MEGA MOCK CHALLENGE

BYJU'S EXAM PREP

UPPSC AE

Mechanical Engineering

Paper - 2 Mega Mock - 2

(May 25th - May 26th 2022)

Questions & Solutions

1. What is the maximum membership of a state Legislative Assembly?

A. 400 B. 500

C. 450 D. 550

Ans. B

Sol. Members of a Vidhan Sabha are direct representatives of the people of the particular state as they are directly elected by an electorate consisting of all citizens above the age of 18 of that state. Its maximum size as outlined in the Constitution of India is not more than 500 members and not less than 60 members.

2. River carrying maximum sediment in the world is?

A. Amazon B. Nile

C. Brahmaputra D. Ganga

Ans. C

Sol. Brahmaputra River is carrying maximum sediment in the world. The river suspended sediment load of about 1.84 billion tons per year is the world's highest.

3. Saffron is obtained from

A. bud B. leaf

C. flower stigma D. calyx

Ans. C

Sol. Saffron is obtained from flower's stigma. Saffron is a spice derived from the flower of Crocus sativus, commonly known as the "saffroncrocus".The vivid crimson stigmas and styles, called threads, are collected and dried to be used mainly as a seasoning and colouring agent in food.

4. Shakuntalam' was written by

A. Kalidas B. Bhasa

C. Kamban D. Asvaghosha

Ans. A

Sol. *Shakuntalam* is a well-known Sanskrit play by Kalidasa, dramatizing the story of Shakuntala told in the epic Mahabharata. It is considered to be the best of Kalidasa's works. Its date is uncertain, but Kalidasa is often placed in the period between the 1st century BCE and 4th century CE.

5. Who among the following rulers was also known as 'Lakh Baksh'?

A. Aram Shah B. Qutub-ud-din Aibak

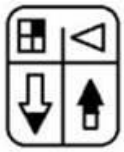
C. Ilthumish D. Sulthana Raziya

Ans. B

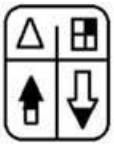
Sol. • Qutub-ud-din Aibak was also known as 'Lakh Baksh'. He used to donate large sums of money in charity, thus people used to call him by a new name 'LAKH BAKSH or giver of lakhs.

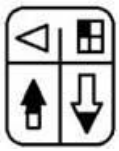
• He founded the Slave Dynasty in 1206 AD.

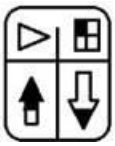
6. **Select the correct mirror image of the given figure when a mirror is placed on its right side.**



A. 

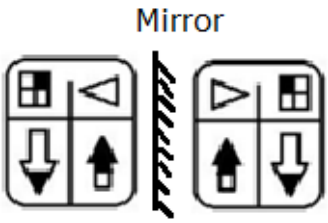
B. 

C. 

D. 

Ans. D

Sol. On close observation we find that the correct mirror image will be:



Hence, option D is the correct answer.

7. Dilwara temples are examples of

A. Jain architecture
B. Buddhist architecture
C. Mughal architecture
D. Sultanate architecture.

Ans. A

Sol. Dilwara Temples of Rajasthan are popular for their beautiful artistic work. Located near Mount Abu in Rajasthan. Dilwara Temples are considered to be an example of perfect architecture, in terms of Jain Temples. The intricately carved ceilings, entryways, pillars and panels highlight the aesthetic appeal of this temple. Dilwara Temple forms a famous pilgrimage of the followers of Jainism. It was built during the 11th and 13th century.

8. Which fertilizer is highly hygroscopic?

A. Calcium ammonium nitrate
B. Sodium nitrate
C. Ammonium sulphate
D. Urea

Ans. D

Sol. Urea is a white, granular, solid and slightly hygroscopic fertilizer. It can also be applied in solution form as a spray.

Urea becomes a remarkably hygroscopic substance if the humidity of the air is at relatively high-level.

9. Freedom of speech and expression is not unlimited. It can be restricted on the basis of

A. threat to national unity and integrity

B. disobeying of Parliament and Judiciary or their contempt

C. public order, decency and morality

D. All of the above

Ans. D

Sol. Freedom of speech and expression is not unlimited. It can be restricted on the basis of threat to national unity and integrity, disobeying of Parliament and Judiciary or their contempt and public order, decency and morality.

10. In a certain code, "COMPREHENSION" is written as "GLQMVBLBRPMLR". How is "ADVENTURES" written in that code?

A. EAZBRQZOIP

B. EAZBRQYOPQ

C. AEBZQROYPI

D. EAZBRQYOIP

E. AEBZRQOYPI

Ans. D

Sol. "COMPREHENSION" is written as "GLQMVBLBRPMLR"

Odd places are increased by +4 while the Even places are decreased by -3

C is preceded by +4 i.e G , O is succeed by -3 i.e L

Similarly "ADVENTURES" is coded as "**EAZBRQYOIP"**

11. Unemployment and poverty estimates in India are based on

A. NSSO household consumption expenditure survey

B. CSO household consumption expenditure survey

C. Planning Commission's household consumption expenditure survey

D. NSSO family income survey

E. None of the above/More than one of the above

Ans. A

Sol. The estimates of poverty and unemployment in India are based on the survey of consumption expenditure of families by NSSO.

National Sample Survey Office was established in the form of a permanent survey organization in the year 1950, so that, a national survey can be conducted to help in socio-economic planning and policy-making.

12. Which one of the following reservoirs is associated with Rihand Project?

A. Gandhi Sagar

B. Govind Ballabh Pant Sagar

C. Jawahar Sagar

D. Govind Sagar

Ans. B

Sol. Govind Ballabh Pant Sagar is a reservoirs associated with Rihand Project. Rihand project is the most important multi-purpose project in Uttar Pradesh. It is located in the borders of Uttar Pradesh and Madhya Pradesh.It consists of 934 m long and 92 m high straight gravity

concrete dam across the Rihand River. It has the capacity to hold 11.4 lakh hectare metres of water. Another dam about 25 km north of the Rihand Dam has been constructed at Obra.

13. Which soil is found in the maximum area in Uttar Pradesh?

A. Sandy Clay
B. Red Clay
C. Alluvial Clay
D. Red and black mixed clay

Ans. C

Sol. Alluvial soil is found in the maximum area in Uttar Pradesh. This soil is deposited by rivers and best for agriculture. This soil is rich in Potash and humus. Alluvial soils are suitable for rice, wheat, sugarcane etc.

14. Firozabad is famous for which industry?

A. Silk Industry
B. Glass making Industry
C. Leather Industry
D. Steel Industry

Ans. B

Sol. The city of Firozabad is famous for Glass making industry. It is the center of India's glass blowing industry. Firozabad is known for the quality of the bangle. In Firozabad, Every other family is engaged in making bangles.

15. Which one among the following is called 'Roof of the World'?

A. Satpura
B. Pamir
C. Aravali
D. Myanmar

Ans. B

Sol. The Pamir Mountains are a mountain goes in Central Asia, at the intersection of the Himalayas with the TianShan, Karakoram, Kunlun, Hindu Kush, Suleman and Hindu Raj ranges. They are among the world's most astounding mountains. Since Victorian occasions, they have been known as the "Top of the World".

16. The sum of the interior angles of a regular polygon is 1260°. What is the difference between an exterior angle and an interior angle of the polygon?

A. 120°
B. 105°
C. 100°
D. 108°

Ans. C

Sol. The sum of the interior angles of a polygon = $(n - 2) \times 180°$

$= (n - 2) \times 180° = 1260°$

$= n - 2 = 7$

$n = 9$

Measure of each interior angle = $1260° / 9 = 140°$

Measure of each exterior angle = $360° / n = 360/9 = 40°$

Required difference = $140° - 40° = 100°$

17. **Arrange the following words in a logical and meaningful order.**

1) Irrigation
2) Harvesting
3) Seed sowing

4) Crop growth

5) Fertilizing

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

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

Ans. A

Sol. The logical order is following steps of harvesting of crop:

3. Seed sowing

1. Irrigation

4. Crop growth

5. Fertilizing

2. Harvesting

Hence, option A is the correct answer.

18. The Ministry of Education (MoE) approved a new scheme "New India Literacy Programme" under which the term "Adult Education" will be replaced by _____.

A. Literacy for All B. Education for All

C. Common Education D. Ageless Education

E. None of the above

Ans. B

Sol. • The Union Govt. approved a new scheme "New India Literacy Programme" during the FYs 2022-2027 to cover all the aspects of adult education and also to align with national education policy 2020

• The scheme will cover non-literates of the age of 15 years and above in the country.

• Now, Govt. has replaced the term "Adult Education (प्रौढ़ शिक्षा)" as 'Education for All' in the country.

• It will be implemented through volunteerism through online mode.

19. Renowned personality Bappi Lahiri passed away recently, he was a veteran _____.

A. Actor B. Composer

C. Politician D. Social Activist

E. Classical Dancer

Ans. B

Sol. * Singer-composer Bappi Lahiri passed away at the age of 69 in Mumbai.

* Best known for popularising disco music to the Indian mainstream, the singer was fondly known as Bappi da, and experienced huge success in the 1980s and 90s.

* He earned the title 'Disco King'.

* Bappi Lahiri ruled the music industry for several years and had given hits such as I am a Disco Dancer, Raat Baaki, Pag Ghoongroo, Bambai Se Aaya Mera Dost, Naino Main Sapna, TaakiTaaki, Humko Aaj Kal Hain Intezaar, Tamma Tamma, Yaad Aa Raha Hai, Yaar Bina Chain Kahan Re, among many others.

20. In February 2022, India signed a letter of intent (LoI) with which country for working towards bringing down the cost of renewable energy (RE) technologies?

A. Germany
B. Australia
C. Japan
D. Denmark
E. Saudi Arabia

Ans. B

Sol. * India and Australia on Tuesday signed a letter of intent (LoI) for working towards bringing down the cost of renewable energy (RE) technologies.

* Both the countries will also focus on scaling up the manufacturing of low cost solar and clean hydrogen.

* This was signed during the fourth India–Australia energy dialogue.

* The dialogue was co-chaired by Power and New & Renewable Energy Minister RK Singh and Hon'ble Minister for Energy and Emissions Reduction, Mr. Angus Taylor from the Australian side.

21. With what financial outlay the central government has pproved the continuation of a mega police modernisation scheme for five years up to 2025-26?

A. Rs 16,275 crore
B. Rs 18,275 crore
C. Rs 20,275 crore
D. Rs 26,275 crore
E. Rs 28,275 crore

Ans. D

Sol. • The central government has approved the continuation of a mega police modernisation scheme for five years up to 2025-26.

• The total financial outlay of the scheme will be Rs 26,275 crore.

• The scheme is being implemented by the Ministry of Home Affairs (MHA) since 1969-70.

• This scheme comprises all relevant sub-schemes that contribute to the modernisation and improvement.

22. Which has become the world's first government to turn 100 per cent paperless?

A. Dubai
B. Singapore
C. Tokyo
D. Riyadh
E. London

Ans. A

Sol. * Dubai became the world's first government to turn 100 percent paperless, the announcement was made by the United Arab Emirate (UAE) Crown Prince, Sheikh Hamdan bin Mohammed bin Rashid Al Maktoum.

* It will save around 3 billion Dirham (USD 350 million) and 14-million-man hours.

* A comprehensive digital government services platform is managing all internal, external transactions and procedures of the Government of Dubai.

* The Dubai Paperless Strategy was implemented in five consecutive phases, each entity consisting of a different group of the Dubai Government's entities.

23. Navrang Saini has been assigned the additional charge of the chairperson of which regulatory body?

A. Insolvency and Bankruptcy Board of India
B. Insurance Regulatory and Development Authority of India
C. Telecom Regulatory Authority of India
D. Pension Fund Regulatory and Development Authority
E. Securities and Exchange Board of India

Ans. A

Sol. * The center has further assigned the additional charge of the chairperson of Insolvency and Bankruptcy Board of India (IBBI) to Navrang Saini.
* The Centre had in Oct last year assigned additional charge of chairperson of IBBI Saini for a period of three months.
* The IBBI Chairperson is appointed by the center on the recommendations of the selection committee headed by the Cabinet Secretary.
* M S Sahoo, who was the first Chairperson of IBBI since October 1, 2016.

24. 83rd National Table Tennis Championships 2022 will be hosted by which state on April 18, 2022?

A. Sikkim
B. Manipur
C. Meghalaya
D. Arunachal Pradesh
E. Mizoram

Ans. C

Sol. The 83rd National Table Tennis Championship 2022, which will begin on April 18, 2022, will be held at SAI Indoor Training Centre, NEHU in Shillong Meghalaya.
The Northeast has hosted the world's largest table tennis tournament for the second time. The event also marks the 50th statehood celebration of Meghalaya.

25. Recently, the Uttar Pradesh government has launched a campaign, 'School Chalo Abhiyan' to ensure 100% enrolment in primary and upper primary schools across the state. What is the female literacy rate in Uttar Pradesh according to the Census 2011?

A. 69.72%
B. 79.24 %
C. 59.26 %
D. 84.56%
E. 74.53%

Ans. C

Sol. • Uttar Pradesh CM Yogi Aditynath has launched School Chalo Abhiyan to ensure 100% enrolment in primary schools across all districts in the state.
• The campaign has been launched from one of the state's lowest literacy districts, Shravasti.
• Governor of Uttar Pradesh: Anandiben Patel
• Uttar Pradesh literacy rate: 69.72%
• Male - 79.24 %
• Female - 59.26 %

26. The maximum percentage of ash content in coal

A. 50% B. 45%

C. 35% D. 30%

Ans. C

Sol. As per the standard of coal

	Best	Worst	Average
Moisture	17.5%	22%	20.5%
Ash	23%	35%	30%

27. Consider the following statement ,which of them are correct.

A. In specular reflection, the angle of Incidence is equal to angle of reflection

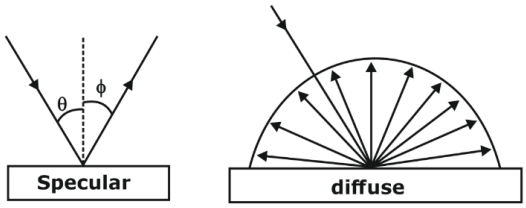
B. In specular reflection ,the incident beam gets distributed unequally

C. In diffuse reflection, the incident beam gets distributed equally in all directions

D. All of above

Ans. D

Sol.



in specular reflection, the reflected beam is mirror image of incident beam. All the incident beam is reflected in one direction only, hence unequal distribution.

In diffuse reflection, the incident beam gets distributed equally in all direction.

28. A long fin of 5 cm diameter, made of aluminum (k = 237 W/m°C) is attached to a surface maintained at 100°C. Air flows over the surface at temperature 20°C with heat transfer coefficient of 10 W/m^{2}C. If the fin can be assumed as infinitely long, its effectiveness is close to

A. 43 B. 36

C. 29 D. 14

Ans. A

Sol. Given,

diameter of the fin,d = 5 cm

Conductivity of fin material,k = 237 W/m°C

Base Temperature, T_0 = 100°C

Air temperature, T_∞ = 20°C

Heat transfer coefficient, h = 10W/m^{2}C

For infinitely long fin,

$$\varepsilon = \frac{\sqrt{hpkA_c}(T_0 - T_\infty)}{hA_c(T_0 - T_\infty)} = \sqrt{\frac{pk}{hA_c}}$$

$$\varepsilon = \sqrt{\frac{\pi \times d \times k}{h\frac{\pi}{4} \times d^2}} = \sqrt{\frac{4k}{hd}} = \sqrt{\frac{4 \times 237}{10 \times 0.05}} = 43.54$$

29. A carnot cycle refrigerator 'A' operates between 500K and 900K, whereas a carnot cycle refrigerator 'B' operates between 300K and 500K. Find out the ratio of coefficient of performance of A to B

A. 1 B. 0.34

C. 0.83 D. 0.54

Ans. C

Sol. We know that, coefficient of performance (C.O.P) = $\frac{T_2}{T_1 - T_2}$

C.O.P of A = $\frac{500}{900-500} = 1.25$

C.O.P of B = $\frac{300}{500-300} = 1.50$

So, ratio of C.O.P's = $\frac{COP_A}{COP_B} = \frac{1.25}{1.50} = 0.83$

30. In order to mix air and petrol in the required proportion and to supply it to the engine during suction stroke, _____ is employed.

A. fuel pump B. injector

C. carburettor D. none of the mentioned

Ans. C

Sol. Carburetor is used in petrol engine to mix air and petrol in the required proportion and to supply it to the engine during suction stroke

31. In a convergent divergent nozzle, the velocity at throat of nozzle is given by

A. $V = \left[\frac{2np_1V_1}{n-1}\right]^{\frac{1}{2}}$ B. $V = \left[\frac{2np_1V_1}{n+1}\right]^{\frac{1}{2}}$

C. $V = \left[2np_1V_1\right]^{\frac{1}{2}}$ D. $V = \left[np_1V_1\right]^{\frac{1}{2}}$

Ans. B

Sol. For isentropic flow through the nozzle, the enthalpy drop

$$(h_1 - h_2) = -\int vdP$$

$$\Rightarrow \frac{V_2^2}{2} = \frac{n}{n-1}(P_1V_1 - P_2V_2)$$

$$= \frac{n}{n-1}P_1V_1\left(1 - \frac{P_2V_2}{P_1V}\right)$$

$$\Rightarrow V_2 = \sqrt{\frac{2n}{n-1}P_1V_1\left[1 - \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}\right]}$$

$$\left[\frac{V_2}{V_1} = \left(\frac{P_2}{P_1}\right)^{\frac{-1}{n}}\right]$$

Velocity of steam at the throat corresponding to maximum mass flow rate can be obtained by using critical pressure ratio i.e.

$$\left(\frac{P_2}{P_1}\right)=\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}}$$

$$\Rightarrow V_{max}=\sqrt{\frac{2n}{n-1}P_1V_1\left[1-\left(\frac{2}{n+1}\right)^{\frac{n}{n-1}\times\frac{n-1}{n}}\right]}$$

$$=\sqrt{\frac{2nP_1V_1}{n+1}}$$

Option (B) is correct.

32. In a vapor absorption refrigerator system, Evaporator temperature is 250K while generator provides heat at a constant temperature of 500K. Condenser and absorber least reject heat to surroundings which is at a temperature of 300K. considering ideal processes and neglecting the pump work, the COP of refrigeration system is _____.

A. 1.6 B. 1.8

C. 2 D. 2.2

Ans. C

Sol. Given:

Evaporator temperature: T_e = 250 K

Generator temperature: T_G = 500 K

T_{surr} = 300 K = T_a

COP of VARS is given as:

$(COP)_{VARS} = \eta_{Carnot} \times COP_{Carnot}$

$$(COP)_{VARS}\left(1-\frac{T_a}{T_G}\right)\times\left(\frac{T_e}{T_a-T_e}\right)$$

$$(COP)_{VARS}=\left(1-\frac{300}{500}\right)\times\left(\frac{250}{50}\right)=2$$

33. Increase in compression ratio in diesel engine _____ delay period.

A. increases B. reduces

C. unpredictable D. none of the mentioned

Ans. B

Sol. Compression ratio is indirectly proportional to delay period, so increase in compression ratio reduces delay period.

34. The flow field of a flow is given by $V = xyz\hat{i} + 2y^2zx\hat{j} - (yz + z^2)\hat{k}$. Find the shear strain in z-direction at point (2, 3, 5) _____.

A. 25 B. 50

C. 100 D. 200

Ans. B

Sol. Given:

Flow field: $V = xyz\hat{i} + 2y^2z\hat{j} - (yz + z^2)\hat{k}$

The shear strain in the z-direction is given by:

$$\gamma_{xy} = \frac{1}{2}\left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)$$

Thus: $u = xyz, v = 2y^2zx, w = -(yz + z^2)$

$\frac{\partial u}{\partial y} = xz$ and $\frac{\partial v}{\partial x} = 2y^2z$

Thus: $\gamma_{xy} = \frac{1}{2}\left\{\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right\} = \frac{1}{2}\{2y^2z + xz\}$

$$(\gamma_{xy})_{(2,3,5)} = \frac{1}{2}\{2 \times 3^2 \times 5 + 2 \times 5\}$$

$$(\gamma_{xy})_{(2,3,5)} = \frac{1}{2}\{90 + 10\} = 50$$

35. In a 50% reaction turbine, absolute velocity angle at inlet is 45 ° and at exit it is axial. If the stage specific maximum work is 5000 J/Kg then, mean peripheral speed of blade at inlet will be _____ m/s.

A. 66.12 B. 70.70

C. 74.54 D. 79.76

Ans. B

Sol. Given.

degree of reaction = 50%,

Angle of absolute velocity at inlet, α = 45°

absolute velocity at outlet is axial

Angle of absolute velocity at outlet , β =90°

thus,

$V_{w2} = 0$

stage specific maximum work = 5000 J/Kg

Maximum specific work per kg of water

$W = V_{w1}U_1 - V_{w2}U_2$

$W = V_{w1}U_1$

$$R = 1 - \frac{V_{W1}}{2U_1} = \frac{1}{2}$$

$$\frac{V_{W1}}{2U_1} = \frac{1}{2} \Rightarrow V_{W1} = U_1$$

Thus ,

$W = u_1^2$

$5000 = u_1^2$

$u_1 = 70.710 m/s$

36. Specific isentropic work of compression in vapor compression refrigeration system decreases with _____.

A. Decrease in evaporator temperature at constant condenser temperature.

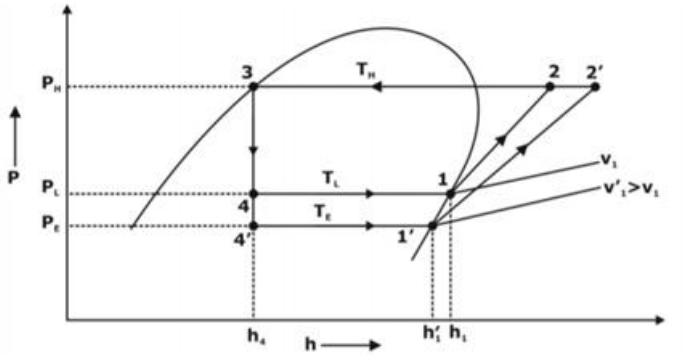
B. Increase in condenser temperature at constant evaporator temperature.

C. Decrease in evaporator temperature and increase in condenser temperature.

D. Increase in evaporator temperature at constant condenser temperature.

Ans. D

Sol.



Specific isotropic work of compression in vapor compression refrigeration system decreases with increase in evaporator temperature at constant condenser temperature because with increase in evaporator pressure the specific volume decreases.

37. For constant _____ process, the change in internal energy in a reversible process is equal to heat transferred.

A. enthalpy B. pressure

C. temperature D. volume

Ans. D

Sol. In case of a reversible constant volume process, dU=dQ

Where, dU= change in internal energy dQ = heat transfer

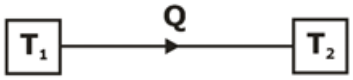
38. Calculate the increase in unavailable energy associated with transfer of 800 kJ of heat from a constant temperature system at 600 K to another constant temp system at 400K. The ambient temperature is 300K.

A. 150 kJ B. 200 kJ

C. 225 kJ D. 250 kJ

Ans. B

Sol.



$T_1 = 600K$

$T_2 = 400K$

Q = 800 kJ

T_0 = 300K

Unavailable energy = irreversibility = $T_0(\Delta S)_u$

$$(\Delta S)_u = (\Delta S)_{system} + (\Delta S)_{surroudings}$$

$(\Delta S)_{surroundings}$ = 0 (∵ No heat interaction with surroundings)

$$(\Delta S)_{system} = Q\left[\frac{-1}{T_1} + \frac{1}{T_2}\right] = 800\left[\frac{-1}{600} + \frac{1}{400}\right] = 0.667\ kJ/K$$

∴ unavailable energy = $T_0(\Delta S)_u$ = 300 × 0.667 = 200 kJ

39. In a Carnot cycle, heat is transferred at _____.

A. constant pressure
B. constant volume
C. constant temperature
D. constant enthalpy

Ans. C

Sol. Carnot cycle include

Two isentropic (compression and expansion)

Two isothermal (heat addition and heat rejection),

and the transfer of heat takes place at constant temperature processes.

40. A two-dimensional flow field has velocities along x and y direction given by u = x^2 and v = −2xy, then equation of streamline is _____.

A. x^2y = constant
B. xy^2 = constant
C. xy = constant
D. None of the above

Ans. A

Sol. Equation of streamline is given by:

$$\frac{dx}{u} = \frac{dy}{v} = \frac{dz}{w}$$

Thus: $\frac{dx}{x^2} = \frac{dy}{-2xy}$

$$2 \times \frac{dx}{x} = \frac{dy}{-y}$$

Now, on integrating on both the sides:

$$2\ln x = -\ln y + \ln c$$

$$\ln x^2 y = \ln c$$

On comparison:

x^2y = constant

41. Consider the following statements

Volumetric efficiency of a reciprocating air compressor increases with

1) increase in clearance ratio

2) decrease in delivery pressure.

3) multi-staging

Which of these statements is/are correct?

A. Only 1 and 2
B. Only 2 and 3
C. Only 3
D. 1, 2 and 3

Ans. B

Sol. Multi-stage compression is used to improved the overall volumetric efficiency.

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

By decreasing the delivery pressure (P_2) the volumetric efficiency of a reciprocating air compressor can be increased.

42. Pull down period in refrigeration system is _____.

A. The time for which the compressor is not working.
B. The time required for charging the refrigerant in the system.
C. The time required to reach the specified temperature inside the cabinet after switching on the unit.
D. Time required to leak the refrigerant from system.

Ans. C

Sol. Pull down time is the time required to achieve the desired temperature of the product from the initial entry temperature of the product after switching on the unit.

43. What is the function of a diffuser?

A. increases pressure at the expense of kinetic energy
B. increses kinetic energy at the expense of pressure
C. it may increase kinetic energy or pressure energy depending upon the Mach no of the flow.
D. increses pressure energy as well as kinetic energy

Ans. A

Sol. A **diffuser** is "a device for reducing the velocity and increasing the static pressure of a fluid passing through a system". The fluid's static pressure rise as it passes through a duct is commonly referred to as pressure recovery. In contrast, a nozle is used to increase the discharge velocity and lower the pressure of a fluid passing through it.

44. Higher cetane number means a _____ delay period and smoother engine operation.

A. higher
B. lower
C. normal
D. none of the mentioned

Ans. B

Sol. Cetane number signifies the anti-detonation capacity of the CI engine.If the cetane number is more ,less will be the detonation in the engine.The detonation in compression ignition engine is due to the delay in the burning of fuel.Hence higher cetane number means lower delay period and less knocking

45. Hydrostatic law of pressure is:

1) $\frac{\partial P}{\partial Z} = -\rho g$ and is valid for incompressible fluid.

2) $\frac{\partial P}{\partial Z} = -\rho g$ and is valid for compressible fluid.

which statement is correct _____?

A. 1 only
B. 2 only
C. 1 & 2 both
D. neither 1 nor 2

Ans. C

Sol. Hydrostatic law is given by:

$$\frac{\partial P}{\partial Z} = -\rho g$$

Which is valid for both compressible and incompressible fluid.

46. Chemical formula for the refrigerant R-22 is _____.

A. $CHClF_2$
B. $C_2Cl_3F_3$
C. $C_2Cl_2F_4$
D. CCl_2F_2

Ans. A

Sol. We have general formula:

As, R (m-1) (n+1) P

& 2m + 2 = n + p + q

For R-22:

m-1 = 0 ⇒ m = 1

n+1 = 2 ⇒ n = 1

p = 2

Thus: 2×1+ 2 = 1 + 2 +q

⇒ q = 1

Where: p = Fluorine (F)

q = chlorine (Cl)

m = Carbon (C)

n = Hydrogen (H)

Thus, R-22 chemical formula: $CHClF_2$.

47. The catalytic converter cannot control the following emission

A. Nox
B. HC
C. CO
D. Particulates

Ans. D

Sol. It cannot control the emission of the particulates.

48. 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.

49. The bulk mean temperature at any section of a pipe if V_{mean} is the mean velocity is

A. $\int_0^R \frac{2\,ru(r)T(r)}{R^2\,V_{mean}}dr$

B. $\int_0^R \frac{2u(r)}{R^2\,V_{mean}T(r)}\,dr$

C. $\int_0^R \frac{rT(r)}{R^2\,V_{mean}u(r)}dr$

D. $\int_0^R \frac{u(r)T(r)}{R^2\,V_{mean}}\,dr$

Ans. A

Sol. • The bulk mean temperature (T_m) at a given cross-section of the pipe of flowing fluid is defined as the constant temperature which takes into account the variation of temperature of fluid layers w.r.t radius at that cross-section of the pipe and hence indicates the total thermal energy or enthalpy carried by the fluid through that cross-section.

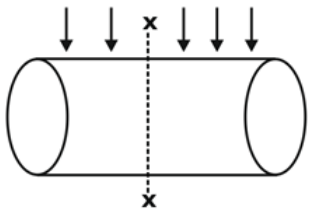


Fig.: Bulk Mean Temperature

• The bulk mean temperature at any section of a pipe,

$$T_{bm} = \int_0^R \frac{2\,ru(r)T(r)}{R^2\,V_{mean}}dr$$

50. In perfect aftercooling, gas from intercooler has temperature equal to

A. inlet temperature

B. outlet temperature

C. intercooler temperature

D. all of the mentioned

Ans. A

Sol.

- In multistage inter-cooling during compression, the gas is compressed in each stage and cooled between stages by passing it through a heat exchanger called an intercooler.
- Ideally, the cooling process takes place at constant pressure and the gas is cooled to the initial temperature or inlet temperature of each stage compressor inlet.

51. The maximum work developed by a closed cycle used in a gas turbine plant when it is working between 900 K and 289 K and using air as working substance is:

A. 11 kJ/kg

B. 13 kJ/kg

C. 170 kJ/kg

D. 21 kJ/kg

Ans. C

Sol. Given,

T_{max} = 900 K

T_{min} = 289 K

Condition for maximum work develop by turbine for per kg of air is

$$W_{max} = c_p(\sqrt{T_{max}} - \sqrt{T_{min}})^2$$

$$=1.005\ (30 - 17)^2$$

$$= 169.845\ kJ/kg = 170\ kJ/kg$$

52. A solid sphere of radius 5 cm is to be covered with insulation (k = 3 W/m-deg). The critical thickness of insulation is (in cm). Assume h = 100 W/m^2.

A. 0.5 B. 1

C. 6 D. 2

Ans. B

Sol. For sphere,

$$r_c = \frac{2k}{h}$$

$$r_c = 2 \times \frac{3}{100}$$

r_C = 6 cm.

Critical thickness of in solation

= 6 - 5 = 1 cm.

53. Humidity ratio of air inside a closed room is 20 gm/kg of dry air. Air inside the room is completely saturated with a saturator pressure P_s of 3.5 kPa. Find the total pressure of air inside the room _____.

A. 112.35 kPa B. 105 kPa

C. 120 kPa D. 103.5 kPa

Ans. A

Sol. Given:

Specific humidity: ω = 20 gm/kg of dry air

Saturation pressure: P_s = 3.5 kPa, 100% saturation

Specific humidity is given as:

$$\omega = \frac{0.622P_V}{P_a}$$

$$0.02 = \frac{0.622 \times 3.50}{P_a} \text{(Air is saturated)}$$

$\Rightarrow P_a$ = 108.85 kPa

$\Rightarrow P_t = P_a + P_v$

P_t = 108.85 + 3.5

P_t = 112.35 kPa

54. Two infinitely large parallel plates 1 and 2 are held at temperatures 800 K and 500 K respectively and placed at a distance 50 mm apart in vaccum. A third large infinite flat

radiation shield is introduced in between the plates 1 and 2. Consider emissivity of all the plates are equal. The ratio of the steady state radiative heat flux with and without the shield is

A. 1 B. 0.5

C. 0.25 D. 0.75

Ans. B

Sol.

$$Q_{with\ shield} = \frac{1}{n+1} Q_{without\ shield}$$

Here number of shield plate n = 1

$$Q_{with\ shield} = \frac{1}{1+1} Q_{without\ shield}$$

$$\frac{Q_{with\ shield}}{Q_{without\ shield}} = 0.5$$

55. The time period of oscillation of a floating body is T. If the time period changes to 2T, the metacentric height_____.

A. Increases by a factor of 2 B. Increases by a factor of 4

C. Decreases by a factor of 2 D. Decreases by a factor of 4

Ans. D

Sol.

- The time period of the oscillation of a floating body is inversely proportional to the square root of the metacentric height.

$$T = 2\pi\sqrt{\frac{k^2}{g\,(GM)}}$$

where GM is metacentric height and T is time period of oscilation,

k = Radius of gyration .

- The time period of the oscillation of a floating body is inversely proportional to the square root of the metacentric height.

$$T \alpha \sqrt{\frac{1}{GM}}$$

$$\frac{T_2^{\,2}}{T_1^{\,2}} = \frac{GM_1}{GM_2}$$

Given,

$$T_2 = 2T_1$$

$$4 = \frac{GM_1}{GM_2}$$

$$GM_2 = \frac{GM_1}{4}$$

- Therefore, when T changes to 2T, Metacentric height will reduce by a factor of 4

56. For the velocity potential function $\emptyset = x^2 - y^2$. Find the velocity components at x = 3 and y = 4

A. -6 m/s; 2m/s
B. -6m/s; 8m/s
C. -3m/s; -7m/s
D. 3m/s; 6.32m/s

Ans. B

Sol. Given :

Velocity potential function $\emptyset = x^2 - y^2$

Velocity component

$u = -\frac{\partial \emptyset}{\partial x} = -2x$; $v = -\frac{\partial \emptyset}{\partial y} = 2y$

Velocity at the x=3 and y=4

u = - 2(3) = - 6 m/s

v = 2(4) = 8 m/s

57. Find the change in availability $\left(\frac{kJ}{kg}\right)$ for open system. Take ambient temperature as 300 K.

	Enthalpy $\left(\frac{kJ}{kg}\right)$	Entropy $\left(\frac{kJ}{kg\ K}\right)$
State-1	600	1.2
State-2	300	0.8

A. 300
B. 200
C. 180
D. 150

Ans. C

Sol. Given,

Ambient temperature = 300 K,

	Enthalpy $\left(\frac{kJ}{kg}\right)$	Entropy $\left(\frac{kJ}{kg\ K}\right)$
State-1	600	1.2
State-2	300	0.8

Change in A.E. for open system,

$$\phi = h - T_0 s + \frac{C^2}{2} + gz$$

$$\phi_2 - \phi_1 = (h_2 - h_1) - T_0 (s_2 - s_1)$$

or

$$\phi_1 - \phi_2 = (h_1 - h_2) - T_0 (s_1 - s_2) = (600 - 300) - 300(1.2 - 0.8)$$

$$\phi_1 - \phi_2 = 180 \frac{kJ}{kg}$$

58. The volumetric efficiency is defined as the ratio of

A. total volume / piston displacement volume

B. total volume / gas volume taken during suction

C. gas volume taken during suction / swept volume

D. swept volume / gas volume taken during suction

Ans. C

Sol. volumetric efficiency is defined as the ratio of gas volume taken during suction / swept volume

$$\eta_v = \frac{V_{actual}}{V_{swept}} = 1 - C\left(\left(\frac{P_2}{P_1}\right)^{\frac{1}{n}} - 1\right)$$

where,

$$C = \frac{V_c}{V_S} \quad V_c = \text{clearance volume}$$

$$V_S = \text{swept volume}$$

$$n = \text{expansion coeffecient}$$

59. Velocity profile of a flow is given by $\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$. The flow

A. has separated

B. is on the verge of separation

C. will attach with the surface

D. cannot be determined

Ans. C

Sol. Given,

$$\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3$$

$$u = U\left[\frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^3\right]$$

$$\frac{du}{dy} = U\left[\frac{3}{2}\left(\frac{1}{\delta}\right) - \frac{3}{2}\left(\frac{y^2}{\delta^3}\right)\right]$$

$$at\ y = 0$$

$$\frac{du}{dy} = \frac{3}{2}\left(\frac{U}{\delta}\right)$$

which is +ve.

Hence, flow will not separate and flow will remain attached with the surface.

60. Which one of the following types of impeller vanes are most commonly used in centrifugal type compressors?

A. Forward curved
B. Radial
C. Backward curved
D. Tangential

Ans. C

Sol. Backward curved blades are slightly better in efficiency and are stable over a wide range of flow. While forward curved blades are used for higher pressure ratio.

In most cases better efficiency is required for centrifugal compressors hence backward curved vanes are mostly used.

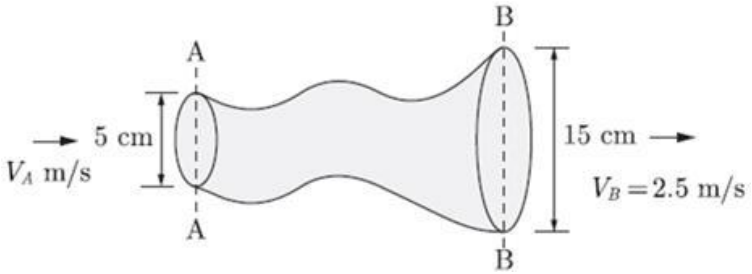
61. An incompressible homogenous fluid is flowing steadily in a variable diameter pipe having the large and small diameters at 15 cm and 5 cm, respectively. If the velocity at a section at the 15 cm diameter portion of the pipe is 2.5 m/s, the velocity of the fluid (in m/s) at a section falling in 5 cm portion of the pipe is _____

A. 43.4
B. 22.5
C. 22.3
D. 21.5

Ans. B

Sol. Correct answer is 22.5.

Given a variable section of Diameters 15 cm & 5 cm at two section as shown



Given velocity at B-B section is 2.5 m/s & velocity at section A-B is V_A m/s.

So by applying continuity equation at section A-A & B-B

$V_A \times A_A = V_B \times A_B$

$$V_A \times \frac{\pi}{4} \times (5)^2 = 2.5 \times \frac{\pi}{4} \times (15)^2$$

So $V_A = 22.5\ m/s$

62. Compression ratio of diesel engine varies from ___.

A. 6 to 10
B. 10 to 15
C. 16 to 20
D. 25 to 40

Ans. C

Sol.

- Diesel engine compression ratio is high and it varies from 16 to 20.

- Due to high compression ratio the diesel engine are bulky than the petrol engine which have less compression engine.

63. Find the extra heat in the boiler if coal power plant which is operating on Rankine cycle carries a boiler pressure 32 bar with condenser pressure 0.75 bar having dry exit state. Assume the superheat steam properties at 32 bar be 592 °C with h_g=3663 kJ/kg and S_g =7.4563 kJ/kgK.

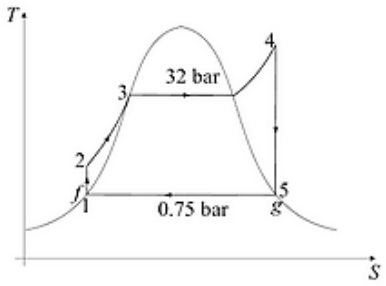
Pressure (bar)	v_f (m^3/kg)	h_f (kJ/kg)	h_g (kJ/kg)	s_f (kJ/kgK)	s_g (kJ/kgK)
0.75	0.001037	384.36	2662.96	1.2129	7.4563
32.0	0.001224	1025	2803	2.678	6.160

A. 1778 B. 2415

C. 2638 D. 3275

Ans. D

Sol. From the diagram of Rankine cycle:



Work of pump in coal boiler

= Wp = h2 – h1 = vΔP

Now Wp = 0.00103 x 32-0.75 * 100 kj/kg = 3.24 kJ/kg

Wp = h2 – h1 = vΔP

Now h2 = h1 + Wp

384.36 + 3.24 = 387.6KJ/kg

Hence, the extra heat in boiler will be:

Q = h4 – h2

Where Q = 3663 – 387.6

= 3275.4 KJ/kg

64. The boundary layer thicknesses, at a point distant x from the leading edge on a flat plate are δ_1 and δ_2 whose Reynolds numbers are 60 and 196 respectively. The ratio of δ_1 to δ_2 will be

A. 0.55 B. 0.36

C. 1.8 D. 2.75

Ans. C

Sol.

As, $\frac{\delta}{x} = \left(\frac{5}{\sqrt{R_{ex}}}\right)$

At distance x, $\delta \propto \frac{1}{\sqrt{R_{ex}}}$

$\frac{\delta_1}{\delta_2} = \left(\frac{\sqrt{196}}{\sqrt{60}}\right) = 1.8$

65. A Bi-molecular gas expanding in a piston cylinder arrangements, following $pv^{1.3}$= constant. If the heat transfer absorbed during this polytropic process is 100kW then the amount of the work done by the gas will be

A. 400 kW
B. –400 kW
C. 25 kW
D. –25 kW

Ans. A

Sol. Given,

n= 1.3, γ for Bi molecular gas =1.4

as we know that,

$$\delta Q = \delta W\left(\frac{\gamma - n}{\gamma - 1}\right)$$

$$100 = \delta W\left(\frac{1.4 - 1.3}{1.4 - 1}\right)$$

$$\delta W = 400\ kW$$

66. Air at 20°C flows over a flat plate maintained at 75 °C . Measurements shows that temperature at a distance of 0.5 mm from the surface of plate is 50 °C . Presuming thermal conductivity of air is 0.0266 W/m K, estimate the value of local heat transfer coefficient _____.

A. 23.18 W/m ^{2} K
B. 24.18 W/m ^{2} K
C. 25.18 W/m ^{2} K
D. 26.18 W/m ^{2} K

Ans. B

Sol. Heat transfer coefficient at fluid and solid interface is given by:

$$h = -\frac{k}{t_s - t_\infty} \times \left(\frac{dt}{dy}\right)_{y=0}$$

h = – k/ (t_s – $t_{infinity}$) [d t/d y] $_{y = 0}$ and d t/d y = – 50 * 10 ^{3} degree Celsius/m

$$h = -\frac{0.0266}{75 - 20} \times (-50000) = 24.18\ w/m^2k$$

67. In supersonic flow of air, a diverging passage result 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

Ans. B

Sol.

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

for supersonic flow, M > 1.

for diverging passage, $\frac{dA}{A}$ is +ve

$\therefore \frac{dA}{A}$ = +ve, so pressure decreases.

As p ∝ P,

$\therefore$ density also decreases.

68. A heat exchanger heats water entering at 10ºC at the rate of 1.5 kg/s by hot air entering at 80ºC at the rate of 3 kg/s. The highest rate of heat transfer in the heat exchanger is _____

For air, C=1.005 kJ/kg K and for water C = 4.18 kJ/kg K

A. 420.5 kJ
B. 211 kJ
C. 128.3 kJ
D. 80.9 kJ

Ans. B

Sol. The maximum heat transfer in the heat exchanger is given by :

$Q_{max} = C_{min}\Delta T_{max}$

$C_{water} = \dot{m}_{water}c_{water} = 6.27$

$C_{air} = \dot{m}_{air}c_{air} = 3.015$

Thus, $C_{min} = C_{air}$

So, $Q_{max} = C_{min}\Delta T_{max}$ = 3.015 × (80 – 10)= 211.05 kJ

69. The value of constant 'b' in Van der Waals equation of gases is

A. $2V_c$
B. $\frac{V_c}{2}$
C. $3Vc$
D. $\frac{V_c}{3}$

Ans. D

Sol. In Van der Waals equation,

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

Where,

$$a = 3p_cV_c^2 \ \& \ b = \frac{V_c}{3}$$

70. For high transfer of a refrigerant, consider the following physical properties:

1. High thermal conductivity.
2. High diffusivity.
3. High viscosity.

Which of the following is/are correct _____?

A. 1 only
B. 1 and 2 only
C. 1 and 3 only
D. 1, 2 and 3

Ans. B

Sol. For high heat transfer rates:

(i). Thermal conductivity should be high.

(ii). Diffusivity is given as:

$$\alpha = \frac{k}{\rho C_p}$$

It should be high.

(iii). A low viscosity refrigerant is desirable for high heat transfer.

71. Which of the following quantities is not the property of the system_____?

A. Pressure
B. Temperature
C. Density
D. Heat

Ans. D

Sol.

- Every system has certain characteristics by which its physical condition may be described. Such characteristics are called properties of the system.
- Since heat transfer is the path function hence it is not the property of the system.

72. For a fluid having Prandtl number equal to unity, how are the hydrodynamic boundary layer thickness (δ) and the thermal boundary layer thickness (δ_t) related _____?

A. $\delta = \delta_t$
B. $\delta > \delta_t$
C. $\delta < \delta_t$
D. $\delta_t = \delta^{1/3}$

Ans. A

Sol. Thermal boundary layer thickness (δ_t) is given by:

$$\delta_t = \frac{\delta}{Pr^{1/3}}$$

(i) when Pr =1; $\delta_t = \delta$

(ii) when Pr >1; $\delta_t < \delta$

(iii) when Pr<1; $\delta_t > \delta$

73. Temperature at the inlet and exit of the compressor of air refrigeration system in a jet plane are 10°C and 150°C respectively. Find ideal COP of the system _____.

A. 3
B. 4
C. 2.5
D. 2

Ans. D

Sol. Given:

T_1 = 10°C = 283 K

T_2 = 150°C = 423 K

COP of air refrigeration system is given as:

$$\Rightarrow (COP)_{R.B.C.} = \frac{1}{(r_p)^{\frac{\gamma-1}{\gamma}} - 1}$$

$$\frac{T_2}{T_1} = (r_p)^{\frac{\gamma-1}{\gamma}}$$

$$(COP)_{R.B.C.} = \frac{1}{\left(\frac{T_2}{T_1}\right) - 1}$$

$$(COP)_{R.B.C.} = \frac{1}{\left(\frac{423}{283}\right) - 1} = 2$$

74. For a plate of length L, an average value of Nusselt number for fully developed laminar flow is given by_____.

A. Nu = 0.664 $(Re)^{0.4}$ $(Pr)^{0.54}$

B. Nu = 0.0234 $(Re)^{0.5}$ $(Pr)^{0.74}$

C. Nu = 0.664 $(Re)^{0.5}$ $(Pr)^{0.27}$

D. Nu = 0.664 $(Re)^{0.5}$ $(Pr)^{0.33}$

Ans. D

Sol. For a plate of length L,

an average value of Nusselt number for fully developed laminar flow is given by,

Nu = 0.664 $(Re)^{0.5}$ $(Pr)^{0.33}$

75. A solid cone of radius R and vertex angle 2α is to rotate with angular velocity 'ω'. An oil of viscosity 'μ' and thickness 'h' fills the gap between cone & housing. What is the torque required to rotate the cone _____?

A. $\frac{\pi\mu\omega^2R^4}{h\sin\alpha}$

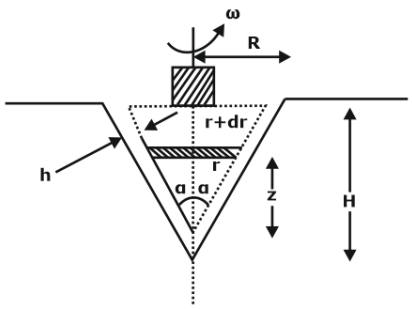
B. $\frac{\pi\mu\omega R^4}{2h\sin\alpha}$

C. $\frac{\pi\omega R^4\sin\alpha}{2h\mu}$

D. $\frac{\pi\omega R^4\sin\alpha}{\mu h}$

Ans. B

Sol. Let us consider an elementary ring on bearing surface of radius r, at a distance z from apex of cone and (r + dr) is radius at (z + dz) distance.



Bearing area:

A= 2πrdl

Where: dl = slant height

From diagram: $dl = \frac{dr}{\sin\alpha}$

$$A = 2\pi r\frac{dr}{\sin\alpha}$$

Now, shear stress (τ) is given as:

$$\tau = \mu\frac{du}{dy} = \mu\left(\frac{\omega r}{h}\right)$$

$$dF = \tau \times \text{Area}$$

$$dF = \left(\frac{\mu\omega r}{h}\right)\times 2\pi r\left(\frac{dr}{\sin\alpha}\right)$$

Torque: dT = dF × r

$$\int dT = \int_0^R \frac{2\pi\mu\omega}{h\sin\alpha}r^3 dr$$

$$\Rightarrow \boxed{T = \frac{\pi\mu\omega R^4}{2h\sin\alpha}}$$

76. What is the optimum reheat pressure for most of the power plants is how many times of the initial steam pressure?

A. 0.1-0.15 B. 0.2-0.20

C. 0.2-0.25 D. 0.1-0.10

Ans. C

Sol. The efficiency increases as the reheat pressure is lowered & reaches a peak at a pressure ratio between 0.2-0.25.

77. An adiabatic container consists of two parts A and B . Part A is initially filled with 1kg of an ideal gas having C_v = 750 J/kg, R = 500 J/kg at 1 bar 600 K. Part B is filled with 1 kg of the same ideal gas at 2 bar,400 K. The piston is now removed. The pressure of the system in the final state (in bar) is_____

A. 1.25 B. 1.30

C. 2.25 D. 3

Ans. A

Sol. Given,

Adiabatic container,

Part A:

mass = 1kg,

ideal gas (C_v)= 750 J/kg,

R = 500 J/kg,

Pressure =1 bar,

temp.= 600K,

Part B:

mass = 1kg,

ideal gas (C_v)= 750 J/kg,

R = 500 J/kg,

Pressure =2 bar,

temp.= 400K,

The volume of the container (V),

$$V = \frac{m_1RT_1}{P_1} + \frac{m_2RT_2}{P_2} = \frac{1\times500\times600}{10^5} + \frac{1\times500\times400}{2\times10^5} = 4m^3$$

The final temperature of the mixture can be calculated as:

$$T_f = \frac{m_1C_{v1}T_1 + m_2C_{v2}T_2}{m_1C_{v1} + m_2C_{v2}}$$

$$T_f = \frac{1\times750\times600 + 1\times750\times400}{750+750} = 500K$$

The final mass of the system is m_f = 1 + 1 = 2 kg

Using the equation of state, the final pressure of the system is:

$$P_f = \frac{m_fRT_f}{V_f} = \frac{2\times500\times500}{4} = 125000Pa = 1.25bar$$

78. A nuclear reactor is said to be critical when the neutron population in the reactor core is

A. rapidly increasing leading to the point of explosion

B. decreasing from a specific value

C. reduced to zero

D. constant

Ans. D

Sol. A nuclear reactor is said to be critical when the neutron population in the reactor core is constant.

79. For a room the dry air is 50 kg in the room and water vapour is 0.8 kg. The temperature of the room is 27ºC . If saturation pressure at 27ºC is 3.5 kPa. Then relative humidity of the room will be (Given P_{room} = 100 kPa)

A. 50% B. 60%

C. 70% D. 80%

Ans. C

Sol. Given:

Mass of dry air in room = 50 kg

Mass of water vapour in the room = 0.8 kg

Temperature of air in room, DBT of air = 27° C

Saturation pressure of water vapour, P_{vs} = 3.5 kPa

Total pressure of room, P_t = 100 kPa

So, specific humidity (ω) = $\frac{0.8}{50}$ kg/kg of d.a. = 0.016 kg per kg of d.a

$$\omega = \frac{0.622 \times P_v}{P_t - P_v}$$

$$\frac{0.8}{50} = \frac{0.622 \times P_v}{100 - P_v}$$

Or P_v = 2.5 kPa

$$\phi = \frac{P_v}{P_{vs}} = \frac{2.5}{3.5} = 0.714 = 71.4\%$$

80. The efficiency of the Otto cycle for the same compression ratio will be maximum when working fluid is

A. Air
B. Helium
C. Carbon Dioxide
D. Oxygen

Ans. B

Sol. The efficiency of the Otto cycle is function of the specific heat ratio

$$\eta = 1 - \frac{1}{r^{\gamma - 1}}$$

with increase in the specific heat ratio efficiency of the otto cycle increases.
The highest specific heat ratio is of Helium i.e. 1.66 thus it will give highest efficiency.

81. A multistage pump lifts 6000 cubic metre/minute against a total head of 215 m, at a speed of 750 rpm. The specific speed is limited to 750. The number of the impellers required for multistage pump is

A. 8
B. 10
C. 12
D. 15

Ans. B

Sol. The limiting N_s for each impeller = 750

$$But, \qquad N_s = \frac{N\sqrt{Q}}{H_m^{3/4}}$$

$$\Rightarrow \qquad 750 = \frac{750(6000/60)^{1/2}}{H_m^{3/4}}$$

$\Rightarrow$ Head per stage = H_m =21.54 m

$$\therefore \quad Number\ of\ stages = \frac{215}{21.54} = 9.98 \simeq 10$$

82. A refrigerator with a COP of 3 uses 4.2 kg/min. refrigerant extracting 200 kJ/kg heat in the evaporator. Assuming compressor efficiency of 70% the minimum size of motor in kW is

A. 6 KW
B. 4.5 KW
C. 6.67 KW
D. 2.5 KW

Ans. C

Sol. Given,

$(COP)_{ref.} = 3$

$m = 4.2/60$ kg/sec

0.07 kg/sec

$Q_2 = 200$ kJ/kg

$_{Efficiency\ comp.} = 0.70$

To find → size of motor

$$(COP)_{ref.} = \frac{\text{Refrigerating capacity}}{\text{Work input}}$$

$$3 = \frac{0.07 \times 200}{W_{inp}}$$

$$W_{inp} = \frac{0.07 \times 200}{3} = 4.67 \text{ KW}$$

$$\eta = \frac{W_{inp}}{W_{act}} = 0.7$$

$$W_{act} = \frac{W_{inp}}{\eta} = \frac{4.67}{0.7} = 6.67\ kW$$

83. In rocket propulsion, the oxygen for combustion of its fuel is taken from _____.

A. Surrounding air

B. The rocket itself

C. Compressed atmospheric air

D. Surrounding air and compressed atmospheric air

Ans. B

Sol.

- Rockets are equipped with both fuel cylinder and oxygen cylinder, they do not take oxygen from atmosphere.
- Rocket engines are reaction engines, producing thrust by ejecting mass rearward, in accordance with Newton's third law.

84. A copper bar of circular cross-section is cooled by air. The velocity and temperature of air is 1.2 m/s and 20°C . Maximum temperature limit of copper bar is fixed and its current carrying capacity is 200 amp under given conditions. The maximum current carrying capacity of bar when velocity of air becomes 4 times is _____. [Correct to two decimal places]

Use relation $Nu = \frac{hd}{k} = 0.5\sqrt{Re}$

A. 141.42 Amp

B. 282.84 Amp

C. 424.26 Amp

D. 565.68 Amp

Ans. B

Sol. Given:

Velocity: V = 1.2 m/s

Temperature of air: T = 20°C.

From energy balance of copper bar

$I^2R = h(pdl)\Delta T$

$I \propto \sqrt{h}$ ..... (1)

Now from given relation:

$I \propto \sqrt{Re} \propto \sqrt{v}$ ..... (2)

where v is velocity of air.

From (1) and (2), we get:

$I \propto (v)^{1/4}$

Now, $I' = I\left(\frac{v'}{v}\right)^{1/4}$

$I' = I \times (4)^{1/4}$

$I' = 200 \times (4)^{1/4}$ = 282.84 amp

85. In I.C. Engines, the compression ratio is given as

A. The ratio of Volume displaced by piston per stroke and clearance volume in cylinder

B. The ratio of volumes of air in cylinder before compression stroke and after compression stroke.

C. Cylinder volume/ swept volume

D. Swept volume/ cylinder volume

Ans. B

Sol. The compression ratio is defined as ratio of volumes of air in cylinder before compression stroke and after compression stroke.

86. Consider the following statements regarding heat exchanger.

1) Fouling in the tubes of heat exchanger increases with increasing temperature and velocity of fluid.

2) Baffles are used to enhance heat transfer between two fluids.

3) The correction factor for a condenser or boiler is always 1

4) For a given NTU and capacity ratio, the counter flow heat exchanger has the highest effectiveness.

Which of above statements are correct?

A. 1, 2, 3 and 4

B. 1, 2 and 3 only

C. 1, 2 and 4 only

D. 2, 3 and 4 only

Ans. D

Sol. 1. Fouling in the tubes of heat exchanger increases with increasing temperature and decreasing velocity of fluid.

2. Baffles are commonly placed in the shell to force the shell side fluid to flow across the shell to enhanced heat transfer by increased heat transfer coefficient and to maintain uniform spacing between tubes.

3. The correction factor for a condenser or boiler is F = 1, regardless of the configuration of the heat exchanger.

$Q = F \cdot UA(LMTD)$

Where, F = correction factor

4. For a given NTU and capacity ratio $C = C_{min}/C_{max}$, the counter flow heat exchanger has the highest effectiveness.

87. Given a polytropic process in which the pressure-volume relation is $PV^{1.1} = C_P$. The ratio of the heat interaction to the work interaction of the system is_____.(Take specific heat ratio equals to 1.4)

A. 0.30 B. 0.75

C. 0.50 D. None of these

Ans. B

Sol. Given,

Pressure-volume relation,

$PV^{1.1} = C$

For a polytropic process we have:

$$\delta Q_{poly.} = \left[\frac{\gamma - n}{\gamma - 1}\right]\delta W_{poly.}$$

$$\frac{\delta Q_{poly.}}{\delta W_{poly.}} = \left[\frac{\gamma - n}{\gamma - 1}\right] = \left(\frac{1.4 - 1.1}{1.4 - 1}\right) = 0.75$$

88. A mercury- oil differential manometer measures a 35 cm difference of mercury level. Mercury has specific gravity 13.6 and oil has has specific gravity 0.8. What is the difference in pressure head (m of oil) ?

A. 6.85 B. 5.95

C. 4.96 D. 3.45

Ans. B

Sol. We know that,

$h_1 s_1 = h_2 s_2$

Here

$h_1 = 35$ cm

$s_1 = 13.6$

$h_2 = ?$

$s_2 = 0.8$

Putting the values in equation, we get:

$0.35 \times 13.6 = h_2 \times 0.8$

$h_2 = 5.95$ m of oil.

89. In a one-ton capacity water cooler, water enters at 30°C with the rate of 200 litre/s. Taking specific heat of water as 4.16 kJ/kg-K, the outlet temperature of water will be _____.

A. 3.5°C
B. 6.3°C
C. 23.7°C
D. 15°C

Ans. D

Sol. Given:

RC: Q = 1 ton ⇒ 3.5 kW

T_1 = 30°C = 303 K

C_p = 4.16 kJ/kg-K

$$\dot{V} = 200 \text{ litre / hr} = \frac{200 \times 10^{-3}}{3600} m^3/\text{sec}$$

$$\dot{V} = \frac{1}{18000} m^3/\text{sec}$$

$$\text{Since } \dot{m} = \rho\dot{V} = 1000 \times \frac{1}{18000} = \frac{1}{18} \text{ kg / s}$$

Now, $Q = mC_p dT$

$$3.5 \times 10^3 = \frac{1}{18} \times 4.16 \times 10^3 \times (303 - T_2)$$

$$T_2 = (303 - 15.144)K = 287.856 \text{ K}$$

T_2 = 14.856°C ≈ 15°C

90. A diesel engine has a compression ratio of 21 and cut-off takes place at 8% of the stroke. What is the cut – off ratio ?

A. 1.2
B. 2.2
C. 1.6
D. 2.6

Ans. D

Sol. Given:

compression ratio, r_k = 21

cut off takes place = 8% of(V_1 - V_2)

$$r_c - 1 = \frac{\%p}{100}\left(r_k - 1\right)$$

$$r_c - 1 = \frac{8}{100}(21 - 1)$$

r_c = 2.6

91. The process of pushing exhausted gas-charge out of the cylinder and drawing in a fresh draught of air or air/fuel mixture for the next cycle is called _____.

A. Priming
B. Knocking
C. Scavenging
D. Combustion Delay

Ans. C

Sol.

- The process of pushing exhausted gas-charge out of the cylinder and drawing in a fresh draught of air or air/fuel mixture for the next cycle is called scavenging.

92. A centrifugal pump needs 1000 W of power when operating at 2000 rpm. If the speed of pump is increased to 4000 rpm, then power requirement is _____ kW.

A. 6 B. 7

C. 5 D. 8

Ans. D

Sol. By similarity laws,

$$\frac{P_1}{\gamma D_1^5 N_1^3} = \frac{P_2}{\gamma D_2^5 N_2^3}$$

For a centrifugal pump, $D_1 = D_2$

$$\therefore \quad \frac{P_1}{N_1^3} = \frac{P_2}{N_2^3}$$

$$\Rightarrow \quad \frac{1000}{(2000)^3} = \frac{P_2}{(4000)^3}$$

$$\Rightarrow \quad 2^3 \times 1000 = P_2$$

$$\therefore \quad P_2 = 8000W = 8kW$$

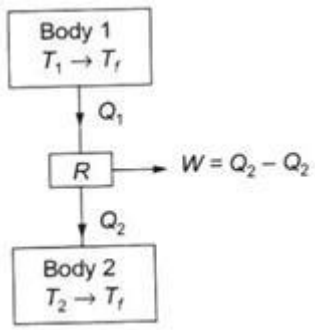
93. Two identical finite bodies of constant heat capacity at temperature T_1 and T_2 are avilable to do work in a heat engine. The final temperature T_f reached by the bodies on delivery of maximum work is

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. $T_f = \sqrt{T_1^2 + T_2^2}$

Ans. B

Sol.



Total heat withdrawn from body 1

$$Q_1 = C_P(T_1 - T_f)$$

Total heat rejected to body 2

$$Q_2 = C_P\left(T_f - T_2\right)$$

$$W = Q_1 - Q_2$$

$$= C_P\left(T_1 + T_2 - 2T_f\right)$$

Work obtainable, W,will be maximum when T_f is minimum.

$$\triangle S_1 = \int_{T_1}^{T_F} C_P \frac{dT}{T} = C_P \ln \frac{T_f}{T_1}$$

$$\triangle S_2 = \int_{T_2}^{T_F} C_P \frac{dT}{T} = C_P \ln \frac{T_f}{T_2}$$

$$\because \quad \triangle S_{univ} \geq 0$$

$$\therefore \quad C_P \ln \frac{T_f}{T_1} + C_P \ln \frac{T_f}{T_2} \geq 0$$

Or $C_P \ln[\frac{T^2_f}{T_1 T_2}] \geq 0$

For T_f to be minimum,

$$\ln[\frac{T_f^2}{T_1 T_2}] = 0 = \ln 1$$

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

94. Absorption dynamometer includes _____.

A. Prony brake dynamometer
B. Rope brake dynamometer
C. Hydraulic dynamometer
D. All of the above

Ans. D

Sol.

- Absorption Type Dynamometer: In these types of dynamometers, the entire power produced by the prime mover is absorbed by the frictional resistance of the brake and is transformed into heat, during the process of obtaining the power of any prime mover.
- The absorption type of dynamometers can be classified as:

(i). Prony Brake Dynamometer
(ii). Rope Brake Dynamometer.
(iii). Hydraulic Dynamometer
(iv). Eddy Current Dynamometer

95. Constant pressure lines in h – s diagram (Mollier chart) in superheated region are of

A. Converging nature
B. Diverging nature
C. Straight line
D. None of these

Ans. B

Sol. From T- ds relationship

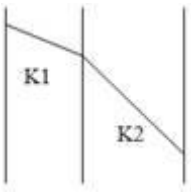
$$Tds = dh - vdP$$

For constant pressure lines, P = Const.

$$\left(\frac{dh}{ds}\right)_P = T$$

So, constant pressure lines in superheated region are of diverging nature.

96.



Which of the following relation is true with respect to the diagram?

A. $K_1 > K_2$ B. $K_1 < K_2$

C. $K_1 = K_2$ D. can not be determine

Ans. A

Sol. Greater the slope, greater is the temperature gradient which is inversely proportional to thermal conductivity.

so the thermal conductivity of material 1 is higher than the thermal conductivity of material 2

Therefore, the correct answer is $K_1 > K_2$ is the relation which is true with respect to the diagram.

97. The surface tension of fluid in contact with air at 25℃ is 0.2 N/m. The pressure inside a droplet is to be 0.08 N/cm^2 greater than outside pressure. Determine the diameter of the droplet.

A. 1 mm B. 10 mm

C. 100 mm D. 1000 mm

Ans. A

Sol. Given,

We know that,

$$\Delta P = \frac{4\sigma}{d} \Rightarrow 800 = \frac{4 \times 0.2}{d}$$

$$d = 1 \times 10^{-3} m$$

$$d = 1mm$$

98. The fouling factor is resistance to heat flow due to a build-up of layer of a layer of dirt or other fouling substance on the tube surfaces of the heat exchanger so if R_f is the resistance due to fouling then fouling factor in heat exchanger is defined as

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

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

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

D. $R_f = U_{dirty} - U_{clean}$

Ans. C

Sol. The resistance due to fouling = R_f

$$\therefore \frac{1}{U_{dirty}} = \frac{1}{U_{clean}} + \frac{\frac{1}{1}}{R_f}$$

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

99. Let us consider a moist air stream having enthalpy of 50 kJ/kg is flowing at a rate of 2 kg/s. Steam is injected into the moist air steam at a rate of 0.01 kg/s. then final enthalpy of moist air will be (given h_s = 2500 kJ/kg)

A. 67.5 kJ/kg

B. 62.2 kJ/kg

C. 62.5 kJ/kg

D. 17.5 kJ/kg

Ans. B

Sol. Given:

Mass flow rate of moist air, m_a = 2 kg/s

Mass flow rate of steam, m_s = 0.01 kg/s

Enthalpy of moist air, h_1 = 50 kJ/kg

Enthalpy of steam, h_s = 2500 kJ/kg

So, final enthalpy of moist air

$$h_2 = \frac{\dot{m}_a h_a + \dot{m}_s h_s}{\dot{m}_a + \dot{m}_s} = \frac{2 \times 50 + 0.01 \times 2500}{2 + 0.01} = 62.2\,kJ/kg$$

100. Which of the following statements about azeotropic mixture of refrigerants is/are true _____?

1. Mixture behaves as pure substance.
2. Components can't be separated by distillation.
3. has constant fixed boiling point.
4. has range of boiling temperature.

A. 1 and 3 only

B. 1 and 4 only

C. 1, 2 and 3 only

D. 1, 2 and 4 only

Ans. C

Sol. • An azeotropic refrigerant is a mixture of two or more components that boil at the same temperature.

• Azeotropes may not require purging because they behave like pure substances.

• Azeotropes have the same composition in both the liquid and vapor phase and they have specific boiling points at which the entire solution evaporates, thus they cannot be separated using distillation.

• Example of an azeotropic refrigerant is R502.

101. Otto cycle efficiency is higher than Diesel cycle efficiency for the same compression ratio and heat input because, in Otto cycle

A. combustion is at constant volume

B. expansion and compression are isentropic

C. maximum temperature is higher

D. heat rejection is lower

Ans. D

Sol. Otto cycle is more efficient than diesel cycle for same compression ratio and heat input as heat rejection in Otto cycle is lower. Lower is the heat rejection higher is the efficiency.

102. Find the heat transfer (in kJ) during a certain process having variable specific heat C = (0.5 + 0.5 T) kJ/ºC. If its temperature changes from 10ºC to 100ºC

A. 2520 B. 2520.12

C. 2519.98 D. 2521

Ans. A

Sol. Given,

Variable heat capacity,

C = (0.5 + 0.5T) kJ/ºC

Heat transfer when temperature changes from 10ºC to 100ºC

$$Q = \int mCdT$$

$$= \int_{10}^{100} 1 \times (0.5 + 0.5T)\, dt$$

$$= 0.5\left[T + \frac{T^2}{2}\right]_{10}^{100}$$

$$= 0.5\left[(100 - 10) + 0.5 \times \left(100^2 - 10^2\right)\right]$$

Q = 2520 kJ

103. Match the Dimensionless number in Group 'A' to their definitions in Group 'B'.

Group 'A'

a) Reynold's number

b) Froude's number

c) Weber's number

d) Euler's number

Group 'B'

A) Ratio of inertia force to the surface tension force

B) Ratio of inertia force to the pressure force

C) Ratio of inertia force to the viscos force

D) Ratio of inertia force to the gravity force

A. a-B, b-A, c-D, d-C
B. a-D, b-C, c-A, d-B
C. a-C, b-D, c-A, d-B
D. a-A, b-B, c-C, d-D

Ans. C

Sol. **The Reynolds number** is an experimental number used in fluid flow to predict the flow velocity at which turbulence will occur. It is described as the ratio of inertial forces to viscous forces. For flow through a tube it is defined by the relationship: The parameters are viscosity η, density ρ and radius r.

The Froude number Fr, is a dimensionless value that describes different flow regimes of open channel flow. The Froude number is a **ratio of inertial and gravitational forces**. The **Weber Number** is the ratio between the inertial force and the **surface tension** force and the **Weber number** indicates whether the kinetic or the surface tension energy is dominant.

The Euler Number is a dimensionless value used for analyzing fluid flow dynamics problems where the pressure difference between two points is important. The Euler Number can be interpreted as a measure of the ratio of the ***pressure forces*** **to the** ***inertial forces***

104. Which of the following device are used for throttling of the fluid?

A. Partially opened valve
B. Orifice
C. Porous plug
D. all of the mentioned

Ans. D

Sol.

- In all of the given cases, there is an appreciable drop in pressure and enthalpy is constant.The examples of the throttling process are
  Flow through a partially opened valve
  Flow through a very small opening (orifice)
  Flow through a porous plug

105. Reaction turbines are characterized by _____

A. relatively low RPM and steam expension over nozzle
B. relatively high RPM and steam expension over nozzle
C. relatively low RPM and steam expension over rotor blades
D. relatively high RPM and steam expansion over rotor blades

Ans. C

Sol. In reaction turbine steam does not expand in nozzle but expands as flows over the rotor blades. Reaction turbines are characterized by relatively low RPM. As steam expands over the turbine blades, causes the reaction force over the turbine which rotates the turbine.

106. A stationary mass of gas is compressed without friction from an initial state of 0.5 m^3, 0.1 MPa to a final state of 0.2 m^3, 0.1 MPa. The transfer of heat from the gas during this process is 40 kJ. The change in internal energy of the gas is

A. 10 kJ
B. -10 kJ
C. 70 kJ
D. -70 kJ

Ans. B

Sol. Work interaction for closed system at constant pressure,

$W_{1-2} = \int_{V_1}^{V_2}(p \times dV) = p\,(V_2 - V_1) = 0.1 \times 10^3\,(0.2 - 0.5)$

$W_{1-2} = -30$ kJ

Heat interaction,

$Q_{1-2} = -40$ kJ

(∵ transfer of heat from gas)

From 1st law of thermodynamics,

Change in internal energy,

$dU = Q_{1-2} - W_{1-2}$

$dU = -40 - (-30)$

$dU = -10$ kJ

107. When the back pressure of a nozzle is below the designed value of pressure at exit of nozzle, the nozzle is said to be

A. overdamping
B. underdamping
C. chocked
D. none of the mentioned

Ans. B

Sol. When the back pressure of a nozzle is below the designed value of pressure at exit of nozzle, the nozzle is said to be underdamping.

108. Mass of moist air inside of closed container is heated, then its relative humidity and wet bulb temperature _____ respectively.

A. Increases, Increases
B. Decreases, Increases
C. Decreases, Decreases
D. Increases, Decreases

Ans. B

Sol. Psychrometry chart for heating in closed container:

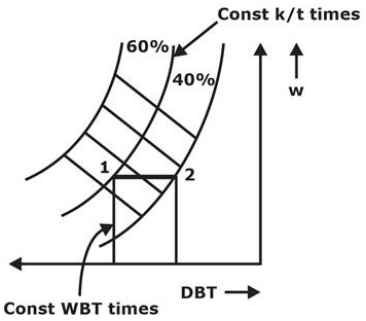


Diagram correction

Since heating takes place inside a closed container its humidity ratio is constant. Hence as per above chart, Relative humidity decreases and WBT increases.

109. Which one of the following type of compressor is mostly used for supercharging of IC engine?

A. Radial flow compressor
B. Axial flow compressor
C. Root blower
D. Reciprocating compressor

Ans. C

Sol. Root blower is suitable for supercharging of IC engine.

110. Mean temperature of heat addition _____ due to Regeneration

A. Decreases
B. not effected
C. Increases
D. varied exponentially

Ans. C

Sol. Mean temperature of heat addition is average temperature at which heat is supplied to the working substance.

In regeneration ,the supply of heat at low temperatures is avoided ,hence the mean temperature of heat addition increases.

111. The efficiency of the pulverized fuel firing system in steam power plant depends on:

A. volume of coal powder
B. quality of coal powder
C. fineness of coal powder
D. all of above

Ans. C

Sol. In steam power plant, efficiency of pulverized fuel firing system depends on size of powder. In this, the fineness of coal should be around 70% to pass through 200 mesh sieve and 98% to pass through 50 mesh sieve.

112. A refrigeration system works under the temperature limits of – 3°C and 33°C respectively. The amount of heat to be removed is 1 ton of refrigeration. Find the minimum input work required _____.

A. 0.38 kW
B. 0.51 kW
C. 0.42 kW
D. 0.46 kW

Ans. D

Sol. Given:

$T_L = -3°C = 270\ K$

$T_H = 33°C = 306\ K$

R.E. = 1 ton = 3.5 kW

$$\text{Ideal COP} = \frac{T_C}{T_H - T_L} = \frac{270}{306 - 270} = 7.5$$

$$\text{Also, } \text{COP} = \frac{RE}{W_{in}}$$

$$\Rightarrow W_{in} = \frac{RE}{COP} = \frac{3.5}{7.5} = 0.467\ kW$$

113. For CI engines, fuels most preferred are _____.

A. Paraffins
B. Napthalene
C. Aromatics
D. Olefins

Ans. A

Sol.

- For C.I. engines fuel most preferred are paraffins and for S.I. engines fuel most preferred are aromatics.

- The paraffins is more preferred due to its high antiknocking tendency.
- Fuels with longer straight chain **hydrocarbons** have higher cetane number. The presence of branched chain structure reduces the cetane number.

114. Which of the following is NOT an Internal Combustion Engine?

A. Gas Engine
B. Wankel Engine
C. Jet Engine
D. Stirling Engine

Ans. D

Sol. A stirling engine is a heat engine that is operated by a cyclic compression and expansion of air or other gas at different temperatures, such that there is net conversion of heat energy to mechanical work.

115. In a gas turbine cycle, the turbine output is 600 kJ/kg, the compressor work is 400 kJ/kg, and the heat supplied is 1000 kJ/kg. the thermal efficiency of the cycle is:

A. 20%
B. 30%
C. 40%
D. 50%

Ans. A

Sol.

$$\eta = \frac{Output}{Input}$$

$$= \frac{600 - 400}{1000} \times 100$$

$$= 20\%$$

116. For Ideal Gas coefficient of volume expansion is

A. Directly proportional to the absolute temperature
B. Inversely proportional to the absolute temperature
C. Directly proportional to the Kelvin temperature
D. Inversely proportional to the Kelvin temperature

Ans. B

Sol. Formula of volume expansion:

$$\beta = \frac{1}{V}\left(\frac{dV}{dT}\right)_P$$

for ideal gas PV= RT

so, differentiating ideal gas equation,

$$d(PV) = d(RT)$$

$$PdV = RdT$$

$$\frac{dV}{dT} =$$

$$\frac{1}{V}\frac{dV}{dT} = \frac{R}{PV} = \frac{1}{T}$$

So, from above discussion it can be concluded that the volume expansion coefficient for ideal gas is Inversely proportional to the absolute temperature.

117. In a nozzle, the effect of supersaturation is to.....

A. Decrease the dryness fraction of steam

B. Decreases the specific volume of steam

C. Increase the entropy

D. Increase the enthalpy drop

Ans. C

Sol. In a nozzle, the effect of supersaturation is to increase the entropy

118. For a sphere falling at terminal velocity in the stokes law range, the drag coefficient C_D is given by _____. (Assume Reynold number R_e is less than 0.2)

A. $\frac{24}{R_e}$ B. 24 R_e

C. $\frac{64}{R_e}$ D. 64 R_e

Ans. A

Sol. For a sphere falling at terminal velocity and Reynold number less than 0.2, the coefficient C_D is

$$C_D = \frac{24}{R_e}$$

119. For a system of ideal gas, in a reversible isothermal process the heat transferred to the system is 0.75 kJ. The internal energy at the initial point is 2.05 kJ. Determine the work done during the process.

A. -1.3 kJ B. 0.75 kJ

C. -0.75 kJ D. 2.8 kJ

Ans. B

Sol. Given:

Heat: Q = 0.75 kJ

For a ideal gas:

$U_a = U_b \Rightarrow dU = 0$ (Isothermal process)

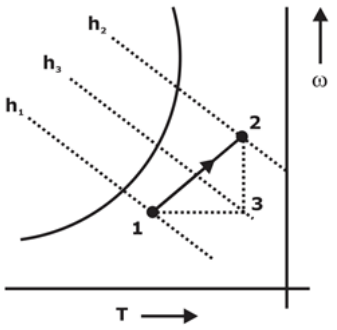
Therefore the work done:

$Q = U_b - U_a + W$

$0.75 = 0 + W$

$W = 0.75$ kJ

120. Let us consider a psychometric process:



Then Latent heat factor will be _____.

A. $\frac{h_2 - h_3}{h_1 - h_3}$

B. $\frac{h_2 - h_3}{h_2 - h_1}$

C. $\frac{h_3 - h_1}{h_2 - h_1}$

D. $\frac{h_3 - h_1}{h_2 - h_3}$

Ans. B

Sol. As we know that

$$\text{Latent heat factor} = \frac{\text{Latent heat}}{\text{Latent heat} + \text{Sensible heat}}$$

Here, Latent heat = $h_2 - h_3$

Sensible heat = $h_3 - h_1$

And Total heat = $h_2 - h_1$

So, Latent heat factor = $\frac{h_2 - h_3}{h_2 - h_1}$

121. A gas is flowing through an insulated nozzle. If the inlet velocity of gas is negligible and there is an enthalpy drop of 45 kJ/kg, the velocity of gas leaving of nozzle is

A. 100 m/s

B. 200 m/s

C. 300 m/s

D. 350 m/s

Ans. C

Sol. $$h_1 + \frac{V_1^2}{2} = h_2 + \frac{V_2^2}{2}$$

$V_1 = 0\,(\text{Given})$

$\Delta h = h_1 - h_2 = 45\,\text{kJ/kg}$

$V_2 = \sqrt{2(h_1 - h_2)}$

$V_2 = \sqrt{2 \times 45 \times 10^3} = 300\,\text{m/s}$

122. Match the differentials in list 1 with the corresponding differentials in list 2

List-1

A). $\left(\frac{\partial P}{\partial T}\right)_v$

B). $\left(\frac{\partial T}{\partial v}\right)_s$

C). $\left(\frac{\partial T}{\partial p}\right)_s$

List-2

1). $-\left(\frac{\partial p}{\partial s}\right)_v$

2). $\left(\frac{\partial v}{\partial s}\right)_p$

3). $\left(\frac{\partial s}{\partial v}\right)_T$

A. A-3,B-1, C-2 B. A-1,B-2,C-3

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

Ans. A

Sol. By Maxwell equations:

$$\left(\frac{\partial P}{\partial T}\right)_v = \left(\frac{\partial s}{\partial v}\right)_T$$

$$\left(\frac{\partial T}{\partial v}\right)_s = -\left(\frac{\partial p}{\partial s}\right)_v$$

$$\left(\frac{\partial T}{\partial p}\right)_s = \left(\frac{\partial v}{\partial s}\right)_p$$

123. Group I gives a list of devices and group II gives the list of uses.

Group I

P. Pitot tube

Q. Manometer

R. Venturimeter

S. Anemometer

Group II

1) Measuring pressure in pipe

2) Measuring velocity of flow in a pipe

3) Measuring air and gas Velocity

4) Measuring discharge in a pipe

The correct match of Group I with Group II is

A. P–1, Q–2, R–4, S–3 B. P–2, Q–1, R–3, S–4

C. P –2, Q–1, R–4, S–3 D. P–4, Q–1, R–3, S–2

Ans. C

Sol. A) Pilot tube relates stagnation pressure when kinetic energy of flow reduces to pressure energy and pilot tube used for the measuring velocity of flow in a pipe.

B) Manometer (piezo meter) pressure in a pipe.

C) Venturimeter employed throat section to measure the discharge in a pipe.

D) Anemometer measured for air and gas velocities employed same technique as used in the pilot tube.

124. How many reversible adiabatic curves are drawn from a point on the P – V diagram.

A. One B. Two

C. Three D. Infinite

Ans. A

Sol. A reversible adiabatic can only have one value for the slope at a point on P-V diagram hence it cannot be possible to have two or more curves through a point.

125. Which of the following process decreases the knocking tendency in diesel engine?

A. Increased Compression ratio B. Supercharging

C. Low self-ignition temperature D. All of the above

Ans. D

Sol. knocking tendency in diesel engine can be decreased by,

1.Increased Compression ratio

2.Supercharging

3.Low self-ignition temperature

All of the above process helps in reducing the knocking tendency in diesel engine.

So the correct option is (d).

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