



No: D1/288/2024 CTE

Office of the  
Controller of Technical Examinations  
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Dated: 15-06-2024

**CIRCULAR**

Sub:- Technical Education – Examination Wing - April 2024 Diploma Examination -  
Out of syllabus questions - Decision taken - Regarding.

Ref :- Complaints received from students of various colleges.

Camp Officers of all the Centralised Valuation Camps of April 2024 Diploma Examination are informed that, the following guidelines should be followed for distribution of marks in connection with out of syllabus questions, of below mentioned codes, in the case of students who tried to attend the said questions.

- |              |                      |        |
|--------------|----------------------|--------|
| 1) R21 4041  | Part C<br>Qn No: III | 7 Mark |
| 2) R 21 4021 | Part A<br>Qn No: 9   | 1 Mark |
|              | Part B<br>Qn No: 9   | 3 Mark |
|              | Part C<br>Qn No: XIV | 7 Mark |

**Guidelines:**

- Calculate the percentage of marks obtained by the student considering the total marks excluding the marks of out of syllabus questions (If he had attended that option).
- Then the proportionate marks of out of syllabus questions shall be calculated based on the above obtained percentage.
- Marks obtained in the above cases shall be added to get the actual marks admissible to the student.

TECHNICAL EXAMINATIONS

To:

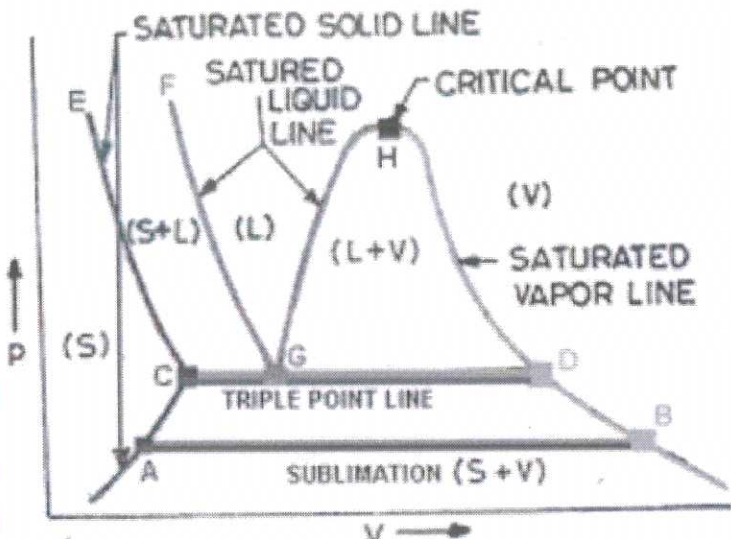
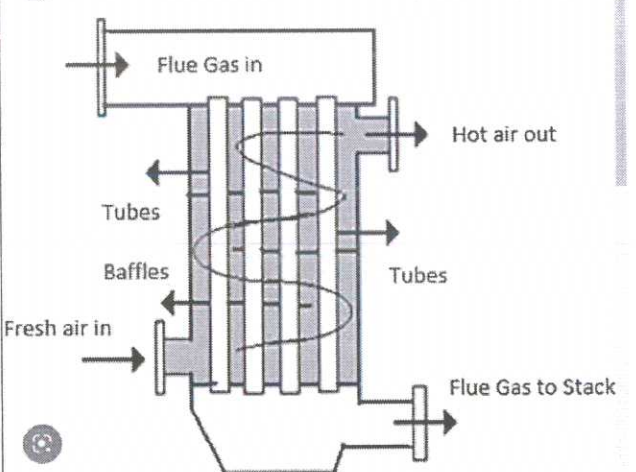
- Camp Officers of Centralised Valuation Camps.
- Stock file & Office copy.

JOINT CONTROLLER





II. 2	<p><b>Quasi-static process:</b></p> <ol style="list-style-type: none"> <li>1. In thermodynamics, a quasi-static process is referred to as a slow process.</li> <li>2. It is a process that happens at an infinitesimally slow rate.</li> <li>3. A quasi-static process has all of its states in equilibrium.</li> <li>4. A quasi-static process is one in which the system is in thermodynamic equilibrium with its surroundings at all times.</li> </ol>	3	3
II. 3	<p>Avogadro's law, also known as Avogadro's principle or Avogadro's hypothesis, is a gas law which states that the total number of atoms/molecules of a gas (i.e. the amount of gaseous substance) is directly proportional to the volume occupied by the gas at constant temperature and pressure</p>	3	3
II. 4	<p><math>C_p - C_v = R</math></p> <p><math>C_p</math> = Specific heat at constant pressure</p> <p><math>C_v</math> = Specific heat at constant volume</p> <p><math>R</math> = Characteristic gas constant</p>	3	3
II. 5	<p>The diagram shows a P-V cycle with the following processes:</p> <ul style="list-style-type: none"> <li><b>a-b:</b> Isentropic Compression</li> <li><b>b-c:</b> Isobaric process (Heat addition at constant pressure, <math>Q_H</math>)</li> <li><b>c-d:</b> Isentropic Expansion (Power stroke)</li> <li><b>d-a:</b> Isochoric process (Heat rejection at constant volume, <math>Q_C</math>)</li> </ul> <p>Key parameters: <math>P_b = P_c</math>, <math>V_d = V_a = V</math>.</p>	3	3
II. 6	<p>A heat balance sheet is an account of heat supplied and heat utilized in various ways in the system. Necessary information concerning the performance of the engine is obtained from the heat balance. The performance of an engine is generally given</p>	1.5	3

	<p>by a heat balance sheet.</p> <p>(1/3) is used in brake power produced, 1/3 in cooling water and 1/3 in exhaust gases</p>	1.5		
II.7	 <p>The diagram shows a pressure-volume (P-V) phase diagram for a pure substance. The vertical axis is pressure (P) and the horizontal axis is volume (V). Key features include: <ul style="list-style-type: none"> <li><b>Saturated Solid Line:</b> The upper-left boundary of the solid phase.</li> <li><b>Saturated Liquid Line:</b> The upper-right boundary of the liquid phase.</li> <li><b>Saturated Vapor Line:</b> The lower-right boundary of the vapor phase.</li> <li><b>Sublimation (S+V):</b> The lower-left boundary of the solid phase.</li> <li><b>Triple Point Line:</b> A horizontal line connecting points C, G, and D.</li> <li><b>Critical Point:</b> Point H, where the saturated liquid and vapor lines meet.</li> <li><b>Regions:</b> (S) for solid, (L) for liquid, (V) for vapor, (S+L) for solid-liquid coexistence, (L+V) for liquid-vapor coexistence, and (S+V) for solid-vapor coexistence.</li> <li><b>Points:</b> A, B, C, D, E, F, G, H mark specific states and transition points.</li> </ul> </p>	3	3	
II.8	<p>The purpose of the air preheater is to recover the heat from the boiler flue gas which increases the thermal efficiency of the boiler by reducing the useful heat lost in the flue gas.</p>  <p>The diagram illustrates a cross-section of an air preheater. It consists of a bundle of vertical tubes supported by horizontal baffles. <ul style="list-style-type: none"> <li><b>Flue Gas in:</b> Enters from the top left and flows through the tubes.</li> <li><b>Hot air out:</b> Exits from the top right, having been heated by the flue gas.</li> <li><b>Fresh air in:</b> Enters from the bottom left and flows through the tubes.</li> <li><b>Flue Gas to Stack:</b> Exits from the bottom right after passing through the tubes.</li> </ul> </p>	1.5	3	1.5
II. 9	<p>Given</p> <p><math>T = 400^{\circ}\text{C}</math></p> <p><math>= (400 + 273) = 673\text{K}</math></p> <p>By Stefan Boltzmann equation</p> <p><math>E_b = \sigma T^4</math></p> <p>Where <math>\sigma = 5.67 \times 10^{-8} \text{ W/m}^2\text{K}^4</math></p>	2	3	1(Ans)

	$E_b = \sigma T^4 = 5.67 \times 10^{-8} (400 + 273)^4 = 11631.7 \text{ W/m}^2$ .			
II.10	Reflectivity: Fraction of total energy reflected from the surface Absorptivity: Fraction of total energy absorbed by the surface. Transmissivity: Fraction of total energy transmitted through the surface	1 X 3	3	

PART C				4 2 7
I.	<p>1. An isothermal process is one that maintains a constant temperature.</p> <p>2. Any heat movement into or out of the system must've been slow enough to keep the system in thermal equilibrium.</p> <p>3. If a system comes into contact with a thermal reservoir externally, the system gradually adapts itself to the reservoir's temperature through heat exchange to preserve thermal equilibrium.</p> <p>Suppose 1 mole of gas is enclosed in isothermal container. Let <math>P_1, V_1, T</math> be initial pressure, volumes and temperature. Let expand to volume <math>V_2</math> &amp; pressure reduces to <math>P_2</math> &amp; temperature remain constant. Then, work done is given by</p> $W = \int dW$ $W = \int_{V_1}^{V_2} P dV$ <p>as <math>PV = RT</math> (n = mole)</p> $P = \frac{RT}{V}$ $W = \int_{V_1}^{V_2} \frac{RT}{V} dV$ $W = RT \int_{V_1}^{V_2} \frac{dV}{V}$ $= RT [\ln V]_{V_1}^{V_2}$ $= RT [\ln V_2 - \ln V_1]$ $W = RT \ln \frac{V_2}{V_1}$	3	7	4 2 7
III. 2	<p>There are two statements on the second law of thermodynamics which are;</p> <ul style="list-style-type: none"> <li>• Kelvin- Plank Statement</li> <li>• Clausius Statement</li> </ul>	1		7  7

	<p><u>Kelvin-Planck Statement</u></p> <p>It is impossible for a heat engine to produce a network in a complete cycle if it exchanges heat only with bodies at a single fixed temperature.</p> <p><u>Clausius's Statement</u></p> <p>It is impossible to construct a device operating in a cycle that can transfer heat from a colder body to a warmer one without consuming any work.</p>	3		
<p>III. 3</p>	<p>     IVO = Inlet valve opens      IVC = Inlet valve closes      FVO = Fuel valve opens      FVC = Fuel valve closes      EVO = Exhaust valve opens      EVC = Exhaust valve closes   </p>	7	7	7

III. 4	<p>Given : <math>p_1 = 20</math> bar; <math>T_1 = 700</math> K and  <math>V_1 = 0.21</math> m<sup>3</sup></p> $\frac{V_4}{V_1} = 6 \quad \text{and} \quad \frac{V_2}{V_1} = 1.5$ <p>For the isothermal expansion process 1 - 2 :</p> $p_2 = p_1 \frac{V_1}{V_2} = 20 \times \frac{1}{1.5} = 13.33 \text{ bar}$ <p>For the isentropic expansion process 2 - 3 :</p> $p_3 = p_2 \left( \frac{V_2}{V_3} \right)^\gamma$ <p>Again, from isentropic processes 4 - 1          and 2 - 3,</p> $\frac{T_1}{T_4} = \left( \frac{V_4}{V_1} \right)^{\gamma-1} = \left( \frac{V_3}{V_2} \right)^{\gamma-1}$ $\therefore \frac{V_4}{V_1} = \frac{V_3}{V_2} \quad \text{or} \quad \frac{V_1}{V_4} = \frac{V_2}{V_3}$ <p>and accordingly</p> $p_3 = p_2 \left( \frac{V_1}{V_4} \right)^\gamma = 13.33 \times \left( \frac{1}{6} \right)^{1.4}$ $= 1.08 \text{ bar}$ $\frac{T_1}{T_4} = \left( \frac{V_4}{V_1} \right)^{\gamma-1} = (6)^{1.4-1} = 2.05$ $\frac{p_1}{p_4} = \left( \frac{V_4}{V_1} \right)^\gamma = (6)^{1.4} = 12.29$ $\therefore T_4 = \frac{700}{2.05} = 341.5 \text{ K} \quad \text{and}$	7	7	7
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$$p_4 = \frac{20}{12.29} = 1.63 \text{ bar}$$

Thus :  $p_1 = 20 \text{ bar}$ ;  $p_2 = 13.33 \text{ bar}$

$p_3 = 1.08 \text{ bar}$  and  $p_4 = 1.63 \text{ bar}$

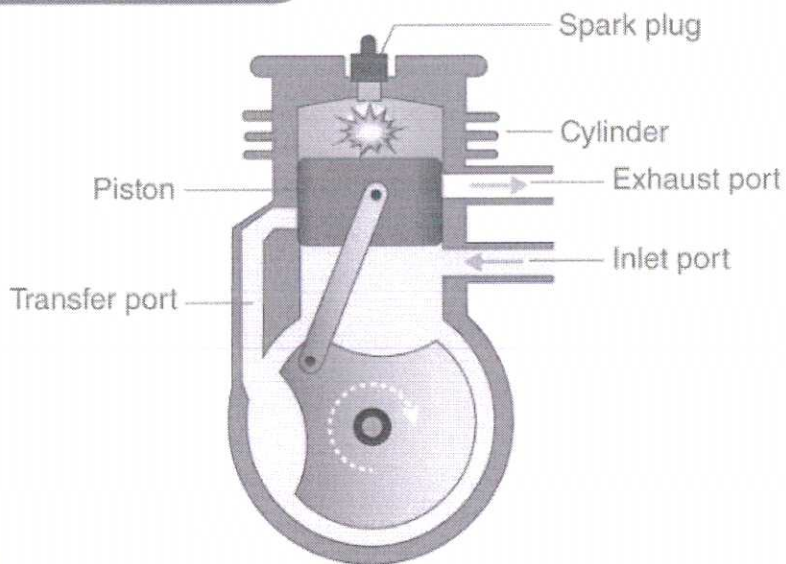
$T_1 = T_2 = 700 \text{ K}$

and  $T_3 = T_4 = 341.5 \text{ K}$

(b) Change in entropy during isothermal expansion,

$$\begin{aligned} S_2 - S_1 &= mR \log_e \left( \frac{V_2}{V_1} \right) \\ &= \frac{p_1 V_1}{T_1} \log_e \frac{V_2}{V_1} \\ &= \frac{20 \times 10^5 \times 0.21}{700} \log_e 1.5 \\ &= 243.3 \text{ J/k} = 0.2433 \text{ kJ/K} \end{aligned}$$

III.  
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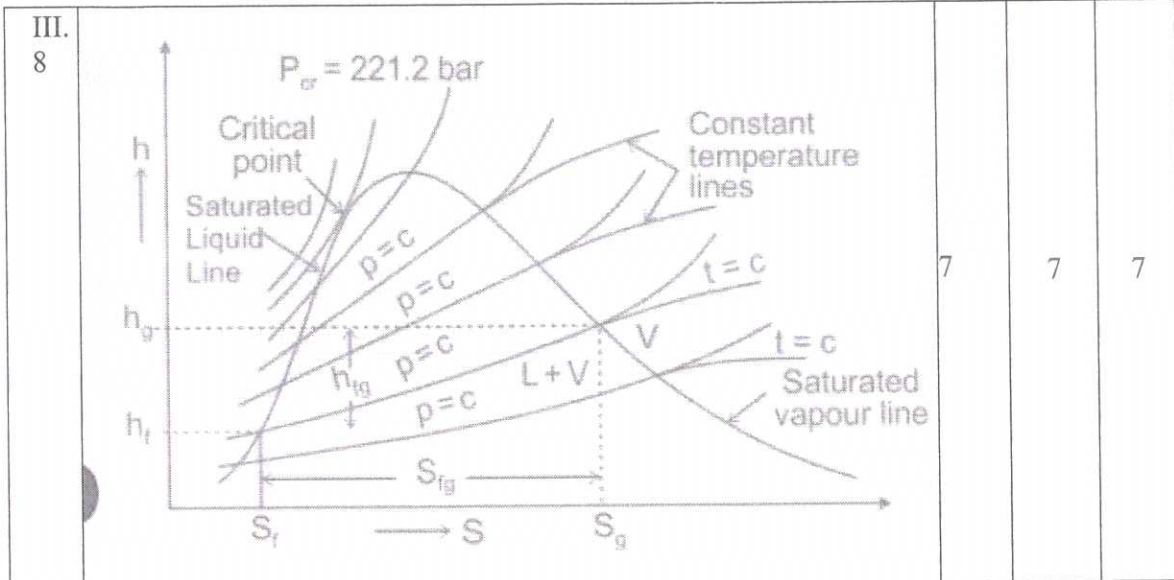


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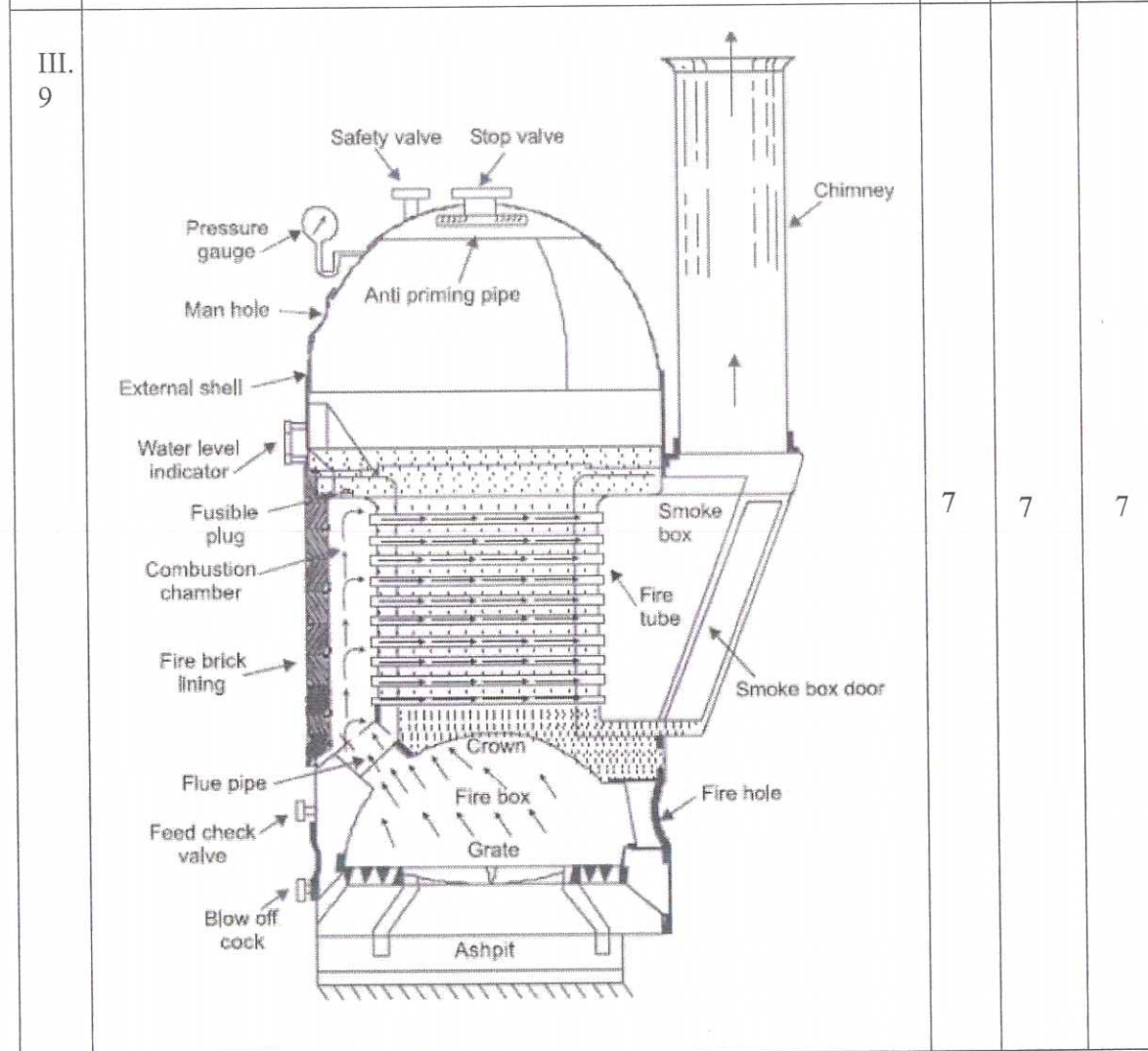
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	<p><b>Two-Stroke Engine Cycle</b></p> <p><b>Down Stroke</b></p> <p>The piston moves from TDC (Top-Dead-Center) to BDC (Bottom-Dead-Center) letting the fresh air enter the combustion chamber. The fresh air-fuel mixture gets into the combustion chamber through the crankcase. In this stroke, the crankshaft makes the rotation of 180°.</p> <p><b>Up Stroke</b></p> <p>The piston is pushed from BDC to TDC. As a result, the fuel-air mixture gets compressed and the spark plug ignites the mixture. The mixture expands and the piston is pushed down. The inlet port is open during the upstroke. While the inlet port is opened, the mixture gets sucked inside the crankcase. When the mixture is pushed up into the combustion chamber during the previous upstroke, a partial vacuum is created as no mixture is left behind in the crankcase. This mixture is ready to go into the combustion chamber during downstroke but remains in the crankcase until the piston goes up to TDC. In this stroke, the crankshaft makes the rotation of 180°.</p> <p>From the 2nd downstroke onwards the exhaust gases get expelled out from one side while a fresh mixture enters into the combustion chamber simultaneously due to a partial vacuum created in the combustion chamber after the removal of exhaust gases. This is the beauty of the engine. Both things happen at the same time which makes it a 2-stroke engine.</p> <p>The exhaust gases are expelled from the 2nd downstroke onwards from one side while simultaneously a fresh mixture of air and fuel is injected into the combustion chamber due to the partial vacuum created in the combustion chamber after the removal of exhaust gases.</p>	3																													
III. 6	<p>The purpose of Morse Test is to obtain the approximate Indicated Power of a Multi-cylinder Engine. It consists of running the engine against a dynamometer at a particular speed, cutting out the firing of each cylinder in turn and noting the fall in BP each time while maintaining the speed constant. When one cylinder is cut off, power developed is reduced and speed of engine falls. Accordingly, the load on the dynamometer is adjusted so as to restore the engine speed. This is done to maintain FP constant, which is considered independent of the load and proportional to the engine speed. The observed difference in BP between all cylinders firing and with one cylinder cut off is the IP of the cut off cylinder. Summation of IP of all the cylinders would then give the total IP of the engine under test.</p>	7	7	7																											
III. 7	<table border="1"> <thead> <tr> <th>BASIS FOR COMPARISON</th> <th>Fire Tube boiler</th> <th>Water Tube boiler</th> </tr> </thead> <tbody> <tr> <td>Position of water and hot gases</td> <td>Hot gases inside the tubes and water outside the tubes</td> <td>Water inside the tubes and hot gases outside the tubes</td> </tr> <tr> <td>Operating pressure</td> <td>Limited to 25 bar</td> <td>More than 125 bars</td> </tr> <tr> <td>Rate of steam generation</td> <td>Lower</td> <td>Higher</td> </tr> <tr> <td>Suitability</td> <td>Not suitable for large power plant</td> <td>Suitable for large power plant</td> </tr> <tr> <td>Chance of explosion</td> <td>Less due to low pressure</td> <td>More due to low pressure</td> </tr> <tr> <td>Floor space requirement</td> <td>More</td> <td>Less</td> </tr> <tr> <td>Cost</td> <td>Less</td> <td>More</td> </tr> <tr> <td>Requirement of skill</td> <td>Required less skill for efficient and economic working</td> <td>Required more skill and careful attention efficient and economic working</td> </tr> </tbody> </table>	BASIS FOR COMPARISON	Fire Tube boiler	Water Tube boiler	Position of water and hot gases	Hot gases inside the tubes and water outside the tubes	Water inside the tubes and hot gases outside the tubes	Operating pressure	Limited to 25 bar	More than 125 bars	Rate of steam generation	Lower	Higher	Suitability	Not suitable for large power plant	Suitable for large power plant	Chance of explosion	Less due to low pressure	More due to low pressure	Floor space requirement	More	Less	Cost	Less	More	Requirement of skill	Required less skill for efficient and economic working	Required more skill and careful attention efficient and economic working	7	7	7
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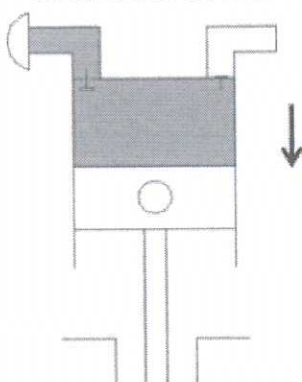
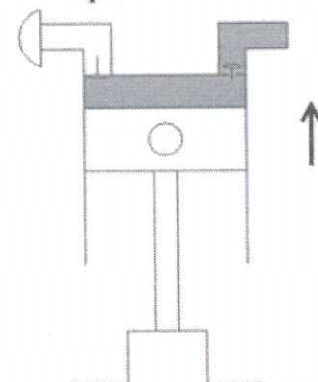


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7 7 7

<p>III. 10</p>	<p><b>Solution :</b> At 20°C ; <math>v_f = 0.001002 \text{ m}^3/\text{kg}</math>;  <math>v_g = 57.79 \text{ m}^3/\text{kg}</math>  That gives  <math display="block">V_f = m_f v_f</math> <math display="block">= 100 \times 0.001002</math> <math display="block">= 0.1002 \text{ m}^3</math> <math display="block">V_g = m_g v_g</math> <math display="block">= 5 \times 57.79 = 288.95 \text{ m}^3</math> <math display="block">\therefore \text{Total volume } V = V_f + V_g</math> <math display="block">= 0.1002 + 288.95 = 289 \text{ m}^3</math> Moisture content refers to wetness fraction which is given by  <math display="block">x = \frac{m_f}{m_f + m_g}</math> <math display="block">= \frac{100}{100 + 5} = 0.952 \text{ or } 95.2 \%</math></p>		7	7
<p>III. 11</p>	<p>In single stage reciprocating air compressor, the entire compression is carried out in a single cylinder. The opening &amp; closing of a simple check valve (plate or spring valve) depends upon the difference in pressure, if mechanically operated valves are used for suction &amp; discharge then their functioning is controlled by cams. The weight of air in the cylinder will be zero when the piston is at top dead centre. At this position, you have to neglect clearance volume. When piston starts moving downwards, the pressure inside the cylinder falls below atmospheric pressure &amp; suction valve/inlet valve opens. The air is drawn into the cylinder through a suction filter element. This operation is known as suction stroke. When the piston moves upwards, compresses the air in cylinder &amp; inlet valve closes when the pressure reaches atmospheric pressure. Further compression follows as the piston moves towards the top of its stroke. Until when the pressure in the cylinder exceeds that in the receiver. This is compression stroke of a compressor. At the end of this stroke discharge/delivery valve opens &amp; air is delivered to a receiver</p>	3	7	7

	<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p><b>Suction of Air</b></p>  </div> <div style="text-align: center;"> <p><b>Compression of Air</b></p>  </div> </div>	4		
III. 12	<p><b>Solution : Given</b></p> <p>Thickness of the first bar, <math>l_1</math> = 500 mm = 0.5m  Thickness of the second bar, <math>l_2</math> = 600 mm = 0.6m  Thermal conductivity of first bar, <math>k_1</math> = 80 W/mK  Thermal conductivity of second bar, <math>k_2</math> = 50 W/mK  Absolute temperature of the hot face, <math>T_1</math> = 100 + 273 = 373 K  Absolute temperature of the cold face, <math>T_2</math> = 20 + 273 = 293 K  Let us consider unit area of the wall, i.e., <math>A = 1 \text{ m}^2</math></p> <p>Thermal resistance of the first bar, <math>R_1 = \frac{l_1}{k_1 A} = \frac{0.5}{80 \times 1} = 6.25 \times 10^{-3} \text{ K/W}</math></p> <p>Thermal resistance of the second bar, <math>R_2 = \frac{l_2}{k_2 A} = \frac{0.6}{50 \times 1} = 0.012 \text{ K/W}</math></p> <hr/> <p>Total thermal resistance, <math>R = R_1 + R_2 = 6.25 \times 10^{-3} + 0.012 = 0.01825 \text{ K/W}</math></p> <p><math>\therefore</math> Rate of heat transfer, <math>Q = \frac{T_1 - T_2}{R} = \frac{373 - 293}{0.01825} = 4383.56 \text{ J/s} = 4383.56 \text{ W}</math> (Ans)</p> <p>Let the temperature of interface = <math>T'</math></p> <p>Temperature drop across the first bar, <math>T_1 - T' = QR_1 = 4383.56 \times 6.25 \times 10^{-3} = 27.3973 \text{ K}</math></p> <p>Now <math>T_1 = 373 \text{ K}</math>; Therefore <math>T' = 373 - 27.3973 = 345.6027 \text{ K} = 72.6027^\circ \text{C}</math></p> <p style="text-align: right;"><i>(Ans)</i></p>	7	7	