SSC JE - 2023
CBT - 02

Q 1 A fluid cannot cross a streamline. The reason is that, at all the points, the velocity perpendicular to the streamline is

(A) zero (B) unity

(C) infinity (D) non-zero

Q 2 Identify the correct statement from the following.

(A) In an SI engine, the carburettor supplies both air and grease mixture to the cylinder.

(B) In an SI engine, the carburettor supplies both air and fuel mixture to the cylinder.

(C) In an SI engine, the carburettor supplies grease to the cylinder.

(D) In an SI engine, the carburettor supplies only fuel to the cylinder.

Q 3 _____ pressure is measured at any point in a fluid which is non-moving.

(A) Hydrostatic (B) Atmospheric

(C) Manometric (D) Differential

Q 4 Among the following impeller arrangements, which impeller of the centrifugal pump offers the maximum efficiency?

(A) Straight blade (B) Radial blade

(C) Forward-curved blade (D) Backward-curved blade

Q 5 Match the thermodynamic systems with their correct examples.

Thermodynamic System	**Example**
A. Open	1. The gas sealed within the cylinder of a spark-ignition engine
B. Closed	2. Liquid nitrogen stored in a sealed and insulated container
C. Isolated	3. A car radiator

(A) A–3, B–1, C–2

(B) A–1, B–2, C–3

(C) A–1, B–3, C–2

(D) A–2, B–3, C–1

Q 6 Centrifugal pumps dealing with mud, slurry, and sewage have _____.

(A) isolated impeller

(B) semi-closed impeller

(C) closed impeller

(D) open impeller

Q 7 _____is the pressure that a fluid attains when it is brought to rest isentropically.

(A) Dynamic pressure

(B) Static pressure

(C) Thermodynamic pressure

(D) Stagnation pressure

Q 8 Which of the following is NOT a method of steam turbine governing?

(A) By-pass governing

(B) Nozzle governing

(C) Excel governing

(D) Throttle governing

Q 9 Based on the two statements given below, select the correct option.

Statements:

A. The state of a simple compressible system is completely specified by three independent, intensive properties.

B. A system is called a simple compressible system in the absence of an electrical, magnetic, gravitational, motion or surface tension effect.

(A) Statement A is incorrect, but Statement B is correct.

(B) Both Statement A and Statement B are correct.

(C) Both Statement A and Statement B are incorrect.

(D) Statement A is correct, but Statement B is incorrect.

Q 10 The basic difference between the reversed Carnot cycle and the ideal vapor-compression refrigeration cycle is that a/an _____ in the reversed Carnot cycle is replaced with a/an _____ in the ideal vapor-compression refrigeration cycle.

(A) turbine; nozzle

(B) expansion valve; turbine

(C) turbine; expansion valve

(D) nozzle; expansion valve

Q 11 The Rankine efficiency of a steam power plant:

(A) improves in winter as compared to that in summer

(B) is unaffected by climatic conditions

(C) improves in summer as compared to that in winter

(D) worst in winter as compared to that in summer

Q 12 Select the correct option based on the assertion (A) and reason (R) listed below.

Assertion (A): Two surfaces are polished and brought into contact with each other to reduce friction.

Reason (R): Rough surfaces have less friction between them.

(A) Both A and R are True

(B) A is false but R is true

(C) A is true but R is false

(D) Both A and R are false

Q 13 Calculate the discharge through a convergent mouthpiece of diameter 50 mm that is discharging water under a constant head of 20 meters in liter/second. (Consider g = 10 m/s^2)

(A) 41.25 (B) 39.25

(C) 37.25 (D) 38.25

Q 14 A single-stage, reciprocating air compressor is required to compress 1 kg of air from 1 bar to 4 bar. The initial temperature is 27°C. Select the correct option.

(Given, W_{iso} = Work required for isothermal compression, W_{poly} = Work required for polytropic compression ($pv^{1.2}$ Constant) and W_{isen} = Work required for isentropic compression)

(A) $W_{iso} > W_{poly} > W_{isen}$

(B) $W_{iso} > W_{isen} > W_{poly}$

(C) $W_{iso} < W_{poly} < W_{isen}$

(D) $W_{iso} < W_{isen} < W_{poly}$

Q 15 In case of frictionless flow with no work or heat transfer, the height of the energy grade line (EGL) is equal to the

(A) variable; total Bernoulli head

(B) variable; elevation and pressure head

(C) constant; elevation and pressure head

(D) constant; total Bernoulli head

Q 16 Which of the following is an INCORRECT statement?

(A) Lancashire boiler is a natural circulation boiler.

(B) Cochran boiler is a forced circulation boiler.

(C) Babcock-Wilcox boiler is a natural circulation boiler.

(D) Locomotive boiler is natural circulation boiler.

Q 17 Which of the following points correctly pairs boiler mountings with primary functions of boilers?

(i) Manhole - Melts and releases steam if the water level in the boiler drops too down,

(ii) Feed check valve - Prevents backflow of water into the feed pump,

(iii) Safety valve - Releases excess steam from the boiler to prevent overpressure,

(iv) Fusible plug - Allows the boiler to be drained for inspection and maintenance

(A) ii (B) i

(C) iv (D) iii

Q 18 Darcy's friction factor for a fully developed flow through a closed duct is given by _____.

(Consider that D_h is hydraulic diameter, τ_w is wall shear stress, Δp^* is piezometric pressure drop over a length of L, ρ is density and V is average flow velocity.)

(A) $\frac{(\frac{1}{2})\rho V^2}{\tau_w}$

(B) $\frac{\rho V^2}{\tau_w}$

(C) $\frac{D_h \Delta p^*}{L(\frac{1}{2})\rho V^2}$

(D) $\frac{D_h \Delta p^*}{2L\rho V^2}$

Q 19 Which of the following pressure measurement gauges is gravity-based?

(A) Pirani gauge (B) McLeod gauge

(C) Bourdon tube (D) Manometer

Q 20 In a fluid flow, if the inertia forces are very large as compared to the viscous force, then the type of flow of fluid is called

(A) laminar flow (B) either laminar flow or turbulent flow

(C) turbulent flow (D) transition flow

Q 21 About which of the following aspects of a thermodynamic process does the first law of thermodynamics NOT provide information?

(A) Work done by a system

(B) Heat transfer into or out of a system

(C) Direction of a spontaneous process

(D) Total energy change in a system

Q 22 The absolute pressure is equal to:

(A) gauge pressure - atmospheric pressure

(B) vacuum pressure - gauge pressure

(C) gauge pressure + atmospheric pressure + vacuum pressure

(D) gauge pressure + atmospheric pressure

Q 23 The Rankine cycle comprises:

(A) two isothermal processes and two constant-volume processes

(B) two isentropic processes and two constant-volume processes

(C) two isentropic processes and two constant-pressure processes

(D) two isentropic processes and two isothermal processes

Q 24 The basic function of an expansion valve in a refrigerator is to _____ the _____ refrigerant from the _____ pressure to the _____ pressure.

(A) expand; liquid; condenser; evaporator

(B) expand; liquid; evaporator; condenser

(C) condense; gaseous; condenser; evaporator

(D) condense; gaseous; evaporator; condenser

Q 25 Based on the following two statements related to the pressure in a static fluid, select the correct option.

Statements:

A) Absolute pressures are always positive, but gauge pressures can be either positive or negative.

B) A gauge pressure of zero corresponds to a pressure that is below the local atmospheric pressure.

(A) Both Statement A and Statement B are correct.

(B) Both Statement A and Statement B are incorrect.

(C) Statement A is correct, but Statement B is incorrect.

(D) Statement A is incorrect, but Statement B is correct.

Q 26 What will be the brake power (BP) of the engine if it is tested with a rope brake dynamometer?

Given, W = Dead load (in Newtons), S = Spring balance reading (in Newtons), D = Diameter of the wheel (in metres), d = Diameter of the rope (in metres) and N = Speed of the engine shaft (in RPM)

(A) $BP = \frac{(W-S)\pi(D-d)N}{60} Watts$

(B) $BP = \frac{(W-S)\pi(D+d)N}{60} Watts$

(C) $BP = \frac{(W+S)\pi(D+d)N}{60} Watts$

(D) $BP = \frac{(W+S)\pi(D-d)N}{60}$ Watts

Q 27 The ratio of the power produced by the turbine runner to the power supplied by water at the turbine inlet is defined as

(A) hydraulic efficiency

(B) manometric efficiency

(C) overall efficiency

(D) mechanical efficiency

Q 28 Which of the following is a boiler accessory?

(A) Pressure gauge (B) Steam stop valve

(C) Economiser (D) Fusible plug

Q 29 A cylindrical pipe of diameter 1.5 m and thickness 1.5 cm is subjected to internal fluid pressure of 1.2 N/mm². Determine the longitudinal stress developed in the pipe.

(A) 60 N/mm^2 (B) 15 N/mm^2

(C) 45 N/mm^2 (D) 30 N/mm^2

Q 30 The sum of datum head and pressure head from Bernoulli's equation is known as _____.

(A) datum head (B) piezometric head

(C) manometric head (D) atmospheric head

Q 31 What is the effect of increase in the evaporator temperature on the COP of a vapour compression refrigeration cycle?

Statement 1: The coefficient of performance (COP) of a vapour compression refrigeration cycle is directly proportional to the evaporator temperature and inversely proportional to the condenser temperature.

Statement 2: A vapour compression refrigeration cycle with a higher COP is more energy efficient.

Considering the above-mentioned question and statements, select the correct option.

(A) Both Statement 1 and Statement 2 are required to answer the question.

(B) Statement 2 alone is required to answer the question.

(C) Statement 1 alone is required to answer the question.

(D) Neither Statement 1 nor Statement 2 is required to answer the question.

Q 32 The Darcy friction factor (f) for fully developed laminar flow in a circular pipe with the Reynolds number of 1600 is given as:

(A) 0.04 (B) 0.02

(C) 0.01 (D) 0.005

Q 33 A diesel engine has a compression ratio of 15 and heat addition at a constant pressure takes place at 6% of stroke. Find the air standard efficiency of the diesel engine.

(Take g for air = 1.4.)

(A) h_{diesel} = 59.5%

(B) h_{diesel} = 61.2%

(C) h_{diesel} = 41.2%

(D) h_{diesel} = 51.2%

Q 34 Based on the following two statements related to the actual vapour power cycle and the ideal Rankine cycle, select the correct option.

Statements

A. Steam leaves the boiler at a somewhat lower pressure in the actual cycle than the ideal one.

B. Water must be pumped to a sufficiently higher pressure in the actual cycle than the ideal one.

(A) Both Statement A and Statement B are correct.

(B) Statement A is correct, but Statement B is incorrect.

(C) Statement A is incorrect, but Statement B is correct.

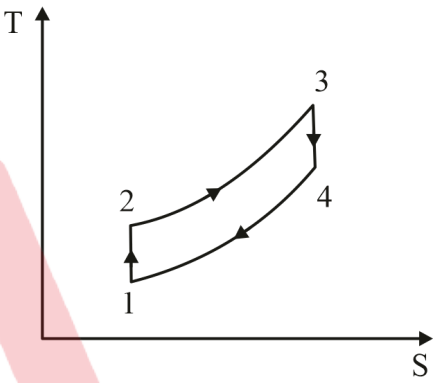
(D) Both Statement A and Statement B are incorrect.

Q 35 The operation of enlarging an already drilled hole is known as _____.

(A) boring (B) shearing

(C) coining (D) punching

Q 36 Identify the cycle on the basis of the T-S diagram shown below.



(A) Otto cycle (B) Diesel cycle

(C) Sterling cycle (D) Carnot cycle

Q 37 Which of the following statements is INCORRECT regarding heat and work?

(A) Systems possess heat and work, but not energy.

(B) Heat and work are associated with a process; not with a state.

(C) Heat and work are boundary phenomena.

(D) Heat and work are path functions.

Q 38 As per the valve timing diagram of the four-stroke cycle diesel engine, typically, the fuel valve closes _____.

(A) 10°-15° before TDC

(B) 39°-50° before BDC

(C) 15°-25° after TDC

(D) 0°-5° after BDC

Q 39 A mass of 2.4 kg of air at 150 kPa and 12°C is contained in a gas-tight, frictionless piston-cylinder device. The air is then compressed to a final pressure of 600 kPa. During this process, heat is transferred from the air in such a way that the temperature inside the cylinder remains constant. Calculate the work input during the process.

(A) 272 kJ (B) 11 kJ

(C) –272 kJ (D) –11 kJ

Q 40 Which of following is a defect that would never occur in shielded metal arc welding?

(A) Porosity (B) Slag inclusion

(C) Crack (D) Tungsten inclusion

Q 41 Free air of volumetric flow rate 30 m^3/min is compressed from 101.3 kPa to 2.23 bar in a Roots blower. Determine the indicated power required.

(A) 65.72 kW (B) 60.85 kW

(C) 44.83 kW (D) 36.51 kW

Q 42 Which of the following statements is true?

(A) Impulse turbine occupies double the space than reaction turbine for the same power output.

(B) Impulse turbine occupies same space as reaction turbine for the same power output.

(C) Impulse turbine occupies less space than reaction turbine for the same power output.

(D) Impulse turbine occupies more space than reaction turbines for same power output.

Q 43 Identify the odd one on the basis of the number of tubes.

(A) Cornish boiler (B) Locomotive boiler

(C) Lancashire boiler (D) Cochran boiler

Q 44 What is the coefficient of performance (COP) of a vapour compression refrigeration system if the enthalpies at the start of compression, at the end of compression and at the end of condensation are 195 kJ/kg, 220 kJ/kg and 95 kJ/kg, respectively?

(A) 0.25 (B) 4

(C) 1 (D) 2

Q 45 In an engine cooling system, the _____ spread(s) the hot water over a large area.

(A) radiator (B) coolant chamber

(C) piston rings (D) air valves

Q 46 The law of thermodynamics that hints at the fact that no heat engine can have efficiency equal to 100% is the

(A) second law (B) zeroth law

(C) third law (D) first law

Q 47 Identify the correct option based on the assertion (A) and reason (R) listed below.

Assertion (A): Dam walls are made thicker at the bottom than top.

Reason (R): Pressure due to water is highest at the bottom.

(A) A is true but R is false

(B) Both A and R are true

(C) Both A and R are false

(D) A is false but R is true

Q 48 Which of the following is NOT a natural circulation boiler?

(A) Babcock & Wilcox boiler

(B) Locomotive boiler

(C) LaMont boiler

(D) Lancashire boiler

Q 49 Based on the two statements given below, select the correct option.

Statements:

A. The first law of thermodynamics is also known as the conservation of energy principle.

B. For all the adiabatic processes between two specified states of a closed system, the net work done is the same, regardless of the nature of the closed system and the details of the process.

(A) Both Statement A and Statement B are correct and are related to each other.

(B) Statement A is incorrect, but Statement B is correct.

(C) Statement A is correct, but Statement B is incorrect.

(D) Both Statement A and Statement B are correct but are not related.

Q 50 Match column A with column B.

Column A	Column B
A. Newtonian fluid	1. Fluid having viscosity
B. Ideal fluid	2. Fluid obeying Newton's law of viscosity
C. Real fluid	3. Fluid is incompressible and non- viscous

(A) A-3, B-1, C-2 (B) A-2, B-3, C-1

(C) A-2, B-1, C-3 (D) A-1, B-3, C-2

Q 51 Which of the following is not a type of oil pump used in IC engine.

(A) Gear type oil pump

(B) Vane type oil pump

(C) Plunger type oil pump

(D) Row type oil pump

Q 52 In the P-V diagram for a pure substance, the point at which the saturated liquid line and the saturated vapour line meet is called _____.

(A) Critiacl point

(B) Saturation point

(C) Triple point

(D) Normal point

Q 53 What will be the maximum coefficient of performance (COP) for the vapour absorption cycle if T_g is generator temperature, T_c is environment temperature and T_e is refrigerated space temperature?

(A) $\frac{T_c(T_g-T_e)}{T_g(T_c-T_e)}$

(B) $\frac{T_e(T_g-T_c)}{T_g(T_c-T_e)}$

(C) $\frac{T_g(T_c-T_e)}{T_c(T_g-T_e)}$

(D) $\frac{T_g(T_c-T_e)}{T_e(T_g-T_c)}$

Q 54 As per the steady flow energy equation, work is done in rotary compressors due to _____

(A) increase in entropy

(B) increase in enthalpy

(C) increase in the adiabatic index

(D) increase in viscosity

Q 55 Calculate the total head of water at the cross-section of 5 m above the datum line. The pipe has a diameter of 5 cm and the water is flowing with a pressure of 100×10^3 N/m^2 and mean velocity of 2 m/s. Take g = 10 m/s^2.

(A) 10.2 (B) 14.1

(C) 15.2 (D) 19.2

Q 56 Select the correct option on the basis of the statements given below.

Statement A: Water tube boilers are low pressure boilers.

Statement B: Fire tube boilers are high pressure boilers.

(A) Both statements A and B are true.

(B) Statement B is true, but statement A is fasle.

(C) Statement A is true, but statement B is fasle.

(D) Both statements A and B are false.

Q 57 Surface tension can also be expressed as _____.

(A) force acting per unit length

(B) velocity per unit length

(C) area per unit length

(D) torsion acting per unit length

Q 58 Which of the following is not a boiler accessory?

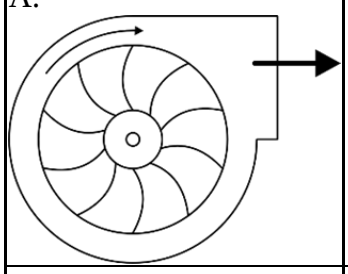
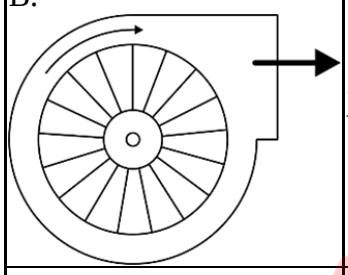
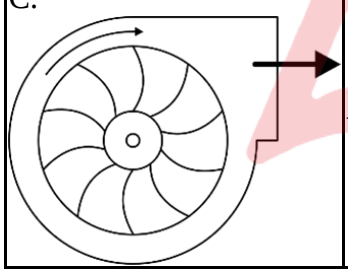
(A) Steam trap

(B) Air preheater

(C) Economiser

(D) Steam stop valve

Q 59 Match column A with column B.

Column A	Column B
A. 	1. Radial vanes
B. 	2. Backward curved vanes
C. 	3. Forward curved vanes

(A) A-2, B-1, C-3 (B) A-1, B-3, C-2

(C) A-3, B-1, C-2 (D) A-2, B-3, C-1

Q 60 Which of the following statements is incorrect regarding a thermodynamics system?

(A) An isolated system is a closed system that does not ineract in any way with its surroundings.

(B) The system boundary may be movable or fixed.

(C) The surface separating the system and its surroundings is known as boundary.

(D) Everything including the system is known as surroundings.

Q 61 What is the pressure increase inside a soap bubble (Dp), which has two interfaces with air, an inner and outer surface of nearly the same radius 'R'? (Consider that g is the coefficient of surface tension)

(A) $\Delta p = \frac{4\gamma}{R}$

(B) $\Delta p = \frac{\gamma}{2R}$

(C) $\Delta p = \frac{\gamma}{R}$

(D) $\Delta p = \frac{2\gamma}{R}$

Q 62 In the gas welding process, a neutral flame contains _____ and ____ in equal proportions.

(A) oxygen, natural gas

(B) oxygen, propylene

(C) oxygen, acetylene

(D) oxygen, propane

Q 63 The flywheel of a steam engine has a radius of gyration 1 m and mass of 3000 kg. The starting torque of the engine is 3000 N-m. The kinetic energy of such a flywheel after 10 sec from rest position will be _____.

(A) 15 kN-m (B) 1500 kN-m

(C) 1.5 kN-m (D) 150 kN-m

Q 64 Calculate the magnitude of resultant of two like parallel forces of 20 N separated by a distance of 20 cm.

(A) 20 N (B) 40 N

(C) 60 N (D) 0 N

Q 65 A draft tube has the inlet diameter of 1 m and the outlet diameter of 2 m. The absolute pressure at the inlet of the draft tube is 0.4 bar. The outlet of the draft tube is exposed to atmosphere. The flow rate of water through the draft tube is 1600 litres per second. Then the vertical distance between the inlet and the outlet is approximately _____.

(A) 6 m (B) 0.6 m

(C) 0.06 m (D) 60 m

Q 66 Which of the following statements expresses the main function of a steam generator?

(A) It transfer the heat to the atmospehric air and thereby,causes condensation of the steam.

(B) It transfer the heat produced by the comubstion of fuel to water and, ultimately, produces steam.

(C) It transfer the water directly to the feed pump and develops electric power.

(D) It reduces the water energy storage capacity and diminishes the steam generation.

Q 67 Calculate the kinetic head (in meter) for a system wherein water is flowing through a pipe of 4 cm diameter under pressure of 20 N/cm^2 and mean velocity of 2 m/s. Take g = 10 m/s^2.

(A) 0.35 (B) 0.2

(C) 0.5 (D) 0.1

Q 68 An efficient lubrication system ensures that _____

(A) The engine runs roughly

(B) The engine runs without noise

(C) The engine runs with greater noise

(D) The engine runs with greater friction

Q 69 The ratio of the sensible heat transfer to the total transfer in air conditioning system is known as _____.

(A) cooling factor

(B) humidity factor

(C) bypass factor

(D) sensible heat factor

Q 70 Regarding the pressure distribution of a fluid in an open rectangular tank, which of the below mentioned statements is false?

(A) The gauge pressure at the water surface on the side wall is zero

(B) Pressure is uniform on the bottom

(C) The pressure is maximum at the middle of the side wall of the tank

(D) The resultant force acts through the centroid of the area of the bottom of the tank

Q 71 According to laws of thermodynamics, which of the following statements is incorrect?

(A) Heat energy can be fully converted into work energy

(B) Fraction of heat energy can be converted into work energy

(C) Work energy can be fully converted into heat energy

(D) The first law of thermodynamics is the same as the law of conservation of energy

Q 72 The shear stress at the outer surface of a solid shaft with diameter D and torque T is _____.

(A) $\frac{\pi D^3}{16T}$ (B) $\frac{16D^3}{\pi T}$

(C) $\frac{16T}{\pi D^3}$ (D) $\frac{\pi T}{16D^3}$

Q 73 The specific gravity of a fluid is 0.8. What is its specific weight at 4°C?

(A) 7848 N/m^3 (B) 12250 N/m^3

(C) 9800 N/m^3 (D) 14000 N/m^3

Q 74 Based on the following two statements related to the manometer, select the correct option.

Statements

A. A piezometer tube can measure the pressure in a container that is lesser than the atmospheric pressure.

B. In case of a simple U-tube manometer, if the pressure to be measured is high then a lighter gauge fluid is preferred and if the pressure is low a heavier gauge fluid preferred.

(A) Both statement A and statement B are correct

(B) Statement A is correct, but statement B is incorrect

(C) Statement A is incorrect, but statement B is correct

(D) Both statement A and statement B are incorrect

Q 75 Which of the following options is not considered as an assumption when deriving Bernoulli's equation for a fluid flow?

(A) Ideal fluid

(B) Streamline flow

(C) Incompressible flow

(D) Unsteady flow

Q 76 Which of the following is not a type of centrifugal pump?

(A) Linear flow pump

(B) Radial flow pump

(C) Axial flow pump

(D) Mixed flow pump

Q 77 Calculate the head loss due to friction using Darcy formula when water flows through a pipe of 100 mm in diameter and 50 m along with velocity of 2 m/s. Assume f = 0.005 and g = 10 m/s^2.

(A) 2 (B) 1

(C) 2.9 (D) 2.2

Q 78 The velocity profile of a turbulent flow along a wall consists of four regions, characterized by the distance from the wall. The correct sequence of these regions from the wall is

(A) buffer layer, viscous sub layer, transition layer, turbulent layer

(B) viscous sub layer, buffer layer, transition layer, turbulent layer

(C) buffer layer, transition layer, viscous sub layer, turbulent layer

(D) viscous sub layer, transition layer, buffer layer, turbulent layer

Q 79 Identify the correct options based on the assertion and reason listed below.

Assertion (A): Compounding is done in the turbine.

Reason (R): Compounding is done to prevent over speeding of turbine.

(A) A is true but R is false

(B) Both A and R are fasle

(C) A is false but R is true

(D) Both A and R are true

Q 80 A gaseous system having internal energy of 50 J is being added by 100 J of heat, Calculate the amount of external work done.

(A) 50 J (B) 150 J

(C) 2 J (D) 20 J

Q 81 Based on the following two statements related to the Curtis stage turbine, select the correct option,

Statement

A. In the Curtis stage turbine, the total enthalpy and pressure drop occurs in the nozzle so that the pressure remains constant in all the three rows of blades.

B. In the fixed (static) blade passage, both pressure and velocity remain constant.

(A) Statement A is incorrect, but Statement B is correct

(B) Statement A is correct, but Statement B is incorrect

(C) Both statement A and statement B are correct

(D) Both statement A and statement B are incorrect

Q 82 Which of the following is/are the correct pair(s) of reaction turbines?

1. Francis turbine – Mixed flow turbine
2. Kaplan turbine – Radial flow turbine

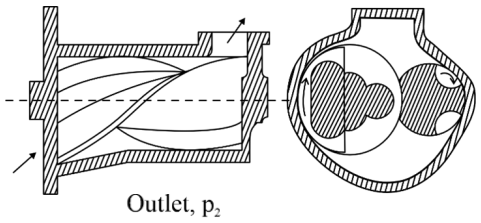
1. **3.** Propeller turbine – Axial flow turbine

(A) Only 2 and 3 (B) Only 1 and 3

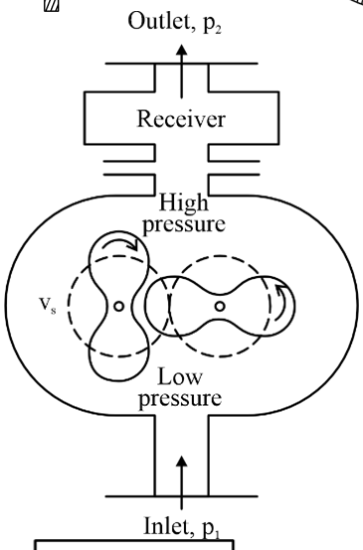
(C) Only 1 (D) Only 1 and 2

Q 83 Which of the following diagrams is that of a lobe compressor?

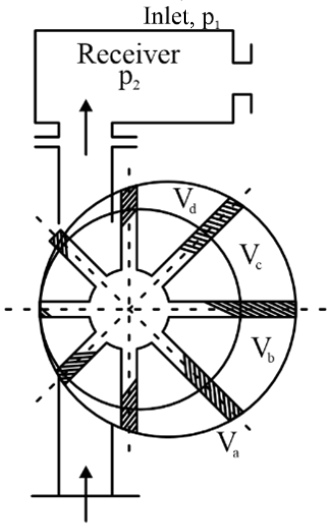
(A)



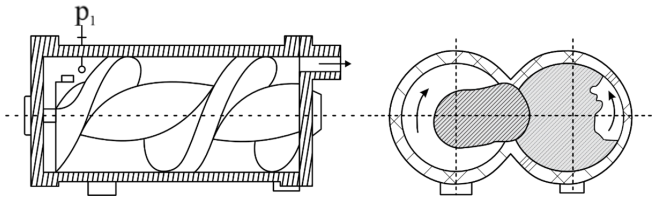
(B)



(C)



(D)



Q 84 Match column A with column B.

Column A	**Column B**
A. Velocity compounded impulse turbine	1. Parson turbine
B. Simple impulse turbine	2. Curtis turbine
C. 50% reaction turbine	3. De-Laval turbine

(A) A-2, B-1, C-3 (B) A-1, B-3, C-2

(C) A-2, B-3, C-1 (D) A-3, B-1, C-2

Q 85 Considering a grinding wheel and a regulating wheel in regard to the centerless grinding machine working principle, the _____ is of greater diameter and has a high rotational speed, whereas the ____ is of smaller diameter and has a low speed.

(A) grinding wheel, work rest blade

(B) regulating wheel, grinding wheel

(C) grinding wheel, regulating wheel

(D) regulating wheel, work rest blade

Q 86 The main purpose of using the evaporator in a refrigeration system is to _____

(A) Condense the refrigerant gas

(B) compress the refrigerant gas

(C) absorb heat from the surrouding air

(D) expand the refrigerant liquid

Q 87 Based on the following two statements related to boilers, select the correct option.

Statements

A. The major drawback in a LaMont boiler is formation and sticking of bubbles in the inner surface of heating tubes.

B. If the boiler pressure is raised to critical pressure, the steam and the water will have the same density and thereby, the risk of bubble formation can be eliminated.

(A) Both Statement A and Statement B are correct, but B is not the correct solution to the problem presented in A

(B) Statement A is incorrect, but Statement B is correct

(C) Statement A is correct, but Statement B is correct

(D) Both Statement A and Statement B are correct and B is the solution to the problem presented in A.

Q 88 Which of the following options represents the correct order of flow of water in the power conversion of the Pelton wheel turbine?

(A) Penstock, runner buckets, nozzle, tail race

(B) Runner buckets, nozzle penstock, tail race

(C) Nozzle, penstock, runner buckets, tail race

(D) Penstock, nozzle, , runner buckets, tail race

Q 89 Isochoric process means

(A) constant-volume process

(B) constant-temperature process

(C) constant-entropy process

(D) constant-pressure process

Q 90 High carbon steels have carbon percentage in the range of

(A) 6–8% (B) 8–10%

(C) 11–15% (D) 0.6–2%

Q 91 As per the boiler regulations, every boiler must be fitted with at least ____ safety valves.

(A) three (B) four

(C) two (D) five

Q 92 What is the maximum coefficient of performance (COP) for an absorption type of refrigerator wherein heating, cooling and refrigeration occur at temperature of 100°C, 20°C and –5°C respectively?

(A) 2.3 (B) 6.9

(C) 1.15 (D) 4.6

Q 93 A single-stage, reciprocating air compressor takes in 1.4 kg of air per minute at 1 bar and 17°C and delivers it at 6 bar. Assuming that the compression process follows the law $pv^{1.35}$ constant, calculate the indicated power input to the compressor.

(A) 1.57 kW (B) 3.42 kW

(C) 4.43 kW (D) 0.26 kW

Q 94 Match the properties of fluids mentioned in column (A) with the related parameters mentioned

Properties of fluids	**Related parameters**
1. Density	I. Reciprocal of bulk modulus of elasticity
2. Coefficient of compressibility	II. Centistoke
3. Kinematic viscosity	III. J/m^2
4. Surface tension	IV. Reciprocal of specific volume

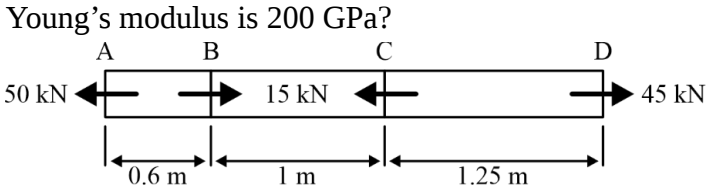
(A) 1-I, 2-II, 3-III, 4-IV

(B) 1-IV, 2-I, 3-II, 4-III

(C) 1-II, 2-I, 3-IV, 4-III

(D) 1-IV, 2-III, 3-II, 4-I

Q 95 A steel bar with the area of cross section 500 mm^2 is acted upon by the forces shown in the figure below. What is the total elongation in the bar if the value of Young's modulus is 200 GPa?



(A) 1.21 mm (B) 0.51 mm

(C) 0.09 mm (D) 0.61 mm

Q 96 A Carnot cycle runs between _____ adiabatic and ____ isothermal process

(A) 1, 3 (B) 3, 1

(C) 2, 2 (D) 0, 4

Q 97 In steady flow air compressor, air enters at a speed of 5 m/s with a pressure of 1 bar and leaves at a speed of 7.5 m/s with a pressure of 7 bar. If the inlet specific volume if 0.5 m^3/kg and the outlet specific volume is 0.15 m^3/kg. What is the ratio of the inlet pipe diameter to the outlet pipe diameter?

(A) 1 : 1.118 (B) 1 : 2.236

(C) 2.236 : 1 (D) 1.118 : 1

Q 98 What is the primary purpose of using an economizer in a boiler system?

(A) To increase the pressure within the boiler

(B) To cool down the exhaust flue gases

(C) To heat the feedwater by utilising heat from the exhaust flue gases

(D) To reduce the emission of greenhouse gases

Q 99 Match column A with column B.

Column A	Column B
A. Mechanical efficiency	1. Ratio of brake power to indicated power
B. Indicated thermal efficiency	2. Ratio of actual volume to swept volume
C. Volumetric efficiency	3. Ratio of indicated power to fuel power

(A) A-1, B-3, C-2 (B) A-2, B-3, C-1

(C) A-3, B-1, C-2 (D) A-2, B-1, C-3

Q 100 In the winter air conditioning, for comfort, moisture is added without changing its dry bulb temperature and the air is made to warm up. Identify the type of process.

(A) Cooling and humidification

(B) Cooling and dehumidification

(C) Heating and dehumidification

(D) Heating and humidification

Answer Key

Q1	A
Q2	B
Q3	A
Q4	D
Q5	A
Q6	D
Q7	D
Q8	C
Q9	A
Q10	C
Q11	A
Q12	C
Q13	B
Q14	C
Q15	D
Q16	B
Q17	A
Q18	C
Q19	D
Q20	C
Q21	C
Q22	D
Q23	C
Q24	A
Q25	C
Q26	B
Q27	A
Q28	C
Q29	D
Q30	B
Q31	C
Q32	A
Q33	B
Q34	A
Q35	A
Q36	A
Q37	A
Q38	C
Q39	C
Q40	D
Q41	B
Q42	C
Q43	A
Q44	B
Q45	A
Q46	A
Q47	B
Q48	C
Q49	A
Q50	B
Q51	D
Q52	A
Q53	B
Q54	B
Q55	C
Q56	D
Q57	A
Q58	D
Q59	C
Q60	D
Q61	A
Q62	C
Q63	D
Q64	B
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Q67	B
Q68	B
Q69	D
Q70	C
Q71	A
Q72	C
Q73	A
Q74	D
Q75	D
Q76	A
Q77	A
Q78	B
Q79	D
Q80	A
Q81	C
Q82	B
Q83	B
Q84	C
Q85	C
Q86	C
Q87	D
Q88	D
Q89	A
Q90	D
Q91	C
Q92	A
Q93	C
Q94	B
Q95	A
Q96	C
Q97	C
Q98	C
Q99	A
Q100	D

Hints & Solutions

Q 1 **Text Solution:**

Streamlines represent the path followed by a fluid particle in steady, laminar flow. At any point along a streamline, the velocity of the fluid is tangent to the streamline. Therefore, the velocity perpendicular to the streamline is zero because the fluid moves along the streamline and doesn't cross it.

Q 2 **Text Solution:**

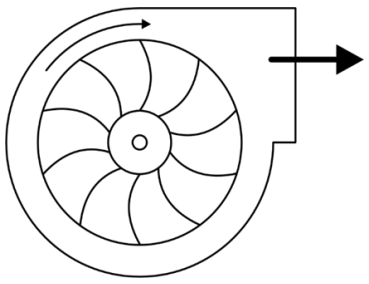
In an SI engine, the carburettor supplies both air and fuel mixture to the cylinder.

The carburetor in a spark-ignition (SI) engine mixes air and fuel to create a combustible mixture that is then supplied to the cylinder for combustion.

Q 3 **Text Solution:**

Hydrostatic pressure is the pressure exerted by a fluid at rest and is determined by the depth of the fluid and the density of the fluid. This pressure is present in a non-moving (static) fluid.

Q 4 **Text Solution:**



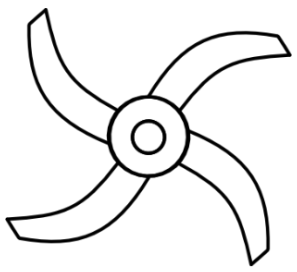
Backward-curved blade:

Backward-curved blades are designed to efficiently move fluids by directing the flow outward from the center of the impeller to the outer edges. They generally provide higher efficiencies compared to other blade designs due to their ability to handle higher flow rates with less energy loss.

Q 5 **Text Solution:**

Thermodynamic System	Example
A. Open	1. A car radiator
B. Closed	2. The gas sealed within the cylinder of a spark-ignition engine
C. Isolated	3. Liquid nitrogen stored in a sealed and insulated container

Q 6 **Text Solution:**



Open impeller

When dealing with mud, slurry, and sewage, centrifugal pumps often employ an open impeller design. The open impeller has vanes that are open on both sides, allowing for easier passage of fluids with high solid content like mud, slurry, or sewage. This design helps prevent clogging and allows the pump to handle these challenging substances more effectively compared to closed or semi-closed impeller designs, which might get clogged due to their tighter clearances and enclosed nature.

Q 7 **Text Solution:**

The pressure that a fluid attains when it is brought to rest isentropically is referred to as "stagnation pressure." This pressure represents the total energy content of the fluid, including its static pressure, dynamic pressure, and potential energy per unit mass.

Q 8 **Text Solution:**

The method of "Excel governing" is not a recognized technique for governing steam turbines. Instead, it might be a typo or a term not commonly associated with governing methods in the context of steam turbines. The correct term often used is "extraction governing," which involves controlling the steam flow by extracting it at various stages in the turbine to regulate power output.

Q 9 **Text Solution:**

Statement A is incorrect because a simple compressible system typically requires only two independent, intensive properties to completely specify its state, as per thermodynamics. These properties could be pressure and temperature, pressure and specific volume, or temperature and specific entropy, among others.

Statement B, on the other hand, correctly defines a simple compressible system as one in which external effects like electrical, magnetic, gravitational forces, motion, or surface tension are negligible or not considered in defining its behavior in thermodynamic processes.

Q 10 **Text Solution:**

The basic difference between the reversed Carnot cycle and the ideal vapor-compression refrigeration cycle is that a/an "turbine" in the reversed Carnot cycle is replaced with a/an "expansion valve" in the ideal vapor-compression refrigeration cycle.

In the reversed Carnot cycle, the expansion process happens through a turbine, while in the vapor-compression refrigeration cycle, the expansion of the refrigerant occurs through an expansion valve. This valve serves to reduce the pressure of the refrigerant, causing it to expand and cool down before entering the evaporator.

Q 11 **Text Solution:**

The Rankine cycle efficiency of a steam power plant is primarily based on the temperature difference within the cycle, particularly between the high-temperature steam entering the turbine and the low-temperature steam at the condenser.

In colder weather (winter), the cooler ambient temperatures can potentially aid in the condensation process, improving efficiency due to a larger

temperature difference between the steam and the surroundings.

Q 12 Text Solution:

Assertion (A) is true. Polishing surfaces can reduce friction between them by smoothing out irregularities and reducing surface roughness. This can result in lower frictional forces between the surfaces when they come into contact.

Reason (R) is false. Rough surfaces generally have higher friction between them due to increased interlocking of surface asperities, which leads to greater resistance to motion and higher frictional forces. Smoothing out rough surfaces can reduce this interlocking and hence reduce friction.

Q 13 Text Solution:

Given data

d = 50 mm = 0.05 m

h = 20 m

$g = 10\ m/s^2$

We know that,

$A = \frac{\pi}{4} \times d^2 = \frac{\pi}{4} \times 0.05^2 = 1.9635 \times 10^{-3} m^2$

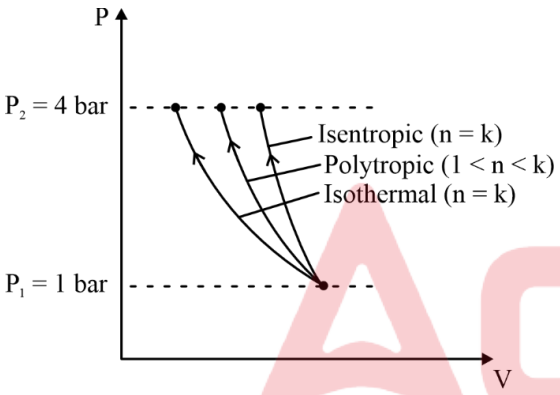
$V = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20\ m/s$

$Q = AV = 1.9635 \times 10^{-3} \times 20 = 39.25 \times 10^{-3} m^3/s$

$\boxed{Q = 39.25\ litre/sec}$

($\because$ 1 liter = $10^{-3}\ m^3$)

Q 14 Text Solution:



In a single–stage, reciprocating air compressor, the work required for different compression processes varies:

- Isentropic process (adiabatic and reversible) : W_{isen}
- Isentropic process (constant temperature) : W_{iso}
- Polytropic process (variable heat transfer): W_{poly}

When comparing these processes for compression of the same mass of air from 1 bar to 4 bars:

1. Isothermal compression (W_{iso}) will be less than the work for an isentropic compression work (W_{isen})
2. Polytropic compression work (W_{poly}) may fall between the work for isentropic and isothermal compression.

$$\therefore \mathbf{W_{iso} < W_{poly} < W_{isen}}$$

Q 15 Text Solution:

In a frictionless flow with no work or heat transfer, the height of the Energy Grade Line (EGL) is constant and is equal to the total Bernoulli head.

Q 16 Text Solution:

In reality, the Cochran boiler is a natural circulation boiler, not a forced circulation one. Forced circulation boilers typically use a pump to force the water through the boiler's tubes, while natural circulation boilers rely on the density difference to circulate the water without an external pump.

Q 17 Text Solution:

Feed check valve - Prevents backflow of water into the feed pump,

Q 18 Text Solution:

we know that,

$h = \frac{fLV^2}{2gD_h}$

by multiplying ρg on both sides

$\rho gh = \left(\rho g\right) \frac{fLV^2}{2gD_h}$

$\Delta p^* = \frac{\rho f LV^2}{2D_h}$ ($\because \triangle p = \rho gh$)

$f = \frac{\Delta p^* \times 2D_h}{\rho LV^2}$

$\boxed{f = \frac{\Delta p^* \times D_h}{\rho\left(\frac{1}{2}\right) LV^2}}$

Q 19 Text Solution:

The gravity-based pressure measurement gauge among the options listed is the Manometer. Manometers rely on the balance of liquid columns under the influence of gravity to measure pressure differentials. The movement of the liquid in response to pressure changes is what allows for the pressure to be determined.

Q 20 Text Solution:

When inertia forces dominate over viscous forces in fluid flow, the flow is typically classified as turbulent flow. Therefore, the correct answer is turbulent flow.

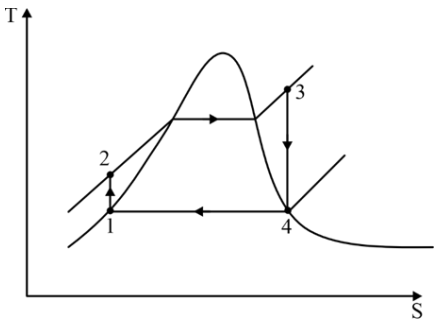
Q 21 Text Solution:

The first law of thermodynamics primarily deals with the conservation of energy within a system and its surroundings. It addresses the concepts of heat transfer, work done by or on a system, and the total energy change within a system. However, it does not explicitly provide information about the direction of a spontaneous process. The directionality of a process is better explained by the second law of thermodynamics, which deals with the concept of entropy and the irreversibility of certain processes.

Q 22 Text Solution:

The correct relationship for absolute pressure is given by option (d): gauge pressure + atmospheric pressure. Absolute pressure is the sum of gauge pressure (pressure measured relative to atmospheric pressure) and atmospheric pressure itself, considering atmospheric pressure as the reference point for absolute pressure measurements.

Q 23 Text Solution:



1 – 2 : Isentropic compression

2 – 3 : Constant perssure heat addition

3 – 4 : Isentropic expansion

4 – 1 : Constant pressure heat rejection

Q 24 Text Solution:

The basic function of an expansion valve in a refrigerator is to expand the liquid refrigerant from the condenser pressure to the evaporator pressure. Therefore, the correct description is: Expand; liquid; condenser; evaporator

Q 25 Text Solution:

Statement A is correct. Absolute pressures are indeed always positive as they are measured relative to absolute zero pressure (perfect vacuum). Gauge pressures, however, can be positive or negative depending on whether they are above or below atmospheric pressure.

Statement B is incorrect. A gauge pressure of zero corresponds to a pressure that is equal to the local atmospheric pressure, not necessarily below it.

Q 26 Text Solution:

$$\mathrm{BP} = \frac{(\mathrm{W}-\mathrm{S})\pi(\mathrm{D}+\mathrm{d})\mathrm{N}}{60}\mathrm{Watts}$$

Where,

BP = Brake Power (watt)

W = Dead load (N)

S = Spring Balance reading (N)

D = Diameter of wheel (m)

d = Diameter of rope (m)

N = speed of engine (RPM)

Q 27 Text Solution:

Hydraulic efficiency represents the ratio of the power produced by the turbine runner to the power supplied by water at the turbine inlet.

$$\eta_H = \frac{\text{Power produced by the turbine runner}}{\text{Power supplied by the water at the turbine inlet}}$$

Q 28 Text Solution:

An economizer is considered a boiler accessory. It's a device used to increase the efficiency of the boiler by preheating the feed water before it enters the boiler, utilizing waste heat from the flue gases to heat the incoming water.

Q 29 Text Solution:

Given data:

d = 1.5 m = 1500 mm

t = 1.5 cm = 15 mm

p = 1.2 N/mm^2

σ_L = ?

Considering the case of thin cylinder

$$\sigma_L = \frac{pd}{4t} = \frac{1.2\times1500}{4\times15} = 30\mathrm{N/mm}^2$$

$$\boxed{\sigma_L = 30\ \mathrm{N/mm}^2}$$

Q 30 Text Solution:

According to Bernoulli's equation :

$$\frac{p}{\rho g} + \frac{V^2}{2g} + z = \text{constant}$$

$\frac{p}{\rho g} \rightarrow$ pressure head

$\frac{V^2}{2g} \rightarrow$ Velocity headz

$z \rightarrow$ Datum head

The sum of datum head and pressure head from Bernoulli's equation is known as "piezometric head." Piezometric head represents the total energy per unit weight of fluid at a specific point in a flow field and includes both the pressure head and the elevation head referenced to a datum.

Q 31 Text Solution:

The effect of an increase in the evaporator temperature on the Coefficient of Performance (COP) of a vapor compression refrigeration cycle can be determined by Statement 1 alone.

Statement 1 indicates that the COP is directly proportional to the evaporator temperature and inversely proportional to the condenser temperature. Therefore, an increase in the evaporator temperature, while keeping other factors constant, tends to increase the COP of the refrigeration cycle.

Statement 2 provides a general understanding that a higher COP signifies a more energy-efficient refrigeration cycle. However, for the specific question regarding the effect of an increase in evaporator temperature on the COP, Statement 1 alone is sufficient to answer. Thus, the correct option is (c).

Q 32 Text Solution:

Given data,

R_e = 1600

f = ?

Since, R_e < 2000, it is the case of laminar flow and for laminar flow through pipe, we know that

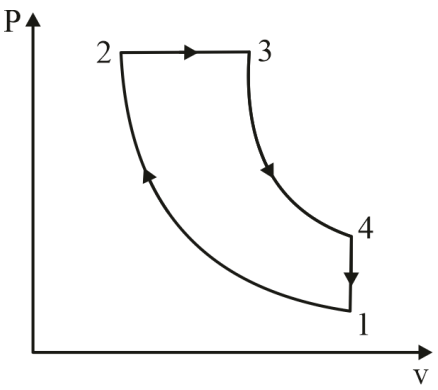
$$f = \frac{64}{R_e}$$

$$f = \frac{64}{1600} = 0.04$$

$$\boxed{f = 0.04}$$

Q 33 Text Solution:

Given data:



r = 15

x = 6% = $\frac{6}{100}$ = 0.06

γ = 1.4

η_0 = ?

we know that

$(\rho-1) = x\,(r-1)$

where,

ρ = cutt – off ratio = V_3/V_2

x = % of stroke

r = compression ratio

$\therefore \quad (\rho-1) = 0.06\,(15-1)$

$$\boxed{\rho = 1.84}$$

we know that,

$$\eta_D = 1-\frac{1}{r^{\gamma-1}} \times \left[\frac{\rho^{\gamma}-1}{\gamma(\rho-1)}\right]$$

$$1-\frac{1}{15^{1.4-1}} \times \left[\frac{1.84^{1.4}-1}{1.4\times(1.84-1)}\right]$$

= 0.61191

$$\boxed{\eta_D = 61.2\%}$$

Q 34 Text Solution:

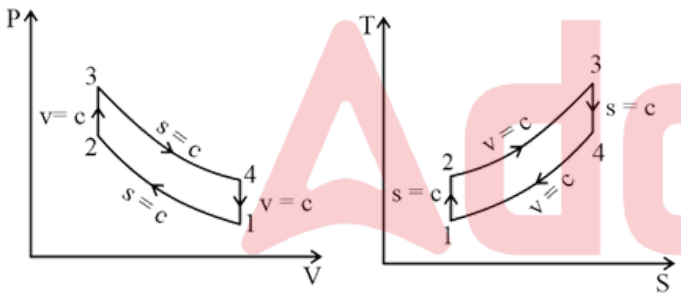
Statement A is accurate. In the actual vapor power cycle, due to losses and inefficiencies, steam might leave the boiler at a slightly lower pressure compared to the ideal Rankine cycle.

Statement B is correct as well. In the actual cycle, due to losses in the system (such as friction losses in pipes), the water often needs to be pumped to a higher pressure than in the ideal Rankine cycle to compensate for these losses.

Q 35 Text Solution:

The operation of enlarging an already drilled hole is commonly known as "boring." This process involves using a cutting tool to enlarge or refine an existing hole's diameter accurately.

Q 36 Text Solution:



1–2 : Isentropic compression

2–3 : Constant volume heat addition

3–4 : Isentropic Expansion

4–1 : Constant volume heat rejection.

Q 37 Text Solution:

"Systems possess heat and work, but not energy."

This statement is incorrect because heat, work, and energy are interconnected concepts within thermodynamics. Systems can possess both heat and work, but they also inherently possess energy. Heat and work are means by which energy is transferred into or out of a system. Therefore, systems do possess energy, in addition to heat and work.

Q 38 Text Solution:

In a four-stroke cycle diesel engine, the fuel valve typically closes after the piston has passed the top dead center (TDC) during the compression stroke. This timing ensures proper injection of fuel into the combustion chamber as the air is compressed, facilitating efficient combustion. Closing the fuel valve after TDC allows sufficient time for fuel atomization and mixing with compressed air before ignition, optimizing combustion efficiency and engine performance.

Therefore "15°-25° after TDC," is the correct timing for the closure of the fuel valve in a four-stroke cycle diesel engine according to the valve timing diagram.

Q 39 Text Solution:

Given data:

m = 2.4 kg

p_1 = 150 kPa

$T_1 = T_2 = T = 12°C = 12+ 273 = 285K$

p_2 = 600 kPa

Isothermal Work (W) = ?

We know that,

Isothermal Work (W) = $p_1v_1 \ln (v_2/v_1) = mRT_1 \ln \left(\frac{p_1}{p_2}\right)$

$= 2.4\times0.287\times285 \times \ln\left(\frac{150}{600}\right)$

$$\boxed{W = -272 \text{ kJ}}$$

Q 40 Text Solution:

Shielded metal arc welding (SMAW), also known as stick welding, uses a flux-coated electrode that doesn't involve the use of tungsten. As a result, the defect of tungsten inclusion wouldn't occur in shielded metal arc welding. Tungsten inclusion is more commonly associated with processes like Tungsten Inert Gas (TIG) welding or Gas Tungsten Arc Welding (GTAW) where a tungsten electrode is used.

Q 41 Text Solution:

Given data;

$\dot{V}$ = 30 m^3/min = 0.5 m^3/s

p_1 = 101.3 kPa

p_2 = 2.23 bar = 223 kPa

$P_{ind} = \dot{V}dp = 0.5\times (223-101.3)$

$$\boxed{P_{ind} = 60.85 \text{ kW}}$$

Q 42 Text Solution:

The impulse turbine occupies less space than reaction turbine for the same power output.

In many cases, impulse turbines tend to be more compact compared to reaction turbines when generating the same amount of power. This is due to differences in design and construction, allowing impulse turbines to occupy relatively less space for equivalent power outputs.

Q 43 Text Solution:

- Locomotive boiler, Lancashire boiler, and Cochran boiler are all examples of fire tube boilers that typically have multiple tubes.
- However, the Cornish boiler is a specific type of fire tube boiler that has only one large flue tube running through the entire length of the boiler,

making it distinct from the others in terms of the number of tubes.

Q 44 Text Solution:

Given data;

$h_1 = 195$ kJ/kg

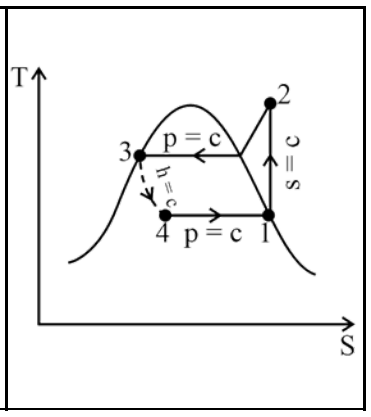
$h_2 = 220$ kJ/kg

$h_3 = h_4 = 95$kJ/kg

$\text{COP} = \frac{\text{Desired Effect}}{\text{Work Input}} = \frac{h_1 - h_4}{h_2 - h_1}$

$\text{COP} = \frac{195-95}{220-195}$

$\boxed{\text{COP} = 4}$



Q 45 Text Solution:

The component in an engine cooling system responsible for spreading the hot water over a large area to facilitate heat dissipation is: Radiator.

The radiator helps in dispersing the heat carried by the coolant fluid over a broad surface area, allowing efficient heat transfer from the coolant to the surrounding air. This process aids in cooling down the engine.

Q 46 Text Solution:

The law of thermodynamics that addresses the fact that no heat engine can have 100% efficiency is:

The Second Law of Thermodynamics.

This law encompasses several principles, one of which includes the statement that it is impossible to create a heat engine with 100% efficiency, meaning that no engine can convert all supplied heat into work without any heat loss or waste.

Q 47 Text Solution:

Both A and R are true.

In some cases, dam walls might indeed be thicker at the bottom compared to the top for structural stability reasons, considering the higher pressure exerted by the water at greater depths. The reason provided aligns with this idea that the pressure of water increases with depth, exerting more force at the bottom of the dam. Therefore, both the assertion and the reason are true in this context.

Q 48 Text Solution:

The LaMont boiler is not a natural circulation boiler. Unlike Babcock & Wilcox, Locomotive, and Lancashire boilers, the LaMont boiler uses forced circulation, employing a pump to circulate water through the tubes instead of relying solely on natural convection currents.

Q 49 Text Solution:

Statement A correctly identifies the first law of thermodynamics, which indeed embodies the principle of conservation of energy.

Statement B refers to the nature of adiabatic processes within closed systems. It asserts that for adiabatic processes between two specified states of a closed system, the net work done is the same, irrespective of the system's nature or the specifics of the process. This aligns with the concept of energy conservation governed by the first law of thermodynamics.

Q 50 Text Solution:

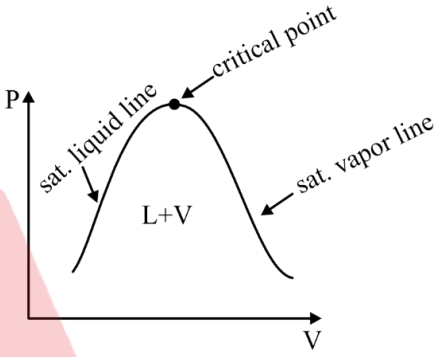
Column A	Column B
A. Newtonian fluid	1. Fluid obeying Newton's law of viscosity
B. Ideal fluid	2. Fluid is incompressible and non- viscous
C. Real fluid	3. Fluid having viscosity

Q 51 Text Solution:

The row-type oil pump is not a standard classification for oil pumps used in internal combustion engines. The correct types of oil pumps commonly used in IC engines include gear-type, vane-type, and plunger-type oil pumps.

Q 52 Text Solution:

In the P-V diagram for a pure substance, the point at which the saturated liquid line and saturated vapour line meet is called critical point.



Q 53 Text Solution:

COP of vapor absorption cycle is given by

$(\text{COP})_{\text{VARS}} = \frac{T_e}{T_g}\frac{(T_g - T_c)}{(T_c - T_e)}$

Where

T_g = Generator temperature

T_c = Environment temperature

T_e = Refrigerated space temperature

Q 54 Text Solution:

According to the steady flow energy equation, work is done in rotary compressors due to an increase in enthalpy.

Enthalpy (h) is a thermodynamic property that includes both internal energy and the product of pressure and volume. When a fluid is compressed, its pressure and temperature increase, leading to an increase in enthalpy. Therefore, the work done in the compressor is associated with an increase in enthalpy.

Q 55 Text Solution:

Total head

$h = \frac{P}{\rho g} + \frac{v^2}{2g} + z$

$= \frac{100 \times 10^3}{10^3 \times 10} + \frac{(2)^2}{2 \times 10} + 5$

$\boxed{h = 15.2 \text{ m}}$ (r_{water} = 1000 kg/m^3)

Q 56 Text Solution:

Both statements A and B are false.

- Water tube boilers are generally high-pressure boilers. In water tube boilers, water circulates

through the tubes, and the heat generated by combustion is transferred to the water, producing steam at high pressures.

- On the other hand, fire tube boilers are typically low to medium-pressure boilers. In fire tube boilers, the hot gases from combustion pass through the tubes, and the water surrounds the tubes, leading to a lower pressure than water tube boilers.

Q 57 Text Solution:

Surface tension is defined as the force acting perpendicular to the length of a line of unit length on the liquid surface.

It describes as

s = F/L

Where

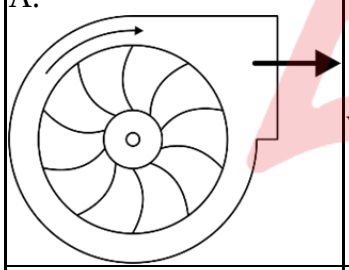
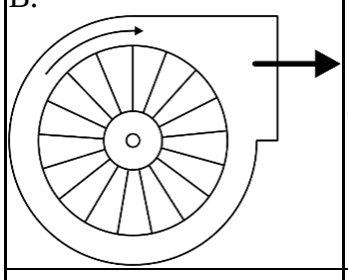
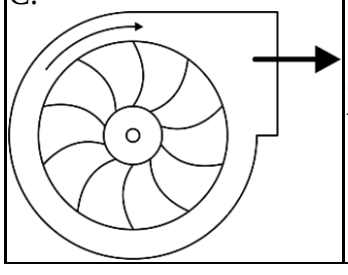
- F is the force per unit length
- L is the length
- s is the surface tension of the liquid

Q 58 Text Solution:

The steam stop valve is a boiler fitting, not an accessory. Boiler accessories typically include items like feedwater heaters, superheaters, air preheaters, economizers, and steam traps, while boiler fittings are essential components for the proper functioning of the boiler, such as safety valves, water level indicators, and steam stop valves.

Q 59 Text Solution:

The correct match is:

Column A	Column B
A. 	1. Forward curved vanes
B. 	2. Radial vanes
C. 	3. Backward curved vanes

Q 60 Text Solution:

In thermodynamics, the surroundings refer to everything external to the system under consideration. The correct understanding is that the system is the specific part of the universe we are interested in studying or analyzing, while the surroundings include everything else. So, the surroundings encompass everything external to the system, not everything, including the system itself.

Q 61 Text Solution:

The pressure increase inside the soap bubble is given by

$\Delta p = \frac{8\gamma}{D}$

or $\boxed{\Delta p = \frac{4\gamma}{R}}$

Q 62 Text Solution:

In the gas welding process, a neutral flame is achieved when oxygen and acetylene are mixed in equal proportions. This balanced mixture provides a flame with neither oxidizing nor reducing characteristics, making it suitable for general welding applications.

Q 63 Text Solution:

Given

Radius of gyration (k) = 1 m

Mass (m) = 3000 kg

Torque (T) = 3000 Nm

Kinetic energy after 10 sec.

We know

$T = I\alpha$

$T = \left(mk^2\right)\alpha$

$3000 = \left[3000(1)^2\right]\alpha$

$\alpha = 1\ \text{rad/s}^2$

Angular speed of flywheel after 10 sec

w = 0 + (1) (10)

(Starting from rest)

w = 10 rad/s

Kinetic energy after 10 sec

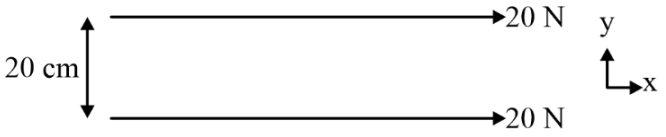
K.E. = $\frac{1}{2}Iw^2 \rightarrow \frac{1}{2}(3000)\ (10)^2$

KE = 150000 N.m

or

$\boxed{K.E. = 150\ \text{kN.m}}$

Q 64 Text Solution:



Resultant force in x direction

$F_{R_x} = (20 + 20)\,\text{kN}$

$[F_{R_x} = 40\ \text{kN}]$

In y direction

$\left[F_{R_y} = 0\right]$

Thus resultant

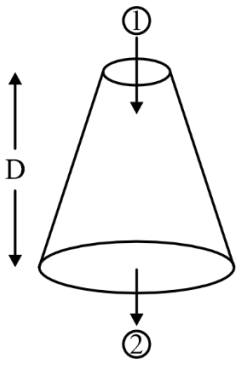
$F_R = \sqrt{F_{R_x}^2 + F_{R_y}^2}$

$F_R = \sqrt{(40)^2 + (0)^2}$

$\boxed{F_R = 40\ \text{kN}}$

Q 65 Text Solution:

Given



d_1 = 1 m

d_2 = 2 m

P_1 = 0.4 bar

P_2 = 1 bar(atm)

Q = 1600 lt/sec

or

Q = 1.6 m^3/s

Velocity at inlet $V_1 = \frac{Q}{A} \Rightarrow \frac{1.6}{\frac{\pi}{4}(1)^2}$

V_1 = 2.037 m/s

by continuity eq. $V_2 = \left(\frac{d_1}{d_2}\right)^2 V_1$

$V_2 = \left(\frac{1}{2}\right)^2 \times 2.037$

V_2 = 0.51 m/s

Applying Bernoulli at 1 and 2 (assuming no losses)

$\frac{P_1}{\rho g} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{\rho g} + \frac{V_2^2}{2g} + z_2$

z_2 = 0 (datum), z_1 = D

$\frac{0.4\times10^5}{10^3\times9.81} + \frac{(2.037)^2}{2\times9.81} + D = \frac{1\times10^6}{10^3\times9.81} + \frac{(0.51)^2}{2\times9.81} + 0$

(r_{water} = 1000 kg/m^3)

D = 5.92 m

or

$\boxed{D \approx 6\ m}$

Q 66 Text Solution:

A steam generator, often referred to as a boiler, is designed to transfer heat energy from the combustion of fuel to water to produce steam. This steam can then be used for various applications, such as power generation, heating, or industrial processes.

Q 67 Text Solution:

Kinetic head $h_k = \frac{v^2}{2g}$

$= \frac{(2)^2}{2\times10}$

$\boxed{h_k = 0.2\ m}$

Q 68 Text Solution:

An efficient lubrication system is crucial for reducing friction and wear between moving parts in an engine. This, in turn, helps to ensure that the engine runs smoothly and without excessive noise. Lubrication is essential for minimizing friction, dissipating heat, and extending the life of engine components.

Q 69 Text Solution:

The sensible heat factor, also known as the sensible heat ratio (SHR), is defined as the ratio of the sensible heat transfer to the total heat transfer. Mathematically, it is expressed as:

Sensible heat factor (SHF or SHR) =

$\frac{\text{Sensible heat transfer}}{\text{Total heat transfer}}$

Q 70 Text Solution:

In an open rectangular tank, the pressure is not maximum at the middle of the side wall; it is maximum at the bottom of the tank. The pressure at the water surface on the side wall is indeed zero. Pressure is generally uniform on the bottom of the tank, and the resultant force due to pressure acts through the centroid of the area of the bottom of the tank.

Q 71 Text Solution:

Heat energy can be fully converted into work energy.

This statement is incorrect. According to the second law of thermodynamics, it is not possible to convert all heat energy into work energy with 100% efficiency. There are inherent limitations to the efficiency of heat-to-work conversion, and some energy is always lost as heat in the process.

Q 72 Text Solution:

Equation for pure shear loading on a shaft is given by

$\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$

Shear stress

$\tau = \frac{T.R}{J}$

$\tau = \frac{T\left(\frac{D}{2}\right)}{\frac{\pi}{32}D^4}$

$\boxed{\tau = \frac{16T}{\pi D^3}}$

Q 73 Text Solution:

Given

S.G = 0.8

Density r = 0.8 × 10^3 kg/m^3

Specific weight

g = rg

= (0.8 × 10^3) (9.81)

$\boxed{\gamma = 7848\ N/m^3}$

Q 74 Text Solution:

Both Statement A and Statement B are incorrect.

A) Statement A is incorrect. A piezometer tube is open to the atmosphere, and it can measure pressure in a container only if the pressure in the container is greater than atmospheric pressure.

B) Statement B is incorrect. In a simple U-tube manometer, for high pressures, a heavier gauge fluid is preferred and for low pressures, a lighter gauge fluid is preferred.

Q 75 Text Solution:

When deriving Bernoulli's equation for fluid flow, certain assumptions are made to simplify the analysis and arrive at a useful expression for energy conservation along a streamline. The typical assumptions include:

- The flow is assumed to be steady
- The fluid is assumed to be incompressible.
- The flow is assumed to be streamlined.
- The fluid is assumed to be ideal, implying that there is no viscosity (no internal friction) in the fluid.

The option "Unsteady Flow" is not considered as an assumption in the derivation of Bernoulli's equation.

Q 76 Text Solution:

Type of centrifugal pump

- Radial flow pump
- Axial flow pump
- Mixed flow pump

Q 77 Text Solution:

Given

d = 100 mm

L = 50 m

V = 2 m/s

Darcy friction coefficient f = 0.005

Darcy friction factor f = 4f Þ 4 × 0.005 Þ 0.02

Head loss

$$h_L = \frac{f\,LV^2}{2gd}$$

$$= \frac{(0.02)(50)(2)^2}{2\times10\times(100\times10^{-3})}$$

$$\boxed{h_L = 2\ \text{m}}$$

Q 78 Text Solution:

The correct sequence of the velocity profile regions in turbulent flow along a wall, characterized by the distance from the wall, is:

Viscous sub-layer, buffer layer, transition layer, turbulent layer

- **Viscous Sub-layer:** Closest to the wall, where viscous effects dominate. Velocity changes rapidly here, and the flow is nearly laminar.
- **Buffer Layer:** Above the viscous sub-layer, where the velocity increases more smoothly. Turbulent fluctuations begin to influence the flow.
- **Transition Layer:** Further away from the wall, where the flow transitions from being influenced by viscosity to being dominated by turbulence.
- **Turbulent Layer:** Farther away from the wall, where turbulence is fully developed, and the velocity profile becomes relatively uniform.

Q 79 Text Solution:

In turbine design, compounding is indeed employed, and one of the reasons for compounding is to control and prevent over speeding of the turbine. Compounding involves dividing the pressure drop across the turbine into multiple stages. This not only helps in efficient energy extraction but also prevents excessive speeds in each stage, contributing to better control and stability of the turbine operation. Therefore, both the assertion and the reason are correct.

Q 80 Text Solution:

Given

DU = 50J

Q = 100 J

W = ?

Using thermodynamics 1st law for closed system

Q = DU + W

100 = 50 + W

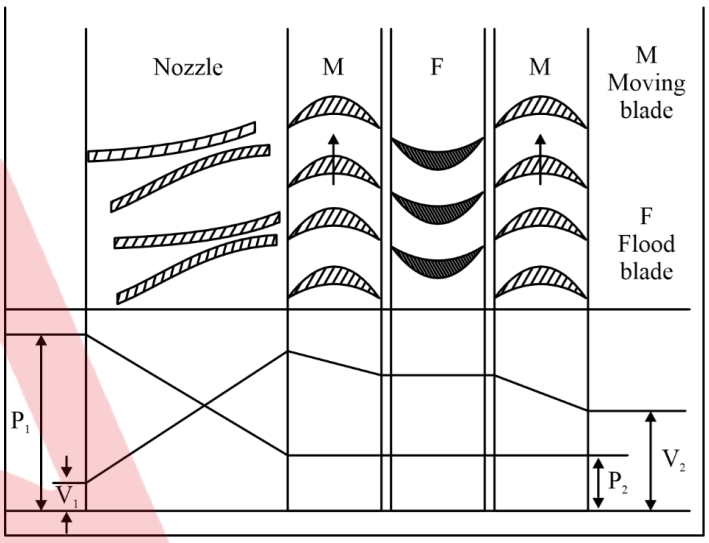
$$\boxed{W = 50\ \text{J}}$$

Q 81 Text Solution:

Both Statement A and Statement B are correct.

Statement A: In the Curtis stage turbine, the total enthalpy and pressure drop occur in the nozzles so that the pressure remains constant in all three rows of blades. This is a characteristic feature of Curtis turbines, where pressure is essentially dropped in the nozzles before entering the rotor blades.

Statement B: In the fixed (static) blade passage, both pressure and velocity remain constant. This is true for fixed blades or stator blades in a turbine.



Q 82 Text Solution:

The correct pairs are

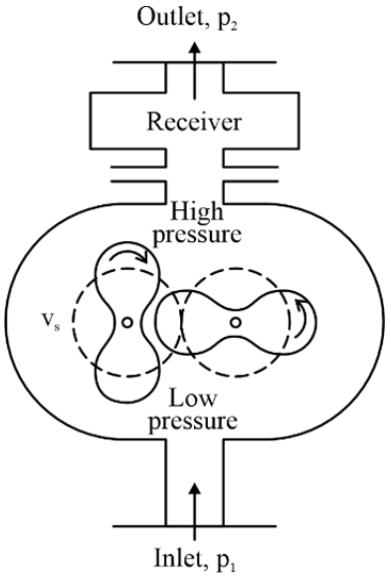
Francis turbine : Mixed flow turbine

Propeller turbine : Axial flow turbine

Kaplan turbine is also a type of axial flow turbine.

Q 83 Text Solution:

A lobe compressor is a type of positive displacement compressor that uses rotating lobed rotors to trap and compress gas. It operates by reducing the volume of gas trapped between the lobes to increase its pressure. Lobe compressors are valued for their smooth operation and are commonly used in various industries. The diagram of lobe compressor is



Q 84 Text Solution:

The correct match is

Column A	Column B

A. Velocity compounded impulse turbine	1. Curtis turbine
B. Simple impulse turbine	2. De-Laval turbine
C. 50% reaction turbine	3. Parson turbine

Q 85 Text Solution:

In a centreless grinding machine, the grinding wheel is the one of greater diameter and has a high rotational speed, while the regulating wheel is of smaller diameter and has a lower rotational speed.

Q 86 Text Solution:

The evaporator is a component in a refrigeration system where the refrigerant evaporates, absorbing heat from its surroundings. This heat absorption causes the refrigerant to change from a liquid to a vapor, and the cooled air is then circulated to provide cooling in the desired space.

Q 87 Text Solution:

Both Statement A and Statement B are correct, and B is the solution to the problem presented in A.

Statement A: LaMont boilers indeed face the challenge of bubble formation and sticking in the inner surface of heating tubes

Statement B: Raising the boiler pressure to critical pressure, where the steam and water have the same density, can indeed reduce the risk of bubble formation. This is a valid solution to the problem presented in Statement A.

Q 88 Text Solution:

The correct order of the flow of water in the power conversion of the Pelton wheel turbine is:

Penstock, nozzle, runner buckets, tail race

- **Penstock:** The water flows through the penstock, which is a pipe or conduit that carries the water from the reservoir to the turbine.
- **Nozzle:** The high-pressure water from the penstock is directed through a nozzle to increase its velocity before it reaches the runner buckets.
- **Runner Buckets:** The high-velocity water strikes the curved buckets on the runner of the Pelton wheel, causing the wheel to rotate and convert the kinetic energy of water into mechanical energy.
- **Tail Race:** After passing through the runner buckets, the water exits the turbine and flows into the tail race, which is a channel that carries the water away from the turbine and back to the natural watercourse.

Q 89 Text Solution:

An isochoric process is a thermodynamic process in which the volume of the system remains constant. Therefore, option 1, "constant-volume process," accurately describes an isochoric process.

Q 90 Text Solution:

High-carbon steels typically have a carbon content in the range of 0.6% to 2.0%.

Q 91 Text Solution:

As per boiler regulations, every boiler must be fitted with at least two safety valves.

Boilers are required to have at least two safety valves to ensure proper safety measures. This redundancy helps ensure that if one safety valve fails to operate, there is a backup for the safe release of excess pressure in the boiler.

Q 92 Text Solution:

Heating temperature T_g = 100°C or 373 K

Cooling temperature T_c = 20°C or 293 K

Refrigeration temperature T_e = –5°C or 268 K

$$(COP)_{VARS} = \frac{T_e}{T_g}\frac{(T_g - T_c)}{(T_c - T_e)}$$

$$= \frac{268}{373}\left(\frac{373-293}{293-268}\right)$$

$$\boxed{(COP)_{VARS} = 2.3}$$

Q 93 Text Solution:

Given

m = 1.4 kg/min or $\frac{1.4}{60}$ kg/sec.

P_1 = 1 bar

T_1 = 17°C or 290 K

P_2 = 6 bar

$PV^{1.35} = C$

Power input

$W_{in} = \left(\frac{n}{n-1}\right)[P_2V_2 - P_1V_1]$

or

$W_{in} = \left(\frac{n}{n-1}\right) mR[T_2 - T_1]$

(Assuming air as ideal gas)

$PV^n = C$

We can write $= \frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}$

$\frac{T_2}{290} = (6)^{\frac{1.35-1}{1.35}}$

T_2 = 461.47 K

$W_{in} = \left(\frac{1.35}{1.35-1}\right)\left(\frac{1.6}{60} \times 0.287\right)(461.47 - 290)$

$$\boxed{W_{in} = 4.43\ \text{kW}}$$

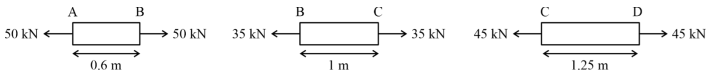
Q 94 Text Solution:

The correct match is

Properties of fluids	Related parameters
1. Density	I. Reciprocal of specific volume
2. Coefficient of compressibility	II. Reciprocal of bulk modulus of elasticity
3. Kinematic viscosity	III. Centistoke
4. Surface tension	IV. J/m^2

Q 95 Text Solution:

Load on individual member



Given

A = 500 mm^2

E = 200 GPa

Total elongation

$\delta_T = \delta_{AB} + \delta_{BC} + \delta_{CD}$

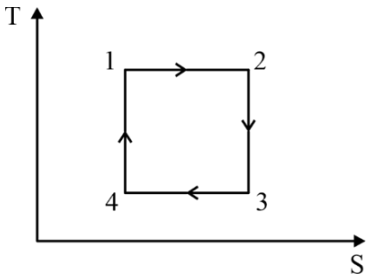
$= \frac{P_{AB}L_{AB}}{AE} + \frac{P_{BC}L_{BC}}{AE} + \frac{P_{CD}L_{CD}}{AE}$

$= \frac{(50\times10^3\times0.6\times10^3)+(35\times10^3\times1000)+(45\times10^3)(1.25\times10^3)}{500\times200\times10^3}$

$\boxed{\delta_T = 1.21 \text{ mm}}$

Q 96 Text Solution:

Carnot cycle



Process 1-2 → Reversible isothrmal expansion

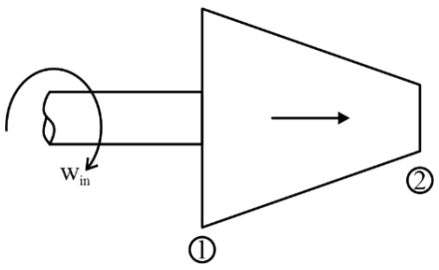
Process 2-3 → Reversible adiabatic expansion

Process 3-4 → Reversible isothrmal compression

Process 4-1 → Reversible adiabatic compression

Q 97 Text Solution:

Given



V_1 = 5 m/s

P_1 = 1 bar

V_2 = 7.5 m/s

P_2 = 7 bar

n_1 = 0.5 m^3/kg

n_2 = 0.15 m^3/kg

Using conservation of mass equation for steady flow

$\sum \dot{m}_{in} = \sum \dot{m}_{out}$

$\dot{m}_1 = \dot{m}_2$

$\frac{A_1V_1}{v_1} = \frac{A_2V_2}{v_2}$

$\left(\frac{d_1}{d_2}\right)^2 = \left(\frac{0.5}{0.15}\right)\left(\frac{7.5}{5}\right)$

$\boxed{\frac{d_1}{d_2} = 2.236}$

Q 98 Text Solution:

The primary purpose of using an economizer in a boiler system is to heat the feedwater by utilizing heat from the exhaust flue gases

An economizer is a heat exchanger that preheats the feedwater by recovering heat from the hot flue gases exiting the boiler. This helps improve the overall efficiency of the boiler system by utilizing waste heat that would otherwise be lost to the atmosphere. The preheated feedwater requires less fuel to reach the desired operating temperature, resulting in energy savings and increased efficiency.

Q 99 Text Solution:

The correct match is

Column A	Column B
A. Mechanical efficiency	1. Ratio of brake power to indicated power
B. Indicated thermal efficiency	2. Ratio of indicated power to fuel power
C. Volumetric efficiency	3. Ratio of actual volume to swept volume

Q 100 Text Solution:

The type of process described, where moisture is added to the air without changing its dry bulb temperature and the air is warmed up, is Heating and humidification.

In the context of winter air-conditioning for comfort, this process involves heating the air to make it warmer and humidifying it to add moisture without changing the dry bulb temperature.