JUNIOR ENGINEER MECHANICAL ENGINEERING EXAMINATION 2024 (PAPER-I)

EXAM DATE	07/06/2024
EXAM TIME	1:00 PM – 3:00 PM
SUBJECT	Junior Engineer 2024 Mechanical Engineering Paper-I

SECTION A & B: MECHANICAL ENGINEERING (NON-TECH)

Q.1. **GST full form**
Sol.   G → Goods
  S → Services
  T → Tax

Q.2. **Who started national clean air program?**
Sol. Ministry of Environment, forest and climate change stated NCAP in Jan, 2019 to improve air quality in 131 cities.

Q.3. **Which state has highest number of seats in legislative assembly?**
Sol. Uttar Pradesh i.e., 403 seats.

Q.4. **Paloma Plateau is situated in**
Sol. Paloma Plateau is situated in Jharkhand.

Q.5. **Time period of second Anglo-Maratha war?**
Sol.

- (1803 – 1805)
- First Anglo – Maratha war (1775 – 1782)
- Second Anglos – Maratha war (1803 – 1805)
- Third Anglo – Maratha (1817 – 1819)

Q.6. **Which state had the highest population density as per census 2011.**
Sol. Bihar (1106 persons/km²)

Q.7. **Where is Arun Jaitely stadium situated?**
Sol. New Delhi

Q.8. **FD Numbers as per 1976?**
Sol. 10

Q.9. **Right to equality is mentioned in which article.**
Sol. Article – 14 to 18
  Article – 14 : Equality before law and equal protection of law.
  Article – 15: No discrimination on the basis of religion, race, sex, caste, place of birth
  Article – 16: Equality of opportunity in Public employment
  Article – 17: Abolition of Untouchability
  Article – 18: Abolition of titles

Q.10. **Which is the Highest population density city?**
Sol.

- In world Manila, Philippines
- In India, Kolkata

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Q.11. **Which article is related to right to freedom?**
Sol. The right to freedom guarantees freedom for citizens to live a life of dignity among other things. These are given in Articles 19, 20, 21A and 22 of the Indian Constitution. We shall take up the articles one by one in this section.

Q.12. **Smallest river systems**
Sol. Arvali river originates in Alwar, Rajasthan and its total length is 45 km.

Q.13. **Ved Samaj was established in?**
Sol. Veda Samaj was established by Keshab Chandra Sen and K. Sridharalu Naidu. Established in Madras (Chennai) in 1864. The Veda Samaj was inspired by the Brahmo Samaj.

Q.14. **Karnam Malleswari won Gold medal in which Olympic?**
Sol. Indian weightlifter won Olympic gold in Sydney 2000 Olympic games.

Q.15. **Iron ore mine in Jharkhand**
Sol. Kiriburu, Meghahatu– Baree, Gua and Chiria Noamundi is the largest iron one wine.

Q.16. **What is the name of Biography of President Draupadi Murmu?**
Sol. Madam president By Sandeep Sahee.

Q.17. **Battle of Plassey.**
Sol. 1757, Dalasi, Bengal

Q.18. **First Battle of Panipat, 1526 happen between?**
Sol. Babar and Ibrahim Lodi

Q.19. **Who is the Chief Minister of Karnataka?**
Sol. Shri Siddaramaiah

Q.20. **Who received Lata Mangeshkar Award in 2023?**
Sol.

- Asha Bhosale – 2023
- 2024 – Amitabh Bachchan

Q.21. **Earthquake is measured by**
Sol. Seismograph

Q.22. **Battle of Khanwa took place between?**
Sol. Babar and Rana Sanga

Q.23. **Highest population dense metro city in India?**
Sol. Mumbai is the most densely populated city in India. Population density: 76,790 per square mile.

Q.24. **Which article is related to right to freedom?**
Sol. The right to freedom guarantees freedom for citizens to live a life of dignity among other things. These are given in Articles 19, 20, 21A and 22 of the Indian Constitution. We shall take up the articles one by one in this section.

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SECTION C: MECHANICAL ENGINEERING

Q.1. **Boiling point of Refrigerant R-744?**

Sol. Refrigerant R-744, also known as carbon dioxide (CO_2), has a boiling point at standard atmospheric pressure (1 atm or 101.325 kPa) of approximately -78.4°C (-109.1°F).

Q.2. **Efficiency of Rankine cycle**

Sol. The efficiency of the Rankine cycle which is commonly used in power plants, can be determined using the following formula.

$$\text{Efficiency}(\eta) = \frac{W_{net}}{Q_{in}}$$

Where,

- W_{net} is the network output of the cycle.
- Q_{in} is the heat input into the cycle.

Net Work output

$W_{net} = W_{Turbine} - W_{Pump}$

Q.3. **Right limb of U tube manometer is free to atmosphere and left end is attached to a pipe. The centre of pipe is 20 cm below the mercury level and the difference between the mercury level is 8cm. Find the pressure in the pipe.**

Sol.

The pressure difference ΔP is given by the hydrostatic pressure difference between the two limbs of the manometer.

$\Delta P = \rho g h$

The density of mercury ρ is 13600 kg/m³

Converting the height difference h from cm to m

h = 8 cm = 0.08 m

The acceleration due to gravity g is 9.81 m/s²

Therefore,

$\Delta P = (13600 \times 9.81 \times 0.08)$ Pa

$\Delta P = 10673.28$ Pa

Q.4. **What is the unit of surface tension?**

Sol. Surface tension is a force per unit length acting along a liquid's surface, typically measured in Newtons per meter (N/m) in the International System of Units (SI).

Q.5. **Due to which of the following, the sound pinging occurs in the cylinder of the IC engine?**
   (a) pre-ignition
   (b) detonation
   (c) heavy supercharger
   (d) heavy turbulence

Sol. Detonation, also known as knocking or pinging, is the result of the air-fuel mixture in the engine cylinder igniting prematurely and explosively. This causes a sharp, metallic knocking or pinging sound.

Q.6. **Which gas is used as shielding gas in TIG?**
(a) O_2
(b) Ne
(c) Ar
(d) None

Sol. The shielding gas used in TIG welding is **argon (Ar)** and **helium (He)**.

Q.7. **VARS COP based on temperatures?**
Sol. The maximum possible COP of an ideal VARS system is given by

$$COP_{Ideal\ VARS} = \left(\frac{T_e}{T_o - T_e}\right)\left(\frac{T_g - T_o}{T_g}\right)$$

Q.8. **Pattern is used in casting for?**
Sol. he pattern is a replica of the object to be cast. It is used to create the mold cavity into which molten material will be poured. The pattern is placed in sand or other mold material to form the shape of the final cast product.

Q.9. **Friction factor in pipe flow depends on?**
Sol. The friction factor in pipe flow is influenced primarily by the Reynolds number and the relative roughness of the pipe. For laminar flow, it depends only on the Reynolds number, while for turbulent flow, it depends on both the Reynolds number and the pipe's relative roughness.

Q.10. **What is the temperature in arc welding?**
(a) 2000°C
(b) 3500°C
(c) 4500°C
(d) 6000°C

Sol. **(d)**

Q.11. **Total gradient line is also known as?**
Sol. The total gradient line in fluid mechanics is also known as the **energy grade line (EGL)**

Q.12. **Which of the following is not an allotropic form of Iron?**
(a) Alpha
(b) Beta
(c) Gamma
(d) Delta

Sol. **(b)**

Q.13. **Which of the following is the hardest material?**
(a) Grey Cast Iron
(b) White Cast Iron
(c) Brittle Cast Iron
(d) Ductile Cast Iron

Sol. **(b)**

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Q.14. **Find the torsional rigidity of shaft whose internal diameter is d and external diameter D, length *l* angle of twist θ?**

Sol. The torsinal rigidity (also known as torsional stiffness) of a shaft can be calculated using the formula.

$$GJ \text{ or } \frac{\pi}{32}.\left(D^4 - d^4\right)$$

Q.15. **If heat supplied (Q) by engine is 500 kJ and Work (W) produced by engine is 250 kJ then find the internal energy (U)**

Sol.

To find the internal energy (U) of the engine, we can use the first law of thermodynamics which states.

$Q = \Delta U + W$

Now, substitute the given values into the equation

$500 \text{ kJ} = \Delta U + 250 \text{ kJ}$

$\Delta U = 250 \text{ kJ}$

Q.16. **In IC engine if indicated power is equal to 100 kW and brake power is equal to 25 kW then find the mechanical efficiency.**

Sol.

The mechanical efficiency (η_m) of an internal engine can be calculated using the formula

$$\eta_m = \frac{\text{Brake power}}{\text{Indicated power}}$$

Given

- Indicated power (IP) = 100 kW
- Brake power (BP) = 25 kW

Now substitue these values into the formula

$$\eta_m = \frac{BP}{IP} = \frac{25}{100}$$

$\eta_m = 0.25 \text{ or } 25\%$

Q.17. **The free expansion process is reversible or irreversible?**

Sol. Due to the lack of work done and heat exchange, and the inability to reverse the process without external intervention, the free expansion process is irreversible in nature.

Q.18. **Atmospheric pressure is also known as -**

Sol. Barometer pressure

Q.19. **What is the difference of the head at discharge and head at eye of impeller in pump?**

Sol. The difference in head between the discharge and the eye (inlet) of an impeller in a pump is known as the **head rise** or **head increase** across the impeller.

Q.20. **Coefficient of discharge is defined as?**

Sol.

The coefficient of discharge (C_d) is a dimensionless quantity that relates the actual discharge of a fluid to the theoretical discharge. It is defined as the actual discharge to the theoretical discharge.

$$C_d = \frac{Q_{actual}}{Q_{theoretical}}$$

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Q.21. **Dimensional formula of dynamic viscosity?**

Sol. We know that,

Unit of dynamic viscosity $(\mu) = \dfrac{Nm}{s^2}$

$\therefore \mu = \dfrac{kg}{m \times s}$

Dimensional formula for dynamic viscosity is given by $[M^1 L^{-1} T^{-1}]$

Q.22. **Find diameter of shaft when, T = 1500 Nm and shear stress = 50 N/mm²?**

Sol. Given data:

T = 1500 Nm

$\tau = 50\ N/mm^2$

d = ?

We know that,

$\tau = \dfrac{16T}{\pi (d)^3}$

$50 = \dfrac{16 \times 1500 \times 10^3}{\pi (d)^3}$

$\boxed{d = 52\ mm}$

Q.23. **At absolute zero temperature enthalpy of ideal gas is?**

Sol. The third law of thermodynamics states that as the temperature of a system approaches absolute zero (0 Kelvin or -273.15 degrees Celsius), the entropy of the system approaches a minimum value.

$\therefore$ As entropy of the system at absolute zero Kelvin temperature becomes Zero, The enthalpy of the system also become **zero**.

Q.24. **In free expansion process, the work done is?**

Sol. Work done is free expansion system is always zero, as in the case of free expansion there is no resistance shown by the system against the expanding gases.

Q.25. **What is the refrigerant name of SO₂?**

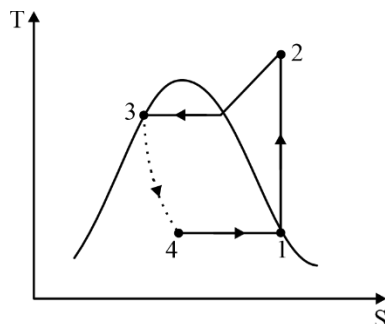**Sol.** Molecular weight of $SO_2 = 32 + 16 \times 2 = 64$

We know that,

Name of refrigerant = R(700 + Molecular weight of refrigerant)

= R(700 + 64)

$\therefore$ **Name of SO_2 = R-764**

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Q.26. **The lowest temperature in VCRS will occur at the end of?**
    (a)   Compression
    (b)   Expansion
    (c)   Condensation
    (d)   Evaporation

Sol.

Process 1-2: Isentropic compression
Process 2-3: Constant pressure heat rejection
Process 3-4: Isenthalpic expansion
Process 4-1: Constant pressure heat addition
From the figure, it is seen that minimum temperature occurs at the end of isenthalpic expansion.

Q.27. **Which of the following is flow area of Kaplan turbine?**
    (a) πDVB
    (b) $\pi D^2 V$
    (c) $\dfrac{\pi}{4}D^2 V$
    (d) $\dfrac{\pi}{4}\left(D_0^2 - D_i^2\right)$

Sol. $\boxed{A_f = \dfrac{\pi}{4}\left(D_0^2 - D_i^2\right)}$

Where

$A_f \rightarrow$ Area of flow

$D_o \rightarrow$ Outer diameter

$D_i \rightarrow$ Inner diameter

Q.28. **Which of the following is fire tube boiler?**
Sol. Scotch marine boiler

Q.29. **Why we use quick return mechanism?**
Sol. To reduce Idle time during return stroke.

Q.30. **Which of the following is not part of hydroelectric power plant?**
    (a)   Penstock
    (b)   Runner
    (c)   Compressor
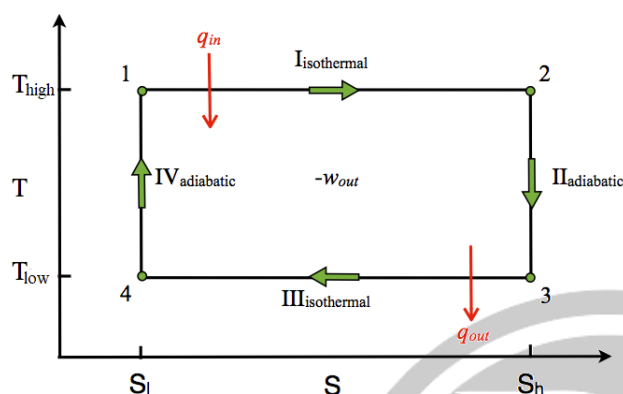   (d)   Turbine
Ans. **(c)**
Sol. Compressor

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Q.31. **The statement "Intensity of the pressure in the static fluid is same in all direction", is known by**
   (a)   Newton law
   (b)   Pascal's law
   (c)   Bernoulli's law
   (d)   None
Sol. Pascal law

Q.32. **The correct statement of Carnot cycle?**
Sol.

   •   Two isentropic and two isothermal processes are used.

Q.33. **According to the second law thermodynamics work is _____ and heat is a _____.**
Sol. According to the second law thermodynamics work is high grade energy and heat is a low grade energy.
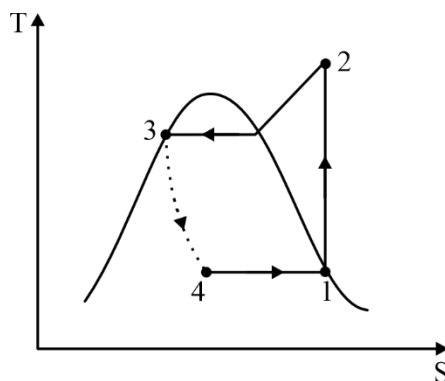
Q.34. **Relation between average velocity and maximum velocity for laminar flow through pipe?**
Sol. $U_{avg} = \dfrac{U_{max}}{2}$

Q.35. **In vapour compression refrigeration system the curve of compression process is**
   (a)   Vertical
   (b)   Horizontal
   (c)   Curved with positive slope
   (d)   Curved with negative slope
Sol.

From figure it is seen that process 1-2 is isentropic compression and the curved is vertically straight in nature.

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Q.36. **By which method metal removal takes places in chemical m/c using?**
Sol. Chemical dissolution

Q.37. **Which milling has facing culture on both side of arbour**
Sol. Staddle mililng

Q.38. **Saw blades are used for which of the following machining operation?**
Sol. Sawing

Q.39. **Difference between absolute pressure and atmospheric pressure is known as?**
Sol. We know that
$$p_{ab} = p_g + p_{atm}$$
$$\therefore p_g = p_{ab} - p_{atm}$$

Q.40. **Coefficient of discharge of orifice meter is?**
    (a) 0.94-0.98
    (b) 0.80-0.86
    (c) 0.68-0.72
    (d) None of the above
Sol. Coefficient of discharge of orifice meter is 0.68-0.72

Q.41. **The pressure measured with reference to absolute vacuum pressure?**
Sol. Absolute pressure: It is defined as the pressure which is measured with reference to absolute vaccum pressure.

Q.42. **What is the specific gravity of mercury?**
Sol. $S_g = 13.6$

Q.43. **If PV = constant the process is called?**
    (a) Isothermal
    (b) adiabatic
    (c) Isobaric
    (d) Isochoric
Ans. **(a)**
Sol. PV = constant, process is called isothermal

Q.44. **The corrosion resistance material is**
    (a) Nickel
    (b) Chromium
    (c) Manganese
    (d) Vanadium
Ans. **(b)**
Sol. Chromium

Q.45. **Brake thermal efficiency expression is given by?**
Sol.
$$\eta_{bth} = \frac{BP}{\dot{m} \times CV}$$
Where,
η_{bth} = Brake thermal efficiency
BP = Brake power
$\dot{m}$ = Mass flow rate of the fuel
CV = Calorific value of the fuel

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