MECHANICAL ENGINEERING

PAPER-I

1. Consider the following statements pertaining to boundary layer :
   1. Boundary layer is a thin layer adjacent to the boundary where maximum viscous energy dissipation takes place.
   2. Boundary layer thickness is a thickness by which the ideal flow is shifted.
   3. Separation of boundary layer is caused by presence of adverse pressure gradient.

   Which of these statements are correct?
   a. 1, 2 and 3
   b. 1 and 2
   c. 1 and 3
   d. 2 and 3

2. The velocity profile for turbulent layerover a flat plate is
   a. $\frac{u}{U}=\sin\left(\frac{\pi}{2}-\frac{y}{\delta}\right)$
   b. $\frac{u}{U}=\left(\frac{y}{\delta}\right)^{1/7}$
   c. $\frac{u}{U}=2\left(\frac{y}{\delta}\right)-\left(\frac{y}{\delta}\right)^{2}$
   d. $\frac{u}{U}=\frac{3}{2}\left(\frac{y}{\delta}\right)-\frac{1}{2}\left(\frac{y}{\delta}\right)^{3}$

3. Match List I (Flows Over or inside the Systems) with List II (Type of Flow) and select the correct answer :

   List I
   A. Flow over a sphere
   B. Flow over a long circular cylinder
   C. Flow in a pipe bend
   D. Fully developed flow in a pipe at constant flow rate

   List II
   1. Two dimensional flow
   2. One dimensional flow
   3. Axis symmetric flow
   4. Three dimensional flow

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

4. Consider the following statements:
   1. Dimensional analysis is used to determine the number of variables involved in a certain phenomenon.
   2. The group of repeating variables in dimensional is should include all the fundamental units.
   3. Buckingham's π theorem stipulates the number of dimensionless groups for a given phenomenon.
   4. The coefficient in Chezy's equation has no dimension

   Which of these are correct ?
   a. 1, 2, 3 and 4
   b. 2, 3 and 4
   c. 1 and 4
   d. 2 and 3

5. Match List I (Flow/Wave) with List II (Dimensionless Number) and select the correct answer :

   List I
   A. Capillary waves in channel
   B. Testing of aerofoils
   C. Flow around bridge piers
   D. Turbulent flow through pipes

   List II
   1. Reynolds number
   2. Froud number
   3. Weber number
   4. Euler number
   5. Mach number

	A	B	C	D
a.	5	4	3	2
b.	3	5	4	1
c.	5	4	2	1

d. 3 5 2 1

6. Consider the following statements :
   1. Complete similarity between model and prototype envisages geometric and dynamic similarities only
   2. Distorted models are necessary where geometric similarity is not possible due to practical reasons.
   3. In testing of model of a ship, the surface tension forces are generally neglected.
   4. The scale effect takes care of the effect of dissimilarity between model and prototype:

   Which of these statements are correct ?
   a. 1 and 3
   b. 1, 2 and 4
   c. 2 and 3
   d. 2 and 4

7. The fluid property that remains unchanged across a normal shock wave is
   a. Stagnation enthalpy
   b. Stagnation pressure
   c. Static pressure
   d. Mass density

8. Match List I (Phenomena) with List II (Causes) and select the correct answer :

   List I

   A. Shock wave
   B. Flow separat4on
   C. V Capillary rise
   D. Cavitation

   List II

   1. Surface tension
   2. Vapour pressure
   3. Compressibility
   4. Adverse pressure gradient

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

9. Consider the following statements pertaining to one-dimensional isentropic flow in a convergent-divergent passage:
   1. A convergent-divergent passage may function as a supersonic nozzle or a venturi depending on the back pressure.
   2. At the throat, sonic conditions exist for subsonic or supersonic flow at the outlet.
   3. A supersonic nozzle discharges fluid at constant rate even if the exit pressure is lower than the design pressure
   4. A normal shock appears in the diverging section of the nozzle if the back pressure is above the design pressure but below a certain minimum pressure for venturi operation.

   Which of the statements are correct?
   a. 1, 2, 3 and 4
   b. 1, 3 and 4
   c. 2, 3 and 4
   d. 1 and 2

10. Two pelton wheels A and B have the same specific speed, and are working under, the same head. When A produces 400 kW at 1000 rpm. If B produces 100 kW, then its rpm is
    a. 4000
    b. 2000
    c. 1500
    d. 1250

11. On the assumption that a double suction impeller is the equivalent of two single suction impellers placed back to back, it is customary to base the specific speed of the double suction pump on
    a. One half of the total capacity
    b. Three fourth of the total capacity
    c. Full total capacity
    d. Double the total capacity

12. Consider the following types of water turbines
    1. Bulb
    2. Francis
    3. Kaplan
    4. Pelton

    The correct sequence of order in which the operating head decreases while developing the same power is
    a. 4, 2, 3, 1
    b. 3, 4, 1, 2
    c. 2, 1, 4, 3
    d. 1, 3, 2, 4

13. Match List I (Type of Pumps) with List II (Associated Features) and select the correct answer :

List I

A. Centrifugal pump
B. Gear pump
C. Reciprocating pump
D. Turbine pump

List II

1. Air vessel
2. Draft tube
3. Guide vanes
4. Rotary pump
5. Rotor having blades

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

14. Match List I (Industrial Needs) with List II (Type of Pump) and select the correct answer :

List I

A. Combustible fluid to be pumped
B. High head but small discharge needed
C. Low head but large discharge needed
D. High head and high discharge needed

List II

1. Single stage centrifugal
2. Multi-stage centrifugal
3. Positive displacement
4. Jet pump

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

15. Consider the following energies associated with a Pelton turbine :

1. Mechanical energy
2. Kinetic energy
3. Potential energy

The correct sequence of energy conversion starting from the entry of fluid is

a. 1, 2, 3
b. 2, 3, 1
c. 3, 2, 1
d. 1, 3, 2

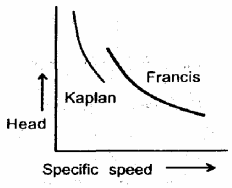
16. Euler equation of turbine giving energy transfer per unit mass E_0 (where U, V_w, V_r and V represent the peripheral, whirl, relative and absolute velocities respectively. Suffix 1 and 2 refer to the turbine inlet and outlet respectively) is given by

a. $E_0 = U_1V_{w1} - U_2 V_{w2}$
b. $E_0 = U_1V_{r1} - U_2 V_{r2}$
c. $E_0 = U_1V_1 - U_2 V_2$
d. $E_0 = V_1V_{w1} - V_2 V_{w2}$

17. The power ratio of a pump and its l/4 the scale model, if the ratio of the heads is 5 : 1, will be

a. 100
b. 3.2
c. 179
d. 12.8

18. Which one of the following graphs correctly represents the relations between Head and Specific speed for Kaplan and Francis turbine?

a.


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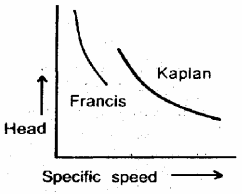

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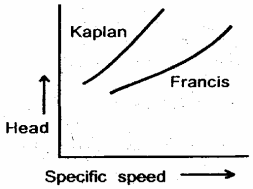
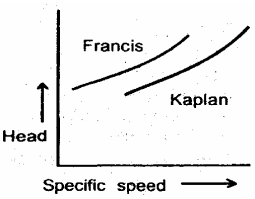


d.


19. Consider the following statements regarding air vessels provided in, reciprocating pump installations

1. The air vessels are fitted both on suction and delivery sides.
2. The air vessels are fitted far from the pump cylinder.
3. The air vessels save energy by reducing the friction loss.

Which of these statements are correct?

a. 1, 2 and 3
b. 2 and 3
c. 1 and 2
d. 1 and 3

20. A pump, is installed at a height of 5 m above the water level in .the sump. Frictional loss on the suction side is 0.6 m. If the atmospheric pressure is 10.3 m of water and vapour pressure head is 0.4 m (abs), the NPSH (Net Positive Suction Head) will be

a. 3.7 m
b. 4 m
c. 4.3 m
d. 4.6 m

21. Priming is necessary in

a. Centrifugal pumps to lift water from a greater depth
b. Centrifugal pumps to remove air in the suction pipe and casing
c. Hydraulic turbine to remove air in the turbine casing
d. Hydraulic turbine to increase the speed of turbine and to generate more power

22. An accumulator is a device to store

a. Sufficient quantity of liquid to compensate the change in discharge
b. Sufficient energy to drive the machine when the normal energy source does, not function
c. Sufficient energy in case of machines which work intermittently to supplement the discharge from the normal source
d. Liquid which otherwise would have gone to waste

23. The draught in locomotive boilers is produced by

a. Chimney
b. Centrifugal fan
c. Steam jet
d. Locomotion

24. In a two-stage compressor with ideal intercooling, for the work requirement to be minimum, the intermediate pressure p_i in terms of condenser and evaporator pressure p_c and p_e respectively is

a. $p_i = p_c p_e$
b. $p_i = \sqrt{p_c p_e}$
c. $p_i = \sqrt{p_c / p_e}$
d. $p_i = p_c / p_e$

25. In a one ton capacity water cooler, water enters at 30°C at the rate of 200 liters per hour. The outlet temperature of water will be (sp. heat of water = 4.18 kJ/kg K)

a. 3.5°C
b. 6.3°C
c. 23.7°C
d. 15°C

26. A refrigerator working on a reversed Carnot cycle has a C.O.P. of 4. If it works as a heat pump and consumes 1 kW, the heating effect will be

a. I kW
b. 4kW
c. 5kW
d. 6kW

27. Theoretical maximum C.O.P. of a vapour absorption system (where, T_G = generator temp, T_E = evaporator temp, T_0 = environmental temp) is

a. $\frac{T_E}{T_G}\left(\frac{T_G - T_O}{T_O - T_E}\right)$
b. $\frac{T_E}{T_G}\left(\frac{T_O - T_E}{T_G - T_O}\right)$
c. $\frac{T_G}{T_E}\left(\frac{T_G - T_O}{T_O - T_E}\right)$
d. $\frac{T_G}{T_E}\left(\frac{T_O - T_E}{T_G - T_O}\right)$

28. When a refrigerator system is started from ambient conditions, the evaporator temperature decreases from ambient temperature to design value. This period is known as a pull-down period. The power requirement of compressor during pull-down

a. decreases continuously
b. increases continuously

c. remains constant

d. increases and then decreases

29. Oil separator is NOT required in refrigeration system if

a. refrigerant and oil are immiscible at all pressures and temperatures

b. refrigerant and oil are immiscible at condensation pressure and temperature

c. refrigerant and oil are miscible at all pressure and temperatures

d. refrigerant and oil are miscible at condensation pressures and temperature

30. If the volume of moist air with 50% relative humidity is isothermally reduced to half its original volume, then relative humidity of moist air becomes

a. 25%

b. 60%

c. 75%

d. 100%

31. When the wet and dry bulb temperatures are identical, which of the following statements is/are true ?

1. Air is fully saturated
2. Dew point temperature is reached
3. Humidity ratio is unity
4. Partial pressure of vapour equals total pressure

Select the correct answer from the codes given below :

a. 1 only

b. 1 and 2

c. 3 and 4

d. 1, 2, 3 and 4

32. In a cooling tower the sum of range and approach is equal to twice the wet bulb depression. Then

a. Dry bulb temperature is mean of water inlet temperature and wet bulb temperature

b. Dry bulb temperature is mean of water outlet temperature and wet bulb temperature

c. Water inlet temperature is mean of dry bulb temperature and wet bulb temperature

d. Water inlet temperature is mean of water outlet temperature and wet bulb temperature

33. Which of the following properties increase(s) during sensible heating of air-water vapour mixture?

1. Relative humidity
2. Humidity ratio
3. Wet bulb temperature
4. Specific enthalpy of air-vapour mixture

Select the correct answer from the codes given below:

a. 1 and 2

b. 3 only

c. 2 and 3

d. 3 and 4

34. Upon which of the following factors does the effective temperature for human comfort depend?

1. Dry bulb temperature
2. Humidity ratio
3. Air velocity
4. Mean radiation temperature

Select the correct answer from the codes given below :

a. 1 and 2

b. 1, 3 and 4

c. 2, 3 and 4

d. 1, 2, 3 and 4

35. Moist air enters the cooling coil with mass flow rate of 10 kgda/s at dry bulb temperature of 30°C and humidity ratio of 0.017 kgw/kgda. It leaves the cooling coil at dry bulb temperature of 16°C and humidity ratio of 0.008 kgw/kgda. If specific heat of humid air is 1.02 kJ/kgda-K and latent heat of water vapour is 2500 kJ/kgw. The sensible and latent heat transfer of cooling coil are, respectively

a. 140 kW and 25000 kW

b. 142.8 kW and 2.25 kW

c. 142.8 kW and 225 kW

d. 225 kW and 142.8 kW

36. An air-conditioned room has length, width and height of 20 m, 30 m and 4 m respectively. The infiltration is assumed to be one air change. The outdoor and indoor dry bulb temperatures are 40°C and 25°C

respectively. The sensible heat load due to infiltration is

a. 734 kW (b) 12.24 kW
b. 0.204 kW (d) 10 kW

37. Consider the following statements in respect of the contraction and expansion in. air conditioning ducts :

1. Pressure drop is more in contraction than in expansion.
2. Pressure drop is more in expansion than in contraction.
3. Static pressure increases (regain) in expansion.
4. Static pressure increases (regain) in contraction.

Which of these statements are correct ?

a. 1 and 2
b. 1, 2 and 3
c. 1 and 3
d. 2 and 4

38. On which, of the following factors does sol-air temperature depend?

1. Outdoor air temperature
2. intensity of solar radiation
3. Absorptivity of wall
4. Convective heat transfer coefficient at outer surface of wall
5. Indoor design temperature

Choose the correct answer from the codes given below:

a. 1, 2 and 5
b. 1, 2 and 3
c. 3 and 4
d. 1, 2, 3 and 4

39. Instantaneous cooling loads are NOT equal to instantaneous heat gains because

a. Heat gains are offset by cooling provided by the AC system
b. Indoor temperatures are tower
c. Comfort conditions are maintained in the space
d. Of the storage effect in the construction material of walls and roof

40. Consider the following statements about hydrostatic force on a submerged surface :

1. It remains the same even when the surface is turned.
2. It acts vertically even when the surface is turned.

Which of these is/are correct ?

a. Only 1
b. Only 2
c. Both 1 and 2
d. Neither 1 nor 2

41. The depth of centre of pressure for a rectangular lamina immersed vertically in water up to height ‘h’ is given by

a. h/2
b. h/4
c. 2h/3
d. 3h/2

42. The vertical component of force on a curved surface submerged in a static liquid is equal to the

a. Weight of liquid column above the C.G. of the curved surface
b. Weight of liquid above the curved surface
c. Product of pressure at C.G., multiplied by the area of the curved surface
d. Product of pressure at C.G., multiplied by the projected area of the curved surface

43. The point of application of a horizontal force on a curved surface submerged in liquid is

a. $\frac{I_G}{A\bar{h}} - \bar{h}$

b. $\frac{I_G + A\bar{h}}{A\bar{h}}$

c. $\frac{A\bar{h}}{I_G} + \bar{h}$

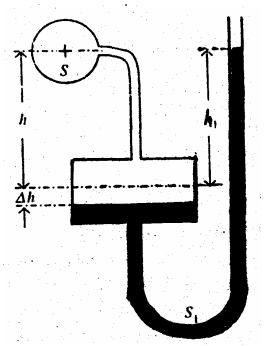
d. $\frac{I_G}{\bar{h}} + A\bar{h}$

where A = area of the immersed surface

$\bar{h}$ = depth of centre of surface immersed

I_G = moment of inertia about centre of gravity

44.



To measure the pressure head of the fluid of specific gravity S flowing through a pipeline, a simple micro-manometer containing a fluid of specific gravity S_1 is connected to it. The readings are as indicated in the diagram. The pressure head in the pipeline is

a. $h_1S_1 - hS - \Delta h(S_1 - S)$

b. $h_1S_1 - hS_1 + \Delta h(S_1 - S)$

c. $hS - h_1S_1 - \Delta h(S_1 - S)$

d. $hS - h_1S_1 + \Delta h\ (S_1 - S)$

45. Match List I (Rheological Equation) with List II (Types of Fluids) and. select the correct answer :

List I

A. $\tau = \mu\ (du/dy)^n$, n = 1

B. $\tau = \mu\ (du/dy)^n$, n < 1

C. $\tau = \mu\ (du/dy)^n$, n > 1

D. $\tau = \tau_0 + \mu\ (du/dy)^n$, n = 1

List II

1. Bingham plastic
2. Dilatant fluid
3. Newtonian fluid
4. Pseudo-plastic fluid

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

46. Which one of the following stream functions is a possible irrotational flow field ?

a. $\psi = x^3y$

b. $\psi = 2xy$

c. $\psi = Ax^2y^2$

d. $\psi = Ax + By^2$

47. The expression

$$\frac{\partial \phi}{\partial t} + \int \frac{\partial p}{\partial} + \frac{1}{2}|\nabla \phi|^2 + gz = \text{constant}$$

represents

a. Steady flow energy equation

b. Unsteady irrotational Bernoulli's equation

c. Steady rotational Bernoulli's equation

d. Unsteady rotational Bernoulli's equation

48. For a circular channel, the wetted parameter (where R = radius of circular channel, θ = half the angle subtended by the water surface at the centre) is given by

a. Rθ/2

b. 3Rθ

c. 2Rθ

d. Rθ

49. Consider the following statements:

A hydraulic jump occurs in. an open channel

1. when the Froude number is equal to or less than one.
2. at the toe of a spillway.
3. downstream of a sluice gate in a canal.
4. when the bed slope suddenly changes.

Which of these are correct ?

a. 1, 2, 3 and 4

b. 1, 2 and 3

c. 2, 3 and 4

d. 1 and 4

50. An orifice meter with C_d = 0.61 is substituted by Venturimeter with C_d = 0.98 in a pipeline carrying crude oil, having the same throat diameter as that of the orifice. For the same flow rate, the ratio of the pressure drops for the venturimeter and the orifice meter is

a. 0.61 / 0.98

b. $(0.61)^2 / (0.98)^2$

c. 0.98 / 0.61

d. $(0.98)^2 / (0.61)^2$

51. The instrument preferred in the measurement of highly fluctuating velocities in air flows is

a. Pitot-static tube

b. Propeller type anemometer

c. Three cup anemometer

d. Hot wire anemometer

52. The friction factor for fully developed turbulent flow through a rough circular pipe depends on
    a. Reynolds number
    b. Relative roughness
    c. Reynolds number and relative roughness
    d. Reynolds number, relative roughness and diameter to length ratio

53. In a steady flow of an oil in a pipe in the fully developed laminar regime, the shear stress is
    a. Constant across the pipe
    b. Maximum at the centre and decreases parabolically towards the pipe. wall boundary
    c. Zero at the boundary and increases linearly towards the centre
    d. Zero at the centre and increases towards the pipe wall

54. Velocity of pressure waves due to pressure disturbances imposed in a liquid is equal to
    a. $(E/\rho)^{1/2}$
    b. $(E\rho)^{1/2}$
    c. $(\rho/E)^{1/2}$
    d. $(1/\rho E)^{1/2}$

55. Match List I (Boilers) with List II(Type/Description) and select the correct answer

List I

A. Lancashire
B. Benson
C. Babcock and Wilcox
D. Stirling

List II

1. Horizontal straight tube, fire-tube boiler
2. Horizontal straight tube, water-tube boiler
3. Bent tube, water-tube boiler
4. High pressure boiler

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

56. Consider the following statements regarding the fluidized bed combustion boilers :
    1. The combustion temperatures are low, around 900°C
    2. The formation of oxides of nitrogen is low.
    3. It removes sulphur from coal during combustion process.
    4. It requires high quality of coal as fuel.

    Which of these statements are correct?
    a. 1, 2, 3 and 4
    b. 1,2 and 3
    c. 2, 3 and 4
    d. 1 and 4

57. The correct gas flow path in a typical large modern natural circulation boiler is
    a. Combustion chamber – Reheater – Superheater – Economiser – Air Preheater – I.D. fan – Electrostatic precipitator – Stack
    b. Combustion chamber – Superheater – Reheater – Economiser – Air Preheater – Electrostatic – precipitator I.D. fan – Stack
    c. Combustion chamber – Reheater – Superheater – Air Preheater – Economiser – Electrostatic precipitator – I.D. fan – Stack
    d. Combustion chamber – Superheater – Reheater – Economiser – Air Preheater – I.D. fan – Electrostatic precipitator – Stack

58. Employing superheated steam in turbines leads to
    a. Increase in erosion of blading
    b. Decrease in erosion of blading
    c. No erosion in blading
    d. No change in erosion of blading

59. Steam enters a De laval steam turbine with an inlet velocity of 30 m/s and leaves with an outlet velocity of 10 m/s. The work done by 1 kg of steam is
    a. 400 Nm
    b. 600 Nm.
    c. 800 Nm
    d. 1200 Nm

60. In a 50% reaction stage, absolute velocity angle at inlet is 45^0, mean peripheral speed

is 75 m/s and the absolute velocity at the exit is axial. The stage specific work is

a. 2500 m^2/s^2
b. 3270 m^2/s^2
c. 4375 m^2/s^2
d. 5625 m^2/s^2

61. In a reaction turbine stage enthalpy drop in the stator blades is 4.62 kJ/kg and that in the rotor blades is 2.38 kJ/ kg. The degree of reaction of the stage is

a. 0.52
b. 0.43
c. 0.34
d. 0.26

62. An emergency governor of a steam turbine trips the turbine when

1. Shaft exceeds 100% of its rated speed
2. Condenser becomes hot due to inadequate cooling water circulation
3. Lubrication system fails
4. Balancing of turbine is not proper

Select the correct answer from the codes given below:

a. 1, 2 and 3
b. 2, 3 and 4
c. 3, 4 and 1
d. 4, 1 and 2

63. Roots blower is an example of

a. Reciprocating (positive displacement) compressor
b. Rotary (positive displacement) compressor
c. Centrifugal compressor
d. Axial compressor

64. Acoustic velocity in an elastic gaseous medium is proportional to

a. Absolute temperature
b. Stagnation temperature
c. Square root of absolute temperature
d. Square root of stagnation temperature

65. In a regenerative feed heating cycle, the economic number of the stages of regeneration

a. increases as the initial pressure and temperature increase
b. decreases as the initial pressure and temperature increase
c. is independent of the initial pressure and temperature
d. depends only on the condenser pressure

66. Match List I (Blades) with List II (Features) and select the correct answer :

List I

A. Ceramic blades
B. Steam turbine blades
C. Alloy steel blades
D. Compressor blades

List II

1. High creep strength
2. Forged and machined
3. Precision cast
4. Thick at mid chord
5. Thin trailing edge

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

67. Assertion (A) : Throttling process for real gases at initial temperature higher than maximum inversion temperature is accompanied by decrease in temperature of the gas.

Reason (R) : Joule-Kelvin coefficient μ_J is given by $(\partial T/\partial p)_h$ and should have a positive value for decrease in temperature during throttling process.

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

68. Assertion (A) : An ideal regenerative Ranking cycle power plant with saturated steam at the inlet to the turbine has same thermal efficiency as Carnot cycle working between the same temperature limits.

Reason (R) : The change in entropy of steam during expansion in the turbine is equal to the change in entropy of the feed water during sensible heating at steam generator pressure.

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

69. Assertion (A) : Octane number is used for rating of fuels in spark ignition engine.

Reason (R) : Octane number of a fuel is defined as percentage by volume, of iso-octane in a mixture of iso-octane and α-methyl naphthalene.

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

70. Assertion (A) : Power generated by a four stroke engine working on Otto cycle is higher than the power generated by a two stroke engine for the same swept volume, speed, temperature and pressure conditions.

Reason (R) : In a four stroke engine one cycle is completed in two revolutions.

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

71. Assertion (A) : A counter flow heat exchanger is thermodynamically more efficient than the parallel flow type

Reason (R) : A counter flow heat ex changer has a lower LMTD for the same temperature conditions.

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

72. Assertion (A) : If the heat flux in pool boiling over a horizontal surface is increased above the critical heat flux, the temperature difference between the surface and liquid decreases sharply.

Reason (R) : With increasing heat flux beyond the value corresponding to the critical heat flux, a stage is reached when the rate of formation of bubbles is so high that they start to coalesce and blanket the surface with a vapour film.

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

73. Assertion (A) : Decrease of pressure and increase of temperature of the refrigerant in the suction pipeline connecting the evaporator to the reciprocating compressor reduces the refrigerating capacity of the system.

Reason (R) : Decrease of pressure and increase of temperature of the refrigerant in the suction pipeline connecting the evaporator to the compressor reduces the volumetric efficiency of the reciprocating compressor.

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

74. Assertion (A) : For a vertically immersed surface, the depth of the centre of pressure is independent of the density of the liquid.

Reason (R) : Centre of pressure lies above the centre of area of the immersed surface.

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

75. Assertion (A) : Streamlines can cross one another if the fluid has higher velocity.

Reason (R) : At sufficiently high velocity, the Reynolds number is high and at sufficiently high Reynolds numbers, the structure of the flow is of turbulent type.

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

76. Assertion (A) : After the fluid has re-established its flow pattern downstream of an orifice plate, it will return to same pressure that it had upstream of the orifice plate.

Reason (R) : Bernoulli's equation when applied between two points having the same elevation and same velocity gives the same pressure at these points.

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

77. Assertion (A) : Aircraft wings are, slotted to control separation of boundary layer especially at large angles of attack.

Reason (R) : This helps to increase the lift and the aircraft can take off from, and land on, short runways.

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

78. Assertion (A) : Reynolds number must be same for the model, and prototype immersed in subsonic flows.

Reason (R) : Equality of Reynolds number for the model and prototype satisfies the dynamic similarity criteria.

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

79. Assertion (A) : A normal shock always makes a supersonic flow of a compressible fluid subsonic, but an oblique shock may not ensure subsonic flow after the shock.

Reason (R) : A normal shock reduces the stagnation pressure and stagnation enthalpy considerably whereas the loss at oblique shock is minimized.

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

80. Assertion (A) : Multi-stage centrifugal pumps are only of the radial flow type.

Reason (R) : In a multi-stage centrifugal pump, two or more impellers are keyed to a single shaft and enclosed in the same casing, the radial inlet to successive impellers being made through guide vanes.

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

81. Assertion (A) : Large reaction turbines have higher overall efficiency than the small reaction turbines.

Reason (R) : The mechanical efficiency of small reaction turbines is higher than that of larger ones.

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

82. Assertion (A) : Impulse staging is commonly employed in high pressure part and reaction staging in intermediate low pressure parts of the steam turbine.

Reason (R) : The tip leakage across moving blades is less in impulse staging as the pressure drop is small and there can be large pressure drop across fixed blades and nozzles.

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

83. Assertion (A) : In constant pressure type gas turbines, large quantity of air is used, in excess of its combustion requirements.

Reason (R) : Excess air is used to compensate for inevitable air-loss due to leakages in the system.

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

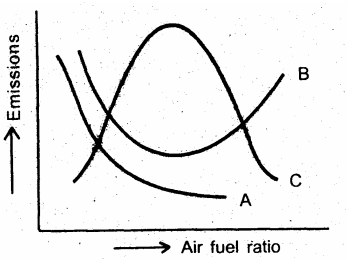
84. A heat, pump for domestic heating operates between a cold system at 0°C and the hot system at 60°C. What is the minimum electric power consumption if the heat rejected is 80000 kJ/hr?
a. 2 kW
b. 3 kW
c. 4 kW
d. 5 kW

85. A Carnot refrigerator requires 1.5 kW/ton of refrigeration to maintain a region at a temperature of –30°C. The C.O.P. of the Carnot refrigerator is
a. 1.42
b. 2.33
c. 2.87
d. 3.26

86. In a standard dual air cycle, for a fixed amount of heat supplied and a fixed value of compression ratio, the mean effective pressure
a. Shall increase with increase in r_p (pressure ratio for constant volume heating) and decrease in r_c (constant pressure cut-off ratio)
b. Shall increase with decrease in r_p and increase in r_c
c. Shall remain independent of r_p
d. Shall remain independent of r_c

87. Bomb calorimeter is used to determine the calorific value of
a. Solid fuel only
b. Gaseous fuels only
c. Solid as well. as gaseous fuels
d. Solids as well as liquid fuels

88.



Exhaust emissions vs. Air fuel ratio curves for a petrol engine are shown in the above figure. The curve C represents
a. Hydro carbon
b. Carbon dioxide
c. Carbon monoxide
d. Oxides of nitrogen

89. Orsat apparatus is used to determine products of
a. All constituents of fuel combustion by mass
b. All constituents of fuel combustion by volume
c. Only dry constituents of combustion by mass
d. Only dry constituents of combustion by volume

90. Match List (Measuring Appliances) with List II (Properties/Composition of Fuel) and select the correct answer :

List I

A. Hydrometer
B. Bomb calorimeter
C. Reid bomb
D. Orsat apparatus

List II

1. Vapour pressure
2. Composition of products combustion
3. Specific gravity
4. Heating value

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

91. For a simple closed system of constant composition, the. difference between the net heat and work interactions is identifiable as the change in
a. Enthalpy
b. Entropy
c. Flow energy
d. Internal energy

92. If the performance of diesel engines of different sizes, cylinder dimensions and power ratings are to be compared, which of the following parameters can be used for such comparison ?

a. Swept volume
b. Air fuel ratio
c. Specific brake fuel consumption
d. Volumetric efficiency

93. The propulsive efficiency of a turbojet aircraft approaches 100% when the thrust approaches
a. Maximum
b. 50% of the maximum
c. 25% of the maximum
d. Zero

94. Identify the process for which the two integrals $\int pdv$ and $-\int vdp$, evaluated between any two given states give the same value
a. Isenthalpic
b. Isothermal
c. Isentropic
d. Polytropic

95. Which one of the following phenomenon occurs when gas in a piston-in-cylinder assembly expands reversibly at constant pressure?
a. Heat is added to the gas
b. Heat is removed from the gas
c. Gas does work from its own stored energy
d. Gas undergoes adiabatic expansion

96. During steady flow compression process of a gas with mass flow rate of 2 kg/s, increase in specific enthalpy is 15 kJ/kg and decrease in kinetic energy is 2 kJ/kg. The rate of heat rejection to the environment is 3 kW. The power needed to drive the compressor is
a. 23 kW
b. 26 kW
c. 29 kW
d. 37 kW

97. Consider the following statements :
1. Zeroth law of thermodynamics is related to temperature.
2. Entropy is related to first law of thermodynamics.
3. Internal energy of an ideal gas is a function of temperature and pressure.
4. van der Waal's' equation is related to an ideal gas.

Which of the above statements is/are correct ?
a. 1 only
b. 2, 3 and 4
c. 1 and 3
d. 2 and 4

98. Gas contained in a closed system consisting of piston cylinder arrangement is expanded. Work done by the gas during expansion is 50 kJ. Decrease in internal energy of the gas during expansion is 30 kJ. Heat transfer during the process is equal to
a. – 20 kJ
b. + 20 kJ
c. – 80 kJ
d. + 80 kJ

99. Van der Waals' equation of state is given by $(p + a/v^2)(v - b) = RT$. The constant b in the equation in terms of specific volume at critical point v_c is equal to
a. $v_c/3$
b. 2 v
c. 3 v
d. $8a / (27 v_c R)$

100. Saturated liquid at a high pressure p1 having enthalpy of saturated liquid 1000 kJ/kg is throttled to a lower pressure p_2. At pressure p_2 enthalpy of saturated liquid and that of the saturated vapour are 800 and 2800 kJ/kg respectively. The dryness fraction of vapour after throttling process is
a. 0.1
b. 0.5
c. 18/28
d. 0.8

101. Match List I (Terms) with List II (Relations) arid select the correct answer :

List I

A. Specific heat at constant volume C_v
B. Isothermal compressibility k_T
C. Volume expansivity β
D. Difference between specific heats at constant pressure and at constant volume, $C_p - C_v$

List II

1. $1/v(\partial v/\partial T)_p$
2. $T(\partial p/\partial T)_v(\partial v/\partial T)_p$

3. $T\left(\partial s / \partial T\right)_v$
4. $-1/v\left(\partial v / \partial p\right)_T$

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

102. Consider the following statements pertaining to the features of a regenerative steam cycle plant as compared to a non-regenerative plant:
1. It increases the cycle efficiency.
2. It requires a bigger boiler.
3. It requires a smaller condenser.

Which of the above statements are correct?
a. 1, 2 and 3
b. 1 and 2
c. 2 and 3
d. 1 and 3

103. For a steady flow process from state 1 to 2, enthalpy changes from h_1 = 400 kJ/kg to h_2 = 100 kJ/kg and entropy changes from s_1 = 1.1 kJ/kg-K to s_2 = 0.7 kJ/kg-K.

Surrounding environmental temperature is 300K. Neglect changes in kinetic and potential energy. The change in availability of the system is
a. 420 kJ/kg
b. 300 kJ/kg
c. 180 kJ/kg
d. 90 kJ/kg

104. For a heat engine operating on the Carnot cycle, the work output is 1/4th of the heat transferred to the sink. The efficiency of the engine is
a. 20%
b. 33.3%
c. 40%
d. 50%

105. Consider the following statements about modification in a gas turbine power plant working on a simple Brayton cycle
1. Incorporation of regeneration process increases specific work output as well as thermal efficiency.
2. Incorporation of regeneration process increases thermal efficiency but specific work putput remains uncharged.
3. Incorporation of intercooling process in a multi-stage compression system increases specific work output but the heat input also increases.
4. Incorporation of intercooling process in a multi-stage compression system increases specific work putput, the heat addition remains uncharged.

Which of the above statements are correct?
a. 1 and 3
b. 1 and 4
c. 2 and 3
d. 2 and 4

106. Match List I with List II and select the correct answer using the codes given below the Lists :

List I

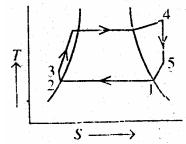
A. Bell Coleman cycle
B. Stirling cycle
C. Ericsson cycle
D. Diesel cycle

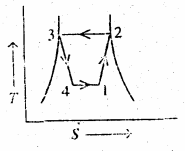
List II

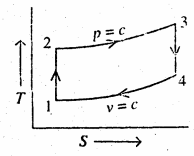
1. One constant pressure, one constant volume and two isentropic
2. Two constant pressure and two isentropic
3. Two constant pressure and two isothermal
4. Two constant volume and two isothermal

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

107.

1. 

2. 

3. 

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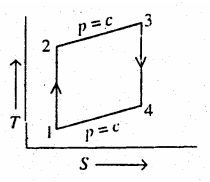


The correct sequence of the cycles given in the above T-S diagrams is

a. Vapour compression refrigeration, Rankine, Diesel, Otto
b. Rankine, Vapour compression refrigeration, Diesel, Brayton
c. Rankine, Carnot, Otto, Brayton
d. Vapour compression refrigeration, Carnot, Diesel, Otto

108. The absolute jet exit velocity from a jet engine is 2800 m/s and the forward flight velocity is 1400 m/s. The propulsive efficiency is

a. 33.33%
b. 40%
c. 66.67%
d. 90%

109. The efficiency of jet engine is

a. higher at high speeds
b. lower at low speeds
c. higher at high altitudes
d. same at all altitudes

110. A metal rod of 2cm diameter has a conductivity of 40 W/m K, which is to be insulated with an insulating material of conductivity of 0.1 W/m K. If the convective heat transfer coefficient with the ambient atmosphere is 5 W/m^2 K, the critical thickness of insulation will be

a. 1 cm
b. 2 cm
c. 7 cm
d. 8 cm

111. Match List I(Process) with List II (Predominant Parameter Association With the Process) and select the correct answer using the codes given below the Lists:

List I

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

List II

1. Reynolds Number
2. Sherwood Number
3. Match Number
4. Biot Number
5. Grashoff Number

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

112. The velocity and temperature distribution in a pipe flow are given by u(r) and T(r). If u_m is the mean velocity at any section of the pipe, the bulk mean temperature at that section is

a. $\int_0^{r_0} u(r)T(r)r^2dr$

b. $\int_0^{r_0} \frac{u(r)}{3r}\frac{T(r)}{2r}dr$

c. $\int_0^{r_0} \frac{u(r)T(r)dr}{2\pi r_0^3}$

d. $\frac{2}{u_m r_0^2}\int_0^{r_0} u(r)(T_r)rdr$

113. For fully-developed turbulent flow in a pipe with heating, the Nusselt number Nu, varies with Reynolds number Re and Prandtl number Pr as

a. $R_e^{0.5}\ P_r^{1/3}$
b. $R_e^{0.8}\ P_r^{0.2}$
c. $R_e^{0.8}\ P_r^{0.4}$
d. $R_e^{0.8}\ P_r^{0.3}$

114. Consider the following statements in respect of automobile engine with thermosyphon cooling

1. Heat transfer from gases to cylinder walls takes place by convection and radiation.
2. Most of the heat transfer from radiator to atmosphere takes place by radiation.
3. Most amount of heat transfer from radiator to atmosphere takes place by convection.
4. Heat transfer from cylinder waits takes place by conduction and convection.

Which of the above statements are correct?

a. 1, 2 and 4
b. 1, 3 and 4
c. 2, 3 and 4

d. 1 and 2

115. A body at 500 K cools by radiating heat to ambient atmosphere maintained at 300 K. When the body has cooled to 400 K, the cooling rate as a percentage of original cooling rate is about

a. 31.1
b. 41.5
c. 50.3
d. 80.4

116. Fraction of radiative energy leaving one surface that strikes the other surface is called

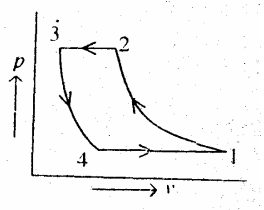
a. Radiative flux
b. Emissive power of the first surface
c. View factor
d. Re-radiation flux

117. A finned surface consists of root or base area of 1 m^2 and fin surface area of 2 m^2. The average heat transfer coefficient for finned surface is 20 W/m^2 K. Effectiveness of fins provided is 0.75. If finned surface with root or base temperature of 50°C is transferring heat to a fluid at 50°C, then rate of heat transfer is

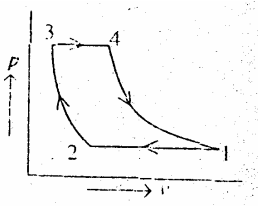
a. 400 W
b. 800 W
c. 1000 W
d. 1200 W

118. Which one of the following is the p-v diagram for air refrigeration cycle?

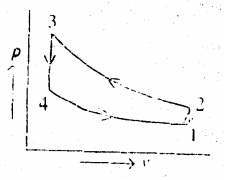
a.



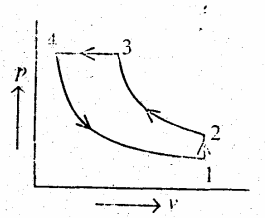
b.



c.



d.



119. Match List I (Process) with List II (Type) for Bell Coleman or Joule or Reverse Brayton cycle for gas cycle refrigeration and select the correct answer:

List I

A. Compression
B. Heat rejection
C. Expansion
D. Heat absorption

List II

1. Isobaric
2. Isothermal
3. Isentropic.
4. Isenthalpic

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

120. Consider the following statements in respect of absorption refrigeration and vapour compression refrigeration systems :

1. The former runs on low grade energy.
2. The pumping work in the former is negligible since specific volume of strong liquid solution is small.
3. The latter uses an absorber while former uses a generator
4. The liquid pump alone replaces compressor of the latter.

Which of these statements are correct?

a. 1 and 2
b. 1 and 3
c. 1 and 4
d. 2 and 4