

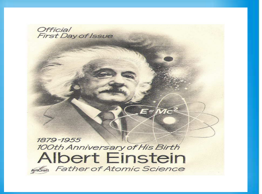

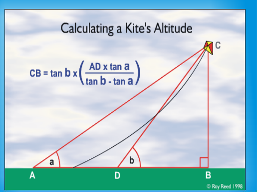

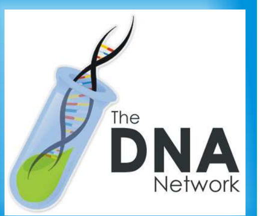

GATE - CHEMICAL ENGINEERING

MOCK TEST PAPER

- *There are a total of 65 questions carrying 100 marks.*
- *Questions (1-25) will carry 1-mark each and questions (26-55) will carry 2-marks each.*
- *Questions (56-65) belongs to general aptitude (GA). Questions (56-60) will carry 1-mark each, and question (61-65) will carry 2-marks each*
- *For Q.1-25 and Q.56-60 1/3 mark will be deducted for each wrong answer.For Q.26-51 and Q. 61-65 2/3 mark will be deducted for each wrong answer. The question pairs (Q.52, Q.53) and (Q.54, Q.55) are linked questions.For Q.52 &54 2/3 mark will be deducted. There is no negative marking for Q.53 &Q.55.*
- *Q.48-51 are common data questions. If first question is attempted wrongly then answer of second question will not be evaluated.*
- *Pattern of questions : MCQs & Numerical*
- *Total marks : 100*
- *Duration of test : 3 Hours*

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Q 1-25 (1 MARK EACH)

1. The product of Reynolds number and Prandtl number is called

(A) Rayleigh number

(B) Peclet number

(C) Stanton number

(D) Graetz number

2. The power required to crush 1000 tons/h of limestone (work index for limestone = 12.74) if 80 percent of the feed passes a 50.8 mm screen and 80 percent of the product passes a 3.175 mm screen, is _________.

3. The inverse Laplace transform of $\frac{1}{2s^2+3s+1}$ is

(A) $e^{-t/2} - e^{-t}$

(B) $2e^{-t/2} - e^{-1}$

(C) $c^{-1} - 2e^{-t/2}$

(D) $e^{-t} - e^{-t/2}$

4. In a countercurrent gas absorber, both the operating and equilibrium relations are linear. The inlet liquid composition and the exit gas composition are maintained constant. In order to increase the absorption factor

(A) The liquid flow rate should decrease

(B) The gas flow rate should increase

(C) The slope of the equilibrium line should increase

(D) The slope of the equilibrium line should decrease

5. A mixture of nitrogen and acetone vapour at 760 mm Hg and 27°C has a percentage solution of 75%. Its molal absolute humidity is_________.(Vapour pressure of acetone is given by

$$\ell n\, p^{sat} = 14.717 - \frac{297595}{T - 39.52})$$

6. If the moisture content of the wet solid on dry basis is twice the moisture content on wet basis, then the moisture content on we basis should be

(A) 0.5 $\frac{\text{kg moisture}}{\text{kg wet solid}}$

(B) 1 $\frac{\text{kg moisture}}{\text{kg wet solid}}$

(C) 1.5 $\frac{\text{kg moisture}}{\text{kg dry solid}}$

(D) 1.5 $\frac{\text{kg moisture}}{\text{kg dry solid}}$

7. Which of the following pairs are correctly matched?

1. Fourier equation for conduction : Transport of energy
2. Newton's equation for shear stress : Transport of momentum
3. Fick's law of diffusion : Transport of mass

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

8. Which one of the following is the correct sequence of the given components of the electromagnet spectrum in the increasing order of their wavelength band?

(A) Gamma rays — Infrared rays – Ultraviolet rays – Microwaves
(B) Microwaves – Ultraviolet rays – Infrared rays – Gamma rays
(C) Gamma rays – Ultraviolet rays – Infrared rays – Microwaves
(D) Microwaves – Infrared rays – Ultraviolet rays – Gamma rays

9. For turbulent flow of an incompressible fluid through a pipe, the flow rate Q is proportional to $(\Delta P)^n$, where ΔP is the pressure drop. The value of exponent n is __________.

10. A designer chooses the value of fluid flow rates and specific heats in such a manner that the heat capacities of the two fluids are equal. A hot fluid enters the counter flow heat exchanger at 100°C and leaves at 60°C. The cold fluid enters the heat exchanger at 40°C. The mean temperature difference between the two fluids is

(A) (100 + 60 + 40) / 3°C

(B) 60°C

(C) 45°C

(D) 20°C

11. Species A is diffusing at steady state from the surface of a sphere (radius = 1 cm) into a statement fluid. If the diffusive flux at a distance r = 3 cm from the centre of the sphere is 27 mol/cm^2, the diffusive flux in mol/cm^2 at a distance r = 9 cm is_________.

12. The volume rate of laminar flow of a Newtonian fluid of constant density in a circular tube of diameter d at steady state is proportional to

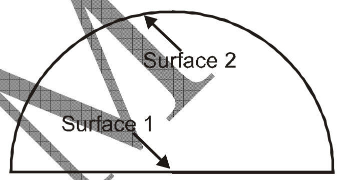
(A) d^2

(B) d^4

(C) d^3

(D) d

13. A well-insulated hemispherical furnace (radius = 1 cm) is shown in Fig. The self view factor of radiation for the curved surface 2 is_________.



14. A thin flat plate 2 m × 2 m is hanging freely in air. The temperature of the surroundings is 25°C. Solar radiation is falling on one side of three plate at the rate of 500 W/m^2. Temperature of the plate will remain constant at 30°C, if the convective heat transfer coefficient (in W/m^2 °C) is

(A) 25

(B) 50

(C) 100

(D) 200

15. The following liquid phase reaction is taking place in an isothermal CSTR

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

$$2A \xrightarrow{k_3} D$$

Reaction mechanism is same as the stoichiometry given above, Given $k_1 = 1\ min^{-1}$, $k^2 = 1\ min^{-1}$, $k_3 = 0.5$ L/mol min; C_{A0} = 10 mol / L, C_{B0} = 0 mol/L and C_B = 1 mol / L, the solution for F / V (flow rate/reactor volume in min^{-1}) yields ________

16. Match the items mentioned in the left column with the appropriate item in the right column.

(I) dU	(a) TdS – PdV
(II) dA	(b) TdS – VdP
	(c) –PdV – SdT
	(d) VdP – SdT

(A) (I) – (a), (II) – (b)

(B) (I) – (c) , (II) – (d)

(C) (I) – (a), (II) – (c)

(D) (I) – (b), (II) – (d)

17. A vessel initially contains n_0 mol of water vapour only. If decomposition of water vapour occurs according to the reaction

$$H_2O \rightarrow H_2 + \frac{1}{2}O_2$$

the fractional decomposition of water vapour in terms of the reaction coordinates ε is equal to

(A) $\frac{\varepsilon}{n_0}$

(B) $1-\frac{\varepsilon}{n_0}$

(C) ε

(D) $1-\varepsilon$

18. The left face of a one dimensional slab of thickness 0.2 m is maintained at 80° C and the right face is exposed to air 30° C. The thermal conductivity of the slab is 1.2 W/(m K) and the heat transfer coefficient from the right face is 10 W / (m^2 K). At steady state the temperature of the right face in °C is _________.

19. Knudsen diffusion coefficient

(A) depends on temperature and it is independent of pressure

(B) depends on pressure and it is independent of temperature

(C) depends on temperature and pressure

(D) Is independent of temperature and pressure

20. For the air-water system under adiabatic conditions, the adiabatic saturation temperature and the wet bulb temperature are nearly equal, because

(A) water has a high latent heat of evaporation

(B) Lewis number is close to unity

(C) they are always equal under all circumstances

(D) Solubility of the components of air in water is very small.

21. Given the following data :

Inside heat transfer coefficient = 25 W / m^2 °C

Outside heat transfer coefficient = 25 W / m^2 °C,

Thermal conductivity of bricks (15 cm think) = 0.15 W / mk

The overall heat transfer coefficient (in W / m^2 K) will be closer to the

(A) inverse of heat transfer coefficient

(B) heat transfer coefficient thermal conductivity of bricks

(D) heat transfer coefficient based on the thermal conductivity of the bricks alone

22. The temperature distribution, at a certain instant of time is a concrete slab during curing is given by,

$$T = 3x^2 + 3x + 16$$

where x is in cm and T is in K.

The rate of change of temperature with time is given by (assume diffusivity to be 0.0003 cm^2 / s)

(A) + 0.0009 K/s

(B) + 0.0048 K/s

(C) – 0.0012 K/s

(D) – 0.0018 K/s

23. Match the equipment in Group I to the raw material in Group II

	Group I		**Group II**
P.	Ethylene	1.	Natural gas
Q.	Methanol	2.	Synthesis gas
R.	Phthalic anhydride	3.	Naphtha
		4.	Naphthalene

(A) P–1, Q–2, R – 3

(B) P–2, Q–1, R–4

(C) P–3, Q–1, R – 4

(D) P – 3, Q – 2, R – 4

24. The open loop transfer function of a process is K $\frac{(s+1)(s+4)}{(s+2)(s+3)}$. In the root locus diagram, the poles will be at ________.

25. The transition Reynolds number for flow over a flat plate is 5×10^5. What is the distance from the leading edge at which transition will occur for flow of water with a uniform velocity of 1 m/s ?

[For water, the kinematic viscosity, v = 0.858 × 10^{-6} m^2 / s.].

(A) 1 m

(B) 0.43 m

(C) 43 m

(D) 103 m

Q 26-55 (2 MARKS EACH)

26. For a pure substance, the Maxwell's relation obtained from the fundamental property relation dU = TdS – PdV is

(A) $(\partial T/\partial V)_S = -(\partial P/\partial S)_V$

(B) $(\partial P/\partial T)_V = (\partial S/\partial V)_T$

(C) $(PT/\partial V)_S = (\partial V/\partial S)_P$

(D) $(\partial V/\partial T)_P = -(\partial S/\partial P)_T$

27. In constant pressure filtration, the rate of filtration follows the relation (υ : filtrate volume, t: time and k & c : constants)

(A) $\frac{d\upsilon}{dt} = k\upsilon + c$

(B) $\frac{d\upsilon}{dt} = \frac{1}{k\upsilon + c}$

(C) $\frac{d\upsilon}{dt} = k\upsilon$

(D) $\frac{d\upsilon}{dt} = k\upsilon^2$

28. It takes 6 hours to dry a wet solid from 50% moisture content to the critical mixture content of 15%. Then ___ time it will take to dry the solid to 10% moisture content, under the same drying conditions. The equilibrium moisture content of the solid is 5%. All these percentages are on dry basis.

29. What is the next radiant interchange per square metre for two very large plates at temperatures 800 K and 500 K respectively ?

(emissivity of the hot and cold plates are 0.8 and 0.6 respectively. Stefan Boltzmann constant is 5.67 × 10W/m^2 K^4)

(A) 1.026 kW/m^2

(B) 10.26 kW/m^2

(C) 102.6 kW/m^2

(D) 1026 kW/m^2

30. In a counter flow heat exchanger, cold fluid enters at 30° C and leaves at 50° C, whereas the hold fluid enters at 15° C and leaves at 130° C. The mean temperature difference for this case is

(A) indeterminate

(B) 20° C

(C) 80° C

(D) 100° C

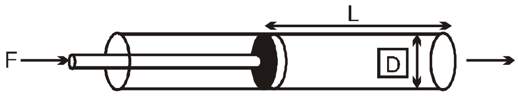
31. A tube of diameter D and length L is initially filled with a liquid of density ρ and viscosity μ. It is then pushed out by the application of a constant force F to the plunger as shown in the Fig.. Assuming laminar flow and pseudo steady state, the time required to expel one half of the liquid out of the tube is

(A) $\frac{3\pi\mu L^2}{F}$

(B) $\frac{3\pi\mu D^2}{F}$

(C) $\frac{6\pi\mu L^2}{F}$

(D) $\frac{6\pi\mu DL}{F}$



32. A piece of wood having weight 5 kg floats in water with 60% of its volume under the liquid. The specific gravity of wood is

(A) 0.83

(B) 0.6

(C) 0.4

(D) 0.9

33. If the equilibrium curve is concave upward, then the minimum liquid gas ratio for absorption

(A) Is zero

(B) Corresponds to an exit liquid concentration in equilibrium with the incoming gas

(C) Corresponds to an exit liquid concentration in equilibrium with the leaving gas

(D) Corresponds to an entering liquid concentration in equilibrium with the entering gas

34. In liquid-liquid extraction 10 kg of a solution containing 2 kg of solute C and 8 kg of solvent A is brought into contact with 10 kg of solvent B. Solvents A and B are completely immiscible in each other whereas solute C is soluble in both the solvents. The extraction process attains equilibrium. The equilibrium relationship between the two phases is Y* = 0.9X where Y* is kg of C/kg of B and X is kg of C/kg of A. Choose the correct answer

(A) The entire amount of C is transferred to solvent B

(B) Less then 2 kg but more than 1 kg of C is transferred to solvent B

(C) Less then 1 kg of C is transferred to B

(D) no amount of C is transferred to B

35. A piece of metal of specific gravity 7 floats in mercury of specific gravity 13.6 What fraction of its volume is under mercury ?

(A) 0.5

(B) 0.4

(C) 0.515

(D) 0.5

36. A ship whose hull length is 100 m is to travel at 10 m/sec. For dynamic similarly, at what velocity should a1 : 25 model be towned through water ?

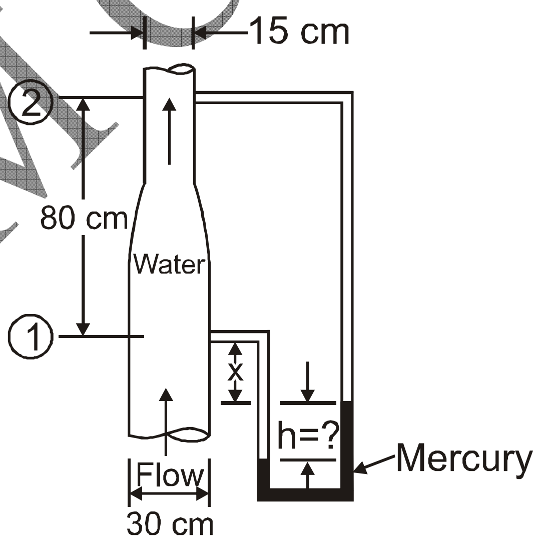
(A) 10 m/sec

(B) 25 m/sec

(C) 2 m/sec

(D) 50 m/sec

37. Water flows up a tapered pipe as shown in the figure. What is the magnitude of the deflection h of the differential mercury manometer corresponding to a discharge of 126 L/s ? Friction in the pipe can be completely neglected.



(A) 16.28 cm

(B) 17.28 cm

(C) 19.28 cm

(D) 25.28 cm

38. For a flow with $\phi = 3xy$, corresponding value of ϕ will be

(A) 4 xy + c

(B) – 4 xy + c

(C) 8 xy + c

(D) – 8 xy + c

39. Extractive distillation is used in the manufacture of

(A) nitric acid

(B) caustic soda

(C) sulphuric acid

(D) urea

40. For the flow $\phi = x + y + 3$, corresponding value of ϕ will be

(A) x + y + c

(B) x – y + c

(C) – x – y + c

(D) – x + y + c

41. A cylinder of 0.122 m radius rotates concentrically inside a fixed cylinder of 0.128 m radius. Both cylinders are 0.305 m long. What is the viscosity of the liquid that fills the space between the cylinders if a torque of 0.881 N-m is required to maintain an angular velocity of 60 revolutions per minute ?

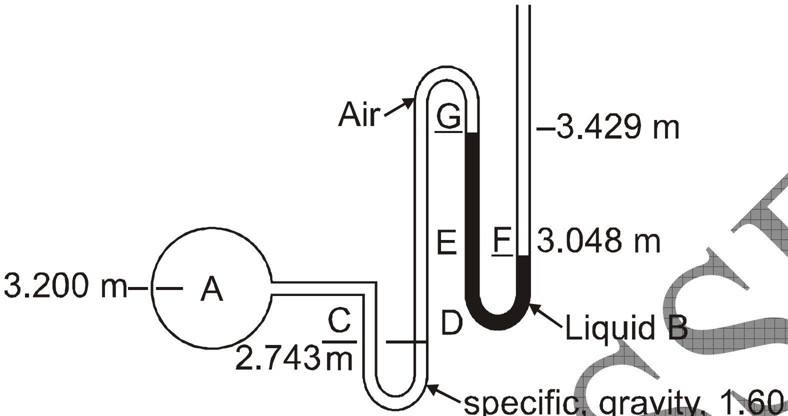
(A) 0.21 Pas

(B) 0.23 Pas

(C) 0.29 Pas

(D) 0.31 Pas

42. For a guage pressure of A of – 10.89 kPa, what is the specific gravity of the gauge liquid B in the figure below ?



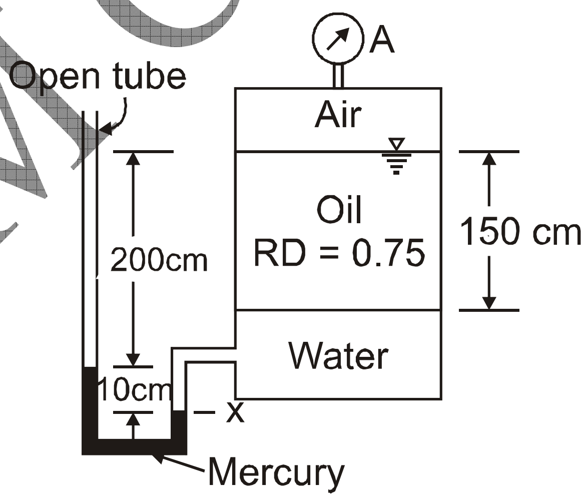
(A) 1

(B) 2

(C) 3

(D) None of these

43. The tank shown in the figure below is closed at top and contains air at a pressure p_A. The value of p_A for the manometer readings shown will be



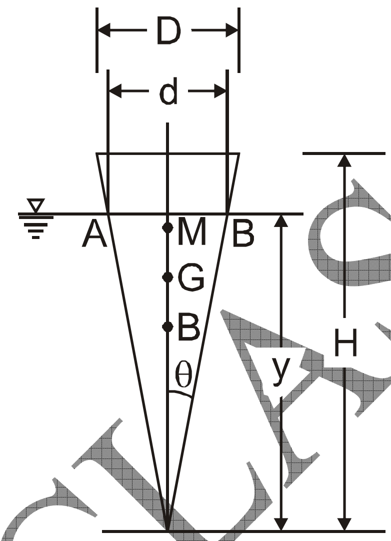
(A) – 3.573 kPa

(B) – 4.573 kPa

(C) – 6.573 kPa

(D) – 7.573 kPa

44. A solid cone of diameter 20 cm and height 16 cm floats with its vertex downwards in water as shown in the figure. This cone is in



(A) Stable equilibrium

(B) Unstable equilibrium

(C) Neutral equilibrium

(D) Uncertain

45. The shear stress at a point in a glycerine mass in motion if velocity gradient is 0.25 metre per sec/ per meter, will be

(A) 0.0236 kg/m^2

(B) 0.2036 kg/m^2

(C) 0.0024 kg/m^2

(D) None of these

46. Glycerine (μ = 1.5 Pa. sec. and r = 1260 kg/m^3) flows at a mean velocity of a 5m/sec in a 10 cm diameter pipe. The power expanded by the flow in a distance of 12 m, will be

(A) 1.8 H.P.

(B) 1.85 H.P.

(C) 18.5 H.P.

(D) 185. H.P.

47. A furnace is made of a red brick wall of thickness 0.5 m and conductivity 0.7 W/mk. For the same heat loss and temperature drop, this can be replaced by a layer of diatomite earth of conductivity 0.14 W/mk and thickness

(A) 0.5 m

(B) 0.1 m

(C) 0.2 m

(D) 0.5 m

Common Data Q. 48-49

The equation of the streamline passing through (1, 1)

48. The the flow V = 3xi – 3yi will be

(A) $x^2y^2 = 1$

(B) xy = 1

(C) x/y = 1

(D) none of these

49. For the flow V – y^2i – 6xj, will be

(A) $x^2y^2 = 1$

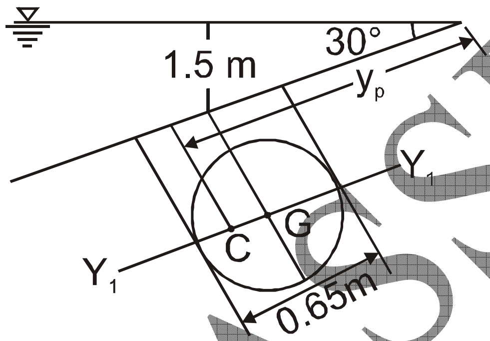
(B) $9x^2 - y^2 = 8$

(C) $x^2 - y^2 = 8$

(D) $9x^2 + y^2 = 8$

Common Data Q. 50-51

A circular plate of diameter of 0.65 m is immersed in a liquid of relative density 0.85 with its plane making an angle of 30° with the horizontal. Centre of the plate is at a depth of 1.50 m below the free surface.



50. What is the total force on one side of the plate ?

(A) 4142 N

(B) 6321 N

(C) 8282 N

(D) 9296 N

51. What is the location of centre of prossure ?

(A) 1.0406 m

(B) 2.0406 m

(C) 3.0406 m

(D) 4.0406 m

Linked Answers Q. 52 – 53

At 318 K and 24.4 kPa, composition of the system ethanol (1) and toluene (2) at equilibrium is $x_1 = 0.3$ and $y_1 = 0.634$. The saturation pressure at the given temperature for the pure components are $P_1^S = 23.06$ kPa and $P_2^S = 10.05$ kPa respectively.

52. The liquid- phase activity coefficients will be

(A) 0.4084

(B) 1.4084

(C) 2.2361

(D) 1.2964

53. The value of G^E/RT for the liquid phase will be

(A) 0.4084

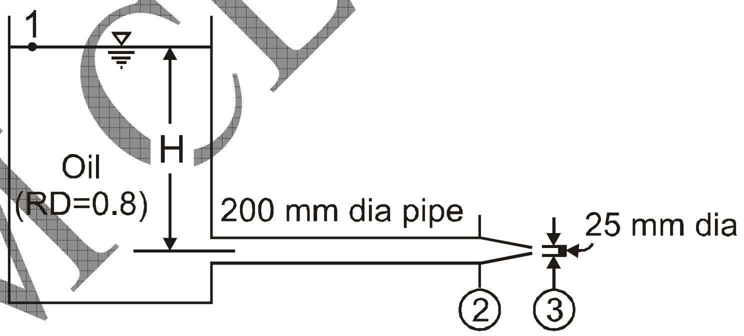
(B) 1.4084

(C) 2.2964

(D) 2.2361

Linked Answer Q. 54-55

Figure below shows a nozzle at the end of a pipe discharging oil from a tank to atmosphere. The head H in the tank is 4.0 m. The loss in the pipe can be taken as $20\ V^2/2g$, where V = velocity in the pipe. The loss of energy in the nozzle can be assumed to be zero.



54. What is the discharge from the nozzle ?

(A) $2.33 \times 10^{-3}\ m^3/s$

(B) $3.33 \times 10^{-3}\ m^3/s$

(C) $4.33 \times 10^{-3}\ m^3/s$

(D) $5.33 \times 10^{-3}\ m^3/s$

55. What is the pressure at the base of the nozzle ?

(A) 21.2 kPa

(B) 31.2 kPa

(C) 41.2 kPa

(D) 51.2 kPa

GENERAL APTITUDE

Q 56-60 (1 MARK EACH)

56. REASON : SFBTPO :: THINK : ?

(A) SGHMJ

(B) UIJOL

(C) UHNKI

(D) UJKPM

57. MORTAL opposite word –

(A) Divine

(B) Immortal

(C) Spiritual

(D) Eternal

58. ALERT similar word –

(A) Energetic

(B) Observant

(C) Intelligent

(D) Watchful

59. A shopkeeper expects a gain of 22.5% on his cost price. If in a week, his sale was of Rs. 392, what was his profit?

(A) Rs. 18.20

(B) Rs. 70

(C) Rs. 72

(D) Rs. 88.25

60. IF '+' stands for '-' , '-' stands for 'x', 'x' stands for '÷'and '÷'stands for '+'then what is the value of 56x7÷13-11+15-8÷2-7?

(A) 30

(B) 45

(C) 60

(D) 90

Q 61-65 (2 MARKS EACH)

61. ‘Captain’ is related to ‘Soldier’ in the same way as ‘Leader’ is related to

(A) Chair

(B) Followers

(C) Party

(D) Minister

62. PORK:PIG

(A) rooster:chicken

(B) mutton:sheep

(C) steer:beef

(D) lobster:crustacean

63. My uncle decided to take ...... and my sister to the market.

(A) I

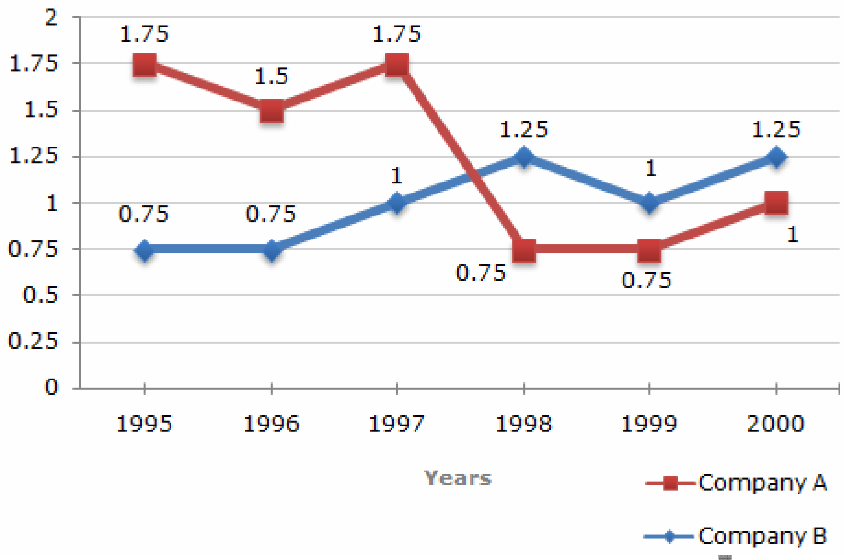
(B) mine

(C) me

(D) myself

64. Answer the question based on the given line graph.

Ratio of Exports to Imports (in terms of money in Rs. crores) of Two Companies Over the Years



In how many of the given years were the exports more than the imports for Company A?

(A) 2

(B) 3

(C) 4

(D) 5

65. Look at this series: 58, 52, 46, 40, 34, ... What number should come next?

(A) 26

(B) 28

(C) 30

(D) 32

Answer key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Answer	B	1696 Kw	A	D	295.3 K or 22.3°C	A	D	C	<1	D	3	B	1/2	A	2.62 and 3.68 min^{-1}	C	B	48.7 °C	A	B
Question	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Answer	D	A	D	-2,-3	B	A	B	1.1882	B	D	C	B	D	B	C	C	C	D	A	B
Question	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Answer	B	A	A	A	B	B	B	B	B	A	C	A	A	C	B	B	B	D	C	B
Question	61	62	63	64	65															
Answer	B	B	C	B	B															

HINTS AND SOLUTIONS

1.(B) Peclet number is the product of Reynolds number and prandtl number

$$\boxed{N_{Pe} = N_{R_2} \times N_{P_r}}$$

where

$$N_{Re} = \frac{\rho v D}{M} \; ; \; N_{Pr} = \frac{C_{pM}}{k}$$

2. **1696 kW**

$$(\text{Power required})\left(\frac{P}{m}\right) = 0.3162\, W_i \left(\frac{1}{\sqrt{D_{Pb}}} - \frac{1}{\sqrt{D_{Pa}}}\right)$$

$$= 1000 \times 0.3162 \times 12.74 \left(\frac{1}{\sqrt{3.175}} - \frac{1}{\sqrt{50.8}}\right)$$

$$= 1696 \text{ kW}$$

3.(A) Given Laplace = $\dfrac{1}{2s^2+3s+1}$

$$= L^{-1}\left\{\frac{1}{2s^2+3s+1}\right\}$$

$$= L^{-1}\left\{\frac{1}{2s^2+25+s+1}\right\}$$

$$= L^{-1}\frac{1}{(2s+1)(s+1)}$$

on partial fraction

$$= L^{-1}\left\{-\frac{1}{(s+1)}+\frac{1}{2}\left(\frac{1}{25+1}\right)\right\}$$

On separating

$$= L^{-1}\left\{\frac{-1}{(s+1)}\right\}+\frac{1}{2}L^{-1}\left\{\frac{1}{2s+1}\right\}$$

$$= -e^{-t} + \frac{1}{2}\frac{e^{-\frac{t}{2}}}{\frac{1}{2}}$$

$$= -e^{-t} + e^{-t/2}$$

$$= e^{-t/2} - e^{-t}$$

4.(D) Absorption factor $\left(\frac{L}{mG}\right)$ is the ratio of the slope of operating line to the equilibrium curve.

So, to increase Absorption factor , Slope of equilibrium curve decreases.

5. $T = 27 + 273 = 300$ K

P_t = 760 mm Hg = 101.325 kPa

Percentage saturation = 75%

P_A^{sat} = Vapour pressure of acetone at 27°C = 33.358 kPa

(a) Saturated molal absolute humidity ,

$$Y_s = \frac{P_A^{sat}}{P_t - P_A^{sat}} = \frac{33.358}{101.325 - 33.358} = 0.4908 \ \frac{\text{kmol acetone vapour}}{\text{kmol nitrogen}}$$ **Ans.**

Percentage saturation $= \frac{Y}{Y_S} \times 100 = 75$

or, $Y = \frac{75}{100} Y_S = 0.75 \times 0.4908$

$= 0.3681 \ \frac{\text{kmol acetone vapour}}{\text{kmol nitrogen}}$

(b) Absolute humidity , $Y' = Y\frac{M_A}{M_B} = 0.3681 \times \frac{58}{28} = 0.7625 \ \frac{\text{kg acetone}}{\text{kg nitrogen}}$

(c) $Y = \frac{P_A}{P_t - p_A}$

$\therefore$ $p_A = \frac{YP_t}{Y+1} = \frac{0.3681 \times 101.325}{0.3681+1} = 27.262 \text{ kPa}$

(d) Relative humidity $= \frac{p_A}{P_A^{sat}} \times 100 = \frac{27.262}{33.358} \times 100 = 81.72\%$

(e) Volume percent acetone $= \frac{p_A}{P_t} \times 100 = \frac{27.262}{101.325} \times 100 = 26.90\%$

(f) At dew point, $p_A = P_A^{sat}$

$\therefore$ $\ln(27.262) = 14.7171 - \frac{2975.95}{T - 34.5228}$

T = dew point = 295.3 K or 22.3°C

6.(A) Moisture content on wet basis $= \left(\frac{\text{kg moisture}}{\text{kg dry solid} + \text{kg moisture}}\right) \times 100$

$= \frac{100x}{1+x}$

Moisture content on Dry basis $= \frac{\text{ky moisture}}{\text{kg dry solid}} \times 100$

from Ques. $100\,x = 2\left(\frac{100x}{1+x}\right)$

$\Rightarrow \frac{100\,x}{1+x} = \frac{1}{2}(100\,x)$

moisture content wet basis = 0.5 (moisture content dry basis)

7.(D) A black body is a good absorber and emitter.

8.(C) Among all the rays

Range of gamma rays 10^{-5} to 10^{-4} μm

Range of u.v rays 10^{-2} to 10^{-1} μm

Range of Infrared rays 1 to 10^{2} μm

Range of microwave 10^{2} to 10^{4} μm

9. **< 1**

For incompressible fluids, the flow rate Q is proportional to $(\Delta P)^n$ where n < 1

10.(D) Let T_e be the exit temperature of cold fluid, then

$$m_h\, c_p\, (100 - 60) = m_c\, c_p\, (T_e - 40)$$

mean temperature of hot fluid

$$= \frac{100+60}{2} = 80°C$$

Mean temperature of cold fluid

$$= \frac{80+40}{2} = 60°$$

Mean temperature difference between two fluids

$$= 80 - 60 = 20°\ C$$

11. **3**

Consider a spherical shell of radius r and thickness Δr. The balance for diffusing component A gives:

$$4\pi r^2 N_{Ar}\Big|_r = 4\pi r^2 N_{Ar}\Big|_{r+\Delta r}$$

or $\frac{d}{dt}\left(4\pi r^2 N_{Ar}\right)=0 \qquad \Rightarrow \qquad 4\pi r^2 N_{Ar} = C \text{ (constant)}$

$$4\pi r_1^2 N_{Ar1} = 4\pi r_2^2 N_{Ar2} \Rightarrow \frac{N_{Ar2}}{N_{Ar1}} = \left(\frac{r_1}{r_2}\right)^2$$

$$\frac{N_{Ar2}}{27} = \left(\frac{3}{9}\right)^2 \qquad \Rightarrow N_{Ar/2} = 3 \text{ mol / cm}^2$$

12.(B) By Hagen - poiseulle equation for laminar flow in circular pipe .

$$\Delta P = \frac{32\mu VL}{D^2} = \frac{128\mu QL}{D^4}$$

$$\frac{\Delta P}{L} = \frac{128MQ}{D^4}$$

$$\left(\frac{\Delta P}{L}\right)\frac{D^4}{128\,N} = Q$$

$$\boxed{Q \propto D^4}$$

13. **1/2**

$F_{11} + F_{12} = 1$

$F_{12} = 1 - F_{11}$

$= 1 - 0$

$= 1$

$A_1 F_{12} = A_2 F_{21}$

$\Rightarrow F_{21} = \left(\frac{A_1}{A_2}\right) F_{12}$

$\left(\frac{A_1}{A_2}\right)$

$F_{21} + F_{22} = 1$

$$F_{22} = 1 - \left(\frac{A_1}{A_2}\right)$$

$$= 1 - \left(\frac{\pi R^2}{2\pi R^2}\right)$$

$$= 1 - \frac{1}{2}$$

$$= \frac{1}{2}$$

14.(A) For heat balance,

Solar radiation falling on plate

= Heat loss by convection

$\therefore$ 500 = h.A.Dt = h . (2 × 2) (30 – 25)

or h = 25 W/m^2 °C

15. **2.62 and 3.68 min^{-1}**

Rate of reaction for component A be

$$-r_A = K_1 C_A + 2K_3 C_A^2$$

$$= 1 \times C_A + 2 \times 0.5\, C^2{}_A$$

$$-r_A = C_A + C_A^2 \qquad ..(1)$$

$$-r_B = K_2 + C_B - K_1 C_A$$

$$= 1 \times 1 - 1 \times C_A$$

$$= 1 - C_A$$

Component B mass balance :

$$F\, C_{BO} = F_{CB} + (-r_B)\, V$$

$$O = F + (1 - C_A)\, V$$

$$C_A = 1 + \frac{F}{V}$$

component A mass balance:

$$FC_{Ao} = FC_A + ((-r_A).V$$

$$10F = FC_A + (C_A + C_A{}^2) . V$$

$$\Rightarrow \quad 10\frac{F}{V} = \frac{F}{V} \cdot C_A + C_A + C_A^2$$

substituting the value of C_A

$$10\left(\frac{F}{V}\right) = \frac{F}{V}\left(1+\frac{F}{V}\right) + \left(1+\frac{F}{V}\right) + \left(1+\frac{F}{V}\right)^2$$

$$10\left(\frac{F}{V}\right) = \frac{F}{V} + \left(\frac{F}{V}\right)^2 + 1 + \frac{F}{V} + 1 + 2\frac{F}{V} + \left(\frac{F}{V}\right)^2$$

$$\Rightarrow \quad 2\left(\frac{F}{V}\right)^2 - 6\left(\frac{F}{V}\right) + 2 = 0$$

$$\Rightarrow \quad \left(\frac{F}{V}\right) = \frac{+3 \pm \sqrt{5}}{2}$$

$$= 2.62 \text{ and } 3.68 \text{ min}^{-1}$$

16.(C) By maxwell equation

$$du = Tds - PdV$$

$$dA = -PdV - SdT$$

17.(B) $n_{i0} = n_0$ $\quad \Sigma n_0 = n_0$

$\Sigma v_i = -1$

fractional decomposition $y_{H_2O} = \dfrac{n_0 - \varepsilon}{n_0}$

$$y_{H_2O} = 1 - \frac{\varepsilon}{n_0}$$

18. **48.7**

Let the temperature of the right face at steady state be T°C.

$$q = -1.2 \frac{(T-80)}{0.2} = 10(T-30)$$

or, $T = 48.7°C$

19.(A) Diffusion in porous solid is given

D_{K_1A} knudsen diffusion coefficient

$$D_{K_1A} \; \alpha \left(\frac{T}{M_A}\right)^{1/2}$$

So, it is dependent on temperature but independent of pressure.

20.(B) When adiabatic saturation temperature and wet bulb temperature are equal. Both thermal diffusivity and mass transfer diffusivity is equal

i.e. $Le = \frac{L}{D} = 1$

21.(D) Overall heat transfer coefficient U is given by the relation

$$\frac{1}{U} = \frac{1}{h_a} + \frac{t}{k}\frac{1}{h_b}$$

where

h_a and h_b = inside and outside heat transfer coefficients (convective),

t = thickness of bricks

k = coefficient of thermal conductivity of the bricks alone.

22.(A) $T = 3x^2 + 3x + 16$

General heat conduction equation is,

$$\frac{1}{\alpha}\frac{\partial T}{\partial \tau} = \left(\frac{\partial^2 t}{\partial x^2} + \frac{\partial^2 t}{\partial y^2} + \frac{\partial t}{\partial x^2}\right) + \frac{Q}{k}$$

Without heat generation (Q = 0) and in x-direction only,

$$\frac{1}{\alpha}\frac{\partial T}{\partial \tau} = \frac{\partial^2 t}{\partial x^2}$$

or $$\frac{\partial T}{\partial \tau} = \alpha \frac{\partial^2 t}{\partial x^2}$$

$$= (0.0003)\ (6) = -\ 0.00018 \text{ K/s}$$

23.(D) d is the correct option as

Naphtha is made from ethylene

Methanol is used for producing synthesis gas.

$$CH_3\ OH \xrightarrow{\Delta} CO + 2H_2$$

Naphthalene is prepared from pthalic anhydride

24. **– 2, – 3**

Given transfer function K $\frac{(S+1)(S+4)}{(S+2)(S+3)}$

for poles of transfer function

$$S = -\ 2 \qquad S = -\ 3$$

25.(B) $R_{ex} = \frac{xU}{\nu}$

$$\therefore \quad x = \frac{5\times10^5 \times 0.858\times10^{-6}}{1} = 0.4293 \approx 0.43$$

26.(A) Maxwell relation

$$du = TdS - PdV$$

It follow exact differential equation

$$dF = Mdx + Ndy$$

$$\left(\frac{\partial M}{\partial y}\right)_x = \left(\frac{\partial N}{\partial x}\right)_y$$

similarly $\boxed{\left(\frac{\partial T}{\partial V}\right)_s = -\left(\frac{\partial P}{\partial S}\right)_v}$

27.(B) The volumetric flow the for constant pressure filtration is given by $\frac{dv}{dt} = \frac{1}{ko + \frac{1}{q_0}}$ q be constant

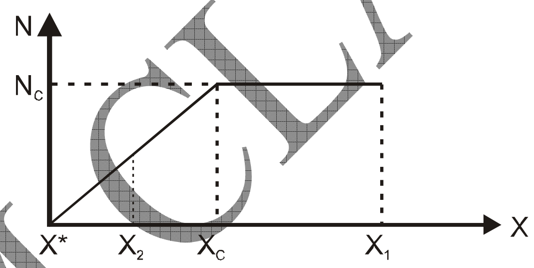
$$\Rightarrow \frac{dv}{dt} = \frac{1}{Kv + C}$$

28. **1.1882H**

Constant-rate period :

$$6 = \frac{S}{AN_C}(X_1 - X_C) = \frac{S}{AN_C}(0.5 - 0.15)$$

or, $\frac{S}{AN_C} = 17.1428$



Falling rate period:

$$N = m(X - X^*) = \frac{N_C(X - X^*)}{(X_C - X^*)}$$

$$\theta = -\int_{X_C}^{X_2} \frac{S}{A} \frac{dX}{\left(\frac{N_C}{X_C - X^*}\right)(X - X^*)} = \frac{S(X_C - X^*)}{AN_C} \ln \frac{X_C - X^*}{X_2 - X^*}$$

$$= 17.1428\,(0.15\text{-}0.05)\ \ln\left(\frac{0.15 - 0.05}{0.10 - 0.05}\right) = 1.1882\ h$$

29.(B) $$Q = \frac{A\sigma(T_1^4 - T_1^4)}{\left(\frac{1}{\epsilon_1}-1\right)+1+\left(\frac{1}{\epsilon_2}-1\right)}$$

$$= \frac{5.67\times10^{-6}(800^4 - 500^4)}{\left(\frac{1}{0.8}-1\right)+1+\left(\frac{1}{0.6}-1\right)} = 10.313 \text{ kW/m}^2$$

30.(D) Mean temperature of cold fluid

$$= \frac{30+50}{2} = 40° \text{ C}$$

Mean temperature of hold fluid

$$= \frac{130+150}{2} = 140° \text{ C}$$

Mean temperature difference

$$= 140 - 40 = 100° \text{ C}$$

31.(C) Pressure exerted on a certain area is equal to the force applied.

So, $(\Delta p)\left(\frac{\pi}{4}D^2\right) = F$

$$\Rightarrow \left(\frac{4fLP\bar{V}^2}{2D}\right)\left(\frac{\pi}{4}D^2\right) = F$$

$$\Rightarrow \left(\frac{4LP\bar{V}^2}{2D}\right)\left(\frac{16\mu}{DV\rho}\right) = F$$

$$\Rightarrow 8\pi\mu\, L\ \bar{V} = F \Rightarrow \int_{4/2}^{L} 8\ \pi\mu^2\, d^2 = F\int_0^t dt$$

$$\Rightarrow \left[\frac{8\pi\mu L^2}{2}\right]_{L/2}^{L} = Ft$$

$$\Rightarrow t = \frac{6\pi\mu L^2}{F}$$

32.(B) $$\frac{\text{Volume under water, } V'}{\text{total volume, } V} = \frac{\text{sp.gravity}}{2}$$

$\therefore$ Specific gravity = $\frac{60}{100}$ = **0.6**

33.(D) Since at this condition the minimum liquid has the greatest slope for any line touching the equilibrium curve. This then represent the limiting liquid-gas ratio. and it correspond to an exit liquid concentration in equilibrium with entering gas.

34.(B) Let 'a' be the amount transferred to solvent B

$$Y = \frac{a}{10} \quad X = \frac{2-a}{8}$$

given $\quad Y^* = 0.9X$

$$\frac{a}{10} = 0.9\left(\frac{2-a}{8}\right)$$

$$a = \frac{18}{17}$$

so, it is less than 2 kg but more than 1 kg of C is transferred

35.(C) If V is volume of metal and x is fraction under mercury, then

$$\frac{xV}{V} = \frac{7}{13.6'}$$

or $\quad x =$ **0.515**

36.(C) Froude number of parototype

= Froude number of model

or $$\frac{V}{\sqrt{gL}} = \frac{V'}{\sqrt{g'L'}}$$

or $$\frac{V}{\sqrt{L}} = \frac{V'}{\sqrt{L'}} \qquad (\because \; g = g')$$

or $\frac{10}{\sqrt{L}} = \frac{V'}{\sqrt{100/25'}}$

or $V' = \mathbf{2\ m/sec.}$

37.(C) Let S is relative density of mercury,

For the manometer, considering the elevation of section 1 as datum

$$\frac{p_1}{\gamma} + x + h = \frac{p_2}{\gamma} + 0.8 + x + Sh$$

or $\left(\frac{P_1}{\gamma} - \frac{P_2}{\gamma}\right) - 0.8 = (S - 1)\,h$

$= (13.6 - 1)\,h = 12.6\,h$

By continuity equation,

$$Q = \frac{\pi}{4} \times (0.30)^2 \times V_1$$

$$= \frac{\pi}{4} \times (0.15)^2 \times V_2$$

$= 0.126$

$\therefore$ $V_1 = 1.782$ m/s and $V_2 = 7.13$ m/s

Applying Bernoulli's equation to points 1 and 2, we have

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + z_2$$

or $\left(\frac{p_1}{\gamma} - \frac{p_2}{\gamma}\right) + 0 - 0.8 = \frac{V_2^2 - V_4^2}{2g} = \frac{(7.13)^2 - (1.728)^2}{2 \times 9.81} = 2.429$

$\therefore$ $\left(\frac{p_1 - p_2}{\gamma}\right) - 0.8 = 12.6h = 2.429$

or $h = \dfrac{2.429}{12.6} = 0.192$ m = **19.28 cm**

38.(D) Given $\phi = 4(x^2 - y^2)$

$$u = -\frac{\partial\phi}{\partial x} = -8x = \frac{\partial\psi}{\partial y}$$

Hence $\psi = -8xy + f(x)$

$$v = -\frac{\partial\phi}{\partial y} = +8y = -\frac{\partial\psi}{\partial x} = +8y - f'(x)$$

Hence $f'(x) = 0$ and $f(x)$ = constant = c

$\therefore \psi = -8xy + c$

39.(A) Nitric acid is manufactured in extractive distillation.

40.(B) $\psi = x + y + 3$

$$u = -\frac{\partial\phi}{\partial x} = -1 = \frac{\partial\psi}{\partial y}$$

Hence $\psi = -y + f(x)$

$$v = -\frac{\partial\phi}{\partial y} = -1 = -\frac{\partial\psi}{\partial x} = f'(x)$$

$f'(x) = 1$ and $f(x) = x$

Hence ψ = $\mathbf{x - y + c}$, where c = constant.

41.(B) The torque is transmitted through the fluid layers to the outer cylinder. Since the gap between cylinders is small, therefore

tangential velocity of the inner cylinder

$= r\omega$

$= (0.122 \text{ m})(2\pi \text{ rad/s})$

$= 0.767$ m/s

For the small space between cylinders, the velocity gradient can be assumed to be a straight line, and mean radius can be used.

$$\therefore \frac{dV}{dy} = \frac{0.767 \text{ m}}{(0.128 - 9.122)} = 127.8 \text{ s}^{-1}$$

Again, torque applied = torque resisting

or $0.881 = \tau$ (area) (arm)

$= \tau (2\pi \times 0.125 \times 0.305)(0.125)$

or $\tau = 29.4$ Pa

$$\therefore \mu = \frac{\tau}{dV/dy} = \frac{29.4}{127.8} = \mathbf{0.230\ Pas}$$

42.(A) Pressure at C = Pressure at D

or $p_A + \gamma h = p_D$

or – 10.89 + (1.60 + 9.79)(3.2 – 2.743) = 3.73 kPa

Since weight of 0.686 m of air can be neglected without introducing significant error, therefore

$p_G = p_D = -3.73$ kPa

Also $p_E = p_F = 0$

∴ Pressure at G

= Pressure at E – pressure of (3.429 – 3.048) m of guage liquid

or $p_G = p_E$ (sp gr × 9.79) (3.429 – 3.048)

or $-3.73 = 0 -$ (sp gr × 9.79) (0.381)

∴ specific gravity = **1.00**

43.(A) Considering the pressure at the horiozntal plane X-X

$p_A + 1.5 + \gamma_0 + (2.0 - 1.5)\gamma_w + 0.10\gamma_w = 0.10\gamma_m$

where, γ_0 = specific weight of oil

$= 0.75 \times 9790$

$= 7342.5 \text{ N/m}^3$

γ_w = specific weight of water

$= 9790 \text{ N/m}^3$

γ_m = specific weight of mercury

$= 13.6 \times 9790$

$= 133144 \text{ N/m}^3$

$\therefore \quad p_A = (0.10 \times 133144) - 0.50 \times 9790 - 1.5 \times 7342.5 - 0.1 \times 9790$

$= -3573.4$ Pa

$=$ **– 3.573 kPa**

44.(A) For the cone,

D = 20 cm, H = 16 m, S = 0.8

Let θ = semi vertex angle, then

$$\tan\theta = \frac{10}{16} = 0.625,$$

or $\theta = 32°$

Diameter of cone at water surface,

$$d = 2y\tan\theta$$

Weight of cone = Weight of water displaced

$$\text{or } \frac{1}{3}\times\frac{\pi D^2}{4}\times H\times\gamma S = \frac{1}{3}\times\frac{\pi d^2}{4}\ y\gamma$$

$$\text{or } D^2 HS = d^2 y$$

$$\text{or } 4y^3\left(\frac{D}{24}\right)^2 = D^2 HS = 4y^3\tan^2\theta = 4y^3\left(\frac{D}{2H}\right)^2$$

or $\quad y^3 = H^3S$

$\therefore \quad y = H\,(S)^{1/3} = 16 \times (0.8)^{1/3} = 14.853$ cm

If B is the centre of buoyancy, then

$$OB = \frac{3}{4}y = 0.75 \times 14.853 = 11.1398 \text{ cm}$$

$$OG = \frac{3}{4}H = 0.75 \times 16 = 12 \text{ cm}$$

Diameter at water surface,

$$d = 2y \tan\theta = 18.566 \text{ cm}$$

$$BM = \frac{I}{V} = \frac{\pi d^4/64}{\frac{1}{3}\left(\frac{\pi d^4}{4}\right)y} = \frac{3}{16}\left(\frac{y^2}{y}\right) = \frac{3}{4}y$$

$$\tan^2\theta = 4.351 \text{ m}$$

$$OM = B + MB = 11.1398 + 4.351 = 15.491 \text{ cm}$$

$$OG = 12.00$$

$$\therefore \quad MG = (15.491 - 12.00) = 3.491 \text{ cm}$$

(i.e. M is above G by 3.491 cm)

Hence the cone is under **stable equilibrium.**

45.(B) Velocity gradient $= \frac{du}{dy} = 0.25$ m/sec meter

Density, $\rho = 129.3$ slug/meter^3

Kinematic viscosity, $v = 6.30 \times 10^{-4}$ meter^2/sec

Shear stress $= \mu \frac{du}{dy} = \rho v \frac{du}{dy}$

$= 129.3 \times 6.30 \times 10^{-4} \times 0.25$

= **0.02036 kg/m^2**

46.(B) Q = A.V.

$$= \frac{\pi}{4} d^2 \times 4 = \frac{\pi}{4} \times (0.1)^2 \times 5$$

= 0.0329 m^3/sec

$$h = \frac{f.l.Q^2}{3d^5} = \frac{0.02 \times 12 \times (0.0329)^2}{3 \times (0.1)^5} = 8.65 \text{ m.}$$

∴ Power transmitted through pipe,

$$P = \frac{wQ(H-h)}{75}$$

$$= \frac{1260 \times 0.0329 \times (12 - 8.65)}{75} = \textbf{1.85 H.P.}$$

47.(B) Fourier's relation for heat conduction is,

$$Q = \frac{kA\ \Delta t}{x}$$

where, k = coefficient of thermal conductivity,

A = cross-sectional area

Δt = Temperature difference

x = Thickness

For same Q and ΔT (A remaining unchanged)

$$\frac{k_1}{x_1} = \frac{k_2}{x_2}$$

or $$\frac{0.7}{0.5} = \frac{0.14}{x_2}$$

$\therefore \quad x_2 = \dfrac{0.14 \times 0.5}{0.7} = 0.1$ m

48.(B) $u = 3x$ and $u = -3y$

Equation of a streamline in two-dimensional flow

$$\frac{dx}{u} = \frac{dy}{v}$$

Here $$\frac{dx}{3x} = -\frac{dy}{3y}$$

Integrating, $\dfrac{1}{3}\ln x = -\dfrac{1}{3}\ln y + \dfrac{1}{3}\ln c$

where c = constant

$\therefore \quad \ln xy = \ln c$

or $\quad xy = c$

For the streamline passing through (1, 1), c = 1.

Hence required streamline equation is,

49.(B) $u = -y^3$ and $v = -6x$

Differential equation of the streamline is,

$$-\frac{dx}{y^2} = \frac{dy}{6x}$$

Integrating, $\int 6x\, dx = \int y^2\, dy + c$

or $\quad 3x^2 - \dfrac{y^3}{3} = c$

Putting $x = 1$, $y = 1$, we get

$$c = 3 - \frac{1}{3} = 2\frac{2}{3}$$

Hence required equation of the streamline is,

$$3x^2 - \frac{y^3}{3} = \frac{8}{3}$$

or $$9x^2 - y^2 = 8$$

50.(A) Given: $\gamma = 0.85 \times 9790 = 8321.5$ N/m^3

$\bar{h} = 1.5$ m

Force on one side of the plate,

$$F = \gamma A \bar{h}$$

$$= 8321.5 \times \left[\frac{\pi}{4}(0.65)^2\right] \times 1.5$$

$$= 4141.99 \approx 4142 \text{ N}$$

51.(C) Bt symmetry $x_p = \bar{x}$

i.e. centre of pressure lies on the Y_1Y_1 axis through CG of the area.

$$y_p = \bar{y} + \frac{I_{gg}}{A\bar{y}}$$

where, $\bar{y} = \dfrac{1.5}{\sin 30^\circ} = 3.0$ m

and $I_{gg} = \dfrac{\pi}{64} D^4 = \dfrac{\pi}{64} \times (0.65)^4 = 8.762$ m^4

$$\therefore \quad y_p = 3.00 + \frac{8.762}{\frac{\pi}{4} \times (0.65)^2 \times (0.65)}$$

$$= 3.0406 \text{ m}$$

52.(A) $= -191,952.7$ kJ

$$y_iP = \gamma_i x_i P_i^S$$

$$\gamma_1 = \frac{y_1 P}{x_1 P_1^s} = \frac{0.634 \times 24.4}{0.3 \times 23.06} = 2.2361,$$

$$\gamma_2 = \frac{y_2 P}{x_2 P_2^s} = \frac{0.366 \times 24.4}{0.7 \times 10.05} = 1.2694$$

53.(A) Excess free energy is related to the activity coefficient and the composition by

$$\frac{C^E}{RT} = x_1 \ln \gamma_1 + x_2 \ln \gamma_2$$

$$= 0.3 \ln 2.2361 + 0.7 \ln 1.2694 = 0.4084$$

54.(C) By continuity equation,

$$Q = V_2 \frac{\pi}{2} (D)^2 = V_3 \frac{\pi}{2} (d)^2$$

Velocity of the pipe,

$$V_2 = V_3 \left(\frac{d}{D}\right)^2 = \left(\frac{25}{200}\right)^2 V_3 = \frac{1}{64} V_3$$

Applying Bernoulli's equation to points 1 and 3 with the centre line of the pipe as datum and atmospheric pressure as zero. The velocity at point 1 can be taken as zero.

$$\frac{p_1}{\gamma} + \frac{V_1^2}{2g} + z_1 = \frac{p_3}{\gamma} + \frac{V_3^2}{2g} + z_3 + H_L$$

or $$0 + 0 + H = 0 + \frac{V_3^2}{2g} + 0 + 20\,\frac{V_2^2}{2g}$$

or $$H = \frac{V_3^2}{2g} + 20 \times \left(\frac{1}{64}\right)^2 \frac{V_3^2}{2g} = 1.004 \frac{V_3^2}{2g}$$

But H = 4.0 m, therefore

$$V_3 = \left(\frac{2\times 9.81\times 4.0}{1.004}\right)^{1/2} = 8.83 \text{ m/s}$$

Discharge, Q $= \dfrac{\pi}{4} \times (0.025)^2 \times 8.83$

$= 4.33 \times 10^{-3}$ m^3/s

55.(B) Velocity in the pipe, $V_2 = \dfrac{1}{64} \times 8.83 = 0.13$ m/s

Loss of head in the pipe,

$$H_L = 20 \times \frac{V_2^2}{2g} = 20 \times \frac{(0.13)^2}{2\times 9.81} = 0.019\text{m}$$

Applying Bernoulli's equation to points 1 and 2,

$$0 + 0 + H = \frac{p_2}{\gamma} + \frac{V_2^2}{2g} + 0 + H_L$$

or $$4.0 = \frac{p_2}{\gamma} = \frac{(0.137)^2}{2\times 9.81} + 0 + 0.019$$

or $$\frac{p_2}{\gamma} = 4.0 - 0.0199 = 3.980 \text{ m}$$

or $$\gamma = \frac{0.8\times 998\times 9.81}{1000} = 7.832 \text{ kN/m}^3$$

$\therefore$ Pressure at the base of the nozzle,

p_2 = .980 × 7.832 = **31.17 kPa**

56.(B)

As	Similarly
$R \xrightarrow{+1} S$	$T \xrightarrow{+1} U$
$E \xrightarrow{+1} F$	$H \xrightarrow{+1} I$
$A \xrightarrow{+1} B$	$I \xrightarrow{+1} J$
$S \xrightarrow{+1} T$	$N \xrightarrow{+1} O$
$O \xrightarrow{+1} P$	$K \xrightarrow{+1} L$
$N \xrightarrow{+1} O$	

57.(B) Mortal means causing or capable of causing death while Immortal means one who is not subject to death.

58.(D) Alert means engaged in or accustomed to close observation, ie. Watchfulness.

59.(C) C.P. = Rs. $\left(\frac{100}{122.5}\times 392\right) = \text{Rs}\left(\frac{1000}{1225}\times 392\right) = 320\text{Rs}$

Profit = Rs. (392 - 320) = Rs. 72.

60.(B) Changing the symbols as given in the problem the above expression is

56÷7+13x11-15x8+2x7

Solving the BODMAS rule, we get 8+143-120+14=165-120=45

61.(B) ‘Captain’ is supposed to lead the battalian of ‘Soldiers’ int he same way as ‘Leader’ is supposed to lead the ‘Followers’

62.(B) Pork is meat from a domestic hog or pig. Similarly, mutton is meat from a mature domestic sheep.

63.(C) My uncle decided to take me and my sister to the market.

64.(B) The exports are more than imports in those years for which the exports to imports ratio are more than 1. For Company A, such years are 1995, 1996 and1997.

Thus, during these 3 years, the exports are more than the imports for Company A.

65.(B) This is a simple subtraction series. Each number is 6 less than the previous number.