



UPPSC AE 2020 PAPER-2

Mechanical Engineering

Mega Mock Challenge
(May 23- May 24 2020)

Questions &
Solutions

1. Which of the following is the correct chronological sequence of struggles led by Gandhiji in India?
- Champan, Ahmedabad, Kheda
 - Kheda, Champan, Ahmedabad
 - Ahmedabad, Kheda, Champan
 - Champan, Kheda, Ahmedabad

Ans. A

Sol. Gandhiji arrived in India in **1915** and travelled across the country for two years before actively entering into politics.

- The correct chronological sequence of Gandhiji's struggles in India is-

- 1) **Champan** in **1917** in Bihar on request of Rajkumar Shukla.
- 2) **Ahmedabad Mill Strike** in **1918** in Gujrat for plague bonus of factory workers.
- 3) **Kheda Satyagrah** in **1918** in Gujrat for compensating drought hit farmers in Kheda.

2. The Battle of Chausa was fought between Humayun and _____.

- | | |
|-------------------|---------------------|
| A. Nadir Shah | B. Krishnadeva Raya |
| C. Sher Shah Suri | D. Hemu |

Ans. C

Sol. • The Battle of Chausa took place between Mughal Emperor Humayun and Sher Shah Suri on June 26, 1539 at **Chausa**, south west of Buxar in modern-day Bihar.

- In this battle Humayun got defeated .

3. Vajji Mahajanpada is located in_____.

- | | |
|-------------------|----------------|
| A. Madhya Pradesh | B. Bihar |
| C. Maharashtra | D. West Bengal |

Ans. B

Sol. • **Vajji or Vrajhi** was one of the 16 Mahajanapadas of ancient India.

- It originated by joining several small states.
- Its capital was **Vaishali**.
- It was located on the north of **River Ganga in Bihar**.

4. Which Kushana dynasty's ruler was known as Second Ashoka?

- | | |
|---------------|-------------|
| A. Vasishka | B. Huvishka |
| C. Vasudeva I | D. Kanishka |

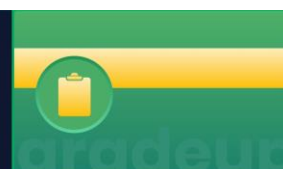
Ans. D

Sol. • **Kanishka** was the most famous ruler of Kushana dynasty.

- He was also known as **second Ashoka**.
- He has two capitals-**Purushpur and Mathura**.
- He started an era in 78 AD, which is now known as Saka era and is used by Government of India.

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5. The first charter act of India was passed in which year?

- A. 1777
- B. 1783
- C. 1793
- D. 1803

Ans. C

Sol. * **The first charter act of India was passed in 1793.**

- * It continued the company's trade monopoly in India for another 20 years.
- * This Act separated the revenue administration and the judiciary functions of the company.
- * Major charter acts are- Charter Act of 1793, Charter Act of 1813, Charter Act of 1833, Charter Act of 1853 and Charter Act of 1858.

6. The concept of union territories was introduced by which constitutional amendment?

- A. Sixth
- B. Seventh
- C. Eighth
- D. Eleventh

Ans. B

Sol. • **The concept of union territories was introduced by the seventh constitutional amendment.** This amendment was done on 1 Nov 1956.

- The Andaman and Nicobar Islands was the first union territory of India.
- Union Territories are special administrative sectors in the republic of India which operate directly under the central government.

7. Which article deals with prohibition of the slaughter of cows, calves and draught cattle?

- A. Article 32
- B. Article 48
- C. Article 53
- D. Article 148

Ans. B

Sol. • **Article 48** deals with prohibition of the slaughter of cows, calves and draught cattle.

- **Article 32** of the Indian Constitution gives the right to individuals to move to the Supreme Court to seek justice.

- **Article 53** deals with Executive power of the Union.

- **Article 148** is related to the Comptroller and Auditor General of India.

8. The President may resign from his office by writing under his hand addressed to the:

- A. Vice President
- B. Prime Minister of India
- C. Speaker of the Lok Sabha
- D. Chief Election Commissioner

Ans. A

Sol. • **Under article 56**, the President shall hold office for a term of five years from the date on which he enters upon his office.

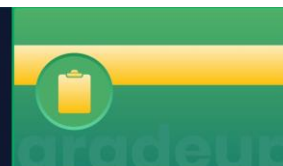
- He may resign from his office by writing under his hand addressed to the Vice-President.

9. Khadi and Village Industries Commission was founded in which year?

- A. 1957
- B. 1956
- C. 1958
- D. 1955

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Ans. B

- Sol. • The Khadi and Village Industries Commission (KVIC) is a statutory body.
- It was formed by the Government of India, under the Act of Parliament, '**Khadi and Village Industries Commission Act of 1956**'.
 - It is an apex organisation under the Ministry of Micro, Small and Medium Enterprises.
 - It is headquartered in **Mumbai, Maharashtra**.

10. Which state is the largest producer of Gypsum in India?

- | | |
|----------------|--------------|
| A. West Bengal | B. Rajasthan |
| C. Bihar | D. Jharkhand |

Ans. B

- Sol. • Rajasthan is considered as the largest producer of gypsum in India.
- Rajasthan produces 99 percent of India's total production of gypsum.
 - The remaining gypsum is produced by Tamil Nadu, Jammu and Kashmir, Gujarat and Uttar Pradesh in order of production.

11. Barren Island, the active volcano, is located in _____.

- | | |
|------------------------|----------------------|
| A. Andaman Islands | B. Nicobar Islands |
| C. Lakshadweep Islands | D. None of the above |

Ans. A

Sol. **Barren Island is located in Andaman Islands archipelago.**

- Barren Island is the only active volcano in South Asia. It belongs to North and Middle Andaman administrative district of Andaman and Nicobar Islands.
- Narcondam Volcano is also situated in Andaman and Nicobar Islands but it is a dormant volcano.
- The volcano here was dormant for a long time, but in the year 1991, it experienced an explosion which was quite major and it again erupted in 2017.

12. Which of the following is NOT a part of the Meghalaya Plateau?

- | | |
|------------------|----------------|
| A. Palamu Hills | B. Khasi Hills |
| C. Jaintia Hills | D. Garo Hills |

Ans. A

- Sol. • **Palamu hills** are located in Jharkhand and are not a part of Meghalaya Plateau.
- **Meghalayan Plateau** is an extension of Indian peninsular plateau.
 - The western, central and the eastern parts of the plateau are known as the **Garo Hills, the Khasi-Jaintia Hills and the Mikir Hills**.
 - Meghalayan Plateau is rich in **coal and uranium deposits**.
 - **Cherrapunji and Mawsynram**, located in the Khasi hills, are the wettest places in India and are a part of the plateau.

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13. As per the Census of 2011 which district of India is the most populous?

- A. Theni, Tamil Nadu
- B. Thane, Maharashtra
- C. Churu, Rajasthan
- D. Ghaziabad, Uttar Pradesh

Ans. B

Sol. • As per the Census of 2011, **Thane district of Maharashtra** is the most populated district of India.

- Thane with population of **1.1 Crore** is the most populated district of India.
- **North Twenty Fourth Pargana in West Bengal** is the second most populous district of India with a population of 1.08 Crore.

14. In which state has the Jawara Dance, a dance form to celebrate wealth, originated?

- A. Gujarat
- B. Madhya Pradesh
- C. Kerala
- D. Rajasthan

Ans. B

Sol. • Jawara Dance is a dance form to celebrate wealth in **Bundelkhand region of Madhya pradesh.**

- It is also known as the Harvest Dance.
- The women carry a basket full of Jawara crop on their heads while performing the dance.

15. Wembley Stadium is located in_____.

- A. London
- B. Washington DC
- C. Mexico
- D. Beijing

Ans. A

Sol. • Wembley Stadium is located in **Wembley, London.**

- It was opened in **2007**.
- It is a football stadium. The stadium hosts major football matches including home matches of the England national football team, and the FA Cup Final.
- It is the most iconic stadium in world football.
- The stadium has a seating capacity of over 90000 people.

16. The National Charkha Museum is located at which place?

- A. Calcutta
- B. Ahmedabad
- C. Gandhinagar
- D. New Delhi

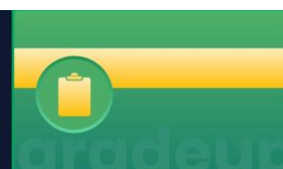
Ans. D

Sol. • **The National Charkha Museum is located in Connaught Place, New Delhi.**

- It has been jointly constructed by the New Delhi Municipal Council and the Khadi Development and Village Industries Commission.
- The Museum was inaugurated on **May 21, 2017 by the then BJP National President Amit Shah.**

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17. Which organization of UNO aims at building space through International Cooperation of Education, Science and Culture?

- | | |
|-----------|----------|
| A. FAO | B. WIPO |
| C. UNESCO | D. UNHCR |

Ans. C

Sol. • The United Nations Education, Scientific and Cultural Organization is a specialised agency which aims at building space through International Cooperation in Education, Science and Culture.

- UNESCO has 193 members and 11 associate members.
- UNESCO has five major objectives:

A) Education

B) Natural Sciences

C) Social Sciences

D) Culture

E) Communication

- UNESCO's aim is "to contribute to the building of peace, the eradication of poverty, sustainable development and intercultural dialogue through education, the sciences, culture, communication and information".

18. The book "Mother India" was written by _____

- | | |
|------------------|-------------------|
| A. B.R Ambedkar | B. Mahatma Gandhi |
| C. Amrita Pritam | D. Katherine Mayo |

Ans. D

Sol. • The book 'Mother India' was published in 1927.

- It was a polemical book by the American author Katherine Mayo.
- In her book, She attacked society, religion and culture of India.
- The book pointed to the treatment of India's women, the untouchables, animals, dirt, and the character of its nationalistic politicians.
- Katherine Mayo was an American researcher and historian.

19. The process of absorption of digested food in the bloodstream is known as _____.

- | | |
|-----------------|--------------|
| A. Digestion | B. Ingestion |
| C. Assimilation | D. Egestion |

Ans. C

Sol. • **Egestion** is the process of discharging waste material from body.

- **Digestion** is the process of breaking larger food particles into smaller one.
- **Ingestion** is the process of taking in food.
- **Assimilation** is process of absorption of digested food in the bloodstream.

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20. The first Kirchhoff's current law states that "current flowing into a node must be _____ current flowing out of it.

- A. Less than
B. More than
C. Equal to
D. Either more or equal to

Ans. C

Sol. • **Kirchhoff's first current law states that current flowing into a node must be equal to current flowing out of it.**

- It is statement of conservation of charge and energy in a circuit. As, charge cannot be created or destroyed at a junction, So whatever current enters a given junction in a circuit must leave that junction.

21. Recently which country launched its first military satellite 'Noor'?

- A. Pakistan
B. Iran
C. Iraq
D. Afghanistan

Ans. B

Sol. * Recently **Iran** launched its first military satellite '**Noor**'.

- * The satellite is launched by **Ghased Launcher**.
- * The Satellite was launched by **Iran's Islamic Revolutionary Guard Corps (IRGC)**.
- * IRGC is operates its own military infrastructure in parallel to armed forces and answerable only to Leader **Ayatollah Ali Khamenei**.
- * The US administration has warned that the technology used to launch satellites could help Iran develop Inter Continental Ballistic Missiles

22. Which is the most commonly used nail polish remover?

- A. Acetone
B. Sodium borate
C. Boric Acid
D. Methyl alcohol

Ans. A

Sol. • The most commonly used nail polish remover is **Acetone**.

- Acetone can also remove artificial nails made of acrylic gel.
- Acetone is a colorless, volatile, flammable liquid and the simplest ketone.

23. Ayushman Bharat Diwas is celebrated on _____.

- A. 22 March
B. 25 April
C. 30 April
D. 25 September

Ans. C

Sol. • **Ayushman Bharat Diwas is celebrated on 30th April.**

- Ayushman Bharat is a centrally sponsored scheme launched in 2018 under Ayushman Bharat Mission. Under this mission, National Health Protection Scheme and Wellness Centres were introduced.

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- National Health Protection Scheme aimed at covering around 10 crore poor and vulnerable families providing coverage up to 5 lakh rupees per family per year for secondary and tertiary care hospitalization.

24. In Microsoft Word shortcut key Ctrl+W is used for?

- A. To underline selected text
- B. To close the currently open document
- C. To save the open document
- D. None of these

Ans. B

Sol. • In Microsoft Word shortcut key Ctrl+W is used for to **close the currently open document**.

- By using this shortcut key we can Closes the active window, but does not Exit Word.
- Ctrl+U is used to underline the selected text.
- Ctrl+S is used to save the open document.

25. The three-day fourth International Diabetes Summit was held from **March 6 to 8, 2020** in_____.

- A. Bengaluru
- B. Mumbai
- C. New Delhi
- D. Pune

Ans. D

Sol. * The three-day Fourth International Diabetes Summit was held from **March 6 to 8, 2020**, in **Pune, Maharashtra**.

* It was organised by the **Chellaram Diabetes Institute**.

* The Chellaram Diabetes Institute (CDI) is well known for its commitment towards the fight against Diabetes organized International Diabetes Summits for three consecutive years.

26. Match **List-I (process)** with **List-II (predominant parameter associated with the process)** and select the correct answer using the codes given below:

List-I:

- (A). Mass transfer
- (B). Forced convection
- (C). Free convection
- (D). Transient conduction

List-II:

- (1). Reynolds number
- (2). Sherwood number
- (3). Mach number
- (4). Biot number
- (5). Grashoff number

- A. A-1, B-2, C-3, D-4
- C. A-3, B-4, C-5, D-1

- B. A-2, B-1, C-5, D-4
- D. A-2, B-1, C-5, D-3

Ans. B

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29. Which of the following is NOT correct for the refrigerant absorption mixture used for the vapor absorption refrigeration system _____?
- The mixture should exhibit a positive deviation from Raoult's Law.
 - It should have small heat of mixing.
 - There should be large difference in boiling points of refrigerant & absorbent.
 - High thermal conductivity.

Ans. A

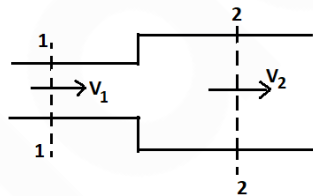
- Sol. • The refrigerant absorbent mixture used in vapor absorption system (VARS) should exhibit negative deviation from Raoult's Law.
- It should have small heat of mixing for achieving high COP.
 - There should be large difference in boiling points of refrigerant & absorbent.
 - High thermal conductivity of the refrigerant.

30. The head loss in a sudden expansion from 6 cm diameter pipe to 12 cm diameter pipe in terms of velocity V_1 in the smaller diameter pipe is _____.

- $\frac{3}{16} \cdot \frac{V_1^2}{2g}$
- $\frac{5}{16} \cdot \frac{V_1^2}{2g}$
- $\frac{7}{16} \cdot \frac{V_1^2}{2g}$
- $\frac{9}{16} \cdot \frac{V_1^2}{2g}$

Ans. D

Sol. Losses due to sudden enlargement :



$$h_e = \frac{1}{2g} (V_1 - V_2)^2$$

Given: $d_1 = 6 \text{ cm}$

$d_2 = 12 \text{ cm}$

From the continuity equation:

$$A_1 V_1 = A_2 V_2$$

$$V_2 = \frac{A_1}{A_2} V_1$$

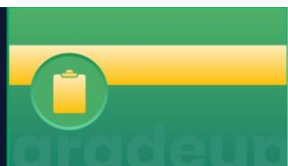
$$V_2 = \frac{36}{144} V_1 = \frac{V_1}{4}$$

$$h_e = \frac{1}{2g} \left(V_1 - \frac{V_1}{4} \right)^2$$

$$h_e = \frac{9}{16} \frac{V_1^2}{2g}$$

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31. Which of the following is the steady flow energy equation for a boiler _____?

A. $h_1 + \frac{v_1^2}{2gJ} = h_2 + \frac{v_2^2}{2gJ}$

B. $Q = (h_2 - h_1)$

C. $h_1 + \frac{v_1^2}{2gJ} + Q = h_2 + \frac{v_2^2}{2gJ}$

D. $w_s = (h_2 - h_1) + Q$

Ans. B

Sol. According to steady flow energy equation for per unit mass between state '1' and '2':

$$h_1 + \frac{1}{2}v_1^2 + gh_1 + Q = h_2 + \frac{1}{2}v_2^2 + gh_2 + W$$

In boiler we can neglect change in kinetic energy and potential energy and work done is zero. Thus:

$$h_1 + Q = h_2$$

$$\Rightarrow Q = h_2 - h_1$$

32. Consider the following statements:

- 1) The knock tendency of diesel engine fuel is given by cetane number.
- 2) Cetane number is defined as percentage by mass of normal cetane in a mixture of normal cetane and α - methyl naphthalene.
- 3) Alpha methyl Naphthalene has cetane number of zero.

Which of the following statements is/are incorrect _____?

A. 1 and 2 only

B. 2 and 3 only

C. 2 only

D. 3 only

Ans. C

Sol. • The knock tendency of diesel engine fuel is given by cetane number.

• Cetane number is defined as percentage by volume of normal cetane in a mixture of normal cetane and α - methyl naphthalene.

• Alpha methyl Naphthalene has cetane number of zero.

33. Which of the following cycles has unequal expansion & Compression strokes _____?

A. Stirling Cycle

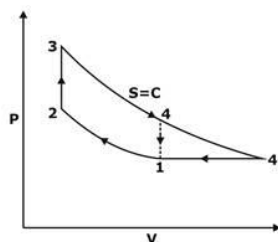
B. Atkinson cycle

C. Joule Cycle

D. Ericsson cycle

Ans. B

Sol.



Atkinson cycle is commonly used to describe any cycle in which expansion stroke is greater than the compression stroke.

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34. If the velocity distribution in a turbulent boundary layer is given by $\frac{u}{u_{\infty}} = \left(\frac{y}{\delta}\right)^{\frac{1}{8}}$, then ratio of displacement thickness to nominal boundary layer thickness will be _____.

A. 1/9
B. 1/8
C. 1/7
D. 1/4

Ans. A

Sol. Displacement thickness (δ^*) is given by:

$$\delta^* = \int_0^{\delta} \left(1 - \frac{u}{u_{\infty}}\right) dy$$

$$\delta^* = \int_0^{\delta} \left(1 - \left(\frac{y}{\delta}\right)^{\frac{1}{8}}\right) dy$$

$$= \left[y - \frac{y^{\frac{1}{8}+1}}{\frac{9}{8}\delta^{\frac{1}{8}}} \right]_0^{\delta} = \left[(\delta - 0) - \frac{8\delta^{\frac{9}{8}}}{9\delta^{\frac{1}{8}}} + 0 \right]$$

$$= \delta - \frac{8}{9}\delta$$

$$\delta^* = \frac{\delta}{9} \Rightarrow \frac{\delta^*}{\delta} = \frac{1}{9}$$

35. The mean piston speed \bar{S}_p in the internal combustion engines lies in the range of _____.
- A. 4 to 8 m/s
B. 8 to 15 m/s
C. 10 to 30 m/s
D. 16 to 35 m/s

Ans. B

Sol. Mean piston speed \bar{S}_p is given by:

$$\bar{S}_p = 2 LN \text{ m/min}$$

Where L is the stroke and N is the rotational speed (in rpm) of the crankshaft.

Resistance to gas flow in to the engine or stresses due to inertia of the moving parts limit maximum values of \bar{S}_p to within 8 to 15 m/s.

36. Which of the following is the correct relation of fill form factor _____.

A. $FF = \frac{V_m I_m}{V_{OC} I_{SC}}$

B. $FF = \frac{V_m}{I_m} \times \frac{I_{SC}}{V_{OC}}$

C. $FF = \frac{I_m}{I_{SC}} \times \frac{V_{OC}}{V_m}$

D. $FF = \frac{I_{SC} V_{OC}}{V_m I_m}$

Ans. A

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Sol. "Fill form factor":

Fill form factor (FF), which indicates the quality of cell, is defined as the peak power to the product of open circuit voltage and short circuit current i.e.

$$FF = \frac{V_m I_m}{V_{OC} I_{SC}}$$

V_{OC} = open circuit Voltage

I_{SC} = Short circuit current

37. Which of the following is the correct relation for heat rejection ratio (HRR) in a refrigerator _____.

A. $HRR = 1 + (COP)_{ref}$

B. $HRR = 1 - (COP)_{ref}$

C. $HRR = 1 + \frac{1}{(COP)_{ref}}$

D. $HRR = 1 - \frac{1}{(COP)_{ref}}$

Ans. C

Sol. For a refrigerator:

$$\text{Heat rejection ratio (HRR)} = \frac{Q_C (\text{Heat rejected in condenser})}{Q_E (\text{Heat absorbed in evaporation})}$$

$$HRR = \frac{W_{in} + Q_E}{Q_E}$$

$$HRR = 1 + \frac{W_{in}}{Q_E}$$

$$\text{Since } (COP)_{Ref} = \frac{Q_{Ref}}{W_{in}}$$

$$HRR = 1 + \frac{1}{(COP)_{Ref}}$$

Thus, HRR is always greater than one.

38. In case of a hydraulic ram, which among the following caters the function of behaving it as pumping device _____?

A. Centrifugal Effect

B. Reciprocating effect

C. Impulse effect

D. Hydraulic cylinder

Ans. C

Sol.

- A hydraulic ram pump is a water pump powered by water with a height difference. **Example:** In areas where natural flows exist with a height difference of the water over a small distance, hydraulic ram pumps can be used to transport water to higher grounds without using electricity or fuel.
- The hydraulic ram uses the water hammer effect (Impulse) to develop pressure that allows a portion of the input water that powers the pump to be lifted to a point higher than where the water originally started.

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39. Entropy is a measure of _____.

- A. Reversible heat transfer B. System efficiency
C. Degree of randomness D. System temperature

Ans. C

Sol.

- Entropy is a thermodynamic property that measures the degree of randomization or disorder at the microscopic level.
- It is explained by second law of thermodynamics which says that the energy degrades to less useful form while conversion.

40. Which one of the following types of nuclear reactor does not require a heat exchanger _____?

- A. Boiling water B. Pressurized water
C. Sodium cooled D. Gas cooled.

Ans. A

Sol. • In the boiling water reactor (BWR), the water in the reactor core is permitted to boil under a pressure of 75 atmospheres, raising the boiling point to 285 °C and the steam generated is used directly to drive a steam turbine. Thus, there is no heat exchanger used.

- Steam pressure and temperature are low compared to a modern coal-fired power plant and the steam turbine is generally very large. Thus, BWRs have capacities up to 1400 MW and an efficiency of around 33%.

41. In a reaction turbine the heat drop in fixed blade is 7 kJ/kg and the total heat drop per stage is 24 kJ/kg. The degree of reaction of the turbine is _____.

- A. 29.17 % B. 70.83%
C. 41.176% D. 54.84%

Ans. B

Sol. For a reaction turbine:

$$\text{Degree of reaction (R)} = \frac{\Delta h_{\text{moving}}}{\Delta h_{\text{total}}} = \frac{\text{Enthalpy drop in moving blades}}{\text{Total enthalpy drop}}$$

$$\Delta h_{\text{moving}} = \Delta h_{\text{total}} - \Delta h_{\text{fixed}}$$

$$\Delta h_{\text{moving}} = 24 - 7 = 17 \text{ kJ/kg}$$

$$R = \frac{17}{24} = 0.70833$$

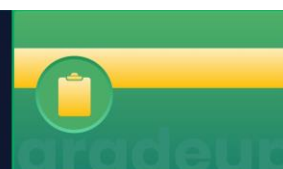
$$R = 70.833\%.$$

42. According to Gay-Lussac's law for perfect gases, the absolute pressure of given mass varies directly as _____.

- A. Temperature
B. Absolute temperature
C. Absolute temperature, if volume remains constant
D. Product of absolute temperature and volume

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Ans. C

Sol. Gay Lussac's law of gaseous volume, states that, at constant volume, pressure of a given mass of a gas varies directly with the temperature.

$$P \propto T$$

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

43. Compounding of steam turbine is done for _____.

- A. Reducing the work done B. increasing the rotor speed
C. Reducing the rotor speed. D. Balancing the turbine.

Ans. C

Sol. Compounding of steam turbines is done for reducing the rotor speed. The following three methods are commonly employed for reducing the rotor speed:

- (i). Velocity compounding (Ex: Deval turbine)
(ii). Pressure Compounding (Ex: Rateau turbine)
(iii). Velocity and Pressure Compounding (Ex: Curtis turbine).

44. The maximum efficiency of Parson's turbine for nozzle angle of 30° is _____.

- A. 93.30% B. 75%
C. 85.71% D. 87.5 %

Ans. C

Sol. The maximum efficiency of Parson's turbine is given by:

$$\eta_{\max} = \frac{2 \cos^2 \alpha}{1 + \cos^2 \alpha}$$

Where α = Nozzle angle

$$\eta_{\max} = \frac{2 \cos^2 30^\circ}{1 + \cos^2 30^\circ}$$

$$= 0.8571$$

$$= 85.71 \%$$

45. Calculate the fuel injection velocity V_{inj} (in m/s) if fuel is injected at a rate 0.3 kg/s with pressure of 180 bar. The fuel has 45 °API. The pressure in combustion chamber is 20 bar

and coefficient of velocity is 0.90. The specific gravity of fuel is given by $S.G. = \frac{140}{130 + ^\circ API}$.

- A. 180 B. 200
C. 162 D. 222.22

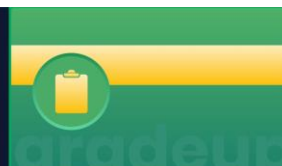
Ans. A

Sol. Since velocity of injection is given by:

$$V_{inj} = C_v \sqrt{\frac{2(P_{inj} - P_{cy})}{\rho_f}}$$

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Given: $C_v = 0.90$

$P_{inj} = 180 \text{ bar} = 20 \times 10^5 \text{ bar}$

$P_{cyl} = 20 \text{ bar} = 20 \times 10^5 \text{ bar}$

Now $S.G. = \frac{140}{130 + ^\circ\text{API}} = \frac{140}{130 + 45}$

$S.G. = 0.8$

Thus, $\rho_f = 800 \text{ kg/m}^3$

$V_{inj} = 0.90 \times \sqrt{\frac{2 \times (180 - 20) \times 10^5}{800}} = 180 \text{ m/s}$

46. Which of the following batteries has the longest battery life (in number of cycles) in Photo voltaic (PV) applications _____?

- A. Lead Acid battery. B. Ni – Cd battery
C. Lithium ion Battery D. Nickel metal hydride battery.

Ans. B

Sol.

Battery type	Battery life (in no. of cycles)
Lead Acid	700
Ni-Cd	1000 to 1500
Lithium Iron	500 to 1000
Nickel metal hydride	500

47. The solar heat pipe works on the principle of _____.

- A. Heating and Condensation cycle B. Evaporation and condensation cycle
C. Cooling and condensation cycle D. Heating and evaporation cycle.

Ans. B

Sol. • The operation of heat pipe is based on thermodynamic properties of fluid vapourizing at one end and condensing at another end.

- The boiling & condensation process are associated with extremely high heat transfer coefficients.

For water, $K_{eff} = 1,00,000 \text{ W/m-K}$

48. In nuclear power reactor, control rods are not made of _____.

- A. cadmium B. arsenic
C. hafnium D. boron

Ans. B

Sol.

- Control rods are used for maintaining the desired state of fission reactions within a nuclear reactor.
- Control rods are made of neutron absorbing material such as cadmium, hafnium and boron.

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49. The comfort conditions in air conditioning system are defined by _____.

- A. 22°C dbt and 60% RH B. 25°C dbt and 100% RH
C. 20°C dbt and 75% RH D. 27°C dbt and 75% RH

Ans. A

Sol.

- Human beings feel comfort between a dry bulb temperature of 24–26°C and 50–60% relative humidity.

50. What is the main purpose of supercharging the engine _____?

- A. To reduce the mass of the engine per brake power.
B. To reduce specific fuel consumption, in turbocharging
C. To increase mechanical efficiency
D. All of the above.

Ans. D

Sol. • Supercharging is the process of supplying the intake air at a density greater than the density of surrounding atmosphere.

Purpose:

- To improve engine power output i.e., mechanical efficiency.
- Reduced specific fuel consumption, in turbocharging.
- To reduce the mass of the engine per brake power.

51. Lumped Heat-transfer analysis of a solid object suddenly exposed to a fluid medium at a different temperature is valid when _____.

- A. Biot number < 0.1 B. Biot number > 0.1
C. Fourier number < 0.1 D. Biot number < 0.01

Ans. A

Sol. Biot number is the ratio of internal conduction resistance to the surface convection resistance.

$$Bi = \frac{hL_c}{K_{solid}} = \frac{\frac{L_c}{K_{solid}A}}{\frac{1}{hA}} = \frac{\text{Internal conduction thermal resistance}}{\text{surface convection resistance}}$$

If the value of thermal conductivity is very large or conduction resistance is negligible as compared to surface convection resistance, then the whole matter will be at the same temperature. Thus, Biot number must be less than 0.1 for lumped analysis to be valid.

52. On a U-V diagram, triple point is a _____.

- A. a point B. a line
C. a triangle D. not present

Ans. C

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Sol. **Triple point:**

- The "triple point" is the point at which the liquid, solid, and vapor phases can exist together.
- On P-V or T-V diagrams, these triple-phase states form a line called the triple line.
- On P-T diagram, triple point is a point.
- On U-V diagram, it is a triangle.

53. A body weighs 30 N and 15 N when weighed under submerged conditions in liquids of relative densities 0.8 and 1.2 respectively. What is the volume of the body in litres?

- A. 12.50
B. 3.82
C. 18.70
D. 75.50

Ans. B

Sol. When a body is submerged in a fluid, then the weight measured is the net result of the actual body weight and Buoyancy force.

$$\text{Weight measured} = \text{Actual weight (W)} - \text{Buoyancy force (F}_B\text{)}$$

$$W - \rho_l V_d g = W_{measured}$$

For submerged body: $V_d = V$

For liquid 1: $\rho_{l,1} = 0.8 \times 1000 = 800 \text{ kg/m}^3$

For liquid 2: $\rho_{l,2} = 1.2 \times 1000 = 1200 \text{ kg/m}^3$

$$W - 800 \times V \times 9.81 = 30 \quad \dots\dots\dots (1)$$

$$W - 1200 \times V \times 9.81 = 15 \quad \dots\dots\dots (2)$$

Subtract the equation (2) from equation (1):

$$400 \times V \times 9.81 = 15$$

$$V = 3.822 \times 10^{-3} \text{ m}^3 = 3.822 \text{ litres}$$

54. What is the speed of sound in Neon gas at a temperature of 500 K (Gas constant of Neon is 0.4210 kJ/kg-K) _____?

- A. 492 m/s
B. 460 m/s
C. 592 m/s
D. 543 m/s

Ans. C

Sol. Since speed of sound variation with temperature (T) is given by:

$$c = \sqrt{\frac{\gamma \overline{RT}}{M}} = \sqrt{\gamma RT}$$

Where:

M = The molecular weight of the gas (in kg/mol)

T = temperature of gas in K

$$\overline{R} = \text{Universal gas constant}$$

R = Gas constant

$$c = \sqrt{1.67 \times 0.4210 \times 10^3 \times 500} = 592.90 \text{ m/s}$$

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55. A gas mixture consists of 4 kg of O_2 , 6 kg of N_2 and 15 kg of CH_4 . The mass fraction and mole fraction of N_2 are_____.
- A. 0.24 and 0.287
B. 0.24 and 0.167
C. 0.24 and 0.265
D. 0.16 and 0.287

Ans. B

Sol. Given: $m_{CO_2} = 15 \text{ kg}$

$$m_{O_2} = 4 \text{ kg}$$

$$m_{N_2} = 6 \text{ kg}$$

For N_2 :

$$\text{Mass fraction}(\alpha) = \frac{m_{N_2}}{m_{N_2} + m_{CO_2} + m_{O_2}}$$

$$\alpha = \frac{6}{6 + 4 + 15} = 0.24$$

$$\text{mole fraction (m)} = \frac{n_{N_2}}{n_{O_2} + n_{CO_2} + n_{N_2}} = \frac{\frac{6}{28}}{\frac{4}{32} + \frac{15}{16} + \frac{6}{28}}$$

Mole fraction (m) = 0.167

56. Which of the following fuel cell has the highest operating temperature _____?
- A. Phosphoric Acid fuel cell B. Alkaline fuel cell
- C. Solid polymer fuel cell D. Solid oxide fuel cell.

Ans. D

Sol.

Type of fuel cell	Operating temperature
Phosphoric Acid fuel cell (PAFC)	150°C to 200°C
Alkaline fuel cell	90°C
PEMFC or Solid polymer fuel cell (SPFC)	40°C to 60°C
Solid oxide fuel cell (SOFC)	600°C to 1000°C

57. The energy of an isolated system always _____.
- A. increases B. Constant
- C. varies depending upon heat transfer D. decreases

Ans. B

Sol. According to first law of thermodynamics:

$$\delta Q = dE + \delta W \quad \dots\dots\dots(1)$$

For isolated system, there is no mass and heat transfer takes place across the boundary.

$$\delta Q = 0, \quad \delta W = 0$$

Thus, from equation (1):

$$0 = dE + 0$$

$E = \text{constant}$

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Ans. B

Sol. **Assumptions of Bernoulli equation:**

- (1). Along a Streamline - Bernoulli's equation can only be used along a streamline i.e. only between points on the same streamline.
- (2). Inviscid flow - Energy loss due to viscous affects is small.
- (3). Stead State - The velocity of the flow (V_{Fluid}) is not a function of time.
- (4). Incompressible and irrotational fluid.

61. Consider the following statements regarding the bomb calorimeter:

- 1) Bomb calorimeter is used for determining calorific value of solid fuels only.
- 2) Bomb calorimeter is used for determining calorific value of solid as well as liquid fuel.
- 3) It measure higher calorific value of fuel at constant pressure.

Which of the following statements is/are correct?

- | | |
|-----------------|-----------------|
| A. 1 only | B. 2 only |
| C. 1 and 3 only | D. 2 and 3 only |

Ans. B

Sol. • Bomb calorimeter is used to determine higher calorific value of liquid as well as solid fuels.
• It measures higher calorific value of fuel at constant volume.

62. The band gap for GaAs at 300°K is _____.

- | | |
|------------|------------|
| A. 1.12 eV | B. 1.5 eV |
| C. 1.43 eV | D. 1.70 eV |

Ans. C

Sol.

Element or compound	Name	Band (eV @ 300°K)
C	Carbon	5.5
Ge	Germanium	0.67
Si	Silicon	1.12
GaAs	Gallium Arsenide	1.43
CdTe	Cadmium Telluride	1.50

63. Which of the following statements is incorrect about MHD generator?

- A. The working fluid of MHD generator is a liquid metal.
- B. Its principle of power generation is based on Faraday's effect.
- C. The MHD generator operates at a temperature of about 2700°C
- D. One of the main disadvantages is that it is very noisy.

Ans. D

Sol. • The working fluid of MHD generator is a liquid metal and its principle of power generation is based on Faraday's effect.
• The MHD generator operates at a temperature of about 2700°C.
• MHD generators do not use moving parts. Thus, there is no issue of noise associated with it.

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64. Helmholtz function(F) is applicable for _____.
 A. closed system B. open system
 C. both closed or open system D. isolated system

Ans. A

Sol.

- Helmholtz free energy in thermodynamics is a thermodynamic potential which is used to measure the work of a closed system with constant temperature and volume.
- Its mathematical form is given by: $F = U - TS$
 F is the Helmholtz free energy in Joules
 U is the internal energy of the system in Joules
 T is the absolute temperature of the surroundings in Kelvin
 S is the entropy of the system in joules per Kelvin

65. A centrifugal pump running at N rpm deliver Q amount of water at a Head h. The dimensionless specific speed of pump is given by (g is the acceleration due to gravity) _____.

- A. $\frac{NQ^2}{gH}$ B. $\frac{NQ^{1/2}}{(gH)^{3/4}}$
 C. $\frac{NQ^{1/2}}{(gH)^{5/4}}$ D. $\frac{Np^{1/2}}{(gH)^{3/4}}$

Ans. B

Sol. Dimensionless specific speed of pump is given by:

$$(N_s)_{\text{dimensionless}} = \frac{NQ^{1/2}}{(gH)^{3/4}}$$

While, specific speed of pump having dimension is given by:

$$(N_s)_{\text{with dimension}} = \frac{NQ^{1/2}}{H^{3/4}}$$

66. Nusselt is the ratio of _____.
 A. Convection resistance offered by fluid to conduction resistance offered by fluid
 B. Convection resistance offered by fluid to conduction resistance offered by solid body
 C. Conduction resistance offered by solid to convection resistance offered by fluid
 D. conduction resistance offered by fluid to convection resistance offered by fluid

Ans. D

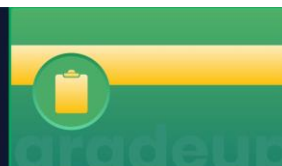
Sol. Nusset Number = $\frac{hD}{k_f}$

Where K_f = conductivity of fluid

h = heat transfer coefficient of fluid

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D = Characteristic length

$$Nu = \left(\frac{D}{k_f} \right) \times \frac{1}{1/h} = \left(\frac{D}{k_f \times A} \right) \times \frac{1}{\left(\frac{1}{hA} \right)}$$

$$Nu = \frac{\left(\frac{D}{k_b A} \right)}{\left(\frac{1}{hA} \right)}$$

$$Nu = \frac{\text{Conductive resistance offered by fluid}}{\text{Convective resistance offered by fluid}}$$

67. The clearance volume of a reciprocating compressor is 6% of the swept volume. Specific volumes at inlet and outlet of compressor are 0.04 and 0.02 m³/kg respectively. Volumetric efficiency of compressor is_____.
- A. 96.16% B. 38.11%
- C. 94% D. 90.16%

Ans. C

Sol. The volumetric efficiency is given by:

$$\eta_v = 1 + C - C \left(\frac{P_2}{P_1} \right)^{\frac{1}{n}} = 1 + C - C \left(\frac{V_1}{V_2} \right)$$

$$\text{Clearance (C)} = \frac{V_c}{V_s} = 0.06$$

$$V_1 = 0.04 \text{ m}^3/\text{kg}$$

$$V_2 = 0.02 \text{ m}^3/\text{kg}$$

$$\eta_v = 1 + 0.06 - 0.06 \times \left(\frac{0.04}{0.02} \right)$$

$$= 1 + 0.06 - 0.12 = 0.94$$

68. The air in a room given dimensions are 3m x 4 m x 5 m at 90 kPa and temp. 24 °C. Determine the density of the gas if the constant of air is R = 0.287 kJ/kg-K.
- A. 1.50 kg/m³ B. 1.09 kg/m³
- C. 1.16 kg/m³ D. 1.06 kg/m³

Ans. D

Sol. Assumptions: At specified conditions, air can be treated as an ideal gas.

Using ideal-gas relation:

$$P = \rho RT$$

$$\rho = \frac{P}{RT} = \frac{90 \times 10^3}{0.287 \times 10^3 \times (24 + 273)} = 1.055 \text{ kg/m}^3$$

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69. For maintaining high efficiency in a Pelton turbine, the value of D/d lies in the range of_____.

Where D is wheel pitch diameter and d is jet diameter.

- A. 8 to 12
B. 12 to 14
C. 14 to 16
D. 12 to 18

Ans. C

Sol. • A larger value of D/d reduces the rpm as well as mechanical efficiency of the wheel.

- It is possible to increase the specific speed by choosing a lower value of D/d , but η_m decreases. Thus, D/d is normally kept 14 to 16 for maintaining high efficiency.

70. The mechanical efficiency of a single-cylinder four stroke engine is 75%. The frictional power is estimated to be 40 kW. Calculate the brake power _____.

- A. 80 kW B. 120 kW
C. 160 kW D. 200 kW

Ans. B

Sol. Given $\eta_{\text{mech}} = 75\% = 0.75$

Frictional power (fP) = 40 kW

Since $\eta_{\text{mech}} = \frac{\text{Brake power (BP)}}{\text{Indicated power (IP)}}$

$$BP = 0.75 \text{ IP}$$

$$IP = \frac{4}{3}BP \dots\dots\dots(i)$$

Since $IP - BP = fP$

Substitution of IP from equation (i):

$$\frac{4}{3}BP - BP = 40$$

$$\text{BP} = 120\text{kW}$$

71. Which of the following property is NOT required for a good refrigerant _____.

- A. Very low freezing point.
- B. Low value of specific heat of vapor
- C. High critical temperature.
- D. High enthalpy of vaporization.

Ans. B

Sol. A good refrigerant should have the following properties:

1. Very low freezing point so that it can freeze water.
2. High enthalpy of vaporization.
3. high conductivity.
4. High critical temperature.
5. High value of specific heat

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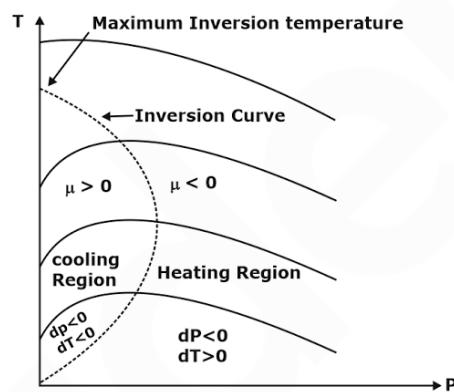
72. Joule-Thomson coefficient is the ratio of _____.

- A. pressure change to temperature change occurring when a gas undergoes the process of adiabatic throttling
- B. temperature change to pressure change occurring when a gas undergoes the process of adiabatic throttling
- C. temperature change to pressure change occurring when a gas undergoes the process of adiabatic compression
- D. pressure change to temperature change occurring when a gas undergoes the process of adiabatic compression

Ans. B

Sol. Joule-Thomson coefficient is given by $\mu_J = \left(\frac{dT}{dP} \right)_h$.

- Thus it is ratio of temperature change to pressure change occurring when a gas undergoes the process of adiabatic throttling.



73. For incompressible flow, a converging section acts as a diffuser for upstream flow which is:

- A. Subsonic only
- B. Supersonic only
- C. Both subsonic and supersonic
- D. Sonic only

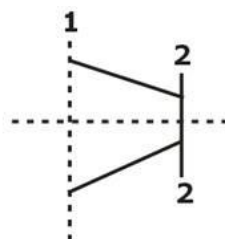
Ans. B

Sol. The relation between change in velocity, change in cross section area and Mach number (M) is given by:

$$\text{Since } \frac{dA}{A} = \frac{dV}{V} (M^2 - 1)$$

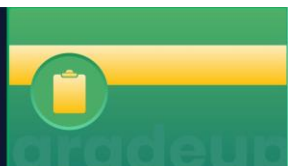
Where M = Mach number

For converging section:



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$$\frac{dA}{A} = \text{Negative}$$

When it acts as a diffuser i.e. velocity decreases at outlet section 2-2.

$$\text{Thus, } \frac{dV}{V} = \text{Negative (-ve)}$$

Thus, $M > 1$ (always) i.e. the flow must be supersonic.

74. A power generation station is to supply four regions of loads with peak demands of 10MW, 15 MW, 25MW and 30MW. If the diversity factor is 1.6, the maximum demand on the station is_____.

- A. 128 MW
B. 50 MW
C. 48 MW
D. 108 MW

Ans. B

Sol. Since Diversity (div) is given by:

$$\text{Diversity factor (div)} = \frac{\text{Sum of maximum demands of individual consumer group}}{\text{Actual maximum demand}}$$

$$\text{maximum demand} = \frac{10 + 15 + 25 + 30}{1.6} = \frac{80}{1.6}$$

Maximum demand = 50 MW

75. The Octane rating of LPG is _____.

- A. 81
B. 95
C. 110
D. 150

Ans. C

Sol. • Octane rating of Petrol is 81.
• Octane rating of LPG is 110.

76. Stanton number is _____.

- A. the ratio of heat transferred into a fluid to the thermal capacity of fluid
B. the ratio of heat diffusion to mass diffusion
C. the dimensionless temperature gradient at the surface
D. the ratio of heat conduction to heat convection

Ans. A

Sol. Stanton number (St) for heat transfer, is a dimensionless parameter relating heat transfer coefficient to heat capacity of the fluid stream per unit cross-sectional area per unit time.

$$St = \frac{h}{\rho \bar{v} c_p}$$

Where: h = heat transfer coefficient, c_p = specific heat of the fluid and \bar{v} is the velocity of the fluid.

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77. Which of the following apparatus is used for measuring gauge vapor pressure of liquefied petroleum _____.

- A. Hydrometer
B. Reid bomb
C. pycnometer
D. Hygrometer

Ans. B

Sol. • The Reid vapor pressure bomb is used for determination of the gauge vapor pressure of liquified petroleum products.

78. If air at 20 °C is heated to 25 °C using heater with a surface temperature of 30 °C then, the bypass factor is _____.

- A. 2.0
B. 0.5
C. 1.0
D. None of the above

Ans. B

Sol. Bypass factor for the heating coil is given by:

$$BPF = \frac{T_s - T_o}{T_s - T_i}$$

Where: T_s = coil surface temperature

T_i = inlet air temperature

T_o = outgoing air temperature

$$BPF = \frac{30 - 25}{30 - 20} = \frac{5}{10} = 0.5$$

79. Which of the following instruments is used to measure the global radiation _____?

- A. Pyranometer
B. Pyre heliometer
C. Sunshine recorder
D. Pycanometer

Ans. A

Sol. • Pyranometer ⇒ designed to measure global radiation.

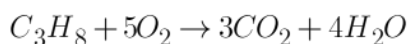
- Pyrheliometer ⇒ measure only beam radiation.
- Sunshine recorder ⇒ Measure the sunshine hours in a day.

80. Propane (C_3H_8) is burned in an oxygen atmosphere with 10% deficit oxygen with respect to the stoichiometric requirement. Assuming no hydrocarbons in the products, the volume percentage of CO in the products is _____.

- A. 14.28
B. 13.24
C. 12.12
D. 19.23

Ans. A

Sol. For complete combustion of the fuel (Stoichiometric):

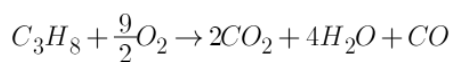


But here it is given that combustion occurs in 10% deficit of O_2 :

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Therefore, percentage CO in the exhaust:

$$\%CO = \frac{1}{7} \times 100 = 14.28\%$$

81. Stalling phenomena in an axial flow compressor stage is caused due to which one of the following?
- Higher mass flow rate than the designed value
 - Lower mass flow rate than the designed value
 - Higher mass flow rate or non-uniformity in the blade profile
 - Lower mass flow rate or non-uniformity in the blade profile

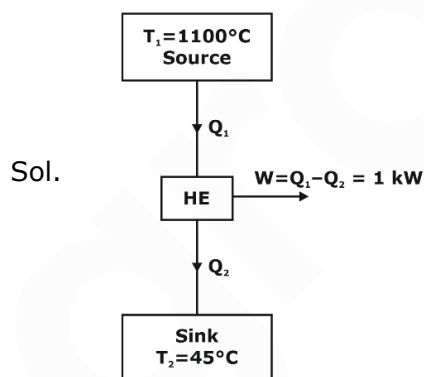
Ans. D

Sol.

- Stalling is an unstable and local phenomenon in an axial compressor.
- It occurs normally when airflow separates from the convex sides of the compressor blades. This means that the airflow and the speed of the rotor does not match and air is not able to follow the blade profiles.

82. What will be the least rate of heat rejection per kW net output of a cyclic heat engine operating between a source temperature of 1100 °C and a sink temperature of 45 °C_____?
- 0.326 kW
 - 0.556 kW
 - 0.301 kW
 - 0.406 kW

Ans. C



Temperature of source: $T_1 = 1100 + 273 = 1373 \text{ K}$

Temperature of sink: $T_2 = 45 + 273 = 318 \text{ K}$

For Least rate of heat rejection per kW net output, engine must be reversible engine.

Thus:

$$\eta_{max} = \eta_{rev} = 1 - \frac{T_2}{T_1}$$

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$$\eta_{max} = 1 - \frac{318}{1373} = 0.768$$

$$\eta_{max} = \frac{W_{net}}{Q_1} = 0.768$$

Now:

$$\text{Given: } W_{net} = 1 \text{ kW}$$

$$Q_1 = \frac{1}{0.768} = 1.301 \text{ kW}$$

$$\text{Now, heat rejected: } Q_2 = Q_1 - W_{net} = 1.301 - 1 = 0.301 \text{ kW}$$

Hence, the least rate of heat rejection = 0.301 kW.

83. Two walls of same thickness and cross-sectional area have thermal, conductivities in the ration 1:2. If the ratio of temperature drop across the two walls is 2:3, what is the ratio of heat flow _____?

A. 1 : 2

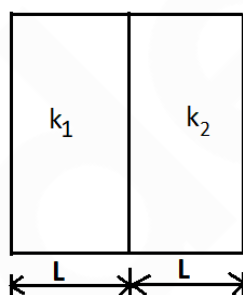
B. 1 : 3

C. 2 : 1

D. 3 : 1

Ans. B

Sol.



$$\text{Given: } \frac{k_1}{k_2} = \frac{1}{2} \text{ and } \frac{\Delta T_1}{\Delta T_2} = \frac{2}{3}$$

$$Q = kA \frac{\Delta T}{L}$$

$$\text{As } A_1 = A_2 \text{ and } L_1 = L_2$$

$$\therefore \frac{Q_1}{Q_2} = \frac{\frac{k_1 A_1 \Delta T_1}{L_1}}{\frac{k_2 A_2 \Delta T_2}{L_2}} = \frac{k_1 \Delta T_1}{k_2 \Delta T_2}$$

$$\frac{Q_1}{Q_2} = \frac{1}{2} \times \frac{2}{3} = \frac{1}{3}$$

84. The pressure inside the soap bubble of 50 mm diameter is 2.5 N/m^2 above the atmosphere. Estimate the surface tension of the soap film _____.

A. 0.0456 N/m

B. 0.080 N/m

C. 0.01562 N/m

D. 0.189 N/m

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Ans. C

Sol. For a soap bubble, the pressure in excess of outside pressure is given by:

$$P_i - P_o = \frac{8\sigma}{d}$$

$$\text{Given: } P_i - P_o = 2.5 \text{ N/m}^2$$

$$d = 50 \text{ mm} = 0.05 \text{ m}$$

$$2.5 = \frac{8\sigma}{50 \times 10^{-3}}$$

$$\sigma = \frac{2.5 \times 50 \times 10^{-3}}{8} = 0.01562 \text{ N/m}$$

85. A two-dimensional flow field is defined as $\vec{V} = \bar{i}x + \bar{j}y$. Then, the equation of streamline passing through the point (1, -1):

A. $xy + 1 = 0$

B. $xy - 1 = 0$

C. $x + y = 0$

D. $x - y = 0$

Ans. C

Sol. Equation of streamline is given by: $\frac{dx}{u} = \frac{dy}{v}$

From given equation: $u = x, v = y$

$$\frac{dx}{x} = \frac{dy}{y}$$

$$\ln x = \ln y + \ln c$$

$$\ln\left(\frac{x}{y}\right) = \ln c$$

$$\left(\frac{x}{y}\right) = c$$

$$C = \frac{1}{-1} = -1$$

$$\frac{x}{y} = -1$$

$$x + y = 0$$

86. A pure substance at 8 MPa and 400 °C is having a specific internal energy of 2864 kJ/kg and a specific volume of 0.03432 m³ /kg. Its specific enthalpy (in kJ/kg) is _____.

A. 3139

B. 4000

C. 8000

D. 2000

Ans. A

Sol. Since specific enthalpy is given by:

$$\text{specific enthalpy: } h = u + pv$$

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Given: $u = 28684$.

Pressure: $p = 8 \text{ MPa}$ or 8000 kPa

Specific volume (v) = $0.03432 \text{ m}^3/\text{kg}$

On substituting values:

$$h = 2864 + (8000 \text{ kPa}) \times (0.03432)$$

$$h = 2864 + 274.56 = 3138.56 \text{ kJ/kg}$$

87. A diesel engine has a compression ratio of 16 and cutoff takes place at 8% of the stroke.

The value of cutoff ratio will be _____.

- A. 1.28
B. 1.20
C. 2.20
D. 2.28

Ans. C

Sol. Since the relation between the cutoff ratio (r_c) and compression ratio (r_k) is given by:

$$r_c - 1 = \frac{\%P}{100} (r_k - 1)$$

Where %P = percentage of slope at which cutoff takes place.

$$\text{Thus } r_c - 1 = \frac{8}{100}(16 - 1)$$

$$r_c - 1 = 1.20$$

$$r_c = 2.20$$

88. The chemical formula for the refrigerant R-1150 is _____.

- A. C₂H₄
B. CCl₂F₂
C. CH₄
D. NH₃

Ans. A

Sol. Designation \Rightarrow R1150, which suggests that refrigerant is unsaturated.

Complete designation is written as:

R-1(m - 1)(n + 1)P and formula will be $C_mH_nF_pCl_q$

$$m - 1 = 1 \Rightarrow m = 2$$

$$n + 1 = 5 \Rightarrow n = 4$$

$$P = 0$$

Since $2m = n + p + q$

$$4 = 4 + 0 + q$$

$$q = 0$$

Thus, formula will be $\Rightarrow \text{C}_2\text{H}_4$.

89. A cylindrical pin fin of diameter 0.6 cm and length of 3 cm with negligible heat loss from the tip has an efficiency of 0.7. The effectiveness of the fin is _____.

- A. 0.3
B. 0.7
C. 8
D. 14

Ans. D

Sol. The relation between the efficiency (η) and the effectiveness (ϵ) is given by:

$$\epsilon = \eta_{fin} \times \frac{\text{Surface Area } (A_s)}{\text{Cross sectional Area } (A_c)}$$

$$\epsilon = 0.7 \times \frac{\pi \times 3 \times 0.6}{\frac{\pi}{4} \times 0.6^2} = 14$$

90. Diversity factor is always _____.

- A. Unity
B. Less than unity
C. Greater than unity
D. Zero

Ans. C

Sol. • The time distribution of maximum demands for similar types of consumers, is measured by a term called diversity factor.

- It is ratio of the sum of the maximum demands of individual consumers and the simultaneous maximum demand of the whole group during a particular time.

$$\text{div} = \frac{\text{Sum of maximum demands of individual consumer groups}}{\text{Actual peak load of system}}$$

- Its value is always greater than 1.

91. During the charging of a storage battery, the current i is 25 A and the voltage E is 10.8 V. The rate of heat transfer from the battery is 9 W. The rate of increasing of the internal energy _____.

- A. 261 J/s
B. 246 J/s
C. 256 J/s
D. 310 J/s

Ans. A

Sol. Since changes in kinetic and potential energy are insignificant, thus the first law can be written as a rate equation in the following form:

$$\frac{dU}{dt} = \frac{\delta Q}{dt} - \frac{\delta W}{dt}$$

In charging process, work is being done on the system.

$$\frac{\delta W}{dt} = -Ei = -10.8 \times 25 = -270 \text{ W}$$

$$\frac{\delta Q}{dt} = -9 \text{ W}$$

$$\frac{dU}{dt} = -9 - (-270) = 261 \text{ W}$$

92. The process of the abstracting steam at a certain section of turbine and subsequently using it for heating feed water supplied to the boiler is called _____.

- A. Reheating
B. Regeneration
C. Bleeding
D. Vapor power cycle

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Ans. B

Sol. • Steam getting expanded in steam turbine, when taken out from the expansion path for some purpose is called bleeding.
• When the purpose of this system is to heat feedwater supplied to the boiler, then whole process is called as regeneration.

93. Which conditions shows that flow separation has occurred in the boundary layer _____.

A. $\left(\frac{\partial u}{\partial y}\right)_{y=0} = 0$

B. $\left(\frac{\partial u}{\partial y}\right)_{y=0} < 0$

C. $\left(\frac{\partial u}{\partial y}\right) < 0$

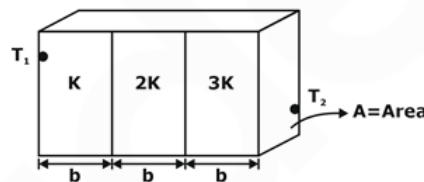
D. $\left(\frac{\partial u}{\partial y}\right)_{y=0} > 0$

Ans. B

Sol. • If $\left(\frac{\partial u}{\partial y}\right)_{y=0} = 0$, then it implies that boundary layer is on the verge of separation.

• Under $\frac{dP}{dx} > 0$ when $\left(\frac{\partial u}{\partial y}\right)_{y=0} < 0$, it implies that boundary layer separation has occurred and flow is in opposite direction now.

94. Equivalent resistance of the thermal circuit given in the figure _____.



A. $\frac{b}{2KA}$

B. $\frac{4b}{3KA}$

C. $\frac{11b}{6kA}$

D. $\frac{3b}{KA}$

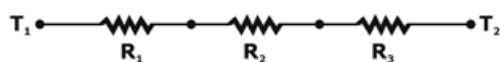
Ans. C

Sol. Since thermal resistance R is given by:

$$R = \frac{b}{KA}$$

$$R_1 = \frac{b_1}{K_1 \times A} = \frac{b}{KA}, \quad R_2 = \frac{b_2}{K_2 A} = \frac{b}{(2K)A}$$

$$R_3 = \frac{b_3}{K_3 A} = \frac{b}{(3K)A}$$



For resistance in series:

$$R_{\text{equivalent}} = R_1 + R_2 + R_3$$

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$$R_{\text{equivalent}} = \frac{b}{KA} + \frac{b}{(2K)A} + \frac{b}{(3K)A}$$

$$= \frac{b}{KA} \left\{ 1 + \frac{1}{2} + \frac{1}{3} \right\}$$

$$R_{\text{equivalent}} = \frac{11}{6} \frac{b}{kA}$$

95. Which of the following wind turbine is a drag type turbine _____.

- A. Darrieus
B. Propeller
C. Musgrove and Evan
D. Savonius

Ans. D

Sol.

Drag type Turbines	Lift type turbines
Dutch Type	Sailwing
Savonius	Chalk multiblade
	Darrieus
	Musgrove & Evan

96. The flow in the runner of Francis turbine is characterized by _____ flow.

- A. Purely radial flow
B. Purely tangential
C. Purely axial
D. Mixed flow of radial and tangential type.

Ans. D

Sol. • Francis turbine is a type of reaction turbine.

- The flow in the runner of Francis turbine is not purely radial but a combination of radial and tangential.

97. Which of the following statements is Not correct _____?

- A. For a pump to run without cavitation NPSH available must be greater than NPSH required.
B. NPSH available is dependent on pump setting and pump and depends upon its specific speed.
C. NPSH available is a pump characteristic and is provided by pump manufacturer.
D. NPSH available is dependent on pump setting and pump operating characteristic.

Ans. C

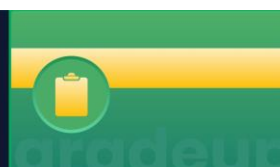
Sol. • The critical cavitation parameter is unique to a pump and depends upon its specific speed.

- NPSH required is a pump characteristic and is provided by pump manufacturer.
- NPSH available is dependent on pump setting and pump operating characteristic.
- For a pump to run free from cavitation.

$$\boxed{\text{NPSH Available} > \text{NPSH Required}}$$

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98. The value of tilt factor for diffuse radiation, if the angle made by the plane surface with the horizontal is 30° , _____.

- A. 0.25
B. 0.067
C. 0.75
D. 0.933

Ans. D

Sol. Tilt factor diffuse radiation is given by:

$$r_d = \frac{1 + \cos \beta}{2}$$

$$r_d = \frac{1 + \cos 30^\circ}{2} = 0.933$$

99. Which of the following is not an extensive property _____.

- A. entropy
B. enthalpy
C. internal energy
D. density

Ans. D

Sol. **Extensive property:**

Extensive properties depend on the system size or the amount of matter contained in the system.

Examples: Entropy, Enthalpy, Internal energy increase with increase mass of the system.

Intensive Property:

Intensive properties are the properties of the system which do not depend on the mass of the system.

Example: For a system under consideration density will be same for any amount of matter.

100. Which of the following statements is incorrect_____.

- A. Tip speed ratio is defined as ratio of speed of oncoming air to speed of tip of rotor blade.
- B. Tip speed ratio is ratio of speed of tip of rotor blade to speed of oncoming air.
- C. Tip speed ratio increases as the number of blades decreases.
- D. According to Betz criterion, maximum possible turbine efficiency is 59.3%

Ans. A

Sol. • Tip speed ratio is ratio of speed of tip of rotor blade to speed of oncoming air.

$$\text{Tip speed ratio (TSR)} = \frac{\text{Speed of tip of rotor blade}}{\text{Speed of oncoming air}}$$

- TSR decreases as the number of blades increases.

$$\lambda_0 = \frac{4\lambda}{n}$$

Where n = number of blades.

- According to Beltz criterion, maximum possible wind turbine efficiency is 59.3%.

101. Two reversible refrigerators are arranged in series and their COP's are 4 and 6. The COP of Cascade refrigeration system would be _____.

- A. 1.5
B. 2.18
C. 2.4
D. 1.2

Ans. B

Sol. COP of cascade refrigeration system is given by:

$$(\text{COP})_{\text{cascade}} = \frac{(\text{COP})_1 \times (\text{COP})_2}{1 + (\text{COP})_1 + (\text{COP})_2} = \frac{4 \times 6}{1 + 4 + 6}$$

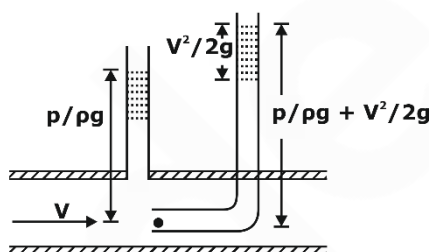
$$(\text{COP})_{\text{cascade}} = 2.18$$

102. A L-shaped Pitot tube shows a reading of 270 mm. The tube is used to measure the velocity of water stream. What is the velocity measured _____?

- A. 72.78 m/s
B. 7.27 m/s
C. 2.3 m/s
D. 1.6 m/s

Ans. C

Sol. Given: Pitot tube reading (h) = 270 mm = 0.27 m



As we know that the head in Pitot tube is achieved by bringing fluid velocity to zero.

Thus: $\frac{V^2}{2g} = h$

Velocity of stream:

$$V = \sqrt{2gh}$$

$$V = \sqrt{2 \times 9.81 \times 0.27} = 2.30 \text{ m/s}$$

103. Azeotropes are designated by which representation series _____.

- A. R-1 ABC series
B. R-ABC Series
C. 700 Series
D. 500 Series

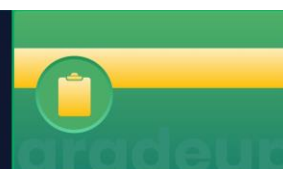
Ans. D

Sol. • The azeotropic mixtures are usually binary mixtures that behave like a pure fluid, i.e. under constant pressure they condense and evaporate at a constant temperature and the composition of the mixture in the vapor and liquid phases will be same.

• Azeotropes are represented by 500 series. The most popular cold storage refrigerant R502 is a mixture of R22 and R152a.

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104. A curve showing the variation of load on a power station with respect to time is known as _____.

- A. Load curve
B. Load duration curve
C. Diversity factor
D. Performance curve

Ans. A

Sol. • A curve showing the variation of load on a power station with respect to time is known as load curve.

• A load duration curve indicates for how many hours a certain load has been required in the course of the day.

• Thus, load duration curve rearranges the load elements of a chronological curve in descending order of magnitude.

105. The power density of an ideal MHD generator is proportional to _____.

- A. Square root of fluid velocity.
B. Directly proportional to fluid velocity.
C. Square of the fluid velocity.
D. Cube of the fluid velocity.

Ans. C

Sol. The power density (P) of Ideal MHD generator is given by:

$$P = \sigma u^2 B^2$$

Where:

σ = Bulk electrical conductivity of fluid

u = fluid velocity

B = Magnetic field strength.

Thus, the power density (P) of Ideal MHD generator is directly proportional to the square of the velocity.

106. If the absolute jet exit velocity from a jet engine is 2500 m/s and forward flight velocity is 1000 m/s, then propulsive efficiency is _____.

- A. 40%
B. 57.14%
C. 71.43%
D. 28.57%

Ans. B

Sol. Propulsive efficiency of jet engine is given by:

$$\eta_p = \frac{2V_a}{V_j + V_a}$$

Where:

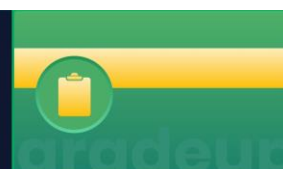
V_a = forward flight velocity

V_j = Jet velocity

$$\eta_p = \frac{2 \times 1000}{2500 + 1000} = 0.5714 = 57.14\%$$

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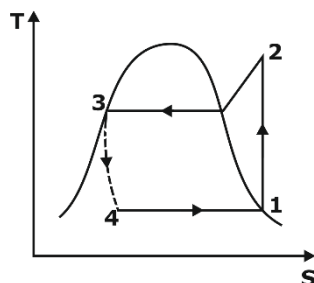


107. The values of enthalpy at the beginning of compression, at the end of compression and at the end of condensation are 185 kJ/kg, 210 kJ/kg and 85 kJ/kg, respectively, What is the value of the COP of the vapour compression refrigeration system?

- A. 0.25 B. 5.4
C. 4 D. 1.35

Ans. C

Sol.



Given:

$$h_1 = 185 \text{ kJ/kg}$$

$$h_2 = 210 \text{ kJ/kg}$$

$$h_4 = 85 \text{ kJ/kg}$$

$$COP = \frac{h_1 - h_4}{h_2 - h_1} = \frac{185 - 85}{210 - 185} = \frac{100}{25} = 4$$

108. For a boundary layer, the shape factor (H) is defined as _____.

- A. $\frac{\delta}{\theta}$ B. $\frac{\delta^*}{\theta}$
C. $\frac{\theta}{\delta}$ D. $\frac{\theta}{\delta^*}$

Ans. B

Sol. Where δ^* is displacement thickness, δ = boundary layer thickness and θ is momentum thickness.

$$\text{Shape factor (H)} = \frac{\text{Displacement thickness}(\delta^*)}{\text{Momentum thickness}(\theta)}$$

- H is always greater than one.

109. An ammonia ice plant has a capacity of 10 TR and operates between -10°C and 35°C . If the actual COP is $1/6$ of the ideal COP, the heat rejected by the plant is _____.

- A. 65 kW B. 50 kW
C. 85 kW D. 71 kW

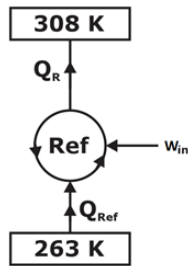
Ans. D

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Sol.



$$\text{Since } (\text{COP})_{\text{carnot}} = \frac{T_2}{T_1 - T_2} = \frac{Q_{\text{Ref}}}{W_{\text{in}}}$$

$$\text{Given: } Q_{\text{Ref}} = 10 \text{ TR} = 10 \times 3.50 \text{ kW} = 35 \text{ kW}$$

$$(\text{COP})_{\text{carnot}} = \frac{263}{308 - 263} = \frac{263}{45}$$

$$(\text{COP})_{\text{actual}} = \frac{1}{6} \times \frac{263}{45} = \frac{Q_{\text{ref}}}{W_{\text{in}}}$$

$$\frac{1}{6} \times \frac{263}{45} = \frac{35}{W_{\text{in}}}$$

$$W_{\text{in}} = \frac{35 \times 45 \times 6}{263} = 35.93 \text{ kW}$$

$$Q_{\text{rej}} = W_{\text{in}} + Q_{\text{Ref}} = 35 + 35.93 = 70.93 \text{ kW}$$

110. Which one of the following is the expression of the vorticity component for a 2-D fluid element in x - y plane _____.

A. $\Omega_z = \frac{1}{2} \left(\frac{\partial u}{\partial y} - \frac{\partial v}{\partial x} \right)$

B. $\Omega_z = \frac{1}{2} \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right)$

C. $\Omega_z = \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right)$

D. $\Omega_z = \frac{1}{2} \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right)$

Ans. C

Sol. Since Vorticity (Ω) is given by:

$$\Omega = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ u & v & w \end{vmatrix}$$

$$\Omega = \hat{i} \left(\frac{\partial w}{\partial x} - \frac{\partial v}{\partial z} \right) - \hat{j} \left(\frac{\partial w}{\partial y} - \frac{\partial u}{\partial z} \right) + \hat{k} \left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y} \right)$$

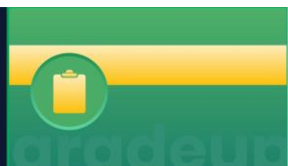
$$\text{On Comparison with: } \Omega = \Omega_x \hat{i} + \Omega_y \hat{j} + \Omega_z \hat{k}$$

Vorticity in x-y plane is given by:

$$\Omega_z = \frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}$$

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111. Which of the following is more commonly used firing order for six-cylinder stroke engine _____?

A. 1 - 5 - 4 - 6 - 2 - 3.

B. 1 - 5 - 3 - 6 - 2 - 4

C. 1 - 5 - 6 - 4 - 2 - 3

D. 1 - 5 - 6 - 3 - 2 - 4.

Ans. B

Sol. Firing orders for 4-cylinders and 6-cylinder engines is as follows:

- The more commonly used firing order for 6-cylinders IC engine is 1 - 5 - 3 - 6 - 2 - 4.
- For 4-cylinders engine: 1 - 3 - 4 - 2.

112. After expansion from a gas turbine, the hot exhaust gases are used to heat the compressed from a compressor with the help of a counter flow compact heat exchanger of 0.6 effectiveness. The number of transfer units of the heat exchanger is _____.

A. 1.5

B. 2.5

C. 3.5

D. 4.5

Ans. A

Sol. For a gas turbine:

Heat capacity ratio (C) = 1

Effectiveness: $\varepsilon = \frac{NTU}{1 + NTU}$

$$0.6 = \frac{NTU}{1 + NTU}$$

$$0.4NTU = 0.6$$

$$NTU = 1.5$$

113. The degree of reaction for the Francis turbine is given by _____.

$$A. R = 1 - \frac{\cot \alpha_1}{2(\cot \alpha_1 - \cot \beta_1)}$$

$$B. R = 1 - \frac{\cot \alpha_1}{2(\cot \alpha_1 + \cot \beta_1)}$$

$$C. R = 1 - \frac{\cot \alpha_1}{2(\cot \alpha_1 - \cot \beta_1)}$$

$$D. R = 1 - \frac{\cot \alpha_1}{\cot \alpha_1 - \cot \beta_1}$$

Ans. B

Sol. The degree of reaction for the Francis turbine is given by:

$$R = 1 - \frac{\cot \alpha_1}{2(\cot \alpha_1 + \cot \beta_1)}$$

Where α_1 = Guide vane angle (45 - 120°).

β_1 = inlet blade angle (10 - 40°).

114. For what wavelength the black body's emissive power reaches at its maximum value when maintained at 100°C _____?

A. 7.7 μm

B. 28.98 μm

C. 77 μm

D. 2.898 μm

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Ans. A

Sol. Using Wien's displacement law:

$$\lambda_{max} T = 2898 \mu m - K$$

$$T = 100 + 273 = 373 K$$

$$\lambda_{max} = \frac{2898}{373} = 7.769 \mu m$$

115. A nuclear reactor with breeding ratio (C) greater than one is called the _____.

- A. Converter
B. Advanced converter
C. Breeder
D. Advanced reactor

Ans. C

Sol. Conversion or breeding ratio (c) = $\eta - 1 - L$

Where η = number of neutrons produced.

L = Number of neutrons lost in parasitic capture in reactor coolant.

- Reactor with a low C \Rightarrow Converter
- Reactor with a high C but less than 1 \Rightarrow Advanced converter.
- Reactor with C > 1 \Rightarrow Breeder.

116. In centrifugal compressor terminology vane less space refers to the space between _____.

- A. The inlet and blade inlet edge.
B. Blade in the impeller.
C. Diffuser exit and volute casing.
D. Impeller and diffuser inlet edge.

Ans. D

Sol. • The region between the impeller exit and the start of diffuser vanes is known as vaneless space.

- The vaneless space is used to reduce the velocity leaving the rotor to a value lower than Mach number.

117. Using Clausius-Claperyon's equation, estimate the enthalpy of vapourisation. The following data is given: At 200 °C: $v_g = 0.1274 \text{ m}^3/\text{kg}$, $v_f = 0.001157 \text{ m}^3/\text{kg}$, $dP/dT = 32 \text{ k-Pa/K}$.

- A. 1687.34 kJ/kg
B. 1910.8 kJ/kg
C. 1789.24 kJ/kg
D. 2136.47 kJ/kg

Ans. B

Sol. Using the Clausius Clapeyron equation:

$$\frac{dP}{dT} = \frac{h_{fg}}{T_{sat}(v_g - v_f)}$$

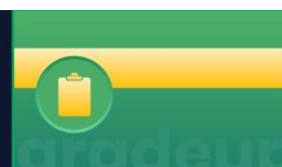
$$T_{sat} = 200 + 273 = 473 K$$

$$32 \times 10^3 = \frac{h_{fg}}{473 \times (0.1274 - 0.001157)}$$

$$h_{fg} = 1910.8 \times 10^3 \text{ J/kg} = 1910.8 \text{ kJ/kg}$$

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118. A control volume is _____.

- A. an isolated system
- B. a closed system but heat and work can cross the boundary.
- C. a specific amount of mass in space
- D. a fixed region in space where mass, heat and work can cross the boundary of that region.

Ans. D

Sol. The boundary of closed system usually changes shape and no mass flow occur but in control volume boundary remain fixed and unaltered but through it moving substance flows.

119. Air conditioning has to be done for a hall whose room latent heat is 80 kW and total heat is 120 kW. There are no other sources of heat addition and leakages. The value of heat sensible heat factor for the room load _____.

- A. 0.40
- B. 0.50
- C. 0.67
- D. 0.33

Ans. D

Sol. Sensible heat factor is given by:

$$\text{Sensible heat factor (SHF)} = \frac{\text{Sensible Heat (SH)}}{\text{Total Heat (TH)}}$$

$$\text{SH} = \text{Sensible heat} = \text{TH} - \text{LH}$$

$$= 120 - 80$$

$$= 40\text{kw}$$

$$\text{Thus, SHF} = \frac{40}{120} = 0.333$$

120. Which of the following type super charger is commonly used in Automatic engines _____?

- A. Centrifugal type
- B. Root's type
- C. Axial type
- D. Vane type

Ans. A

Sol. **Types of superchargers:** There are three types of superchargers:

1. Centrifugal type
2. Root's type
3. Vane type

- The centrifugal type supercharger is commonly used in automatic applications.

121. On a Psychrometric chart, what does a vertical downward line represent _____?

- A. Adiabatic saturation
- B. Sensible cooling
- C. Dehumidification
- D. Humidification

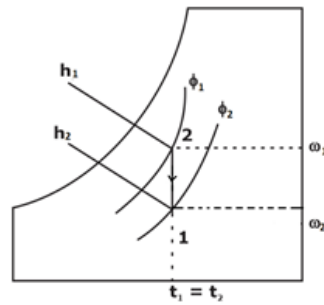
Ans. C

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Sol.



Process 2-1 shows the dehumidification process. It is a process of decreasing the specific humidity at the constant dry bulb temperature.

122. The overall heat transfer coefficient, based on outside surface area of an heat exchanger, dropped down from 500 W/m²K to 400 W/m²K due to dirt. What is the value of film coefficient for this heat exchange operation (in W/m²K) _____?

- A. 1000
B. 5×10^{-4}
C. 100
D. 2000

Ans. D

Sol. Since fouling factor is given by:

$$R_f = \frac{1}{U_{dirty}} - \frac{1}{U_{clean}}$$

$$R_f = \frac{1}{400} - \frac{1}{500} = 5 \times 10^{-4}$$

Film coefficient is the reciprocal of the fouling factor.

$$\text{Film coefficient} = \frac{1}{R_f} = \frac{1}{5 \times 10^{-4}} = 2000 \text{ W/m}^2\text{K}$$

123. Which of the following statements is incorrect about L-head engines _____?

- A. In a L-head engine, both the valves are on same side of cylinder.
B. In L-head engines, combustion process is slow.
C. The inlet and exhaust valves are actuated by two different camshafts.
D. The L-head engines are mainly used in buses and Lorries.

Ans. C

- Sol.
- In a L-head engine both inlet and exhaust valves are same side of cylinder. Thus, the valves are operated by a single camshaft.
 - In this design, air flow has to take two right angles turns to enter the cylinder. This causes a loss of velocity head and a loss in turbulence level resulting in a slow combustion process.
 - The L-head engines are mainly used in buses and lorries.

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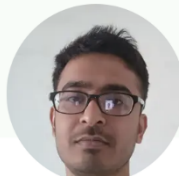
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