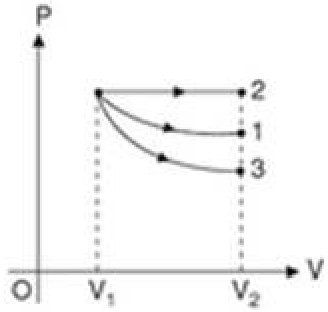
1. Ans. A

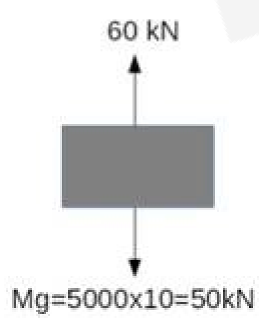



From the above graph, we see that:
Curve 1 - isobaric process
Curve 2 - isothermal process
Curve 3 - idiabatic process
Since work done Area under PV graph
=W2>W1>W3

2. Ans. C
We see that as per Newtons Law of cooling:
-dT/dt ∞(T-Tambient)
Now, t1-t2/time = k ( t1+t2/2 - T(surrounding))
On putting values of temp and time by keeping time and $t_{surr}$ same in form of variable, we have 3 different time, hence we get:
0.5/t1 = k (125/2- Tsu)
0.5/t2 = k (115/2-Tsu)
0.5/t3 =k (105/2 -Tsu) which shows that t1 < t2 < t3

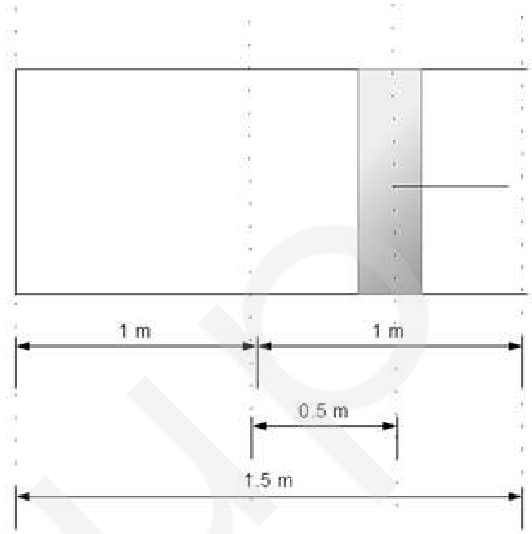
3. Ans. C
In any refrigerator a certain amount of heat Q2 is absorbed from the objects you want to cool and a larger amount of heat Q1 is released to the outside through the radiator behind the refrigerator. If you keep your hand on the radiator, it will feel warm. When the door of the refrigerator is kept open, the compressor will work all the time as the heat in the room is too large and the temperature never reaches the cutoff point of the thermostatic switch. So more heat is released into the room than what is absorbed. If the ventilation is insufficient this will cause the room to warm up.

4. Ans. D




If g=10m/s, the Net force = 60-50 = 10KN
Now F = ma
F = $10*10^3 = 10^4$KN
a = $10^4/5000 = 2m/s^2$

5. Ans. A




If N = 120 R.P.M, then frequency ω = 2*120/60 = 4 rad/s
So 2r = 2 m or r = 1 m
The piston will move 0.5m from its centre, so x = 0.5 m. Now the velocity of the piston can be calculated as:
v = ω $r^2/x^2$
= $4\pi 1^2/(0.5)^2$
= 16π

6. Ans. A
a = 3i + j + k and b = 2i- 2j + k
cosθ = a.b / |a||b|
= 5/3√11 = 5/√99 $\sin^2\theta + \cos^2\theta = 1$
sinθ = √1- $\cos^2\theta$
= √1-25/99
= √74/99

7. Ans. D
Let f = y = $(x- 8)^{2/3} + 1$
Now slope of line m1 = dy/dx which is 2/3 $(x-8)^{-1/3}$ at point (0,5) where m1 = -1/3 for normal line which is m1 x m2 = -1
Now m1 = -1/3 and m2 = 3. So equation of line will be y=mx+c
y=3x+c at coordinates (0,5) where c=5

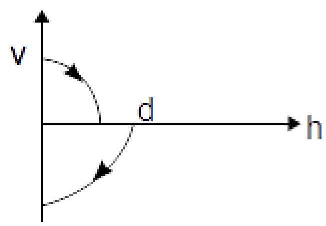
8. Ans. A
We see that (N - 1) n / 2
Since locks are 20 and matching keys are also 20, then:
= (20 - 1) 20 / 2
= (19 * 20) / 2
= 380 / 2
So the maximum matching trials needed will be 190

9. Ans. B
We see that when Φ(x,y,z) is a scalar function and $\delta^2\Phi / \delta x^2 + \delta^2\Phi / \delta y^2 + \delta^2\Phi / \delta z^2 = 0$ , then Φ is harmonic

10. Ans. C
From the question, we see that A and B are independent events, so their selection will be:
P(A)*P(B)=0.3
0.5*P(B)=0.3
Hence the probability of B getting selected is 0.6

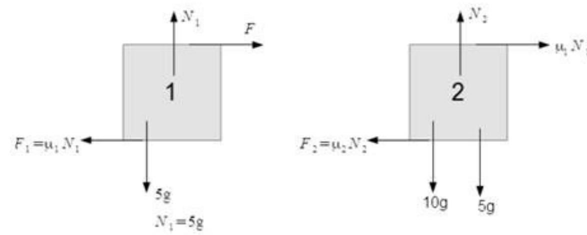
11. Ans. B
We see that the frequency of spring balance is observed as 2 Hz, so finding the spring stiffness, we get:
K=F/l = 200/0.1 = 2000N
Now the frequency f=1/2π√k/m
F=1/2π√2000/m
So finding mass, we get, m = 12.5

12. Ans. A
From the above graphs we see that graph between h and v is a parabola, so at point h=d , its velocity becomes zero through negative downward direction. We see that as its negative value increases, then at a point at h=0, its velocity gets reversed which further goes on decreasing and results 0 at point h=d/2, so we see that graph shown in option a is correct.




13. Ans. C
We see that, the power of the machine, P=10 kW=$10^4$ W and time for which machine is used, t=2.5 minute=2.5* 60 seconds=150 s
Now since the mass of machine, M=8 kg and specific heat of aluminum, C=0.91x $10^3$ J/kgK, then rise in temperature of block let say be Δt.
The energy supplied to aluminum block will be heat produced or heat transfer to surroundings
= Q-Q/2
= Q/2
So, Q/2 m CΔt
Δt = Q/2mC
= $10^4$x150/2*8*0.9*$10^3$
= $103^0$C

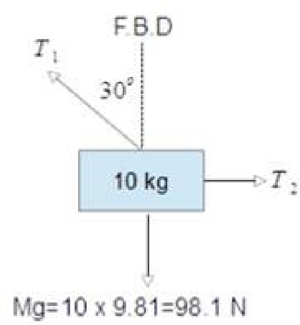
14. Ans. D
We see that:




Force $F_1$=5g $\mu_1$ and force $F_2$ = 15g$\mu_2$
Now the minimum force will be: $F_{min}$ = $F_1$ + $F_2$
= 5g $\mu_1$ + 15g$\mu_2$
Also, F = $\mu_1 N_1$ - $\mu_2 N_2$ = ma
F = ma = 10a
Now again, F - $\mu_1 N_1$ = ma = 5a
= 5g $\mu_1$ + 15g$\mu_2$ - 5g $\mu_1$ = 5a, so a= 3g $\mu_1$
= 5g $\mu_1$ + 15g$\mu_2$ = 3 - g$\mu_2$
= $\mu_1$/6$\mu_2$ - ½ = 0
= $\mu_1/\mu_2$ = 3

15. Ans. D
We see that the moment of inertia of circular ring about diameter is ½ $mr^2$. As the axis of rotation given is tangent to the ring, then the moment of inertia of ring about tangent is ½ $mr^2$ + $mr^2$ = (3/2)$mr^2$ using parallel axis theorem.
Further, m= ρL and radius r is given by 2πr = L, so r = L/2π. On substituting m and r values, we see that moment of inertia will be:
= (3/2) Lρ×$L^2$/ 4$\pi^2$
= 3ρL3/8π2

16. Ans. B
Consider the figure, so




Σ$F_v$ = 0$T_1$cos $30^0$ = 98.1
So $T_1$ = 98.1/cos $30^0$
Σ$F_H$ = 0, so $T_2$ = $T_1$sin $30^0$
So $T_2$ = 98.1 * sin $30^0$/ cos $30^0$
On solving we get, tension in the horizontal string will be 57 N

17. Ans. A
From the graphs we see that the ice at -$10^0$C converts to ice at $0^0$C with increase in temperature. When the block is heated, ice at $0^0$C gets converted into water at $0^0$C with constant temperature due to phase occurrence change. It is noted that water at

$0^0C$ on heating changes to water at $100^0C$ with increase of temperature while water at $100^0C$ converts to steam at $100^0C$ with change of phase. With this, it seems that the graph shown in option (a) is correct.

18. Ans. D
We see that as per Stefan's law radiation. Intensity $\propto T^4$, so if we double the Kelvin temperature, then its intensity will increases by a factor $2^4 = 16$

19. Ans. B
We know that transmission of heat with the result of molecular collision is conduction where molecules collides and transfer their energy to other molecules. In case of convection, there is a heat current due to density variation.

20. Ans. D
We see that:
$\Delta Q/\Delta t = KA\Delta T/\Delta x$
$= K(\pi r^2)\ \Delta T / L$
Since $\Delta Q/\Delta t$ is maximum in case of $r^2$ / Lwhere it is also maximum
Now Q A/L = $r^2$ / L, so finding every relational value as:
Q $r^2 / L = 1^2/50 = 0.02$
Q $r^2 / L = 0.5^2/50 = 0.125$
Q $r^2 / L = 2^2/100 = 0.04$
Q $r^2 / L = 1^2/3 = 0.33$
So rod having L=3cm and r=1cm conducts most heat per unit time.

21. Ans. B
Thermometers work on the principle that elements and compounds expand with increase in temperature. It is seen that liquids or solids which expands at constant rate over required temperature are applied as amount on expansion can be measured and compared against expansion rates for knowing the temperature.

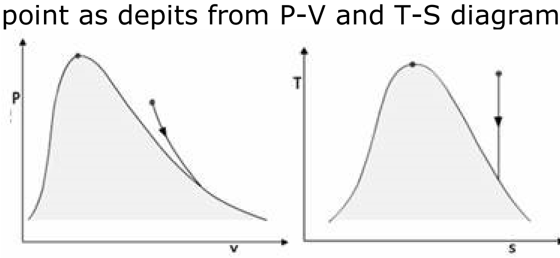
22. Ans. A
Given:
Working temperatures in evaporator coils of refrigerator as Te = -25 °C = 248K
Working temperatures in condenser coils of refrigerator as Tc = 30 °C = 303K
Now, COP of refrigerator = 0.85, so it will be $COP = 0.85*COP_{max}$
COP = Refrigeration effect/Power input = 0.85*( Te /Tc – Te)
Finding Refrigeration effect, we get:
2+0.85 (248 / 303-248)
= 7.66KW

23. Ans. B
We see that total temperature T=al+b, so in case of thermometer to be in melting ice, T=0, so the equation will result as:
T=al+b
0=al+b
Now since l is the length of mercury column as 10 mm, so we have:
0=a*10+b------(i)
Now total temperature T=al+b when thermometer is placed in steam, where T=100, so the equation will result as:
T=al+b
100=al+b
Now as l length of mercury column is 250 mm, so we have:
100=a*250+b------(ii)
From above equations, we see that
a=(-b/10) and b=(-100)/24
so a=10/24
Now finding temperature T as:
T=(10l/24) – (100/24), since l=58, then:
T = 580-100/24 = $T=20^0$

24. Ans. D
From the above we see that amount of water ($m_W$) = 200g which is 0.2kg, T1 = 60 and T2=100
Now, specific heat of water will be $C_W$=4.187 Kj/KgK while latent heat of water is 2257 KJ/kg, then:
$m_s$ * latent heat = $m_W c_W \rho_W (T_2-T_1)$
$m_s$ * 2257 = 0.02 * 4.187* (100-60)
so $m_s = 14.8 * 10^{-3}$ kg
$m_s$ = 14.8g

25. Ans. A
The efficiency of an engine working between temperatures T1 and T2 is given by fraction of heat absorbed by an engine that can be converted into work. If T1= 727 °C = 1000K and T2 =227 °C = 500K, then efficiency is given as:
$\eta = 1 - T2/ T1$
$\eta = 1 - 500/1000$
$\eta = 0.5$ which is 50%

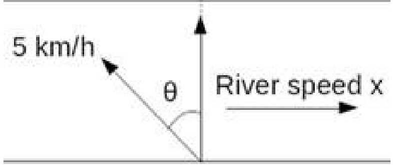
26. Ans. B
We that a thermal power plants uses water for its working and when turbine blades rotates with high pressure and high temperature steam, then steam loses its energy which gives low pressure and temperature steam at outlet of turbine where steam expands until reached at saturation point as depits from P-V and T-S diagrams.



In this, an external heat gets added using heat exchanger which brings the fluid back to original temperature. When pressure of fluid remains same, the temperature rises and liquid gets transformed to vapor and brings to original temperature. The full cycle of thermal power plant is called as Rankine Cycle.

27. Ans. A

Given, time taken is 15minutes and boat speed is 5km/hr with river width as 1km



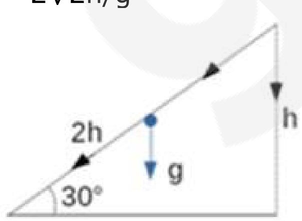

So we see that:
Time = Distance/Speed
But time taken is 15 minutes which is 0.25 hrs
Now, ¼ = 1/5cosθ, so cosθ = 4/5
$\sin\theta = \sqrt{1-\cos^2\theta}$
$= \sqrt{1-16/25} = 3/5$
Now 5sinθ = 3 or 5sinθ = x
Hence x=3km/hr

28. Ans. C

Since velocity is vector quantity, so average velocity will be displacement upon time. From the figure shown, coordinates for center of circle is (0,0) while coordinate for point A be (0,1) and for point B is (0,-1), then Average Velocity=Displacement / Time. In this question, total displacement is 2m and time elapsed is 1s, so Average Velocity will be 2.0m/s.

29. Ans. B

To solve this question, we have to consider two cases:
Case 1: When the object is sliding down
Then $S=ut+1/2at^2$
Now since the initial velocity u=0 and acceleration a=g, then solving for $S=ut+1/2at^2$
$2h=1/2 * g/2* t_1^2$
Now finding initial time, we get:
$t_1^2= \sqrt{8h/g}$
$= 2\sqrt{2h/g}$




Case II: When considering Free fall of object
Then $h=1/2 * gt_2^2$
$t_2= \sqrt{2h/g}$
$= t_1 /2$

30. Ans. D

Work and heat transfer is zero in case of throttling process
$h_1 + V_1^2/2 +q$
$h_2 + V_2^2/2 +w$
w =0; q=0; $V_1 = V_2$
Hence h1=h2

31. Ans. C

As per part geometry, part material, shot material, shot quality, shot intensity, and shot coverage, shot peening result in increase in fatigue life up to 1000%.

32. Ans. B

At the time of strain hardening, strength of the metal increases and its ductility decreases.

33. Ans. A

Power screw is a device that converts rotary motion into linear motion and transmits power. Among the following, ACME threads are used to take load in both the direction since they are strong, smooth and has less wear and tear.

34. Ans. A

We have:
Maximum hole size – 50+0.05
Clearance fit = 0.02 mm
Shaft tolerance = 0.03 mm
So, minimum shaft size = 50-0.02-0.03
Now we see that maximum clearance between hole and shaft will be:
Maximum hole size – minimum shaft size
= (50+0.05) – (50-0.02-0.03)
= 0.100 mm

35. Ans. D

Given:
n = 0.5, C = 350 and $V_2 = 0.8V_1$
Using Taylor equation:
$V_1T_1^n = V_2T_2^n$
Since n=0.5
$V_1T_1^{0.5} = V_2T_2^{0.5}$
Now finding $T_2 = (10/8)^2T_1$
$T_2 = 1.56T_1$
Now we see that percentage increase in tool life will be:
$T_2 - T_1 / T_1$
$= 1.56T_1 – T_1 / T_1 = 56\%$

36. Ans. D

For mass production of seamless tubes uses extrusion process as when rolling welding is applied, it provides seam in which the strength is very less.

37. Ans. C

Misrun is a defect which occurs using casting alloy where surface is shiny and can be cleaned. This defect appears due to lack of alloy fluidity, slow mold filling, inadequate venting of mold and low temperatures.

38. Ans. B

Given:
Heat received $Q_S$ = 100,000kj/min

Heat rejected $Q_R$ = 66,000Kj/min
Pump power = 1400Kj/min
Total Work $W_{net} = Q_S - Q_R$
$W_{net} = Q_S - Q_R$
= 100,000 – 66,000
= 34,000Kj/min
Turbine work = $W_{net}$ + Pump power
= 34,000 + 1400 = 35400 KJ/min
Now work of Turbine = 35400/60 = 590KW
Thermal Efficiency = $1 - Q_R / Q_S$
= 1 – 66000/100000 = 0.34
= 34%

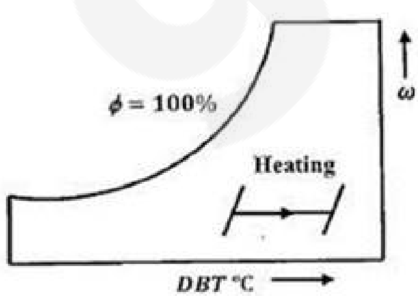
39. Ans. D
Given
ρ = 100 kPa
$V_2$ = 20 liters = $20*10^{-3} m^3$
$V_1$ = 10 liter = $10*10^{-3} m^3$
Now the work done will be:
$\rho dv = \rho (V_2 - V_1)$
= $100* (20 - 10) * 10^{-3}$
= 1KJ

40. Ans. C
Given:
Thermal efficiency of heat engine η = 35% = 0.35
Heat supplied by the engine Qs = 2 kW
From the formula of efficiency $\eta = 1 - Q_R/Q_S$
= $0.35 = 1 - Q_R / 2$
We see that heat rejected will be $Q_R$ = 1.3KW

41. Ans. C
Joule-Thompson coefficient of an ideal gas is zero as its enthalpy depends on only temperature.

42. Ans. C
Density is ratio mass to volume. If container is sealed hence mass and volume both is fixed which results in no change in density.
On the other hand, density is ratio of pressure to temperature in that case pressure increases in the same ratio as the temperature increases which nullify each other and hence density is unchanged.

43. Ans. D

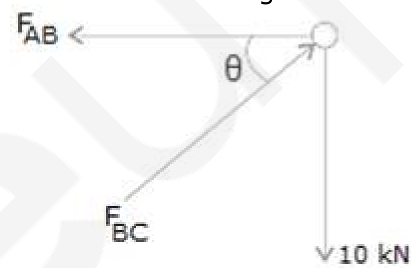



From the above graph we see that when a particular mass of moist air in air tight vessel is heated to high temperature, its relative humidity of air decreases.

44. Ans. A
We know that V1 = 100m/s, R = 287J/kgK, V2 = 300m/s, γ = 1.4 and T1 = $127^0$C = 400K
Now the inlet match number will be:
$M1 = V1/\sqrt{\gamma RT1}$
= $100 / \sqrt{1.4 \times 287 \times 400}$
= 0.249

45. Ans. D
If two equal forces at a point acts an angle Φ then magnitude of resultant force is
= $2F\cos(\Phi/2)$
$60\sqrt{3} = 2F\cos(60/2)$
$30\sqrt{3} = F\sqrt{3}/2$
F = 60 N
hence magnitude of each force = 60 N

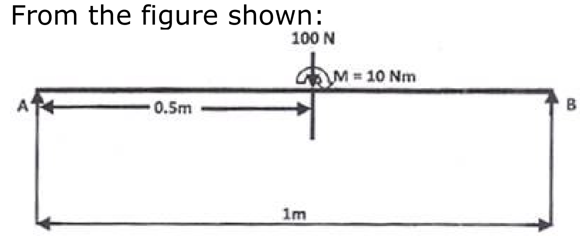
46. Ans. C
We see from the figure that:




$\theta = \tan^{-1}(0.5/1) = 26.5^0$
Now sum of forces at point V is:
$\Sigma V = 0 = F_{BC}\sin\theta - 10 = 0$ = 22.36KN
Now sum of forces at point H is:
$\Sigma H = 0 = F_{BC}\cos\theta - F_{AB}$
So force on member AB = 19.99KN

47. Ans. A
We see from the figure that:
ΣV = 20 – 60 = -40
ΣH = 40 – 80 = -40
Now Magnitude will be:
$R = \sqrt{(-40)^2 + (-40)^2}$
$R = 40\sqrt{2}$

48. Ans. B
From the figure shown:




Taking moment about A, we get:
$100*0.5+10 = R_B$
Solving for $R_B$, we get, $R_B$ = 60N
Solving for $R_N$, we get $R_N$ = 100 - 60N = 40N
Mow the maximum bending moment will be 30

49. Ans. C

**Given**

L=12m=12000mm

**Thermal stress produced, is given by**

$$\sigma_{th} = \frac{E(\alpha \Delta t L - \lambda)}{L}$$

$$\sigma_{th} = \frac{2\times10^5(12\times10^{-6}\times(40-24)\times12000-1.5)}{12000}$$

$$\sigma_{th} = 13.4N/mm^2$$

Note : The expansion takes place in rod from both ends so we do not need to take half length of the gap but twice of half length which is full length i.e. 1.5 mm.

50. Ans. A
Given:
Gauge length, L = 250 mm = 0.250 m
Elongated Gauge length, L = 1.25 mm = $1.25*10^{-3}$ m
Force F = 175 kN = 175,000 N
cross-sectional area A
$=\pi r^2 = \pi(d/2)^2 = \pi(25*10^{-3}/2)^2 = 490.625 *10^{-6}m^2$
Now Gradient of the graph = Force/ Elongated Gauge length
= 175,000 N/$1.25*10^{-3}$ m = $140*10^6$ N/m
Young's modulus of elasticity = (gradient)(L/A)
= $140*10^6$ N/m (0.250m/490.625 $*10^{-6}m^2$)
= 71 GPa

51. Ans. C
The maximum torque supplied to the shaft will be:
$\tau_{max}$= TC/J
$50x10^6N/m^2$ = T(0.021m) / (π/2)[$(0.021m)^4$ – $(0.015m)^4$]
T = 538Nm
Now frequency of rotation = P=2πfT
$80*10^3$ = 2πf(538Nm)
f= 80,000/3378.64 = 23.67Hz
So speed ω = 1778 rpm

52. Ans. B
We see that deflection using moment area method will be:
δA = Area/EI
= ½ x (2PL/3)*(2l/3) * (1/3+4/9l) / EI
= $PL^3$/EI * 2/9*7/9
= 14/81*$PL^3$/EI

53. Ans. A
We that Steel Heat Treating gives the most common processes of Carburizing, Carbonitriding, and Gas Nitriding.

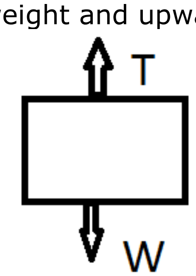
54. Ans. D
By considering the Crystal Structure shown in the table, we see that for metals Iron — Copper — Zinc, the correct structure will be BCC — FCC — HCP
Table: Crystal Structure of Metals

| | | | |
|---|---|---|---|
| Aluminum | FCC | Nickel | FCC |
| Cadmium | HCP | Niobium | BCC |
| Chromium | BCC | Platinum | FCC |
| Cobalt | HCP | Silver | FCC |
| Copper | FCC | Titanium | HCP |
| Gold | FCC | Vanadium | BCC |
| Iron | BCC | Zinc | HCP |
| Lead | FCC | Zirconium | HCP |
| Magnesium | HCP | | |

55. Ans. A
The heat generated in operation will be:
H = $(12,000)^2$ (0.0001) (0.2)
= 2880 J
Now the volume of weld nugget is V= 2.5xπ$(6)^2$/4 = 70.7 $mm^2$
Heat required to melt volume of metal will be $H_m$
= 70.7 (12.0)
= 848 J which is 29%

56. Ans. C
We see that specific gravity of manometer fluids is 0.85 and the standard density of water is 1000kg/m ³. Now, the density of fluid will be:
P = SG ($pH_2O$)
= (0.85)(1000kg/m ³)
= 850 kg/m ³
P = P atm + pgh
= 96 kPa + (850kg/m ³)(9.81m/s ²)(0.55m)
= 100.6 kPa

57. Ans. B
From the free-body diagram, we see that forces acting on concrete block in air are its weight and upward pull action by the rope.




These forces are balanced and the tension in the rope will be equal to weight of the block as:
V = (0.4 m)(0.4 m)(3 m)
= 0.48 $m^3$
FT, air = W =r concrete gV
= (2300kg/$m^3$) * (9.81 m/$s^2$) * (0.48 $m^3$)

$*(1KN/1000kgm/s^2)$
= 10.8 KN which is 55%

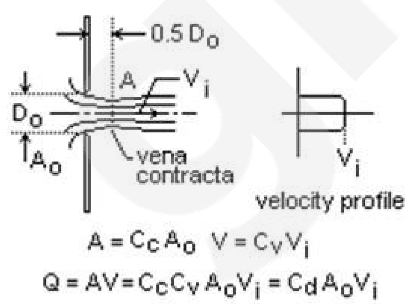
58. Ans. C
From above we see that v is the vector where all components are zero for v to be zero.
Now we will find the stagnation points as:
u = 0.5 + 0.8x = 0 ------ x= -0.625m
v = 1.5 - 0.8y = 0 ------ y = 1.875m
We see that there exists one stagnation point at x= -0.625m, y = 1.875m

59. Ans. B
We see from the figure that point 2 is a stagnation point and thus $V2 = 0$ and $z1 = z2$ results as the application of Bernoulli equation between points 1 and 2 gives.
$p1/\rho g + V_1^2/2g + z1 = p2/\rho g + V_2^2/2g + z2$
$V_1^2/2g = p2 - p1/\rho g$
The gage pressures at points 1and 2 can be expressed as
$p1 = \rho g (h_1 + h_2)$
$p2 = \rho g (h_2 + h_1 + h_3)$
Putting $p1$ and $p2$ expressions in Bernoulli equation and solving for $V1$, we get:
$V_1 \sqrt{2gh_3}$
$= \sqrt{2} (9.81m/s^2)(0.12m)$
= 1.53m/s

60. Ans. A
The pressure difference between the inside and outside of liquid droplet depends on the surface tension and the radius of liquid droplet. If the liquid droplet has diameter d due to surface tension σ, then the relation is given as $P_i - P_o = 4\sigma/d$

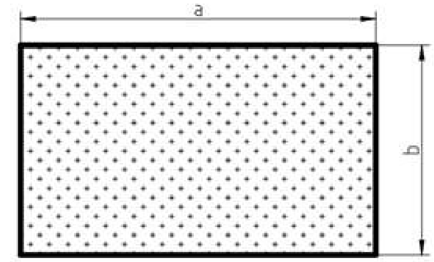
61. Ans. D
We see that:
u= -δψ / δy = 3 and v= δψ / δx = 4
Now the resultant velocity will be:
$v = \sqrt{u^2 + v^2} = \sqrt{3^2 + 4^2} = 5$ units

62. Ans. C




We see that area A of vena contracta is less than area $A_o$ of orifice as velocity is more. In case of sharp edge circular orifice, $A/A_o = C_c = \pi/(\pi + 2) = 0.611$ where $C_c$ is coefficient of contraction. In sharp orifice, coefficient of discharge is normally as 0.62.

63. Ans. B




We see that the hydraulic diameter be written as $d_h = 4 A / p$
where
$d_h$ = hydraulic diameter (m, ft)
A = area section of the duct or pipe ($m^2$, $ft^2$)
p = "wetted" perimeter of the duct or pipe (m, ft)
But we see that hydraulic diameter of rectangular duct or pipe can be calculated as
$d_h = 4 a b / (2 (a + b))$
$= 2 a b / (a + b)$
where
a = width/height of the duct (m, ft)
b = height/width of the duct (m, ft)

64. Ans. A
Given:
Heat transfer coefficient h = 30 $W/(m^2K)$
Area of flat plate = A = 1 x 0.5 m
Temperature T1 = 30 °C
Temperature T2 = 400 °C
Now in flat plate, heat transfer by convection is given as hAΔT
= 30 * 1 * 0.5 * (400-30)
= 5550 Watts = 5.5KW

65. Ans. B
The thickness of insulation will be δ
K=0.043 Wi(m K))
Q = 400 $W/m^2$
Ti = 225 °C
T0 = 40 °C
We see that according to formula:
Q = kA/δ * ΔT
Q/A = k/δ * ΔT
400 = 0.043/δ ( 225 – 40) = 2cm

66. Ans. A
$Q = A\varepsilon\sigma T^4$
$P = 5.67 \times 10^{-8} Wim^2K^4 \times (328)^4$

67. Ans. C
Grey body is a body which emits radiation in constant proportion to the corresponding black-body in which monochromatic emissivity of body is independent of wavelength.

68. Ans. C
We see that a possible critical insulation thickness yields in maximum rate of entropy generation

69. Ans. A
As per First law of thermodynamics process:
$\Delta E_1 = Q_1 - W_1 = 23 - 5 = 15Kj$
$\Delta E_2 = Q_2 - W_2 = -50 - 0 = -50Kj$

$\Delta E_3 = Q_3 - W_3$
In case of complete cycle, change in energy is zero, so:
$\Delta E_1 + \Delta E_2 + \Delta E_3 = 0$
Putting values we see that $\Delta E_3$ = 32Kj
Now, the third process is adiabatic, so Q3=0, hence
$\Delta E_3$ = 0 – W3
$W_3 = -\Delta E_3$ = -32Kj

70. Ans. B
Multi stage centrifugal pumps are used for high head

71. Ans. D
We see that density of wire is: D = Mass/Volume
$= \rho = M / \pi R^2 L$
Hence the percentage error in density will be:
$\Delta\rho/\rho \times 100 = \pm (\Delta M/M + 2\Delta R/R + \Delta L/L) \times 100$
$= \pm(0.003/3 + 2 \times 0.005/0.5 + 0.06/6) \times 100$
$= \pm(0.01 + 0.02 + 0.01) \times 100 = 4\%$

72. Ans. B
A Francis turbine is an inward flow reaction turbine. The Kaplan turbine is an outward flow reaction turbine where fluid changes pressure as it moves through the turbine. Fourneyron turbine is an axial flow turbine where flow of water is in the direction parallel to the axis of the shaft

73. Ans. C
Dead Weight Pressure Gauge is normally applied for calibration of other Pressure Gauge which carries a Piston and a Cylinder of known area and connected to a Fluid by a Tube.

74. Ans. D
We see that static load capacity will be
$C_o = kd^2 / 5 \times Z$
$C'_o = k(4d)^2 / 5 \times Z/2$
$C'_o / C_o = 4^2 \times 2 = 32$
Hence the static load capacity of ball bearing increases 8 times $C'_o = 32\ C_o$

75. Ans. B
We see that sound travels faster in summer season than in winter season as temperature is major factor in speed of sound where temperature increases, then speed of sound also increases, while in winters the velocity of sound decreases.

76. Ans. C
We see from the question: Pb = 0.5 and γ = 1.4
Now, we know that the critical pressure ratio is $P_c/P_b = [2/\gamma+1]^{\gamma / \gamma-1}$
Now $P_c = 0.5\ (2/2.4)^{1.4/0.4}$
So critical pressure Pc will be 0.2641MPa
Now from the above we see that when we increase pressure from 0.1MPa to 110.26MPa, then mass flow rate will remain constant. Hence above 0.641 MPa to 0.4MPa, the mass flow rate will slowly decrease.

77. Ans. A
Let $\Delta = \begin{vmatrix} b^2+c^2 & ab & ac \\ ba & c^2+a^2 & bc \\ ca & cb & a^2+b^2 \end{vmatrix}$

Multiply R1, R2 and R3 by a, b, c, we get
$\Delta = 1/abc \begin{vmatrix} a(b^2+c^2) & a^2b & a^2c \\ b^2a & b(c^2+a^2) & b^2c \\ c^2a & c^2b & c(a^2+b^2) \end{vmatrix}$

Taking a, b, c common from C1,C2 and C3
$= abc/abc \begin{vmatrix} b^2+c^2 & a^2 & a^2 \\ b^2 & a^2+c^2 & b^2 \\ c^2 & c^2 & a^2+b^2 \end{vmatrix}$

Applying R1—R1 + R2 + R3
$= \begin{vmatrix} 2(b^2+c^2) & 2(a^2+c^2) & 2(a^2+b^2) \\ b^2 & a^2+c^2 & b^2 \\ c^2 & c^2 & a^2+b^2 \end{vmatrix}$

Taking 2 common from R1
$= 2\begin{vmatrix} (b^2+c^2) & (a^2+c^2) & (a^2+b^2) \\ b^2 & a^2+c^2 & b^2 \\ c^2 & c^2 & a^2+b^2 \end{vmatrix}$

Applying R2—R2 – R1 and R3---R3 – R1
$= 2\begin{vmatrix} (b^2+c^2) & (a^2+c^2) & (a^2+b^2) \\ -c^2 & 0 & -a^2 \\ -b^2 & -a^2 & 0 \end{vmatrix}$

Applying R1—R1 + R2 + R3
$= 2\begin{vmatrix} 0 & c^2 & b^2 \\ -c^2 & 0 & -a^2 \\ -b^2 & -a^2 & 0 \end{vmatrix}$

On expanding along R1, we get:
$2\ [a^2b^2c^2 + a^2b^2c^2]$
$= 4a^2b^2c^2$

78. Ans. D
We see that in a reservoir as shown, there exists flow of path of arbitrary geometry from one reservoir to other by controlling

thermodynamic state. If P1 is reduced, it will flow the fluid from A to B at a rate which increases with pressure drop till velocity at certain point is obtained. Here a choked plane will lower in downstream pressure with no effect on conditions upstream due to rarefaction waves flowing at sound speed. Reduction in P1 increases pressure drop across choked plane where pressure gradient is indeterminate. Here ratio of critical pressure P* at choked plane to inlet pressure $P_0$ is critical pressure ratio ($P^*/P_0$). In case of isentropic flow in nozzle, critical pressure ratio is $P^*/P_0 = [2/\gamma+1]^{\gamma/\gamma-1}$

79. Ans. D

Resilience is ability of a material to absorb energy when it is deformed elastically, and release that energy upon unloading. Fatigue is weakening of material due to repeated loads. Stiffness is the material's resistance to change in shape and depends on elastic deformation.

80. Ans. A

Given:

Speed of Pelton wheel turbine U = 2000 rpm

Pelton wheel turbine head H = 125 m

D of the wheel will be = 2U/ω

But u=V/2, so u = 24.76 m/s

Also, u = πDN/60

We can also see that rotational speed N is $N = U/\pi D$

u = πDN/60 = 24.76 = 3.14 x D x 2000 / 60

= 24 cm

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