}{\downarrow} (\Delta T) \Rightarrow H = f(T)$

12. Consider the following statements pertaining to the properties of perfect, non reacting gas mixtures:

1. The total volume of a mixture is the sum of partial volumes at the same pressure and temperature
2. The entropy of a mixture of gases is the same as the entropies of the constituents
3. The total pressure of a mixture of gases is the sum of the partial pressures of the substances
4. The mole fraction of a mixture of gases is equal to both pressure and volume fraction

Which of the above statements is/are correct?

(A) 1, 2, 3 and 4 (B) 1, 2 and 3 only (C) 1, 2 and 4 only (D) 3 and 4 only

Key: (A)

Exp: 1. Partial volume is volume occupied by 1 component alone

$$PV_t = m_t R_e T$$

$$P(V_1 + V_2 + ...) > (m_1 R_1 + m_2 R_2 + ...)T$$

or $V = V_1 + V_2 + ...$ where V_1, V_2 = partial volumes

2. By Gibbs theorem entropy of mixture is sum of partial entropies
3. Dalton's law of partial pressure
4. $P_k = x_k . P_t$

x_k = mole fraction $= \frac{P_k}{P_t}$ = pressure fraction $= \frac{V_k}{V_t}$ = Volume fraction

13. An inventor claims to have developed a refrigeration unit which maintains –10°C in the refrigerator which is kept in a room where the surrounding temperature is 25°C and which has COP 8.5. His claim is

(A) Valid (B) Marginally correct

(C) Invalid (D) None of these

Key: (C)

Exp: $[COP]_{ref} = \frac{T_2}{T_1 - T_2} = 7.5$ so given is incorrect

14. An Otto cycle has a compression ratio of 8. If 250 kJ of work is extracted from the cycle, the heat rejected by the cycle is

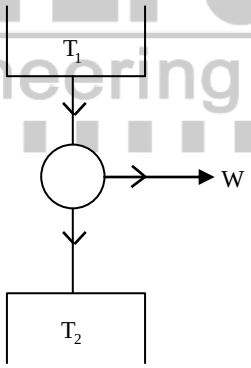
(A) 500 kJ (B) 442.69 kJ (C) 331.4 kJ (D) 192.69 kJ

Key: (D)

Exp: $\eta_{otto} = 1 - \frac{1}{r^{\gamma-1}} = \frac{W}{W + Q_2} = \frac{250}{250 + Q_2}$

$1 - \frac{1}{8^{0.4}} = \frac{250}{250 + Q_2}$

$\Rightarrow Q_2 = 192.69\,kJ$



15. In an engine working on air standard Stirling cycle the temperature at the beginning of isothermal compression is 127°C. The engine thermal efficiency is 50%. The specific heat of air at constant volume is C_V. The heat transferred to the regenerator is

(A) 200 C_V kJ / kg (B) 300 C_V kJ / kg (C) 400 C_V kJ / kg (D) 500 C_V kJ / kg

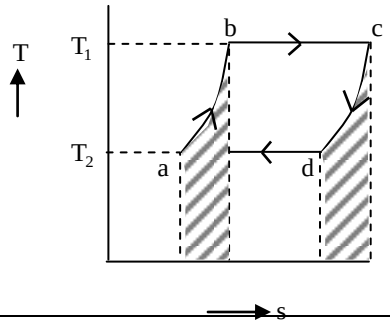
Key: (C)

Exp: $T_2 = 127^o; T_1 = 527^o C$

$\eta = 1 - \frac{T_2}{T_1} = \frac{50}{100}$

(For regenerative)

$Q_{reg} = C_v (T_1 - T_2) = 400\,C_V$



16. An ideal spark ignition engine has a compression ratio of 9. What is its Air standard efficiency if ratio of specific heats is 1.5?

(A) 63% (B) 67% (C) 70% (D) 72%

Key: (B)

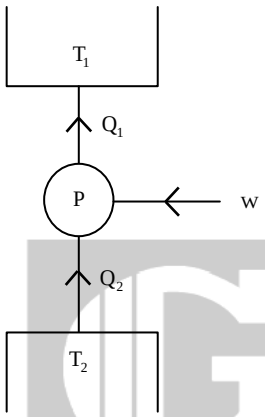
Exp: $\eta = 1 - \frac{1}{r^{\gamma-1}} = 66.67\%$

17. A Carnot heat pump works between27°C and 327°C. What will be its COP?

(A) 0.09 (B) 1.00 (C) 1.09 (D) 2.0

Key: (D)

Exp:



COP of Carnot Heat pump $= \frac{T_1}{T_1 - T_2} = 2$

18. Practically it is not feasible to design an engine which closely follows the 'Carnot cycle' for the following reasons

1. Transfer of heat energy at constant temperature is very difficult to achieve
2. Isentropic processes are very fast processes
3. It makes use of smaller pressure ratios
4. Thermal efficiency is not a function of source and sink temperatures

Which of the above reasons are correct?

(A) 1 and 2 (B) 2 and 3 (C) 3 and 4 (D) 4 and 1

Key: (A)

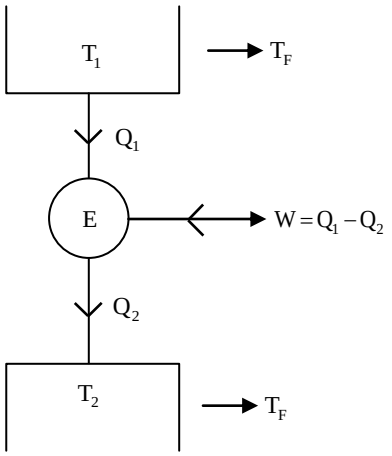
Exp: Isothermal heat transfer is very difficult due to entropy generation.

19. Two identical finite bodies of constant heat capacity at temperatures T_1 and T_2 are available to do work in a heat engine. The final temperature T_f –reached by the bodies on delivery of maximum work is

(A) $T_f = \frac{T_1 + T_2}{2}$ (B) $T_f = \sqrt{T_1 T_2}$ (C) $T_f = T_1 - T_2$ (D) $T_f = \sqrt{T_1^2 + T_2^2}$

Key: (B)

Exp: Assume $T_1 > T_2$



$Q_1 = c_p (T_1 - T_F)$

$Q_2 = c_p (T_F - T_2)$

$\therefore W = Q_1 - Q_2 = c_p (T_1 + T_2 - 2T_F)$

for 'w' to be max, T_F to be minimum

$$\Delta S_1 = \int_{T_1}^{T_F} C_p \frac{dT}{T} = C_p \ln \frac{T_F}{T_1}$$

$$\Delta S_2 = \int_{T_2}^{T_F} C_p \frac{dT}{T} = C_p \ln \frac{T_F}{T_2}$$

$$\text{as } (\Delta S)_{univ.} \geq 0 \quad \therefore C_p \ln \frac{T_F}{T_1} + C_p \ln \frac{T_F}{T_2} \geq 0$$

$$\therefore C_p \ln \left[\frac{T_F^2}{T_1 T_2} \right] \geq 0$$

For T_F to be min,

$$\ln \frac{T_F^2}{T_1 T_2} = 0 \therefore \ln \frac{T_F^2}{T_1 T_2} = \ln 1$$

$$T_F = \sqrt{T_1 T_2}$$

20. The mechanical efficiency of a single cylinder four stroke engine is 80%. If the frictional power is estimated to be 25 kW, the indicated power will be

(A) 100 kW (B) 125 kW (C) 150 kW (D) 175 kW

Key: (B)

Exp: $BP = \eta \times I.P$; $F.P = I.P - B.P$

$B.P = 75\,kW$

$I.P = 125\,kW$

21. A single cylinder four stroke engine operating at 80% of mechanical efficiency develops a brake power of 60 kW. The indicated power and the power lost due to friction respectively are

(A) 40 kW and 15 kW (B) 75 kW and 20 kW

(C) 40 kW and 20 kW (D) 75 kW and 15 kW

Key: (D)

Exp: $I.P = \frac{BP}{\eta_{mech}} = \frac{60}{0.8} = 75\,kW$

$F.P = I.P - B.P = 15\,kW$

22. The following reasons are mentioned while recommending supercharging for the engines used in aeroplanes and sub-marines

1. More volumetric efficiency, better combustion and increased power output
2. Higher peak pressure, increased temperature and smaller size

Which of the above reasons is/are correct?

(A) 1 only (B) 2 only (C) Both 1 and 2 (D) Neither 1 nor 2

Key: (C)

Exp: Statement '2' is wrong as higher peak pressure, increased temperature, makes bulky and heavier engine and not smaller engine.

23. Consider the following statements regarding supercharging of Diesel engines:

1. The mechanical efficiency of a supercharged Diesel engine is slightly better than that of naturally aspirated engine
2. There is reduction in smoke in the case of supercharged engine in the overload operation
3. Increased valve overlap is used in supercharged engine

Which of the above statements are correct?

(A) 1, 2 and 3 (B) 1 and 2 only (C) 1 and 3 only (D) 2 and 3 only

Key: (A)

Exp: → Increases temperature, pressure (& compression ratio) for more efficiency

→ Less smoke due to ample amount of O_2 for combustion

→ Increased volumetric efficiency

24. In Diesel engines, the control of black smoke in exhaust can be achieved by:

1. Running the engine at lower load
2. Maintaining the injection system perfect
3. Using Diesel fuel of higher Cetane number

Which of the above statements are correct?

(A) 1,2 and 3 (B) 1 and 2 only (C) 1 and 3 only (D) 2 and 3 only

Key: (A)

Exp: Each point is regarding better combustion,

Lower load → less fuel → proper combustion → less smoke

Injection system → Better air fuel ratio → less smoke

High Cetane number → more O_2 available for combustion

25. The source of energy which keeps the sun shining for billions of years is

(A) Combustion of Hydrogen

(B) Nuclear fusion of light elements

(C) Nuclear fission of heavy elements

(D) Interaction of currents in the interior of the sun with the galactic magnetic field

Key: (B)

Exp: The source of energy which keeps sun shining for billions of years is nuclear fusion of light elements

26. Which one of the following statements is correct?

(A) During heating and humidification process, humidity ratio decreases

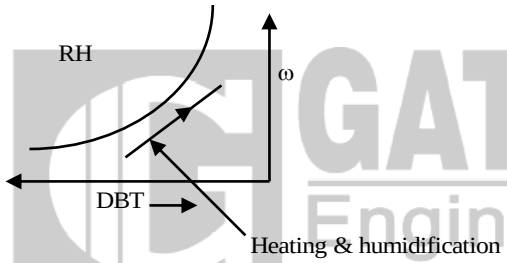
(B) During cooling and dehumidification process, humidity ratio increases

(C) During cooling and dehumidification process, dry bulb temperature increases

(D) During heating and humidification process, dry bulb temperature increases

Key: (D)

Exp:



27. A dimensionless quantity that connects the link between velocity flow field and the temperature field is

(A) Nusselt number (B) Prandtl number

(C) Reynolds number (D) Grashof number

Key: (B)

Exp: $Nu = f(Pr, Re)$

$Re = \text{function of velocity}\ \ Pr = \text{function of}\ k(\text{temp field})$

28. The conduction heat diffuses in a material when the material has

1. High thermal conductivity
2. Low density
3. High specific heat
4. High viscosity

Which of the above are correct?

(A) 1 and 2 (B) 2 and 3 (C) 3 and 4 (D) 4 and 1

Key: (A)

Exp: $Pr = \frac{\mu c_p}{k} < 1$ thermal Boundary Layer is large (diffusion is more)

$$\text{so } \begin{matrix} k \text{ large} \\ \rho \text{ large} \end{matrix} \Big\} \rightarrow Pr < 1$$

29. In an equation of Fourier law of heat conduction, heat flow through a body per unit time is $Q = -kA\frac{dT}{dx}$ the negative sign of k in this equation is to take care of

(A) Decreasing temperature along the direction of increasing thickness

(B) Increasing temperature along the direction of increasing thickness

(C) Constant temperature along the direction with constant thickness

(D) All of the above

Key: (A)

Exp: Heat flows from high temperature to low temperature.

So, $\frac{dT}{dx}$ = negitive along x

30. A flat wall with a thermal conductivity of 0.2 kW/mK has its inner and outer surface temperatures 600°C and 200°C respectively. If the heat flux through the wall is 200 kW/m^2, what is the thickness of the wall?

(A) 10 cm (B) 20 cm (C) 30 cm (D) 40 cm

Key: (D)

Exp: $q = -k\frac{dT}{dx} = -k\frac{(T_2 - T_1)}{\Delta x}$

substituting all the values we get

$\Delta x = 0.4\,m = 40\,cm$

31. Which of the following thermodynamic properties are intensive properties?

1. Density ρ 2. Entropy E 3. Viscosity μ

(A) 1, 2 and 3 (B) 1 and 2 only (C) 2 and 3 only (D) 1 and 3 only

Key: (D)

Exp: From the given properties Density and Viscosity are intensive properties.

32. In a concentric double–pipe heat exchanger where one of the fluids undergoes phase change

(A) The two fluids should flow opposite to each other

(B) The two fluids should flow parallel to each other

(C) The two fluids should flow normal to each other

(D) The directions of flow of the two fluids are of no consequence

Key: (D)

Exp: For phase change of one fluid case, effectiveness is same for both parallel and counter flow heat exchanger.

33. The characteristic length for computing Grashof number in the case of horizontal cylinder is

(A) The length of the cylinder
(B) The diameter of the cylinder
(C) The perimeter of the cylinder
(D) The radius of the cylinder

Key: (B)

Exp: Diameter becomes the characteristic length in case of free convection. Whereas length is for force convection

34. For which of these configurations is a minimum temperature difference required for natural convection to set in

(A) Fluid near a heated vertical plate
(B) Fluid near a heated plate inclined at 45° to the vertical
(C) Fluid over a heated horizontal plate
(D) Fluid near a heated cylinder

Key: (C)

Exp: Grashoff number heated horizontal plate is larger and thereby, Nusselt number is large which indeed makes higher convective coefficient therefore less temperature difference is required.

35. A counter flow shell and tube heat exchanger is used to heat water with hot exhaust gases. The water (c = 4180 J/kg K) flows at the rate of 2 kg/s and the exhaust gases (c = 1000 J/kg K) flow at the rate of 5 kg/s. If the heat transfer surface area is 32 m^2 and the overall heat transfer coefficient is 200 W/m^2K, the NTU of the heat exchanger is

(A) 4.5 (B) 2.4 (C) 8.6 (D) 1.28

Key: (D)

Exp: $NTU = \frac{UA}{C_{min}} = \frac{200 \times 32}{1000 \times 5} = 1.28$

36. In a two–fluid heat exchanger, the inlet and outlet temperatures of the hot fluid are 65°C and 40°C respectively. For the cold fluid, these are 15°C and 43°C. The heat exchanger is a

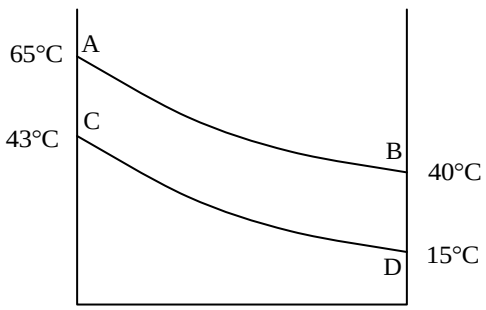
(A) Parallel flow heat exchanger
(B) Counter flow heat exchanger
(C) Mixed flow heat exchanger
(D) Phase–change heat exchanger

Key: (B)

Exp: $\in_p = \frac{43-15}{65-15} = 0.56$

$\in_c = \frac{43-15}{65-45} = 1.27$

≤ 0.5 so exchanger is Counter flow heat exchanger



37. In a double–pipe heat exchanger, the cold fluid is water with inlet temperature 20°C and mass flow rate 20 kg/s and the hot fluid water inlet temperature 80°C and mass flow rate 10 kg/s. Assume that for water $C_p = 4.2\ kJ/kg^oC$, independent of temperature. What is the maximum temperature to which the cold fluid can be heated in a parallel flow and in a counter flow heat exchanger?

(A) 80°C in both parallel flow and counter flow

(B) 50°C in both parallel flow and counter flow

(C) 40°C in parallel flow and 50°C in counter flow

(D) 40°C in parallel flow and 80°C in counter flow

Key: (D)

Exp: $\in_p = 0.5 = \dfrac{T_{h_1} - T_{h_2}}{T_{h_1} - T_{C_1}}$

$T_{h_2} = 50^oC$

$mc_p\Delta T_h = mc_p\Delta T_c$

$10 \times 4.18\left(T_{h_1} - T_{h_2}\right) = 20 \times 4.18\left(T_{C_2} - T_{C_1}\right)$

$T_{C_2} = 40^oC$

For counter flow

$\left(T_{C_2}\right)_{max} = T_{h_1} = 80^oC$

38. If a body is at 2000 K, the wavelength at which the body emits maximum amount of radiation is

(A) 1.45μm (B) 1.45 cm (C) 0.345 cm (D) 0.345μm

Key: (A)

Exp: As per Wien's displacement law $\lambda_{max}.T = 2898\ \mu mk$

$\lambda_{max} = 1.45\ \mu m$

39. An isothermal cubical $(10m \times 10m \times 10m)$ blackbody at 200°C is suspended in air. The total radiation emitted by this body to its surroundings will be

(A) 1702.9 kW (B) 1800.7 kW (C) 54.4 kW (D) 2838.1 kW

Key: (A)

Exp: $Q = \in \sigma AT^4$

$= 1 \times 5.67 \times 10^{-8} \times 6 \times \left(10^2\right) \times (200 + 273)^4$

$= 1702\ kW$

40. A 1 m diameter spherical cavity is maintained at a uniform temperature of 500 K. The emissivity of the material of the sphere is 0.5; One 10 mm diameter hole is drilled. The maximum rate of radiant energy streaming through the hole will be

(A) 2782 W (B) 0.139 W (C) 1392 W (D) 0.278 W

Key: (B)

Exp: $Q_{12} = \in \sigma A_1 F_{12} T_1^4$

$$F_{12} = F_{21}.\frac{A_2}{A_1} = 1 \times \frac{\frac{\pi}{4} \times (0.01)^2}{4\pi \times (0.5)^2} = 2.5 \times 10^{-5}$$

$$Q_{12} = 0.5 \times 5.67 \times 10^{-8} \times 4\pi \times (0.5)^2 \times 2.5 \times 10^{-5} \times (500)^2$$
$$= 0.139\,W$$

41. For a hemispherical furnace with a flat circular base of diameter D, the view factor from the dome to its base is

(A) 0.5 (B) 1 (C) 0 (D) 0.32

Key: (A)

Exp: $F_{11} + F_{12} = 1$

$F_{21} + F_{22} = 1$

$F_{22} = 0$

$F_{21} = 1 \Rightarrow F_{12} = F_{21}\frac{A_2}{A_1}$

$F_{12} = 0.5$

42. In a vapour compression refrigeration system, the high pressure liquid from the condenser/receiver is cooled below its saturation temperature to

(A) Reduce the net work per cycle

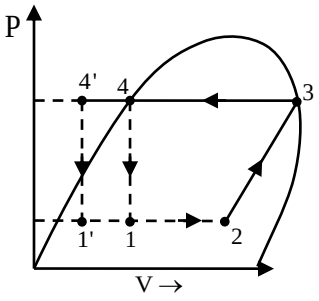
(B) Reduce the net refrigerating effect

(C) Increase the net refrigerating effect

(D) Reduce the pressure on the high pressure side

Key: (C)

Exp:



$4-4' \rightarrow$ Sub cooling below saturation temperature which increases refrigerating effect

$Q_r' = (h_2 - h_1')$; $Q_r = (h_2 - h_1)$

$Q_r' > Q_r$

43. Specific humidity is defined as Mass of

(A) Water vapour contained in air–vapour mixture per kg of dry air

(B) Water vapour contained per kg of air–vapour mixture

(C) Dry air contained per kg of air–vapour mixture

(D) None of these

Key: (A)

Exp: $\text{Specific Humidity} = \frac{\text{Mass of water vapour}}{\text{Mas of dry air}} = \frac{m_v}{m_{da}}$

44. In an ideal Vapour Compression Refrigeration cycle the enthalpy values at salient points are as follows

At inlet to compressor : 1500 kJ/kg

At outlet to compressor : 1800 kJ/kg

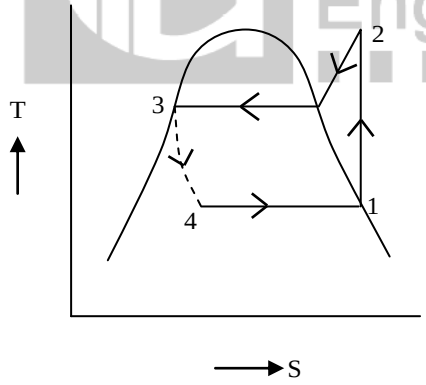
At inlet to evaporator : 300 kJ/kg

What' is the COP of the cycle?

(A) 3 (B) 4 (C) 5 (D) 6

Key: (B)

Exp:



1-2 : compression
2-3 : condensation
3-4 : expansion
4-1 : evaporation

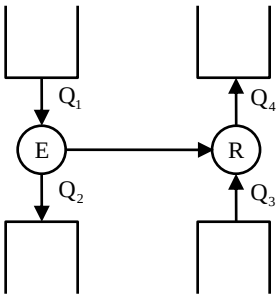
$h_1 = 1500$ kJ/kg

$h_2 = 1800$ kJ/kg

$h_3 - h_4 = 300$ kJ/kg

$$\therefore \text{COP} = \frac{h_1 - h_4}{h_2 - h_1} = \frac{1500 - 300}{1800 - 1500} = 4$$

45.



In the figure shown above, E is the heat engine, with efficiency of 0.4 and R is the refrigerator. If $Q_2 + Q_4 = 3Q_1$, the COP of the refrigerator will be

(A) 3.0 (B) 4.5 (C) 5.0 (D) 5.5

Key: (C)

Exp: $(COP)_{HP} = \dfrac{Q_4}{Q_1 - Q_2}$ $\eta = 1 - \dfrac{Q_2}{Q_1} = 0.4$

$= \dfrac{3Q_1 - Q_2}{Q_1 - Q_2} = \dfrac{3Q_1 - 0.6Q_1}{Q_1 - .6Q_1} = 6$

$(COP)_{ref} = (COP)_{HP} - 1 = 5$

46. The COP of an ideal refrigerator is N. If the machine is operated as a heat pump between the same temperature limits, its COP will be

(A) N – 1 (B) N (C) N + 1 (D) 2N

Key: (C)

Exp: $(COP)_{HP} = (COP)_{ref} + 1$

$= N + 1$

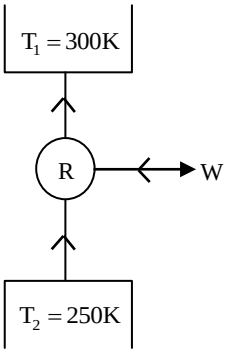
47. An ideal refrigerator based on reversed Carnot cycle works between -23^oC and $+27^oC$. What will be the required power in kW, if a cooling rate of 1.5 kW is desired?

(A) 0.25 kW (B) 0.3 kW (C) 3.25 kW (D) 7.5 kW

Key: (B)

Exp: $(COP)_{ref} = \dfrac{T_2}{T_1 - T_2} = \dfrac{Q_{ref}}{W}$

$\Rightarrow \dfrac{-23 + 273}{27 - (-23)} = \dfrac{1.5}{W} \Rightarrow W = 0.3kW$



48. Consider the following functions:
1. Minimizing friction
2. Sealing the gas between suction and discharge ports
3. As a coolant to transfer heat from the crankcase to the compressor shell
4. To dampen the noise generated by moving parts

Which of the above functions do lubricants in refrigeration systems perform?

(A) 1, 2, 3 and 4 (B) 1 and 2 only (C) 2 and 3 only (D) 3 and 4 only

Key: (A)

Exp: - Minimizing friction – compressor
- Sealing gas prevents leakage
- Removes heat from compressor as coolant
- lubrication provides less friction thus less noise and also dampen the noise

49. Consider the following statements for sensible heating. In this process:
1. Wet bulb temperature increases
2. Relative humidity decreases
3. Vapour pressure remains constant

Which of the above statements are correct?

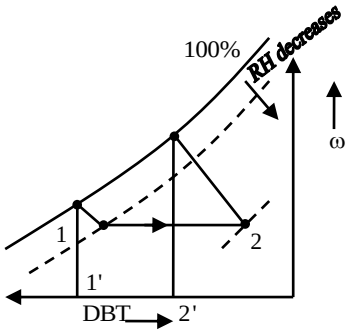
(A) 1, 2 and 3 (B) 1 and 2 only (C) 1 and 3 only (D) 2 and 3 only

Key: (A)

Exp: Process 1 – 2 – sensible Heating

$T_{1'}$ = WBT 1
$T_{2'}$ = WBT2 \ Clearly WBT increases /

Vapour pressure will remain constant since ω is constant (i.e, mass of water vapour is constant)

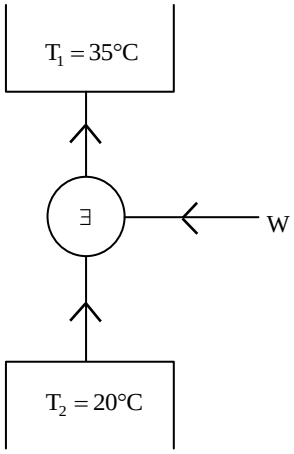


50. An air–conditioning system operating on the reversed Carnot cycle is required to remove heat from the room at a rate of 25kW to maintain its temperature constant at 20°C. The temperature of the surroundings being 35°C, the power required to operate this air–conditioning system will be

(A) 1.28 kW (B) 4.02 kW (C) 5.12 kW (D) 12.80 kW

Key: (A)

Exp:



$$(COP)_{ref} = \frac{T_2}{T_1 - T_2} = \frac{Q_{ref}}{W} \Rightarrow W = 1.28\,kW$$

51. The pressure inside a soap bubble of 50mm diameter is 25 N/m^2 above the atmospheric pressure. The surface tension in soap film would be

(A) 0.156 N/m (B) 0.312 N/m (C) 0.624 N/m (D) 0.078 N/m

Key: (A)

Exp: $\sigma = \frac{\Delta P d}{8} = \frac{25 \times 50 \times 10^{-3}}{8} = 0.156\,N/m$

52. A Newtonian fluid is one which

(A) is viscous but incompressible

(B) has a linear relationship between the shear stress and the rate of angular deflection

(C) exhibits an increase in viscosity with increasing rate of deformation

(D) exhibits a decrease in viscosity with increasing rate of deformation

Key: (B)

Exp: For newtonian fluids $\tau = \frac{\mu du}{dy}$ which is linear relationship

53. Unlike the viscosity of liquids, the viscosity, of gases increases with increasing temperature. This is due to

(A) Increased cohesive force between the molecules

(B) Increased momentum transfer in the molecules

(C) Decreased momentum transfer in the molecules

(D) Increase in both cohesive force and momentum transfer

Key: (B)

Exp: Viscosity of gases increases with increasing temperature due to increased momentum transfer due to collision of gas molecules

54. Manometer is a device used for measuring

(A) Velocity at a point in a fluid (B) Pressure at a point in a fluid

(C) Discharge of a fluid (D) None of these

Key: (B)

Exp: Manometer is a pressure measuring device

55. When a dolphin glides through air, it experiences an external pressure of 0.75 m of mercury. The absolute pressure on dolphin when it is 5 m below the free surface of the water is

(A) $0.10\,N/mm^2$ (B) $0.5\,N/mm^2$ (C) $1.0\,N/mm^2$ (D) $0.15\,N/mm^2$

Key: (D)

Exp: $P = \rho gh$

$= 10^3 \times 9.81(0.75 \times 13.6 + 5)$

$= 10^3 \times 9.81 \times 15.2 = 0.149\ N/mm^2$

$\simeq 0.15\ N/mm^2$

56. Which one of the following statements is correct?

(A) For a floating body, the stable equilibrium condition exists when position of metacentre remains higher than the centre of gravity of the body

(B) For a floating body, the stable equilibrium condition exists when position of metacentre remains lower than the centre of gravity of the body

(C) For a floating body, the neutral equilibrium condition exists when position of metacentre remains higher than the centre of gravity of the body

(D) For a floating body, the unstable equilibrium condition exists when position of metacentre remains higher than the centre of gravity of the body

Key: (A)

Exp: For stability of floating body, metacenter is higher than centre of gravity

57. A 2–D flow field is defined as $\vec{V} = \vec{i}x - \vec{j}y$. The equation of streamline passing through the point (1, 1) is

(A) $xy - 1 = 0$ (B) $xy + 1 = 0$ (C) $xy + 2 = 0$ (D) $xy - 2 = 0$

Key: (A)

Exp: $\frac{dx}{x} = -\frac{dy}{y}$

$xy = k$

at $(x, y) = (1,1)$

$xy - 1 = 0$

58. A flownet is a graphical representation of streamlines and equipotential lines such that these lines

(A) Intersect each other at various different angles forming irregular shaped nets

(B) Intersect each other orthogonally forming curvilinear squares

(C) Indicate the direction but not magnitude of vector

(D) Indicate the direction and magnitude of vector

Key: (B)

Exp: Stream lines and equipotential lines are orthogonal

59. Which one of the following statements is correct for the velocity potential?

(A) Existence of velocity potential is an indication of irrotational nature of the flow

(B) The velocity potential automatically satisfies the continuity equation

(C) Velocity potential can be defined only for 2–dimensional flow

(D) All of the above

Key: (A)

Exp: Velocity potential is defined for 3-D flow. And continuity is satisfied when velocity potential satisfies poisson equation

60. Angle of diverging portion of the venturimeter is limited to 7°, because

1. Flow decelerates in the diverging portion and pressure increases in the downstream direction. Hence, the fluid experience an adverse pressure gradient, if the divergence angle is large
2. Flow separation takes place due to adverse pressure gradient when divergence angle is large
3. If the divergence angle is large, a negative pressure is created at the throat which obstructs the flow of fluid

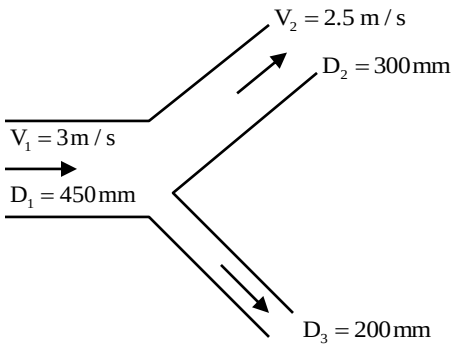
Which of the above reasons are correct?

(A) 1, 2 and 3 (B) 1 and 2 only (C) 1 and 3 only (D) 2 and 3 only

Key: (B)

Exp: For angle of diverging portion greater than 7° adverse pressure gradients are developed which causes flow separation

61.



In the above layout of piping, what is the velocity in 200 mm diameter pipe?

(A) 2.5 m/s (B) 5.55 m/s (C) 7.25 m/s (D) 9.56 m/s

Key: (D)

Exp: $Q_1 = Q_2 + Q_3$

$3 \times 450^2 = 2.5 \times 300^2 + V_3 \times 200^2$

$V_3 = 9.56 \text{ m/s}$

62. Bernoulli's equation is applicable between any two points located in

(A) Rotational flow of an incompressible fluid

(B) Irrotational flow of compressible or incompressible fluid

(C) Steady, rotational flow of an incompressible fluid

(D) Steady, irrotational flow of an incompressible fluid

Key: (D)

Exp: Assumptions of Bernoulli's equation

–steady flow

–incompressible fluid

–Irroational flow

–invisid fluid

63. Water flows through a smooth circular pipe of diameter D and length L because of a pressure difference ΔP across the length. The volume flow rate is Q and the flow is turbulent with Reynolds number 10^5. If the pressure difference is increased to $4\Delta P$ the volume flow rate will be

(A) 2Q (B) A little more than 2Q

(C) A little less than 2Q (D) 4Q

Key: (A)

Exp: $h_f = \frac{4fLV^2}{2gd} \propto \Delta P$

$Q^2 \propto \Delta P$

$\therefore \Delta P$ becomes $4\Delta P$, then Q doubles

64. When the pressure drop across a converging–diverging nozzle is different from the design value for isentropic flow, which of the following is possible?

(A) There is one normal shock in the converging part and one normal shock in the diverging part

(B) There is only one normal shock in the converging part and none in the diverging part

(C) There is only one normal shock in the diverging part and none in the converging part

(D) There are two or more normal shocks, depending on the pressure drop, in the diverging part and none in the converging part

Key: (C)

Exp: No shocks occurs in convergent portion. While in diverges portion is either no shock or one shock present depending upon the back pressure, for off design condition, one normal shock is present.

65. Consider the following statements pertaining to boundary layer on solid surfaces:

1. The boundary layer separation takes place if the pressure gradient is zero
2. The condition of boundary layer separation is $\left(\frac{\partial u}{\partial y}\right)_{y=0} = 0$
3. Boundary layer on a flat plate is laminar if the Reynolds number is less than 5×10^5

Which of the above statements is/are correct?

(A) 1, 2 and 3 (B) 1 and 2 only (C) 2 and 3 only (D) 1 and 3 only

Key: (C)

Exp: Separation occurs when $\frac{\partial P}{\partial x} > 0$, i.e., adverse pressure gradients.

66. For laminar flow through a round pipe, the shear stress

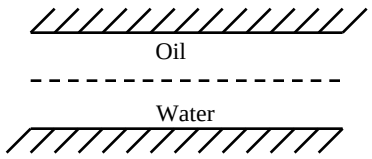
(A) Remains constant over the cross–section
(B) Varies linearly with the radial distance
(C) Must be zero at all points
(D) Varies parabolically with radial distance

Key: (B)

Exp: Relation between shear stress and radial distance in laminar flow a pipe is given by $\tau = \frac{-\partial P}{\partial x}\frac{r}{2}$

Therefore linear variation with radial distance.

67.



Consider flow of oil and water through a channel; the boundary conditions at the interface are

(A) Velocity and shear stress are continuous
(B) Shear stress is continuous and velocity is discontinuous
(C) Shear stress is zero and velocity is continuous
(D) Shear stress is zero

Key: (B)

Exp: Interface boundary conditions

$P_1V_1 = P_2V_2$ Velocity discontinous

$\mu_1 . \frac{du_1}{dy} = \mu_2 \frac{du_2}{dy}$, shear stress continuity

68. Which one of the following statements is not correct in the context of laminar flow through a pipeline?

(A) Shear stress is zero at the centre and varies linearly with pipe radius

(B) Head loss is proportional to square of the average flow velocity

(C) The friction factor varies inversely with flow Reynolds number

(D) No dispersion of die injected into the flow stream

Key: (B)

Exp: $h_f = \frac{32\mu \bar{u} L}{\rho g D^2}$; $h_f \ \alpha \ \bar{u}$ not $\bar{u}^2$

B is correct option

69. Laminar flow between closely spaced parallel plates is governed by the consideration of which one of the following pair of forces?

(A) Pressure and inertial forces (B) Gravity and inertial forces

(C) Viscous and inertial forces (D) Pressure and viscous forces

Key: (D)

Exp: Laminar flow between closely spaced parallel plates is governed by the equation $\frac{\partial P}{\partial x} = \mu \frac{\partial u}{\partial y}$,

Which is the balance of pressure and viscous forces.

70. Across the normal shock, fluid properties change in such a manner that the:

1. Velocity of flow is subsonic
2. Pressure increases
3. Specific volume decreases
4. Temperature decreases

Which of the above are correct?

(A) 1, 2, 3, and 4 (B) 2, 3 and 4 only (C) 1 and 4 only (D) 1, 2 and 3 only

Key: (D)

Exp: Across normal shock temperature increases

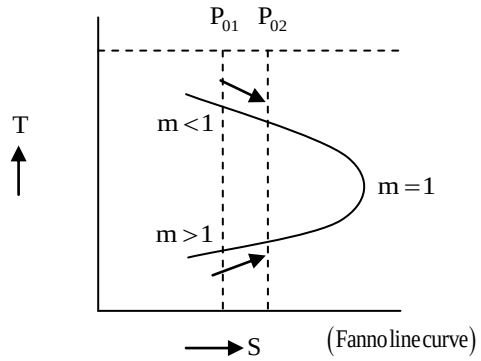
71. In a compressible flow with friction choking through a constant area duct with supersonic flow at inlet, if the pipe length is reduced with the same exit pressure

(A) Exit flow will still be sonic (B) The velocity at exit is subsonic

(C) The flow will still be supersonic (D) A shock will appear at the exit

Key: (C)

Exp:



Exit velocity is always subsonic, $M_2 < 1$ if $M_1 > 1$

72. When a converging–diverging nozzle is operated at off–design conditions, a normal shock forms in the diverging portion. The nozzle can be assumed to be perfectly insulated from the surroundings. Then across the shock

(A) The velocity undergoes a jump but pressure and entropy remain unchanged

(B) The pressure undergoes a jump but velocity and entropy remain unchanged

(C) The velocity and pressure undergo a jump, but entropy remains unchanged because there is no heat transfer

(D) Velocity, pressure and entropy all undergo a jump

Key: (D)

Exp: Pressure, velocity and entropy vary across the shock wave

73. Formation and collapse of vapour bubbles are believed to be the root cause for cavitations in hydraulic turbines. Most favourable condition for the formation of bubbles is set in the turbines at

(A) Penstock/Nozzle

(B) Guide vanes/Inlet of the runner

(C) Vanes receiving impact of jet

(D) Outlet of the runner/Entrance of the draft tube

Key: (D)

Exp: Formation of vapor bubbles is observed at Outlet of runner or entrance of the draft tube because pressure is minimum at entrance

74. For fully developed laminar flow through a circular pipe with Reynolds number Re the friction factor is

(A) Inversely proportional to Re (B) Proportional to Re

(C) Proportional to square of Re (D) Independent of Re

Key: (A)

Exp: $f = \frac{64}{Re} \Rightarrow f \propto \frac{1}{Re}$

75. Choked flow through an isentropic nozzle implies:
1. Discharge is maximum
2. Discharge is zero
3. Nozzle exit pressure ≤ critical pressure
4. Mach number at the throat is unity

Which of the above statements are correct?

(A) 1, 2, 3 and 4 (B) 1, 2 and 3 only (C) 1, 3 and 4 only (D) 2, 3 and 4 only

Key: (C)

Exp: Discharge is not zero and Nozzle exit pressure ≤ critical pressure

76. In a two stage gas turbine plant, with intercooling and reheating

(A) Both work ratio and thermal efficiency increase

(B) Work ratio increases but thermal efficiency decreases

(C) Thermal efficiency increases but work ratio decreases

(D) Both work ratio and thermal efficiency decrease

Key: (B)

Exp: With intercoling and reheating, work ratio increases, but efficiency decreases due to decrease in mean temperature of heat addition

77. The ratio of power outlet of the pump to the power input to the pump is known as

(A) Mechanical efficiency (B) Static efficiency

(C) Overall efficiency (D) Manometric efficiency

Key: (C)

Exp: Overall efficiency $\eta_0 = \frac{\text{Power output as pump}}{\text{Power input to pump}}$

78. A pump is defined as a device which converts

(A) Hydraulic energy into mechanical energy

(B) Mechanical energy into hydraulic energy

(C) Kinetic energy into mechanical energy

(D) None of the above

Key: (B)

Exp: Pump converts mechanical energy into hydraulic energy (in form of pressure energy)

79. The specific speed of a pump is defined as the speed of the unit of such a size that it

(A) Delivers unit discharge at unit head

(B) Requires unit power to develop unit head

(C) Delivers unit discharge at unit power

(D) Produces unit power with unit head available

Key: (A)

Exp: Specific speed is speed of geometrically similar pump which would deliver $1m^3/s$ as liquid against 1m head.

80. Negative slip occurs in reciprocating pumps, when delivery pipe is

(A) Long and suction pipe is short and pump is running at low speed

(B) Long and suction pipe is short and pump is running at high speed

(C) Short and suction pipe is long and pump is running at low speed

(D) Short and suction pipe is long and pump is running at high speed

Key: (D)

Exp: Negative slip occurs when delivery pipe is short, suction pipe is long and pump is running at high speed.

81. Consider the following statements:

1. The wheel can be operated freely in air
2. Pressure at the exit of the nozzle is atmospheric
3. Pressure does not vary along the moving vanes
4. Change in direction of momentum imparts thrust over moving vanes

Which of the above statements are applied to impulse turbine?

(A) 1, 2 and 3 only (B) 1, 2 and 4 only (C) 3 and 4 only (D) 1, 2, 3 and 4

Key: (D)

Exp: As the water flows over the vanes, the pressure is atmospheric from inlet to outlet of the turbine

Thrust over vanes is due to change in momentum of water jet

82. A water jet 0.0015 m^2 in area issues from a nozzle with 15 m/s velocity. It is made to impinge perpendicular on to a plate that moves away from the jet with a velocity of 5 m/s. The force on the plate due to this impact is

(A) 150 N (B) 1470 N (C) 340 N (D) 900 N

Key: (A)

Exp: Force on plate due to impact $(F)=\rho A(v_2-v_1)^2=10^3\times0.0015(15-5)^2=150\,N$

83. Consider the following statements with regard to hydraulic turbines:

1. Kaplan turbines are most efficient at part load operations
2. If n is the number of jets in a Pelton turbine, then the specific speed is proportional to n^2
3. The flow ratio of Francis turbines are in the range of 0.1 – 0.3

Which of the above statements is/are correct?

(A) 1, 2 and 3 (B) 1 and 2 only (C) 1 and 3 only (D) 2 and 3 only

Key: (C)

Exp: Regarding hydraulic turbines

Kaplan turbines are most efficient at part load

Flow ratio of Francis turbine is in the range of 0.1-0.3

Specific speed $\alpha \sqrt{n}$

84. A converging–diverging nozzle is operated at a pressure difference which is not the design value for isentropic flow. As a consequence a normal shock is formed in the diverging portion. In this situation the Mach number at the throat is

(A) Less than 1

(B) More that 1

(C) Exactly 1

(D) Could be less or more than 1 depending on the pressure difference

Key: (C)

Exp: At throat Mach number is always unity, irrespective of back pressure

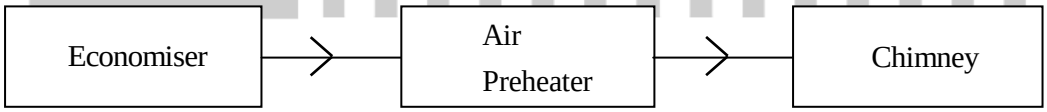
85. The air pre–heater of a boiler is located between

(A) Forced draft fan and furnace (B) Furnace and economizer

(C) Economizer and chimney (D) Superheater and furnace

Key: (A)

Exp:



Air preheater of boiler is located after economizer and chimney

86. A super critical boiler requires

(A) Only preheater and superheater (B) Preheater, evaporator and superheater

(C) Only preheater (D) Only superheater

Key: (A)

Exp: Preheater and supeheater are required for super critical boiler

87. The correct sequence of location of equipment in the flue gas path from furnace exit up to chimney is

(A) Superheater, economizer, air heater, electrostatic precipitator and induced draft fans

(B) Superheater, economizer, electrostatic precipitator, induced draft fans and air heater

(C) Superheater, electrostatic precipitator, economizer, air heater and induced draft fans

(D) Superheater, electrostatic precipitator, induced draft fans, economizer and air heater

Key: (A)

Exp: Correct sequence of location of equipment from furnace exit to chimney is

super heater – economizer – air preheater – electrostatic precipitator – induced draft fans - chimney

88. The main advantage of the water tube boiler over the fire–tube boiler is

(A) The water tube boiler can operate safely at higher pressure

(B) Soot deposition in the tubes is avoided

(C) Corrosion of the tubes is less

(D) Fouling of the tubes is reduced

Key: (A)

Exp: Water-tube boiler can operate under pressure as high as 100 bar compared to 16 – 20 bar for fire tube boiler.

89. A super critical boiler consists of only economizer and superheater and it does not have an evaporator because

(A) Water temperature can be raised to critical temperature in the economizer itself

(B) High evaporation rate is achieved through forced circulation of water through tubes

(C) Enthalpy of evaporation becomes zero at critical pressure or above that

(D) Flue gas used to run rotary compressor supply high pressure air to the furnace

Key: (C)

Exp: Evaporator is not required because above and at critical temperature enthalpy of evaporation is zero.

90. The effect of considering friction in steam nozzle for the same pressure ratio leads to

(A) Increase in dryness fraction of exit steam

(B) Decrease in dryness fraction of exit steam

(C) No change in the quality of exit steam

(D) Decrease or increase of dryness fraction of exit steam depending upon inlet quality

Key: (A)

Exp: Effect as friction is to increase the quality of stream at exit

91. In a half–degree reaction Parson's turbine, operating at design conditions, the enthalpy drop of steam in one stage of the turbine occurs

(A) Entirely in the fixed blades

(B) Entirely in the moving blades

(C) Half in the fixed blades and half in the moving blades

(D) None of the above

Key: (C)

Exp: Parson's reaction turbine is a 50% reaction turbine

92. The collection efficiency of cyclone separators increases with:
1. Decreasing particle size
2. Increasing particle density
3. Decreasing gas velocity
4. Increasing number of gas revolutions
5. Increasing cyclone diameter

Which of the above statements are correct?
(A) 1, 3 and 4 only (B) 2 and 4 only (C) 2, 4 and 5 only (D) 1, 2, 3, 4 and 5

Key: (B)

Exp: The collector efficiency of cyclone separator increase with increasing particle density as well as number of gas revolutions.

93. Reheating of steam in a steam power plant:
1. Increases the cycle efficiency
2. Reduces the turbine speed
3. Reduces blade erosion
4. Increases specific output

Which of the above statements are correct?
(A) 1, 2, 3 and 4 (B) 1, 2 and 3 only (C) 2 and 4 only (D) 1, 3 and 4 only

Key: (D)

Exp: Reheating doesn't influences turbine speed

94. Following points express the effect of keeping high clearance volume for the cylinders in reciprocating compressor. Which one of the following points is disagreeable?
(A) By increasing clearance volume volumetric efficiency decreases
(B) By increasing clearance volume power consumption increases
(C) By increasing clearance volume chances of piston striking cylinder head gets reduced
(D) By increasing clearance volume maximum compression pressure value decreases

Key: (B)

Exp: By increasing clearance volume power consumption increases

95. Consider the following statements:
1. Stalling is the separation of flow from the blade surface
2. Surging leads to physical damage due to impact loads and high frequency vibration
3. Mass flow rate is minimum if choking occurs

Which of the above statements are correct?
(A) 1, 2 and 3 (B) 1 and 3 only (C) 1 and 2 only (D) 2 and 3 only

Key: (C)

Exp: Mass flow rate is maximum if chocking occurs

96. Across the normal shockwave:

1. Stagnation pressure decreases whereas stagnation temperature remains constant
2. Mach number before the shock–wave is always greater than one and after the shockwave, the Mach number need not be less than one
3. Across the shockwave there is a rise in pressure and temperature
4. The product of Mach number downstream of normal shockwave and upstream of normal shockwave is always one

Which of the above statements are correct?

(A) 1 and 3 (B) 2 and 3 (C) 1 and 4 (D) 2 and 4

Key: (A)

Exp: After shock Mach number is always <1, and $M_1 \times M_2$ need note be 1

∴Statements 2 and 4 are incorrect

97. Which of the following statements are correct?

1. Velocity compounded impulse turbine gives less speed and less efficiency
2. For an ideal centrifugal compressor, the pressure produced depends on impeller velocity and diameter.
3. While flowing through the rotor blades in a gas turbine, the relative velocity of gas continuously decreases
4. While flowing through the rotor blades in an axial flow compressor, the relative velocity of air continuously decreases

(A) 1 and 3 (B) 2 and 3 (C) 1 and 4 (D) 2 and 4

Key: (C)

Exp: Velocity compounding is done to reduce rotor speed but it leads to low efficiency

Due to diffusion in diverging passages formed by rotor blade there is some pressure rise, which is at the expense of relative velocity. Thus relative velocity decreases from C_{r1} to C_{r2}

98. What is the power required to drive a centrifugal air compressor, when impeller diameter is 0.45 m and N is 7200 rpm

(A) 28.78 kW/kg/s (B) 30.78 kW/kg/s

(C) 27.78 kW/kg/s (D) 26.78 kW/kg/s

Key: (A)

Exp: $W = \frac{C_v^2}{1000}$ kw / kg / s

C_v = absolute velocity at the outlet of rotor

$$W = \frac{1}{1000}\left(\frac{\pi DN}{60}\right)^2$$

$$= \frac{1}{1000}\left[\frac{0.45 \times \pi \times 7200}{60}\right]^2$$

$$= 28.78 \text{ kW / kg / s}$$

99. Cooling of reciprocating compressor cylinder

1. Increases the volumetric efficiency
2. Increases the work input
3. Decreases the volumetric efficiency
4. Decreases the work input

Which of the above statements are correct?

(A) 1 and 3 (B) 2 and 3 (C) 3 and 4 (D) 1 and 4

Key: (D)

Exp: Cooling leads to increase in volumetric efficiency but decrease in work input

100. In supersonic flow of air, a diverging passage results in

(A) Increase in velocity and pressure

(B) Decrease in pressure and density

(C) Increase in velocity and density

(D) Decrease in velocity and pressure

Key: (B)

Exp: For M > 1 in diverging passage

$du > 0$ velocity increases

And from Euler's equation,

density, $d\rho < 0$ i..e, decreases and pressure also decreases

Directions:

Each of the next **Twenty (20)** items consists of two statements, one labelled as the 'Statement (I)' and the other as 'Statement (II)'. You are to examine these two statements carefully and select the answer to these items using the codes given below:

Codes:

(A) Both Statement (I) and Statement (II) are individually true and Statement (II) is the correct explanation of Statement (I)

(B) Both Statement (I) and Statement (II) are individually true but Statement (II) is not the correct explanation of Statement (I)

(C) Statement (I) is true but Statement (II) is false

(D) Statement (I) is false but Statement (II) is true

101. **Statement (I)** : Negative temperatures are impossible on the Kelvin scale
Statement (II) : The Kelvin scale is thermodynamic temperature scale

Key: (B)

Exp: Absolute zero $= 0\text{K} = -273.15^{\circ}\text{C}$ i.e., Negative temperatures are impossible on Kelvin scale and Kelvin scale is also called thermodynamic temperature scale.

102. **Statement (I)** : A breeder reactor does not require moderator
Statement (II) : The parasite absorption of neutrons is low.

Key: (A)

Exp: Breeder reactor doesn't require moderater because neutrons move with very large velocities and thus can not or absorbed in a very less amount.

103. **Statement (I)** : Property tables list different values of some properties for a substance at the same state as a result of using different reference states.
Statement (II) : The reference state chosen is of no consequence in thermodynamic process calculations as long as we use values from the single consistent set of tables.

Key: (C)

Exp: For one substance reference state for every property is the same
Thus statement I is wrong
Whereas II is correct

104. **Statement (I)** : In an air–conditioned room , the reflective coating should be on the inside of the window.
Statement (II) : Window pane glass is transparent to solar radiation

Key: (B)

105. **Statement (I)** : The coefficient of discharge for a mouthpiece is higher than that of an orifice
Statement (II) : The discharge through an orifice varies as $H^{1/2}$ whereas the discharge through a mouthpiece varies as $H^{2/3}$ (where H is the head causing the flow in both cases).

Key: (C)

Exp: Statement II is false

106. **Statement (I)** : A rocket engine can operate even in vacuum and in any fluid medium

Statement (II) : Rocket engine is a pure reaction engine which produces propulsive thrust

Key: (B)

Exp: Both are correct, rocket engine carries oxidizer with it so it can operate even in vacuum

107. **Statement (I)** : Both pressure and temperature across the normal shock increase

Statement (II) : The stagnation pressure across the normal shock decreases

Key: (B)

108. **Statement (I)** : When a given body floats in different liquids, the volume displaced will decrease with increase in the specific gravity of the fluid

Statement (II) : The weight of the floating body is equal to the weight of the volume displaced

Key: (A)

Exp: Both are correct

$F_B = \rho_{Liq} \times \text{Vol displaced} = s \times \rho_{water} \times \text{Vol. displaced}$

if s more $\leftrightarrow$ volume decreases

109. **Statement (I)** : The vertical boilers are used to save the floor space.

Statement (II) : Horizontal boilers are more efficient than vertical boilers

Key: (B)

110. **Statement (I)** : A. small insect can sit on the free surface of a liquid though insect's density is higher than that of the liquid

Statement (II) : Liquids have viscosity

Key: (B)

Exp: Insect can sit over free surface because of surface tension forces.

Both statements are correct.

111. **Statement (I)** : An SI engine requires greater spark advance at lower loads

Statement (II) : Increased dilution by residual gases at lower loads reduces the combustion rate

Key: (A)

112. **Statement (I)** : In Boiling Water Reactor (BWR) coolant serves the triple function of coolant, moderator and working fluid

Statement (II) : The steam flowing to the turbine is produced directly in the reactor core

Key: (A)

113. **Statement (I)** : Modern turbines have velocity compounding at the initial stages and pressure compounding in subsequent stages

Statement (II) : Excessive tip leakage occurs in the high pressure region of reaction blading

Key: (A)

114. **Statement (I)** : In CI engines increase of load decreases the knocking tendency

Statement (II) : Increase of load increases the temperature of mixture and thereby decrease in delay angle

Key: (A)

Exp: Both statements are correct & II is correct reason for I

115. **Statement (I)** : In Impulse turbines pressure change occurs only in the nozzles of the machine. The pressure of liquid does not change while flowing through the rotor of the machine

Statement (II) : The pressure of liquid changes while it flows through the rotor of the machine in Reaction turbine

Key: (B)

Exp: Both are correct but II is not correct explanation of I

116. **Statement (I)** : The efficiency of a boiler is more if it is provided with mechanical draught rather than with natural draught

Statement (II) : Natural draught is very costly but highly efficient

Key: (C)

Exp: II is wrong natural draught is not highly effective

117. **Statement (I)** : In common rail system, the nozzle construction must be closely matched to ensure equality of fuel discharge from cylinder to cylinder

Statement (II) : The discharge from the nozzles is regulated by the size of orifice and pressure drop

Key: (C)

Exp: It is wrong. Discharge is regulated by varying the length of the push rod stroke

118. **Statement (I)** : The term surge indicates a phenomenon of instability which takes place at low flow values and which involves an entire system including not only the centrifugal compressor, but also the group of components traversed by the fluid upstream and downstream of it

Statement (II) : Choking is defined as separation of fluid from the rotor blades of centrifugal compressor

Key: (C)

Exp: It is wrong, choking means means flow rate cannot be further increased

119. **Statement (I)** : The four stroke cycle internal combustion reciprocating engines run at higher speeds than the two stroke cycle engines

Statement (II) : The separate exhaust and intake strokes of the four stroke cycle engines provide greater opportunity for the dissipation of heat from critical parts such as piston

Key: (D)

Exp: I is false. Two stroke engine runs at higher speeds than four stroke engines.

120. **Statement (I)** : An impulse turbine can run without change in its hydraulic efficiency even if its casing is damaged

Statement (II) : An impulse turbine will not have draft tube

Key: (D)

Exp: Both statements are correct casing performs no hydraulic function