

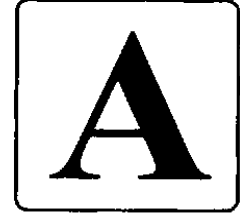
**DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO**

T.B.C. : O-FTF-J-NFA

Test Booklet Series

Serial No.

31585



**TEST BOOKLET**  
**MECHANICAL ENGINEERING**  
**Paper—I**

**Time Allowed : Two Hours**

**Maximum Marks : 200**

**INSTRUCTIONS**

1. IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS TEST BOOKLET **DOES NOT** HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS, ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.
2. ENCODE CLEARLY THE TEST BOOKLET SERIES A, B, C OR D AS THE CASE MAY BE IN THE APPROPRIATE PLACE IN THE ANSWER SHEET.
3. You have to enter your Roll Number on the Test Booklet in the Box provided alongside. **DO NOT** write *anything else* on the Test Booklet.
4. This Test Booklet contains 120 items (questions). Each item comprises four responses (answers). You will select the response which you want to mark on the Answer Sheet. In case you feel that there is more than one correct response, mark the response which you consider the best. In any case, choose **ONLY ONE** response for each item.
5. You have to mark all your responses **ONLY** on the separate Answer Sheet provided. See directions in the Answer Sheet.
6. All items carry equal marks.
7. Before you proceed to mark in the Answer Sheet the response to various items in the Test Booklet, you have to fill in some particulars in the Answer Sheet as per instructions sent to you with your Admission Certificate.
8. After you have completed filling in all your responses on the Answer Sheet and the examination has concluded, you should hand over to the Invigilator **only the Answer Sheet**. You are permitted to take away with you the Test Booklet.
9. Sheets for rough work are appended in the Test Booklet at the end.
10. **Penalty for wrong answers :**  
THERE WILL BE PENALTY FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBJECTIVE TYPE QUESTION PAPERS.
  - (i) There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, **one-third (0.33)** of the marks assigned to that question will be deducted as penalty.
  - (ii) If a candidate gives more than one answer, it will be treated as a **wrong answer** even if one of the given answers happens to be correct and there will be same penalty as above to that question.
  - (iii) If a question is left blank, i.e., no answer is given by the candidate, there will be **no penalty** for that question.

**DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO**

1. Ice kept in a well insulated thermo flask is an example of which system ?
  - (a) Closed system
  - (b) Isolated system
  - (c) Open system
  - (d) Non-flow adiabatic system
  
2. The relation  $ds = \frac{dQ}{T}$ , where s represents entropy, Q represents heat and T represents temperature (absolute), holds good in which one of the following processes ?
  - (a) Reversible processes only
  - (b) Irreversible processes only
  - (c) Both reversible and irreversible processes
  - (d) All real processes
  
3. Consider the following properties of vapour :
  1. Pressure
  2. Temperature
  3. Dryness fraction
  4. Specific volume
 Which of these two properties alone are not sufficient to specify the condition of a vapour ?
  - (a) 1 and 2
  - (b) 1 and 3
  - (c) 2 and 3
  - (d) 3 and 4
  
4. In a reversible isothermal expansion process, the fluid expands from 10 bar and 2 m<sup>3</sup> to 2 bar and 10 m<sup>3</sup>, during the process the heat supplied is 100.kW. What is the work done during the process ?
  - (a) 33.3 kW
  - (b) 100 kW
  - (c) 80 kW
  - (d) 20 kW
  
5. Measurement of temperature is based on which law of thermodynamics ?
  - (a) Zeroth law of thermodynamics
  - (b) First law of thermodynamics
  - (c) Second law of thermodynamics
  - (d) Third law of thermodynamics
  
6. 85 kJ of heat is supplied to a closed system at constant volume. During the next process, the system rejects 90 kJ of heat at constant pressure while 20 kJ of work is done on it. The system is brought to the original state by an adiabatic process. The initial internal energy is 100 kJ. Then what is the quantity of work transfer during the process ?
  - (a) 30 kJ
  - (b) 25 kJ
  - (c) 20 kJ
  - (d) 15 kJ

7. An inventor says that his new concept of an engine, while working between temperature limits of  $27^{\circ}\text{C}$  and  $327^{\circ}\text{C}$  rejects 45% of heat absorbed from the source. His engine is then equivalent to which one of the following engines ?
- Carnot-engine
  - Diesel engine
  - An impossible engine
  - Ericsson engine
8. Three engines A, B and C operating on Carnot cycle use working substances as Argon, Oxygen and Air respectively. Which engine will have higher efficiency ?
- Engine A
  - Engine B
  - Engine C
  - All engines have same efficiency
9. A series combination of two Carnot's engines operate between the temperatures of  $180^{\circ}\text{C}$  and  $20^{\circ}\text{C}$ . If the engines produce equal amount of work, then what is the intermediate temperature ?
- $80^{\circ}\text{C}$
  - $90^{\circ}\text{C}$
  - $100^{\circ}\text{C}$
  - $110^{\circ}\text{C}$
10. An engine working on Carnot cycle rejects 40% of absorbed heat from the source, while the sink temperature is maintained at  $27^{\circ}\text{C}$ , then what is the source temperature ?
- $750^{\circ}\text{C}$
  - $477^{\circ}\text{C}$
  - $203^{\circ}\text{C}$
  - $67.5^{\circ}\text{C}$
11. A thermal electric power plant produces 1000 MW of power. If the coal releases  $900 \times 10^7$  kJ/h of energy, then what is the rate at which heat is rejected from the power plant ?
- 500 MW
  - 1000 MW
  - 1500 MW
  - 2000 MW
12. A heat engine is supplied with 250 kJ/s of heat at a constant fixed temperature of  $227^{\circ}\text{C}$ ; the heat is rejected at  $27^{\circ}\text{C}$ , the cycle is reversible, then what amount of heat is rejected ?
- 250 kJ/s
  - 200 kJ/s
  - 180 kJ/s
  - 150 kJ/s

13. Match List-I with List-II and select the correct answer using the code given below the lists :

<i>List-I</i>	<i>List-II</i>
A. Isolated system	1. Energy is always constant
B. Nozzle	2. Increase in velocity at the expense of its pressure drop
C. Throttling device	3. Appreciable drop in pressure without any change in energy
D. Centrifugal compressor	4. Enthalpy of the fluid increases by the amount of work input

**Code :**

	A	B	C	D
(a)	4	3	2	1
(b)	1	3	2	4
(c)	4	2	3	1
(d)	1	2	3	4

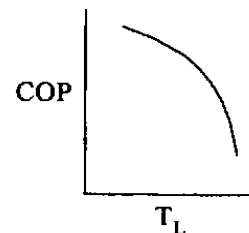
14. 0.70 kg/s of air enters with a specific enthalpy of 290 kJ and leaves it with 450 kJ of specific enthalpy. Velocities at inlet and exit are 6 m/s and 2 m/s respectively. Assuming adiabatic process, what is power input to the compressor ?
- (a) 120 kW  
 (b) 118 kW  
 (c) 115 kW  
 (d) 112 kW

15. In a throttling process, which one of the following parameters remains constant ?

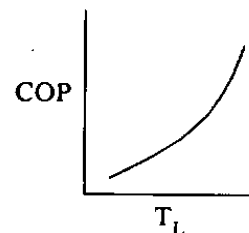
- (a) temperature  
 (b) pressure  
 (c) enthalpy  
 (d) entropy

16. For a given value of  $T_H$  (Source temperature) for a reversed Carnot cycle, the variation of  $T_L$  (Sink temperature) for different values of COP is represented by which one of the following graphs ?

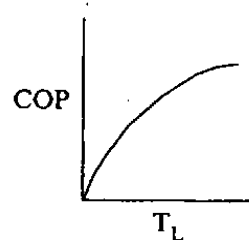
(a)



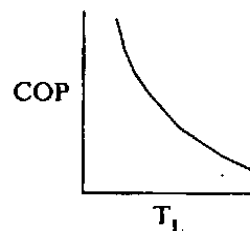
(b)



(c)



(d)



17. Which cycle consists of two reversible isotherms and two reversible isobars ?

- (a) Carnot cycle
- (b) Stirling cycle
- (c) Ericsson cycle
- (d) Brayton cycle

18. Which one of the following parameters is significant to ascertain chemical equilibrium of a system ?

- (a) Clapeyron relation
- (b) Maxwell relation
- (c) Gibbs function
- (d) Helmholtz function

19. Consider the following :

- 1. Air
- 2. Gaseous combustion products
- 3. Steam

Which of these are pure substances, assuming there is no phase change ?

- (a) 1 and 2 only
- (b) 1 and 3 only
- (c) 2 and 3 only
- (d) 1, 2 and 3

20. Consider the following properties :

- 1. Temperature
- 2. Viscosity
- 3. Specific entropy
- 4. Thermal conductivity

Which of the above properties of a system is/are intensive ?

- (a) 1 only
- (b) 2 and 3 only
- (c) 2, 3 and 4 only
- (d) 1, 2, 3 and 4

21. Consider the following properties :

- 1. Entropy
- 2. Viscosity
- 3. Temperature
- 4. Specific heat at constant volume

Which of the above properties of a system is/are extensive ?

- (a) 1 only
- (b) 1 and 2 only
- (c) 2, 3 and 4
- (d) 1, 2 and 4

22. A reversible heat engine rejects 50 percent of the heat supplied during a cycle of operation. If this engine is reversed and operates as a heat pump, then what is its coefficient of performance ?

- (a) 1.0
- (b) 1.5
- (c) 2.0
- (d) 2.5

23. Match List-I with List-II and select the correct answer using the code given below the lists :

<i>List-I</i>	<i>List-II</i>
<i>(Gas Cycles)</i>	<i>(Thermodynamic co-ordinates)</i>

- |                   |                         |
|-------------------|-------------------------|
| A. Carnot cycle   | 1. Pressure-Entropy     |
| B. Brayton cycle  | 2. Pressure-Temperature |
| C. Ericsson cycle | 3. Temperature-Volume   |
| D. Stirling cycle | 4. Temperature-Entropy  |

**Code :**

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 2 | 1 | 3 |
| (b) | 3 | 2 | 1 | 4 |
| (c) | 4 | 1 | 2 | 3 |
| (d) | 3 | 1 | 2 | 4 |

24. The bore and stroke of the cylinder of a 6-cylinder engine working on an Otto-cycle are 17 cm and 30 cm respectively, total clearance volume is 9225 cm<sup>3</sup>, then what is the compression ratio ?

- (a) 7.8
- (b) 6.2
- (c) 15.8
- (d) 5.4

25. Which of the following performance advantages does a rocket engine have as compared to a turbojet engine ?

- 1. No altitude limitation
- 2. Higher efficiency
- 3. Longer flight duration
- 4. No ram drag

Select the correct answer from the code given below :

- (a) 1 and 2 only
- (b) 1 and 4 only
- (c) 1, 2 and 3
- (d) 2, 3 and 4

26. Which of the following symptoms shows that the combustion is necessarily complete ?

- (a) Presence of free carbon in exhaust
- (b) Presence of CO in exhaust
- (c) Presence of oxygen in exhaust
- (d) Presence of nitrogen in exhaust

27. What is the purpose of supercharging an engine ?

- (a) To increase the power output of engine
- (b) To reduce specific fuel consumption
- (c) To reduce the noise of the engine
- (d) To improve cooling of cylinders

28. With natural uranium, which of the following is used as moderator ?
- Heavy water
  - Graphite
  - Beryllium
  - All the above
29. Which one of the following statements is correct ?  
The nuclear radiators produced in a reactor, which must be shielded, are :
- Electrons only
  - Alpha, Beta and Gamma rays
  - Neutrons and Gamma rays
  - Electrons and Gamma rays
30. In  $MLT\theta$  system ( $\theta$  being time and  $T$  temperature), what is the dimension of thermal conductivity ?
- $ML^{-1}T^{-1}\theta^{-3}$
  - $MLT^{-1}\theta^{-1}$
  - $ML\theta^{-1}T^{-3}$
  - $ML\theta^{-1}T^{-2}$
31. A steel plate of thermal conductivity  $50 \text{ W/m-K}$  and thickness  $10 \text{ cm}$  passes a heat flux by conduction of  $25 \text{ kW/m}^2$ . If the temperature of the hot surface of the plate is  $100^\circ\text{C}$ , then what is the temperature of the cooler side of the plate ?
- $30^\circ\text{C}$
  - $40^\circ\text{C}$
  - $50^\circ\text{C}$
  - $60^\circ\text{C}$
32. A composite slab has two layers of different materials having internal conductivities  $k_1$  and  $k_2$ . If each layer has the same thickness, then what is the equivalent thermal conductivity of the slab ?
- $\frac{k_1 k_2}{(k_1 + k_2)}$
  - $\frac{k_1 k_2}{2(k_1 + k_2)}$
  - $\frac{2k_1}{(k_1 + k_2)}$
  - $\frac{2k_1 k_2}{(k_1 + k_2)}$
33. A composite wall of a furnace has 3 layers of equal thickness having thermal conductivities in the ratio of  $1 : 2 : 4$ . What will be the temperature drop ratio across the three respective layers ?
- $1 : 2 : 4$
  - $4 : 2 : 1$
  - $1 : 1 : 1$
  - $\log 4 : \log 2 : \log 1$
34. What is the heat lost per hour across a wall  $4 \text{ m}$  high,  $10 \text{ m}$  long and  $115 \text{ mm}$  thick, if the inside wall temperature is  $30^\circ\text{C}$  and outside ambient temperature is  $10^\circ\text{C}$  ? Conductivity of brick wall is  $1.15 \text{ W/mK}$ , heat transfer coefficient for inside wall is  $2.5 \text{ W/m}^2\text{K}$  and that for outside wall is  $4 \text{ W/m}^2\text{K}$ .
- $3635 \text{ kJ}$
  - $3750 \text{ kJ}$
  - $3840 \text{ kJ}$
  - $3920 \text{ kJ}$

35. When a liquid flows through a tube with sub-cooled or saturated boiling, what is the process known ?

- (a) Pool boiling
- (b) Bulk boiling
- (c) Convection boiling
- (d) Forced convection boiling

36. In a balanced counter flow heat exchanger with  $\dot{m}_h c_h = \dot{m}_c c_c$ , the NTU is equal to 1.0. What is the effectiveness of the heat exchanger ?

- (a) 0.5
- (b) 1.5
- (c) 0.33
- (d) 0.2

37. A large concrete slab 1 m thick has one dimensional temperature distribution :

$$T = 4 - 10x + 20x^2 + 10x^3,$$

where T is temperature and x is distance from one face towards other face of wall.

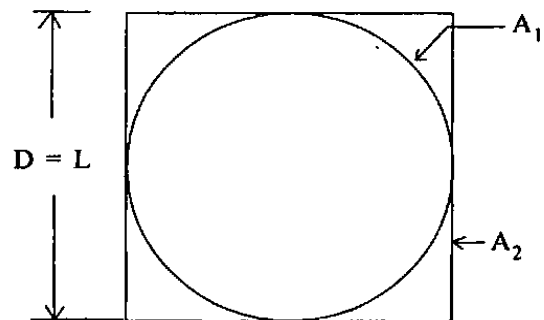
If the slab material has thermal diffusivity of  $2 \times 10^{-3} \text{ m}^2/\text{hr}$ , what is the rate of change of temperature at the other face of the wall ?

- (a)  $0.1^\circ\text{C}/\text{h}$
- (b)  $0.2^\circ\text{C}/\text{h}$
- (c)  $0.3^\circ\text{C}/\text{h}$
- (d)  $0.4^\circ\text{C}/\text{h}$

38. Air at  $20^\circ\text{C}$  blows over a hot plate of  $50 \times 60 \text{ cm}$  made of carbon steel maintained at  $220^\circ\text{C}$ . The convective heat transfer co-efficient is  $25 \text{ W}/\text{m}^2\text{K}$ . What will be the heat loss from the plate ?

- (a) 1500 W
- (b) 2500 W
- (c) 3000 W
- (d) 4000 W

39.



What will be the view factor  $F_{21}$  for the geometry as shown in the figure above (sphere within a cube) ?

- (a)  $\frac{\pi}{2}$
- (b)  $\frac{\pi}{4}$
- (c)  $\frac{\pi}{3}$
- (d)  $\frac{\pi}{6}$



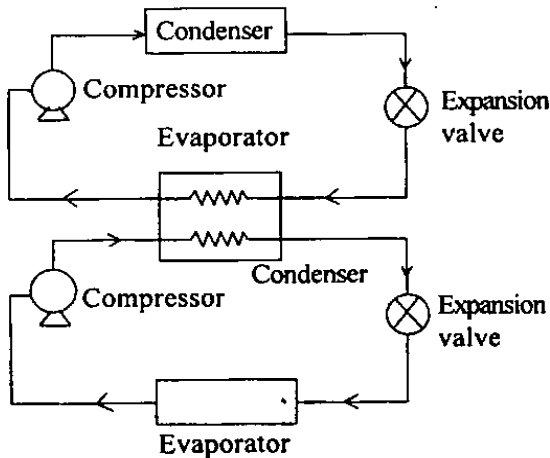
40. In vapour compression refrigeration system, at entrance to which component the working fluid is superheated vapour ?

- (a) Evaporator
- (b) Condenser
- (c) Compressor
- (d) Expansion valve

41. Which one of the following expansion processes takes place in a vapour compression cycle ?

- (a) Polytropic process with change in temperature
- (b) Adiabatic process with work transfer
- (c) Isentropic process with change in enthalpy
- (d) Adiabatic process with constant enthalpy

42.



Which one of the following statements is correct with respect to the schematic diagram as shown above ?

- (a) Multi-evaporator vapour compression system of refrigeration
- (b) Two stage compression vapour compression refrigeration system
- (c) Cascade system of vapour compression refrigeration system
- (d) None of the above

43. The thermal efficiency of a Carnot heat engine is 30%. If the engine is reversed in operation to work as a heat pump with operating conditions unchanged, then what will be the COP for heat pump ?

- (a) 0.30
- (b) 2.33
- (c) 3.33
- (d) Cannot be calculated

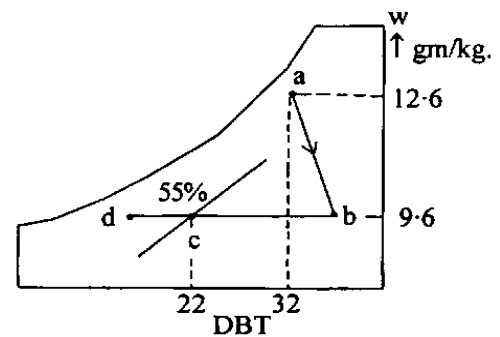
44. In vapour absorption refrigeration system heating in generator is done at  $177^{\circ}\text{C}$ , refrigeration in evaporator at  $-3^{\circ}\text{C}$  and cooling in condenser at  $27^{\circ}\text{C}$ . Then what will be the maximum COP of the system ?

- (a) 1.5
- (b) 2.0
- (c) 3.0
- (d) 4.0

45. In conventional refrigerants what is the element responsible for ozone depletion ?

- (a) Chlorine
- (b) Fluorine
- (c) Carbon
- (d) Hydrogen

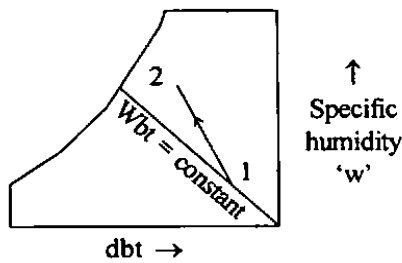
46. The refrigerating efficiency, that is, the ratio of actual COP to reversible COP of a refrigeration cycle is 0.8, the condenser and evaporator temperatures are 51°C and -30°C respectively. If cooling capacity of the plant is 2.4 kW then what is the work requirement ?
- (a) 1.00 kW  
 (b) 1.33 kW  
 (c) 1.25 kW  
 (d) 2.08 kW
47. The atmospheric air at 760 mm of Hg, dry bulb temperature 15°C and wet bulb temperature 11°C enters a heating coil whose temperature is 41°C. If the by-pass factor of the heating coil is 0.5, then what will be the dry bulb temperature of the air leaving the coil ?
- (a) 28°C  
 (b) 29°C  
 (c) 30°C  
 (d) 26°C
48. In a psychrometric chart, what does a vertical downward line represent ?
- (a) Sensible cooling process  
 (b) Adiabatic saturation process  
 (c) Humidification process  
 (d) Dehumidification process
49. In a sample of moist air at standard atmospheric pressure of 101.325 kPa and 26°C the partial pressure of water vapour is 1.344 kPa. If the saturation pressure of water vapour is 3.36 kPa at 26°C, then what are the humidity ratio and relative humidity of moist air sample ?
- (a) 0.00836 and 1.32%  
 (b) 0.00836 and 40%  
 (c) 0.01344 and 1.32%  
 (d) 0.01344 and 40%
- 50.



A classroom is to be air-conditioned by obtaining the comfort conditions of 22°C dbt and 55% RH from outdoor conditions of 32°C dbt and 22°C wbt. The weight of outside air supplied is 30 kg/min. The comfort conditions required are achieved first by chemical dehumidification and then by cooling with a cooling coil as shown in the psychrometric chart above. What is the capacity of the dehumidification in kg/hr ?

- (a) 3.2  
 (b) 5.4  
 (c) 6.8  
 (d) 9.5

51.



Which one of the following statements is correct for a cooling and humidification process 1-2 as shown on the psychrometric chart above ?

- (a) Wbt decreases in the process
  - (b) The total enthalpy increases in the process
  - (c) The total enthalpy remains constant in the process
  - (d) It is an adiabatic saturation process
52. What is the saturation temperature at the partial pressure of water vapour in the air-water vapour mixture called ?
- (a) Dry bulb temperature
  - (b) Wet bulb temperature
  - (c) Dew point temperature
  - (d) Saturation temperature
53. The humidity ratio of atmospheric air at 28°C dbt and 760 mm of Hg is 0.016 kN/m<sup>2</sup>. What is the partial pressure of water vapour ?
- (a) 2.242 kN/m<sup>2</sup>
  - (b) 2.535 kN/m<sup>2</sup>
  - (c) 3.535 kN/m<sup>2</sup>
  - (d) 4.242 kN/m<sup>2</sup>

54. Operating temperature of a cold storage is -2°C. From the surrounding at ambient temperature of 40°C heat leaked into the cold storage is 30 kW. If the actual COP of the plant is 1/10<sup>th</sup> of the maximum possible COP, then what will be the power required to pump out the heat to maintain the cold storage temperature at -2°C ?

- (a) 1.90 kW
  - (b) 3.70 kW
  - (c) 20.28 kW
  - (d) 46.50 kW
55. Air enters a rectangular duct measuring 30 × 40 cm with a velocity of 8.5 m/s and a temperature of 40°C. Kinematic viscosity of the air is 16.95 × 10<sup>-6</sup> m<sup>2</sup>/s. What will be the Reynolds number ?
- (a) 1.72 × 10<sup>5</sup>
  - (b) 2.58 × 10<sup>5</sup>
  - (c) 0.86 × 10<sup>5</sup>
  - (d) 0.72 × 10<sup>5</sup>
56. What is the capillary rise in a narrow two-dimensional slit of width 'w' ?
- (a) Half of that in a capillary tube of diameter 'w'
  - (b) Two-third of that in a capillary tube of diameter 'w'
  - (c) One-third of that in a capillary tube of diameter 'w'
  - (d) One-fourth of that in a capillary tube of diameter 'w'

57. What is the difference in pressure head, measured by a mercury-oil differential manometer for a 20 cm difference of mercury level ? (Sp. gravity of oil = 0.8)
- 2.72 m of oil
  - 2.52 m of oil
  - 3.40 m of oil
  - 2.00 m of oil
58. In order to increase sensitivity of U-tube manometer, one leg is usually inclined by an angle  $\theta$ . What is the sensitivity of inclined tube compared to sensitivity of U-tube ?
- $\sin \theta$
  - $\frac{1}{\sin \theta}$
  - $\frac{1}{\cos \theta}$
  - $\tan \theta$
59. A tank has in its side a very small horizontal cylinder fitted with a frictionless piston. The head of liquid above the piston is  $h$  and the piston area  $a$ , the liquid having a specific weight  $\gamma$ . What is the force that must be exerted on the piston to hold it in position against the hydrostatic pressure ?
- $2\gamma ha$
  - $\gamma ha$
  - $\frac{2\gamma ha}{3}$
  - $\frac{\gamma ha}{2}$
60. What is the vertical distance of the centre of pressure below the centroid of the plane area ?
- $\frac{I_G}{A \cdot h}$
  - $\frac{I_G \cdot \sin \theta}{A \cdot h}$
  - $\frac{I_G \cdot \sin^2 \theta}{A \cdot h}$
  - $\frac{I_G \cdot \sin^2 \theta}{A \cdot h^2}$
61. What are the forces that influence the problem of fluid statics ?
- Gravity and viscous forces
  - Gravity and pressure forces
  - Viscous and surface tension forces
  - Gravity and surface tension forces
62. A body weighs 30 N and 15 N when weighed under submerged conditions in liquids of relative densities 0.8 and 1.2 respectively. What is the volume of the body ?
- 12.50 l
  - 3.82 l
  - 18.70 l
  - 75.50 l

63. For floating bodies, how is the metacentric radius defined ?
- The distance between centre of gravity and the metacentre.
  - Second moment of area of plane of flotation about centroidal axis perpendicular to plane of rotation/immersed volume.
  - The distance between centre of gravity and the centre of buoyancy.
  - Moment of inertia of the body about its axis of rotation/immersed volume.

64. Match List-I with List-II and select the correct answer using the code given below the lists :

*List-I*

*List-II*

- |  |                    |
|--|--------------------|
| A. Singing of telephone wires  | 1. Vortex flow     |
| B. Velocity profile in a pipe is initially parabolic and then flattens | 2. Drag            |
| C. Formation of cyclones   | 3. Vortex shedding |
| D. Shape of rotameter tube   | 4. Turbulence      |

**Code :**

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 3 | 1 | 4 | 2 |
| (b) | 2 | 1 | 4 | 3 |
| (c) | 3 | 4 | 1 | 2 |
| (d) | 2 | 4 | 1 | 3 |

65. Consider the following equations :

$$1. A_1 v_1 = A_2 v_2$$

$$2. \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0$$

$$3. \int_s \rho v \cdot dA + \frac{\partial}{\partial t} \left( \int_v \rho dV \right) = 0$$

$$4. \frac{1}{r} \frac{\partial}{\partial r} (r v_r) + \frac{\partial}{\partial z} (v_z) = 0$$

Which of the above equations are forms of continuity equations ? (Where u, v are velocities and V is volume)

- 1 only
- 1 and 2
- 2 and 3
- 3 and 4

66. A penstock pipe of 10 m diameter carries water under a pressure head of 100 m. If the wall thickness is 9 mm, what is the tensile stress in the pipe wall in MPa ?

- 2725
- 545.0
- 272.5
- 1090

67. Which one of the statements is correct for a forced vortex ?

- Turns in an opposite direction to a free vortex
- Always occurs in conjunction with a free vortex
- Has the linear velocity directly proportional to the radius
- Has the linear velocity inversely proportional to the radius

68. How could 'Magnus effect' be simulated as a combination ?
- Uniform flow and doublet
  - Uniform flow, irrotational vortex and doublet
  - Uniform flow and vortex
  - Uniform flow and line source
69. When is Bernoulli's equation applicable between any two points in a flow field ?
- The flow is steady, incompressible and rotational
  - The flow is steady, compressible and irrotational
  - The flow is unsteady, incompressible and irrotational
  - The flow is steady, incompressible and irrotational
70. Three identical pipes of length  $l$ , diameter  $d$  and friction factor  $f$  are connected in parallel between two reservoirs. What is the size of a pipe of length  $l$  and of the same friction factor  $f$  equivalent to the above pipe ?
- 1.55  $d$
  - 1.4  $d$
  - 3  $d$
  - 1.732  $d$
71. How does the head loss in turbulent flow in pipe vary ?
- Directly as velocity
  - Inversely as square of velocity
  - Approximately as square of velocity
  - Inversely as velocity
72. In a submerged orifice flow, the discharge is proportional to which one of the following parameters ?
- Square root of the downstream head
  - Square root of the upstream head
  - Square of the upstream head
  - Square root of the difference between upstream and downstream heads
73. Which one of the following statements is correct for a fully developed pipe flow ?
- Pressure gradient balances the wall shear stress only and has a constant value.
  - Pressure gradient is greater than the wall shear stress.
  - The velocity profile is changing continuously.
  - Inertia force balances the wall shear stress.
74. Which one of the following statements is appropriate for the free surface, the hydraulic gradient line and energy gradient line in an open channel flow ?
- Parallel to each other but they are different lines
  - All coinciding
  - Such that only the first two coincide
  - Such that they are all inclined to each other
75. A sluice gate discharges water into a horizontal rectangular channel with a velocity of 12 m/s and depth of flow of 1 m. What is the depth of flow after the hydraulic jump ?
- 6.42 m
  - 5.84 m
  - 4.94 m
  - 2.21 m

76. What is the commonly used boundary layer control method to prevent separation ?
- Use of smooth boundaries
  - Using large divergence angle in the boundary
  - Suction of accelerating fluid within the boundary layer
  - Suction of retarded fluid within the boundary layer
77. The time period of a simple pendulum depends on its effective length  $l$  and the local acceleration due to gravity  $g$ . What is the number of dimensionless parameter involved ?
- Two
  - One
  - Three
  - Zero
78. What is the correct dimensionless group formed with the variables  $\rho$ —density,  $N$ —rotational speed,  $d$ —diameter and  $\mu$ —coefficient of viscosity ?
- $\frac{\rho N d^2}{\mu}$
  - $\frac{\rho N d}{\mu}$
  - $\frac{N d}{\rho \mu}$
  - $\frac{N d^2}{\rho \mu}$
79. Which one of the following is proper for a normal shock wave ?
- Reversible
  - Irreversible
  - Isentropic
  - Occurs in a converging tube
80. Which one of the following statements relates to expression ' $\rho v c$ ' ?
- Pressure rise in a duct due to normal closure of valve in the duct
  - Pressure rise in a duct due to abrupt closure of valve in the duct
  - Pressure rise in a duct due to slow opening of valve in the duct
  - Pressure rise in a duct due to propagation of supersonic wave through the duct
81. Which one of the following is correct for tangential component of velocities before and after an oblique shock ?
- Unity
  - Equal
  - Unequal
  - None of the above
82. A hydraulic reaction turbine working under a head of 16 m develops 640 kW of power. What is the unit power of the turbine ?
- 10 kW
  - 40 kW
  - 60 kW
  - 160 kW

83. A Francis turbine working at 400 rpm has a unit speed of 50 rpm and develops 500 kW of power. What is the effective head under which this turbine operates ?

- (a) 62.5 m
- (b) 64.0 m
- (c) 40.0 m
- (d) 100 m

84. A centrifugal pump with radial vane tips at the outlet has an impeller of 100 mm outer diameter. If the rotative speed is 3000 rpm and manometric efficiency 0.8 then what is the net head developed ?

- (a) 10 m
- (b) 20 m
- (c) 30 m
- (d) 40 m

85. The speed ratio of a Pelton wheel operating under a head of 900 m is 0.45. What is the peripheral velocity of the turbine wheel ?

- (a) 28 m/s
- (b) 96 m/s
- (c) 42 m/s
- (d) 60 m/s

86. A mixed flow pump is driven by a 8 kW motor running at 1000 rpm. It delivers water at the rate of 1000 liters/min against a total head of 25 m. What is the specific speed of the pump in meter-minutes ?

- (a) 90
- (b) 50
- (c) 45
- (d) 75

87. Match List-I with List-II and select the correct answer using the code given below the lists :

*List-I*

*List-II*

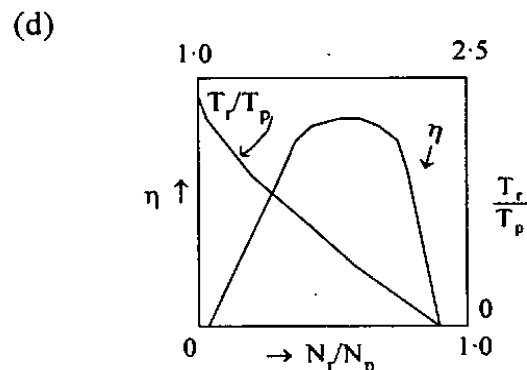
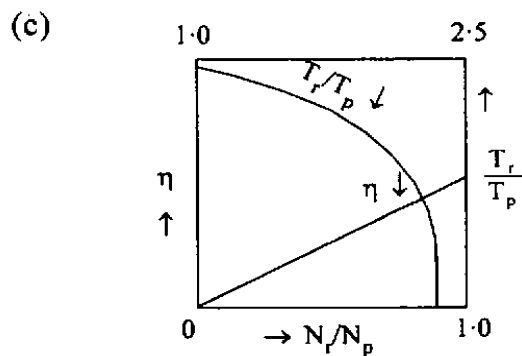
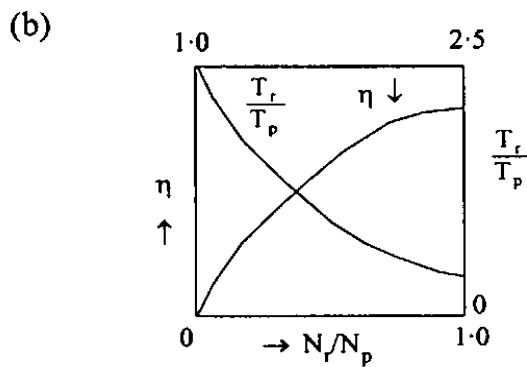
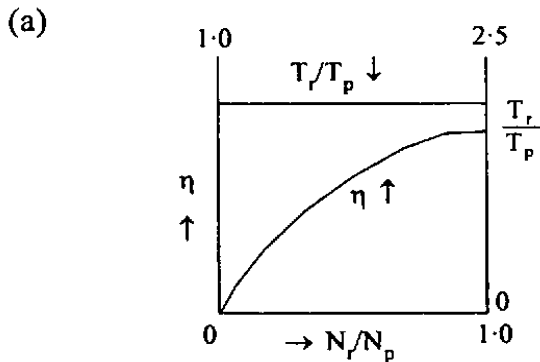
- |                      |   |
|----------------------|---|
| A. Pelton turbine    | 1. Specific speed from 300 to 1000 + axial flow with fixed runner vanes.      |
| B. Francis turbine   | 2. Specific speed from 10 to 50 + Tangential flow.                            |
| C. Propeller turbine | 3. Specific speed from 60 to 300 + mixed flow.                                |
| D. Kaplan turbine    | 4. Specific speed from 300 to 1000 + axial flow with adjustable runner vanes. |

**Code :**

- |     | A | B | C | D |
|-----|---|---|---|---|
| (a) | 2 | 1 | 3 | 4 |
| (b) | 4 | 1 | 3 | 2 |
| (c) | 2 | 3 | 1 | 4 |
| (d) | 4 | 3 | 1 | 2 |



88. Which one of the following graphs represents the characteristics of a torque converter ? Where suffix r stands for turbine runner and P stands for pump impeller.



89. Which one of the following combination represents the power transmission systems ?

- (a) Pump, hydraulic accumulator, hydraulic intensifier and hydraulic coupling
- (b) Pump, turbine, hydraulic accumulator and hydraulic coupling
- (c) Turbine, accumulator, intensifier and hydraulic coupling
- (d) Accumulator, intensifier, hydraulic coupling and torque converter

90. Which one of the following is NOT an accessory for the boiler ?

- (a) Condenser
- (b) Economizer
- (c) Air preheater
- (d) Feed water pump

91. Match List-I with List-II and select the correct answer using the code given below the lists :

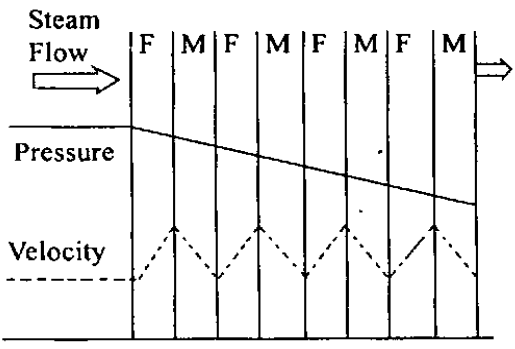
<i>List-I</i> (Type of boiler)	<i>List-II</i> (Features)
A. Benson	1. Vertical fire tube
B. Stirling	2. Horizontal fire tube
C. Babcock-Wilcox	3. Bent water tube
D. Cochran	4. Once through flow
	5. Inclined water tube

Code :

	A	B	C	D
(a)	4	5	3	1
(b)	1	2	5	4
(c)	4	3	5	1
(d)	1	5	2	4

92. Steam pressures at the inlet and exit of a nozzle are 16 bar and 5.2 bar respectively and discharge is  $0.28 \text{ m}^3/\text{s}$ . Critical pressure ratio is 0.5475. If the exit pressure is reduced to 3.2 bar then what will be the flow rate in  $\text{m}^3/\text{s}$  ?
- 0.280
  - 0.328
  - 0.356
  - 0.455
93. Consider the following statements :  
Choked flow through a nozzle means :
- Discharge is maximum
  - Discharge is zero
  - Velocity at throat is supersonic
  - Nozzle exit pressure is less than or equal to critical pressure.
- Which of the above statements is/are correct ?
- 1 only
  - 1 and 2
  - 2 and 3
  - 1 and 4
94. The index of expansion of dry saturated steam flowing through a nozzle is equal to 1.135, and then what is the critical pressure ratio for this flowing steam in the nozzle ?
- 0.96
  - 0.58
  - 0.33
  - 0.15
95. Water ( $C_p = 4 \text{ kJ/kgK}$ ) is fed to a boiler at  $30^\circ\text{C}$ , the enthalpy of vaporization at atmospheric pressure in the boiler is  $2400 \text{ kJ/kg}$ ; the steam coming from the boiler is 0.9 dry. What is the net heat supplied in the boiler ?
- 2160 kJ/kg
  - 2400 kJ/kg
  - 2440 kJ/kg
  - 2280 kJ/kg
96. In a simple impulse turbine the nozzle angle at the entrance is  $30^\circ$ . For maximum diagram efficiency what is the blade-speed ratio ?
- (Note :  $\sin 30^\circ = 0.5$ ,  $\cos 30^\circ = 0.866$ ,  $\sin 15^\circ = 0.259$ ,  $\cos 15^\circ = 0.966$ )
- 0.259
  - 0.75
  - 0.5
  - 0.433
97. Consider the following statements pertaining to gas turbines :
- The degree of reaction of a reaction turbine is the ratio of energy transfer in fixed blade to the overall energy transfer across a stage.
  - The overall pressure drop in a turbine is the product of pressure drop per stage and number of stages.
  - Gas turbine cycle (Brayton cycle) is not as efficient as Rankine cycle for steam.
- Which of the above statements is/are correct ?
- 1 only
  - 2 only
  - 2 and 3
  - 3 only

98.



The pressure and velocity diagram as shown in the figure above for a steam turbine refers to which one of the following ?

- (Where : M—moving blade, F—fixed blade)
- (a) Impulse turbine-Velocity compounded
  - (b) Impulse turbine-Pressure compounded
  - (c) Impulse turbine-Pressure and Velocity compounded
  - (d) Reaction turbine stages

99. If the enthalpy drop in the moving blades and fixed blades of a steam turbine is 10 kJ/kg and 15 kJ/kg respectively then what is the degree of reaction ?

- (a) 67%
- (b) 60%
- (c) 40%
- (d) 33%

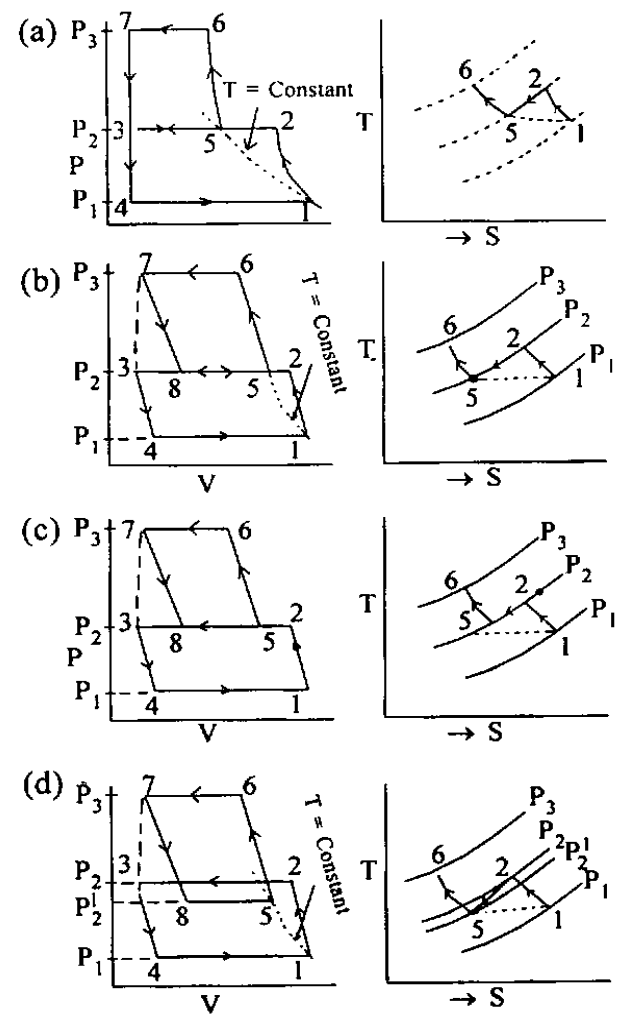
100. In a simple single stage gas turbine plant, if  $T_1$  is the minimum temperature and  $T_3$  is the maximum temperature then what is the work ratio in terms of  $r_p$  ?

- (a)  $1 - \frac{T_3}{T_1} r_p^{\frac{\gamma-1}{\gamma}}$
- (b)  $1 - \frac{T_1}{T_3} r_p^{\frac{\gamma-1}{\gamma}}$
- (c)  $1 - \frac{T_1}{T_3} r_p^{\frac{\gamma}{\gamma-1}}$
- (d)  $1 - \frac{T_1}{T_3} r_p^{\frac{1}{\gamma}}$

101. Which one of the following statements is correct ?

- (a) Reciprocating compressors are used to supply large quantities of air at a lower pressure ratio.
- (b) Centrifugal compressors are used to supply large quantities of air at a lower pressure ratio.
- (c) Centrifugal compressors are used to supply small quantities of air at a lower pressure ratio.
- (d) Centrifugal compressors cannot be run at high speed because of impeller, diffuser and casing.

102. Which one of the following graphs shows the correct representation of the processes for a two stage air compressor with perfect intercooling and no pressure drop in the intercooler ?



(Contd.)

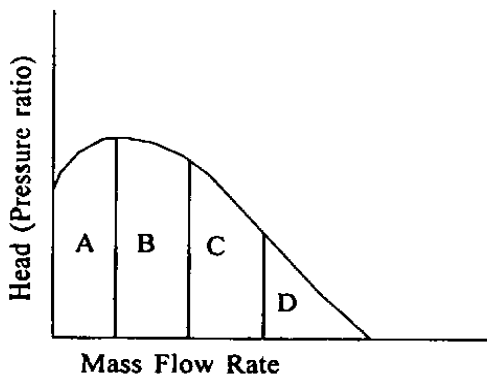
103. Consider the following statements pertaining to axial flow compressors :

1. Like centrifugal compressor, axial flow compressors are limited by surge at low mass flow rates.
2. Axial flow compressors experience choking at low flow rates.
3. The design point of axial flow compressors is close to the surge limit.
4. As mass flow diminishes the compressor blades stall causing flow separation.

Which of the above statements is/are correct ?

- (a) 1 and 2 only
- (b) 1, 2 and 3
- (c) 1, 3 and 4
- (d) 3 and 4 only

104.



In the graph as shown above, for an axial flow compressor, surging is likely to occur in which one of the following zones ?

- (a) A
- (b) B
- (c) C
- (d) D

105. Which one of the following diagrams depicts correctly the radial distribution of axial velocity over the blades in the last stage of multistage axial flow compressors ?

- (a)
- (b)
- (c)
- (d)

106. Which one of the following statements is correct ?

Increasing the number of reheating stages in a gas turbine to infinity, makes the expansion tending :

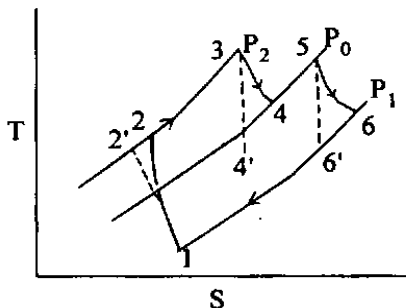
- (a) Reversible adiabatic
- (b) Isothermal
- (c) Isobaric
- (d) Adiabatic

107. Which one of the following statements is correct ?

In a boiler, the air preheater is invariably located between :

- (a) Forced draft fan and chimney
- (b) Forced draft fan and furnace
- (c) Economizer and feed pump
- (d) Condenser and feed pump

108.



The above T-S diagram for a gas turbine plant is drawn for the case where :

- (a) Compression of air is done in two stages incorporating an intercooler between two.
- (b) Expansion of gases is done in two stages followed by regeneration.
- (c) Expansion of gases is done in two stages with a reheater between the two.
- (d) Expansion of gases is done in two stages with a reheater between the two followed by regeneration.

**Directions :**

Each of the next TWELVE (12) items consists of two statements, one labelled as the 'Assertion (A)' and the other as 'Reason (R)'. You are to examine these two statements carefully and select the answers to these items using the codes given below :

**Codes :**

- (a) Both A and R are individually true and R is the correct explanation of A
- (b) Both A and R are individually true but R is *not* the correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

109. Assertion (A) : An air-conditioner operating as a heat pump is superior to an electric resistance heater for winter heating.

Reason (R) : A heat pump rejects more heat than the heat equivalent of the heat absorbed.

110. Assertion (A) : After burning increases the thrust of a jet engine.

Reason (R) : The air fuel ratio of jet engine is high.

111. Assertion (A) : Cork is a good insulator.

Reason (R) : Good insulators are highly porous.

112. Assertion (A) : Drop-wise condensation is associated with higher heat transfer rate as compared to the heat transfer rate in film condensation.
- Reason (R) : In drop condensation there is free surface through which direct heat transfer takes place.
113. Assertion (A) : For the similar conditions the values of convection heat transfer coefficients are more in forced convection than in free convection.
- Reason (R) : In case of forced convection system the movement of fluid is by means of external agency.
114. Assertion (A) : If a domestic refrigerator works inside an adiabatic room with its door open, the room temperature gradually decreases.
- Reason (R) : Vapour compression refrigeration cycles have high COP compared to air refrigeration cycles.
115. Assertion (A) : In a fluid, the rate of deformation is far more important than the total deformation itself.
- Reason (R) : A fluid continues to deform so long as the external forces are applied.
116. Assertion (A) : A narrow glass tube, when immersed into mercury causes capillary depression, and when immersed into water causes capillary rise.
- Reason (R) : Mercury is denser than water.
117. Assertion (A) : The local acceleration is zero in a steady motion.
- Reason (R) : The convective component arises due to the fact that a fluid element experiences different velocities at different locations.
118. Assertion (A) : The 'dimples' on a golf ball are intentionally provided.
- Reason (R) : A turbulent boundary layer, since it has more momentum than a laminar boundary layer, can better resist an adverse pressure gradient.
119. Assertion (A) : Increase in static suction lift of centrifugal pump may cause cavitation.
- Reason (R) : Available Net Positive Suction Head increases with increase in static suction lift.
120. Assertion (A) : Multistaging compression is done only in reciprocating compressors.
- Reason (R) : Reciprocating compressors are used to compress a large pressure ratio and low discharge.

**SPACE FOR ROUGH WORK**

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