MECHANICAL ENGINEERING

PAPER-I

1. A rectangular tank of square cross-section is having its height equal to twice the length of any side at the base If the tank is filled up with a liquid, the ratio of the total hydrostatic force on any vertical wall to that at the bottom is
   a. 2.0
   b. 1.5
   c. 1.0
   d. 0.5

2. Differential pressure head measured by mercury oil differential manometer (specific gravity of oil is 0.9) equivalent to a 600 mm difference of mercury levels will nearly be
   a. 7.62 m of oil
   b. 76.2 m of oil
   c. 7.34 m of oil
   d. 8.47 m of oil

3. A block of aluminium having mass of 12 kg is suspended by a wire and lowered until submerged into a tank containing oil of relative density 0.8. Taking the relative density of aluminium as 2 : 4, the tension in the wire will be (take g = 10 m/s^2)
   a. 12000 N
   b. 800 N
   c. 120 N
   d. 80 N

4. A barge 30 m long and 10 m wide has a draft of 3 m when floating with its sides in vertical position. If its centre of gravity is 2.5 m above the bottom, the nearest value of metacentric height is
   a. 328 m
   b. 2.78 m
   c. 1.78 m
   d. zero

5. A cylindrical vessel having its height equal to its diameter is filled with liquid and moved horizontality at an acceleration equal to acceleration due to gravity. The ratio of the liquid left in the vessel to the liquid at static equilibrium condition is
   a. 0.2
   b. 0.4
   c. 0.5
   d. 0.75

6. The shear stress developed in a lubricating oil, of viscosity 9.81 poise, filled between two parallel plates 1 cm part and moving with relative velocity of 2 m/s is
   a. 20 N/m^2
   b. 19.62 N/m^2
   c. 29.62 N/m^2
   d. 40 N/m^2

7. The convective acceleration of fluid in the x-direction is given by
   a. $u\frac{\partial u}{\partial x}+v\frac{\partial v}{\partial y}+\omega\frac{\partial \omega}{\partial z}$
   b. $\frac{\partial u}{\partial t}+\frac{\partial v}{\partial t}+\frac{\partial \omega}{\partial t}$
   c. $u\frac{\partial u}{\partial x}+u\frac{\partial v}{\partial y}+u\frac{\partial \omega}{\partial z}$
   d. $u\frac{\partial u}{\partial x}+v\frac{\partial v}{\partial y}+\omega\frac{\partial u}{\partial z}$

8. Match List I (Types of flow) with List II (Basic ideal flows) and select the. correct answer :

   List I

   A. Flow over a stationary cylinder
   B. Flow over a half Rankine body
   C. Flow over a rotating body
   D. Flow over a Rankine oval

   List II

   1. source + sink + uniform flow
   2. doublet + uniform flow
   3. source + uniform flow
   4. doublet + free vortex + uniform flow

	A	B	C	D
a.	1	4	3	2

b. 2 4 3 1

c. 1 3 4 2

d. 2 3 4 1

9. A glass tube with a 90° bend is open at both the ends. It is inserted into a flowing stream of oil, S = 0.90, so that one opening is directed upstream and the other is directed upward. Oil inside the tube is 50 mm higher than the surface of flowing nil. The velocity measured by the tube is, nearly,

a. 0.89 m/s

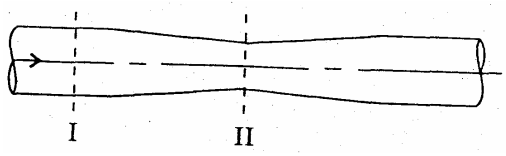
b. 0.99 m/s

c. 1.40 m/s

d. 1.90 m/s

10. At location-I of a horizontal line, the fluid pressure head is 32 cm and velocity head is 4 cm. The reduction in area at location II is such that the pressure head drops down to zero.

The ratio of velocities at location-II to that at location-I is



a. 3

b. 2.5

c. 2

d. 1.5

11. For maximum transmission of power through a pipe line with total head H, the head lost due to friction h_f is given by

a. 0.1 H

b. H/3

c. H/2

d. 2H/3

12. Two pipelines of equal length and with diameters of 15 cm and 10 cm are in parallel and connect two reservoirs. The difference in water levels in the reservoirs is 3 m. If the friction is assumed to be equal, the ratio of the discharges due to the larger dia pipe to that of the smaller dia pipe is, nearly,

a. 3.375

b. 2.756

c. 2.25

d. 1.5

13. The critical depth of a rectangular channel of width 4.0 m for a discharge of 12 m^3/s is, nearly,

a. 300 mm

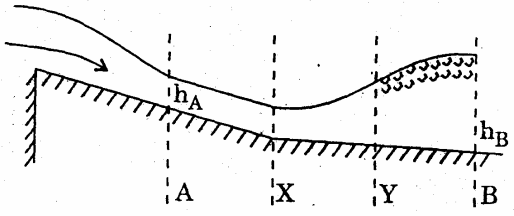
b. 30 mm

c. 0.972 m

d. 0.674 m

14. An open channel flow encounters a hydraulic jump as shown in the figure. The following fluid flow conditions are observed between A and B :

1. Critical depth
2. Steady non-uniform flow
3. Unsteady non-uniform flow
4. Steady uniform flow



The correct sequence of the flow conditions in the direction of flow is

a. 1, 2, 3, 4

b. 1, 4, 2, 3

c. 2, 1, 4, 3

d. 4, 2, 3, 1

15. Laminar developed flow at an average velocity of 5 m/s occurs in a pipe of 10 cm radius. The velocity at 5 cm radius is

a. 7.5 m/s

b. 10 m/s

c. 2.5 m/s

d. 5 m/s

16. In a fully-developed turbulent pipe flow, assuming 1/7th power law, the ratio of time mean. velocity at the centre of the pipe to that average velocity of the flow is

a. 2.0

b. 1.5

c. 1.22

d. 0.817

17. The pressure drop in a 100 mm diameter horizontal pipe is 50 kPa over a length of 10 m. The shear stress at the pipe wall is

a. 0.25 kPa

b. 0.125 kPa

c. 0.50 kPa

d. 25.0 kPa

18. The velocity distribution in the boundary layer is given as $u/u_s = y/\delta$, where u is the velocity at a distance y from the boundary u_s is the free stream velocity and δ is the boundary layer thickness at a certain distance from the leading edge of a plate. The ratio of displacement to momentum thicknesses is

a. 5

b. 4

c. 3

d. 2

19. For the velocity profile $u / u_\infty = \eta$, the momentum thickness of a laminar boundary layer on a flat plate at a distance of 1 m from leading edge for air (kinematic viscosity = 2×10^{-5} m^2/s) flowing at a free stream velocity of 2 m/s is given by

a. 3.16 mm

b. 2.1 mm

c. 3.16 m

d. 2.1 m

20. According to Blasius law, the local skin friction coefficient in the boundary-layer over a flat plate is given by

a. $0.332/\sqrt{R_e}$

b. $0.664/\sqrt{R_e}$

c. $0.647/\sqrt{R_e}$

d. $1.328/\sqrt{R_e}$

21. Match List I with List II and select the correct answer :

List I

A. Stokes' law

B. Bluff body

C. Streamline body

D. Karman Vortex Street

List II

1. Strouhal number
2. Creeping motion
3. Pressure drag
4. Skin friction drag

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

22. Match List I (Dimensionless numbers) with List II (Definition as the ratio of) and select the correct answer :

List I

A. Reynolds number

B. Froude number

C. Weber number

D. Mach number

List II

1. Inertia force and elastic force
2. Inertia force and surface tension force
3. Inertia force and gravity force
4. Inertia force and viscous force

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

23. The stream function in a 2-dimensional flow field is given by $\psi = xy$.

The potential function is

a. $\frac{\left(x^2 + y^2\right)}{2}$

b. $\frac{\left(x^2 - y^2\right)}{2}$

c. xy

d. $x^2y + y^2x$

24. Assertion (A): A convergent-divergent nozzle may give supersonic or subsonic flow at the exit even if the throat is choked.

Reason (R): Depending on the back pressure ratio P_b/P_o, the divergent part of the nozzle may act as a supersonic nozzle or a subsonic diffuser.

a. Both A and R are true and R is the correct explanation of A

b. Both A. and R are 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

25. Assertion (A) : In a pipe line, the nature of the fluid flow depends entirely on the velocity.

Reason (R) : Reynolds number depends on the velocity, diameter of the pipe and kinematic viscosity of the fluid.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

26. A capillary tube is inserted in mercury kept in an open container.

Assertion (A) : The mercury level inside the tube shall rise above the level of mercury outside.

Reason (R) : The cohesive force between the molecules of mercury is greater than the adhesive force between mercury and glass.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

27. Assertion (A) : Reaction blading is commonly used in intermediate and low pressure parts of steam turbines.

Reason (R) : Reaction blading gives higher efficiency than impulse blading.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

28. Assertion (A) : In conventional impulse steam turbine designs, only two rows of moving blades are used in a Curtis stage.

Reason (R) : As the number of rows of moving blades in a Curtis stage increases, the effectiveness of the later rows decreases.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

29. Assertion (A) : With throttle governing of a steam turbine, the turbine power is reduced by reduction in the available heat drop together with decrease in the rate of steal flow.

Reason (R) : The pressure and the rate of steam flow are simultaneously decreased with the help of a throttle valve.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

30. Assertion (A) : A Kaplan turbine is an axial flow reaction turbine with its vanes fixed to the hub.

Reason (R) : Water flows parallel to the axis of rotation of the turbine and a part of the pressure energy gets converted to kinetic energy during its flow through the vanes.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

31. Assertion (A) : Effective temperature, an index of comfort, is defined as that temperature of saturated air at which one would experience the same feeling of comfort as experienced in the actual environment.

Reason (R) : Comfort does not depend on humidity and air velocity.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

32. Assertion (A) : According to Reynolds analogy for Prandtl number equal to unity, Stanton number is equal to one half of the friction factor.

Reason (R) : If thermal diffusivity is equal to kinematic viscosity, the velocity and the

temperature distribution in the flow will be the same.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

33. Assertion (A) : Nusselt number is always greater than unity.

Reason (R) : Nusselt number is the ratio of two thermal resistances, one the thermal resistance which would be offered by the fluid, if it was stationary and the other, the thermal resistance associated with convective heat transfer coefficient at the surface.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

34. Assertion (A) : If the enthalpy of a closed system decreased by 25 kJ while the system receives 30 kJ of energy by heat transfer, the work done by the system is 55 kJ.

Reason (R) : The first law energy balance for a closed system is (notations have their usual meaning).

$$\Delta E = Q - W.$$

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

35. Assertion (A) : In thermodynamic analysis, the concept of reversibility is that a reversible process is the most efficient process.

Reason (R) : The energy transfer as heat and work during the forward process, is always identically equal to the energy transfer as heat and work, during the reversal of the process.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

36. Assertion (A) : Pressurized water reactor (PWR) nuclear power plants use superheated steam.

Reason (R) : An increase in the superheat at constant pressure increases the cycle efficiency.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

37. Assertion (A) : The air standard air efficiency of the diesel cycle decreases as the load, is increased.

Reason (R) : With increase of load, cut-off ratio increases.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

38. Assertion (A) : Knocking in S.I. engines is due to auto-ignition of the end charge while knocking in C.I. engines is due to auto-ignition of the first charge.

Reason (R) : Spark ignition engines employ lower compression ratio than diesel engines and the fuel used has a calorific value lower than that of diesel oil.

a. Both A and R are true and R is the correct explanation of A
b. Both A and R are 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

39. Assertion (A) : The C.I. engine is found to be more efficient than an S.1. engine.

Reason (R) : Modern C.I. engines operate on a dual-cycle, which has an efficiency greater than the Otto cycle.

a. Both A and R are true and R is the correct explanation of A

b. Both A and R are 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

40. A ship with hull length of 100 m is to run with a speed of 10 m/s. For dynamic similarity, the velocity for a 1 : 25 model of the ship in a towing tank should be

a. 2 m/s

b. 10 m/s

c. 20 m/s

d. 25 m/s

41. A standard 90^0 V-notch weir is used to measure discharge. The discharge is Q_1 for a height H_1 above the sill and Q_2 is the discharge for a height H_2. If H_2/H_1 is 4, then Q_2/Q_1 is

a. 32

b. $16\sqrt{2}$

c. 16

d. 8

42. A right circular cylinder is filled with a liquid upto its top level. It is rotated about its vertical axis at such a speed that half the liquid spills out, then the pressure at the point of intersection of the axis and bottom surface is

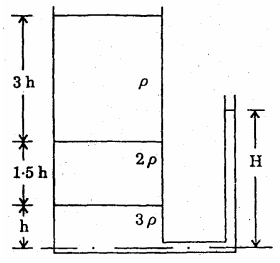
a. same as before rotation

b. half of the value before rotation.

c. quarter of the value before. rotation

d. equal to the atmospheric pressure.

43. Three immiscible liquids of specific densities ρ, 2ρ and 3ρ are kept in a jar. The-height of the liquids in the jar and at the piezometer fitted to the bottom of the jar are as shown in the given figure. The ratio H/h is



a. 4

b. 3.5

c. 3

d. 2.5

44. Which one of the following sequences indicates the correct order for flue gas flow in the steam power plant layout?

a. superheater, economiser, air preheater

b. economiser, air preheater, superheater

c. air preheater, economiser, superheater

d. economiser, superheater, air preheater

45. Which one of the following statements is not correct?

In a fluidized-bed boiler

a. the combustion temperatures are higher than those in the conventional boilers

b. inferior grade of coal can be used without slagging problems

c. the formation of NO_X is less than that in the conventional boilers

d. the volumetric heat release rates are higher than those in the conventional boilers

46. Match list I with list II and select the correct answer:

List I (Machines)

A. Steam engine

B. Impulse turbine

C. Reaction turbine V

D. Centrifugal compressor

List II (Features)

1. Velocity compounding
2. Diagram factor
3. Continuous pressure drop
4. Isentropic efficiency

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

47. Match List I with List II and select the correct answer :

List I (Names)

A. Subsonic nozzle

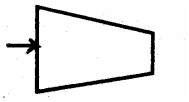
B. Supersonic nozzle

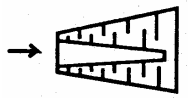
C. Subsonic diffuser

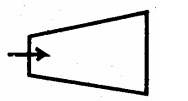
D. Centrifugal compressor

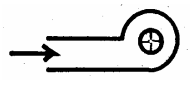
List II (Figures)

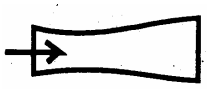
1.

2. 

3. 

4. 

5. 



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

48. For maximum blade efficiency of a single-stage impulse turbine, the blade speed ratio, (α is the angle made by absolute velocity at inlet) should be

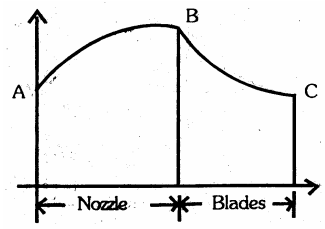
a. $\cos 2\alpha$

b. $\cos 2\alpha / 2$

c. $\cos \alpha / 2$

d. $2 / \cos \alpha$

49. The given figure shows the variation of certain steam parameter in case of a simple impulse turbine. The curve A-B-C represents the variation of



a. pressure in nozzle and blades

b. velocity in nozzle and blades

c. temperature in nozzle and blades

d. enthalpy in nozzle and blades

50. If n is the polytrophic index of compression and p_2/p_1 is the pressure ratio for a three-stage compressor with ideal intercooling, the expression for total work of three stage is

a. $\frac{3n}{(n-1)} p_1 v_1 \left\{ \left(\frac{p_2}{p_1} \right)^{\frac{(n-1)}{n}} - 1 \right\}$

b. $\frac{n}{(n-1)} p_1 v_1 \left\{ \left(\frac{p_2}{p_1} \right)^{\frac{(n-1)}{3n}} - 1 \right\}$

c. $\frac{n}{(n-1)} p_1 v_1 \left\{ \left(\frac{p_2}{p_1} \right)^{\frac{(n-1)}{n}} - 1 \right\}$

d. $\frac{3n}{(n-1)} p_1 v_1 \left\{ \left(\frac{p_2}{p_1} \right)^{\frac{(n-1)}{3n}} - 1 \right\}$

51. The flaw in the vaneless space between the impeller exits a diffuser inlet of a centrifugal compressor can be assumed as

a. free vortex

b. force vortex

c. solid body rotation

d. logarithmic spiral

52. Which of the following statement(s) is/are relevant to critical flow through a steam nozzle?

1. Flow rate through the nozzle is minimum
2. Flow rate through the nozzle is maximum
3. Velocity at the throat is supersonic.
4. Velocity at the throat is sonic.

Select the correct answer using the codes given below :

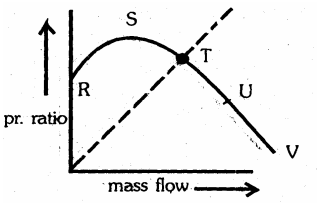
a. 1 alone

b. 1 and 3

c. 2 and 4

d. 4 alone

53. Which portion of the centrifugal compressor characteristics shown in the figure is difficult to obtain experimentally?



a. RS
b. ST
c. TU
d. UV

54. Consider the following statements regarding the axial flow in an air compressor :
1. Surging is a local phenomenon while stalling affects the entire compressor.
2. Stalling is a local phenomenon while surging affects the entire compressor.
3. The pressure ratio of an axial compressor stage is smaller than that of a centrifugal compressor stage.

Of these statements
a. 1, 2 and correct
b. 1 and 2 are correct
c. 2 and 3 are correct
d. 1 and 3 are correct

55. The thermal efficiency of a gas turbine cycle with regeneration in terms of T_3 (maximum minimum), temperature), r_p (pressure ratio and k (= C_p/C_v) is given by

a. $1-\frac{T_1}{T_3}r_p^{\left(\frac{k}{k-1}\right)}$

b. $1-\frac{T_3}{T_1}r_p^{\left(\frac{k}{k-1}\right)}$

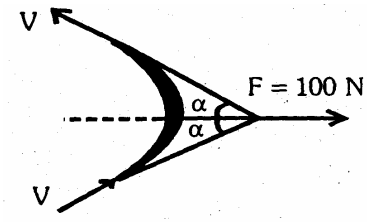
c. $1-\frac{T_3}{T_1}r_p^{\left(\frac{k-1}{k}\right)}$

d. $1-\frac{T_1}{T_3}r_p^{\left(\frac{k-1}{k}\right)}$

56. Consider the specific speed ranges of the following types of turbines :
1. Francis
2. Kaplan
3. Pelton

The sequence of their specific speed in increasing order is
a. 1, 2, 3
b. 3, 1, 2
c. 3, 2, 1
d. 2, 3, 1

57. A symmetrical stationary vane experiences a force 'F' of 100 N as shown in the given figure, when the mass flow rate of water over the vane is 5 kg/s with a velocity 'V' 20 m/s without friction. The angle 'α' of the vane is



a. Zero
b. 30^o
c. 45^o
d. 60^o

58. In a fluid coupling, the torque transmitted is 50 kNm, when the speed of the driving and driven shaft is 900 rpm and 720 rpm respectively. The efficiency of the fluid coupling will be
a. 20%
b. 25%
c. 80%
d. 90%

59. Consider the following statements regarding the fluid coupling :
1. Efficiency increases with increase in speed ratio.
2. Neglecting friction the output torque is equal to input torque.
3. At the same input speed, higher slip requires higher input torque.

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

60. The level of runner exit is 5 m above the tail race, and atmospheric pressure is 10.3m. The pressure at the exit of the runner for a divergent draft tube can be
a. 5 m
b. 5.3 m
c. 10 m
d. 10.3 m

61. Consider the following statements:

A surge tank provided on the penstock connected to a water turbine
1. helps in reducing the water hammer.
2. stores extra water when not needed.

3. provides increased demand of water.

Which of these statements are correct?

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

62. If the reciprocating pump having a mechanical efficiency of 80% delivers water at the rate of 80 kg/s with a head of 30 m, the brake power of the pump is

a. 29.4 kW
b. 20.8 kW
c. 15.4 kW
d. 10.8 kW

63. The gross head on a turbine is 300 m. The length of penstock supplying water from reservoir to the turbine is 400 m. The diameter of the penstock is 1 m and velocity of water through penstock is 5 m/s. If coefficient of friction is 0.0098, the net head on the turbine would be, nearly

a. 310 m
b. 295m
c. 200 m
d. 150 m

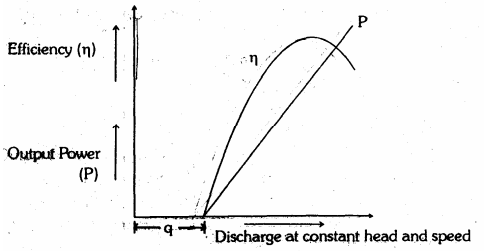
64. Consider the following statements pertaining to a centrifugal pump :

1. The manometric head is the head is developed by the pump.
2. The suction pipe has, generally, a larger diameter as compared to the discharge pipe.
3. The suction pipe is provided with a foot valve and a strainer.
4. The delivery pipe is provided with a foot valve and a strainer.

Of these statements

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

65. For a water turbine, running at constant head and speed, the operating characteristic curves in the given figure show that upto a certain discharge 'q' both output power and efficiency remain zero. The discharge q is required to



a. overcome initial inertia
b. overcome initial friction
c. keep the hydraulic circuit full
d. keep the turbine running at no load

66. In fluid machinery the relationship between saturation temperature and pressure decides the process of

a. flow separation
b. turbulent mixing
c. cavitation
d. water hammer

67. A centrifugal blower delivering Q m^3/s against a head of H m is driven at half the original speed. The new head and discharge would be

a. H and Q/2
b. H/4 and Q/2
c. H/2 and Q/8
d. H and Q/4

68. The maximum number of jets generally employed in an impulse turbine without jet interference is

a. 4
b. 6
c. 8
d. 12

69. A hydraulic coupling transmits 1 kW of power at an input speed of 200 rpm, with a slip of 2%. If the input is changed to 400 rpm, the power transmitted with the same slip is

a. 2 kW
b. 1/2 kW
c. 4 kW
d. 8 kW

70. A plane well of thickness 2L has a uniform volumetric heat source q* (W/m^3). It is exposed to local ambient temperature T_∞ at both the ends (x = ± L). The surface temperature T_s of the wall under steady-

state condition (where h and k have their usual meaning) is given by

a. $T_s = T_\infty + \frac{q^* L}{h}$

b. $T_s = T_\infty + \frac{q^* L^2}{2k}$

c. $T_s = T_\infty + \frac{q^* L^2}{h}$

d. $T_s = T_\infty + \frac{q^* L^3}{2k}$

71. A flat plate has thickness 5 cm, thermal conductivity 1 W/(mK) convective heat transfer coefficients on its two flat faces of 10 W/(m^2K) and 20 W/(m^2K). The overall heat transfer coefficient for such a flat plate is

a. 5 W/(m^2K)

b. 6.33. W/(m^2K)

c. 20 W/(m^2K)

d. 30 W/(m^2K)

72. The efficiency of a pin fin with insulated tip is

a. $\frac{\tanh\ mL}{(hA/kP)^{0.5}}$

b. $\frac{\tanh\ mL}{mL}$

c. $\frac{mL}{\tanh mL}$

d. $\frac{(hA/kP)^{0.5}}{\tanh\ mL}$

73. A cylinder made of metal of conductivity 40 W/(mK) is to be insulated with a material of conductivity 0.1 W/(mK). If the convective heat transfer coefficient with the ambient atmosphere is 5 W/(m^2K), the critical radius of insulation is

a. 2 cm

b. 4 cm

c. 8 cm

d. 50 cm

74. Nusselt number for fully developed turbulent flow in a pipe is given by $N_u = CR_e^a : P_r^b$. The values of a and b are

a. a = 0.5 and b = 0.33 for .heating and cooling both

b. a = 0.5 and b = 0.4 for heating and b = 0.3 for cooling

c. a = 0.8 and b = 0.4 for heating and b = 0.3 for cooling

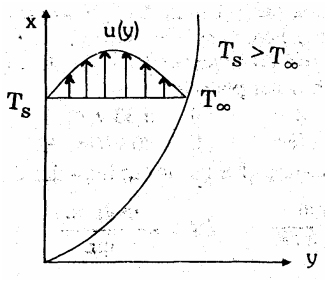
d. a = 0.8 and b = 0.3 for heating and b = 0.4 for cooling

75. For natural convective flow over a vertical flat plate as shown in the given figure, the governing differential equation for momentum is

$$\left(u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y}\right) = g\beta(T - T_\infty) + \frac{\partial^2 u}{\partial y^2}$$

If equation is non-dimentionalized by U = u/U_∞ , V = v/U_∞, X = x/L, y = y/L, y/L and $\theta = \frac{T - T_\infty}{T_s - T_\infty}$

Then the term $g\beta(T - T_\infty)$ to



a. Grashof number

b. Prandtl number

c. Rayleight number

d. Grashof number/(Reynolds number)^2

76. The shape factor of a hemispherical body placed on a flat surface with respect to itself is

a. zero

b. 0.25

c. 0.5

d. 1.0

77. Which one of the following heat exchanges is gives parallel straight line pattern of temperature distribution for both cold and hot fluid?

a. Parallel flow with unequal heat capacities

b. Counter-flow with equal heat capacities

c. Parallel-flow with equal heat capacities

d. Counter-flow with unequal heat capacities

78. In a counter-flow heat exchanger, the hot fluid is cooled from 110^0 C to 80° C by a cold fluid which, gets heated from 30° C to 60° C. LMTD for the heat exchanger is
   a. 20°C
   b. 30°C.
   c. 50°C
   d. 80°C

79. In a counter-flow heat exchanger, the product of specific heat and mass flow rate is same for the hot and cold fluids. If NTU is equal to 0.5, then the effectiveness of the heat exchanger is
   a. 1.0
   b. 0.5
   c. 0.33
   d. 0.2

80. For flow over a flat plate the hydrodynamic boundary layer thickness is 0.5 mm. The dynamic viscosity is 25×10^{-6} Pa s, specific heat is 2.0 kJ/(kg K) and thermal conductivity is 0.05 W/(m-K). The thermal boundary layer thickness would be
   a. 0.1 mm
   b. 0.5 mm
   c. 1 mm
   d. 2 mm

81. An enclosure consists of four surfaces 1, 2, 3 and 4. The view factors for radiation heat transfer (where the subscripts 1, 2, 3, 4 refer to the respective surfaces) are F_{11} = 0.1, F_{12} = 0.4 and F_{13} = 0.25. The surface areas A_1 and A_4 are $4m^2$ and 2 m^2 respectively. The view factor F_{41} is
   a. 0.75
   b. 0.50
   c. 0.25
   d. 0.10

82. The working temperature in evaporators and condenser coils of a refrigerator are -23^o C and 27^o C respectively. The COP of the refrigerator is 0.8 of the maximum COP. For a power input of 1 kW, the refrigeration effect produced will be
   a. 4 kW
   b. 5 kW
   c. 8 kW
   d. 2.5 kW

83. For a heat pump working on vapour compression cycle, enthalpy value of the working fluid at the end of heat addition process, at the end of compression process, at the end of heat rejection process, and at the end of isenthalpic expansion process are 195 kJ/kg, 210 kJ/kg and 90 kJ/kg respectively. The mass flow rate is 0.5 kg/s. Then the heating capacity of heat pump is, nearly
   a. 7.5 kW
   b. 45 kW
   c. 52.5 kW
   d. 60 kW

84. A one ton capacity water cooler cools water steadily from 35^o C to 20^o C. The specific heat of water is 4.18 kJ/(kg K). The water flow rate will be, nearly
   a. 13.33 *l* /hr
   b. 33.3 *l* /hr
   c. 200 *l*/hr
   d. 250 *l*/hr

85. Match List I (Refrigerant) with List II (Chemical constituent) and select the correct answer :

List I

A. R – 12
B. R – 22
C. R – 717
D. R – 113

List II

1. Trichlorotrifluorethane (CCl_2FCClF_2)
2. Difluoro monochloro methane (CHF_2)
3. Ammonia (NH_3)
4. Difluoro dichloro methane(CCl_2F_2)

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

86. In a cooling tower, the minimum temperature to which water can be cooled is equal to the
   a. dew point temperature of the air at the inlet
   b. dry bulb temperature of the air at the inlet

c. thermodynamic wet bulb temperature of the air at the inlet

d. mean of the dew point and dry bulb temperature of the air at the inlet

87. Match List I (Expansion device) with List II (Operation) and select the correct answer :

List I

A. Float value

B. Automatic expansion valve

C. Internally equalized thermostatic expansion valve

D. Externally equalized thermostatic expansion valve

List II

1. constant degree of superheat at evaporator exit pressure
2. Constant degree of superheat at evaporator inlet pressure
3. Constant level of refrigerant in the evaporator
4. Constant pressure in the evaporator

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

88. A solar-absorption refrigeration system has generator temperature of 87^{o} C, evaporator temperature of -3^{o} C, condenser and absorber temperature of 27^{o}C each, then its maximum possible COP is

a. 10.0

b. 9.0

c. 1.80

d. 1.50

89. Consider the following statements :

Subcooling in the condenser of a refrigeration system is advisable when

1. expansion value is at a higher elevation than condenser.
2. there is a large pressure drop in the line connecting condenser to the expansion value.
3. the refrigeration effect is to be increased.
4. the compressor work is to be reduced.

Which of these statements are correct ?

a. 1 and 2

b. 1, 3 and 4

c. 2, 3 and 4

d. 1, 2 and 3

90. Consider the following statements:

When dry bulb and thermodynamic wet bulb temperatures are same ;

1. humidity ratio is 100%.,
2. partial pressure of water vapour equals total pressure.
3. air is fully saturated.
4. dew point temperature is reached.

Select the correct statement(s) using the codes given below:

a. 3 alone

b. 1 and 2

c. 3 and 4

d. 1, 2, 3 and 4

91. If p is the partial pressure of vapour, p is the partial pressure of vapour for saturated air and P_b is the barometric pressure, the relationship between relative humidity 'ϕ' and degree of saturation 'μ' given by

a. $\mu = \phi\left[\frac{p_b - p_s}{p_b - p_v}\right]$

b. $\mu = \phi\left[\frac{p_b - p_v}{p_b - p_s}\right]$

c. $\mu = \phi\frac{p_v}{p_b}$

d. $\mu = \phi\frac{p_v}{p_s}$

92. The by-pass factor of single cooling coil in an air-conditioner is 0.7. The by-pass factor if three such cooling coils with the same apparatus dew point ate kept one behind the other, will be

a. 0.210

b. 0.292

c. 0.343

d. 0.412

93. Which one of the following statements is true for air conditioning duct design?

a. Static regain method is used when the duct work is extensive, total pressure drop is low and flow is balanced

b. Static regain method is used, when the duct work is extensive, total pressure drop is high and flow is unbalanced

c. Equal friction method is used, when the duct work is extensive, total pressure drop is low and flow is balanced

d. Equal friction method is used, when duct work is extensive, total pressure drop is low and flow is unbalanced

94. For an air-conditioned space, RTH = 100 kW, RSHF = 0.75, volume flow rate is equal to 100 m^3/minute and indoor design specific humidity is 0.01 kg/(kg of dry air). The specific humidity of supply air is

a. 0.010

b. 0.0075

c. 0.005

d. 0.0025

95. For an air-conditioning system, the outdoor and indoor design dry bulb temperatures are 45^0 C and 25° C respectively. The space to be air-conditioned is 20 m × 30 m × 5 m and infiltration is estimated to be one air change. If the density and specific heat of air are 1.2 (kg of dry air)/m^3 and 1.02 kJ/k (kg of dry air)°C, then the sensible heat load due to infiltration is, nearly

a. 122.4 kW

b. 61.2 kW

c. 12.24 kW

d. 20.4 kW

96. Match List I with List II and select the correct answer :

(h_m – mass transfer coefficient,

D – molecular diffusion coefficient,

L – characteristic length dimension,

k – thermal conductivity; ρ - density,

C_p – specific heat of constant pressure,

μ– dynamic viscosity)

List I

A. Schmidt number

B. Thermal diffusivity

C. Lewis number

D. Sherwood number

List II

1. k/ (ρ C_p D)
2. h_m L/D)
3. μ / ρ D
4. k / ρ C_p

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

97. In the operation of four stroke diesel engines, the term 'squish' refers to the

a. Injection of fuel in the precombustion chamber

b. discharge of gases from the precombustion chamber

c. entry of air. into the combustion chamber

d. stripping of fuel from the core

98. Consider the following statements regarding the advantages of fuel Injection over carburetion in S.I. engines:

1. Higher power output and increased volumetric efficiency.
2. Simple and inexpensive injection equipment.
3. Longer Ilk of injection equipment.
4. Less knocking and reduced tendency for back-fire.

Select the correct answer using the codes given below:

a. 1, 2 and 3

b. 1, 2 and 4

c. 2 and 3

d. 1 and 4

99. Match List I (Performance Parameter Y) with List II (Curves labelled 1, 2, 3, 4 and BHP vs. Y) regarding a C.I. engine run constant speed and select the correct answer:

List I

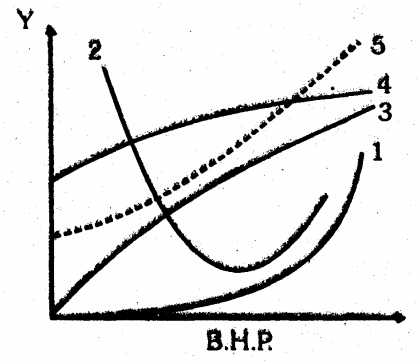
A. Total fuel consumption rate

B. Mechanical efficiency

C. Indicated power

D. Brake specific fueld consumption

List II



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

100. Match the List I with List II and select correct answer :

List I

A. Supercharging

B. Morse test

C. Heterogeneous combustion

D. Ignition quality of petrol

List II

1. Multicylinder engine
2. C. I .engine
3. Calorific value
4. Aircraft engine
5. Octane number
6. Single cylinder S.I. engine

	A	B	C	D
a.	4	1	2	5
b.	6	3	2	5
c.	6	1	5	2
d.	4	3	5	2

101. With reference to Turbojet and Rocket engines, consider the following statements:

1. Efficiency of Rocket engines is higher than that of Jet engines.
2. Exit velocities of exhaust gases in Rocket engines are much higher than those in Jet engines.
3. Stagnation conditions exist at the combustion chamber in Rocket engines.
4. Rocket engines are air-breathing engines.

Which of these statements are correct?

a. 1 and 2

b. 1, 3 and 4

c. 2, 3 and 4

d. 1, 2 and 3

102. With respect to I.C. engine emissions, consider the following statements:

1. Evaporative emissions have no carbon monoxide and oxides of nitrogen.
2. Blow by emissions are essentially carbon monoxide and suspended particulate matter.
3. Exhaust emissions contain 100% of carbon monoxide, 100% of oxides of nitrogen and around 50 - 55% of hydrocarbons emitted by the engine.
4. There are no suspended particulates in the exhaust.

Of these statements

a. 1 and 4 are correct

b. 1 and 3 are correct

c. 2 and 3 are correct

d. 1, 2, 3 and 4 are correct

103. A hydrocarbon fuel was burnt with air and the Orsat analysis of the dry products of combustion yielded the following data :

Initial volume of dry gas sample	: 100c
Volume after absorption in pipette 1 containing potassium hydroxide solution	: 89 cc
Volume after absorption in pipette 2 containing solution of pyrogallic acid and potassium hydroxide	: 84 cc
Volume after absorption in pipette 3 containing cuprous chloride solution	: 82 cc

The percentage (by volume) of CO_2 in the dry products was

a. 2%

b. 5%

c. 11%

d. 18%

104. Match list I (Material) with list II (Use) and select the correct answer:

List I

A. Graphite

B. Thorium - 233

C. Molten Sodium

D. Plutonium-239

List II

1. Coolant
2. Moderator
3. Fissionable material
4. Fissile material

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

105. The data given in the table refers to an engine based on Carnot cycle,

where Q_1 = Heat received (kJ/min)

Q_2 = Heat rejected (kJ/s)

W = Work output (kW)

S.No.	Q_1	Q_2	W
1.	1500	16.80	8.20
2.	1600	17.92	8.75
3.	1700	19.03	9.30
4.	1800	20.15	9.85

If heat received output will be, nearly by the engine is 2000 kJ/minute the work

a. 9.98

b. 10.39

c. 11.54

d. 10.95

106. A system while undergoing a cycle A – B – C – D – A has the values of heat and work transfers as given in the table:

Process	Q kJ/min	W kJ/min
A – B	+ 687	+ 474
B – C	– 269	0
C – D	– 199	– 180
D – A	+ 75	0

The power developed in kW is nearly,

a. 4.9

b. 24.5

c. 49

d. 98

107. In a new temperature scale say $^{o}\rho$, the boiling and freezing points of water at one atmosphere are 100^{o} ρ and 300^{o} ρ respectively. Correlate this scale with the Centigrade scale. The reading of 0^{o} ρ on the centigrade scale is

a. 0^{o} C

b. 50^{o} C

c. 100^{o} C

d. 150^{o} C

108. Match List I (Name of entity) with List II (Definition) and select the correct answer :

List I

A. Compressibility factor

B. Joule-Thomson coefficient

C. Constant pressure specific heat

D. Isothermal compressibility

List II

1. $-\frac{1}{v}\left(\frac{\partial v}{\partial T}\right)_p$

2. $\left(\frac{\partial h}{\partial T}\right)_p$

3. $\left(\frac{\partial T}{\partial p}\right)_h$

4. $\left(\frac{pv}{RT}\right)$

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

109. If p_a and p_v denote respectively the partial pressure of dry air and that of water vapour in moist air, the specific humidity of air is given by

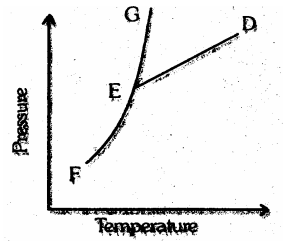
a. $\frac{p_v}{p_a + p_v}$

b. $\frac{p_v}{p_a}$

c. $\frac{0.622\,p_v}{p_a}$

d. $\frac{0.622\,p_v}{p_a + p_v}$

110. Consider the phase diagram of a certain substance as shown in the given figure. Match List I (Process) with List II (Curves/lines) and select the correct answer :



List I

A. Vaporization

B. Fusion

C. Sublimation

List II

1. FE
2. EG
3. ED

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

111. Number of components (C) , phases (P) and degrees of freedom(F) are related by Gibbs-phase rule as

a. C – P – F = 2

b. F – C – P = 2

c. C + F – P = 2

d. P + F – X = 2

112. Consider the following statements :

1. Availability is the maximum theoretical work obtainable.
2. Clapeyron's equation for dry saturation is given by

$$(V_s - V_f) = \frac{dT_s}{dQ}\left(\frac{h_s - h_f}{T_s}\right)$$

3. A gas can have any temperature at given pressure unlike a vapour which has a fixed temperature at a given pressure.
4. Joule Thomson coefficient is expressed as $\mu = [\partial s/\partial p]_h$

Of these statements

a. 1, 2 and 3 are correct

b. 1, 3 and 4 are correct

c. 2 and 3 are correct

d. 1, 2 and 4 are correct

113. Match List I with list II and select the correct answer :

List I (Cycles operating between fixed temperature limits)

A. Otto cycle

B. Diesel cycle

C. Carnot cycle

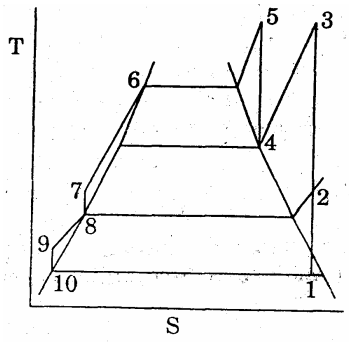
D. Brayton cycle

List II (Characteristic of cycle efficiency η)

1. η depends only upon temperature limits
2. η depends only, on pressure limits
3. η depends on volume compression ratio
4. η depends on cut-off ratio and volume compression ratio

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

114. The temperature-entropy diagram for a steam turbine power plant, operating on the Rankine cycle with reheat and regenerative feed heating is shown in the given figure. If m denotes the fraction of steam bled for feed heating, the work developed in the turbine per kg steam entering the turbine at state 5 is



a. $(h_5 - h_4) + (1 - m)(h_3 - h_1)$

b. $(h_5 - h_4) + (h_3 - h_2) + (1 - m)(h_2 - h_1)$

c. $2h_5 - h_4 - h_1 + (1 - m)(h_2 - h_1)$

d. $(h_5 - h_4) + (1 - m)(h_3 - h_2)$

115. The working temperatures in the evaporator and condenser coils of a refrigerator are –30° C and 32° C respectively. If the actual refrigerator has a C.O.P of 0.75 of the maximum, the required power input for a refrigerating effect of 5 kW, is, nearly

a. 1.7 kW
b. 2.94 kW
c. 3.92 kW
d. 4.0 kW

116. Match List I with List II and select the correct answer :

List I

A. Air standard efficiency of Otto cycle
B. Morse test
C. Constant volume cycle
D. Constant pressure heat addition

List II

1. Mechanical efficiency
2. Diesel cycle
3. Brake thermal efficiency
4. Otto cycle
5. $1-\frac{1}{r^{(\gamma-1)}}$

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

117. Match List I with List II and select the correct answer:

List I (Fuels)

A. Semi-bituminous coal
B. High-speed diesel oil
C. Biogas
D. LPG

List II (Characteristics/usages)

1. Methane and carbon dioxide
2. Propane and butane
3. Calorific value of 10,600 kCal/kg
4. Power plants

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

118. Consider the following statements :

1. motor gasoline is a mixture of various hydrocarbons.
2. Compressed natural gas is mainly composed of methane.
3. producer gas has a predominant component of hydrogen with lesser proportion of carbon monoxide
4. Cetane number of fuel used in diesel engines in India is in the range of 80 to 90.

Which of these statements are correct ?

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

119. Consider the following statements :

1. For the combustion of pulverized coal, 5 to 10% excess air is required.
2. Air contains 21% oxygen by weight.
3. The flue gases from a coal-fired furnace contain around 70% nitrogen by volume
4. In the combustion of liquid fuels, the number of moles of the reactants.

Of these statements

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

120. Match List I with List II and select the correct answer :

List I (Process)

A. Throttling process
B. Isentropic process
C. Free expansion
D. Isothermal process

List II(Characteristic)

1. No work done
2. No change in entropy
3. Constant internal energy
4. Constant enthalpy

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