Question Paper Name: GATE 2020 Paper

Duration: 180

Total Marks: 100

ABOUT US

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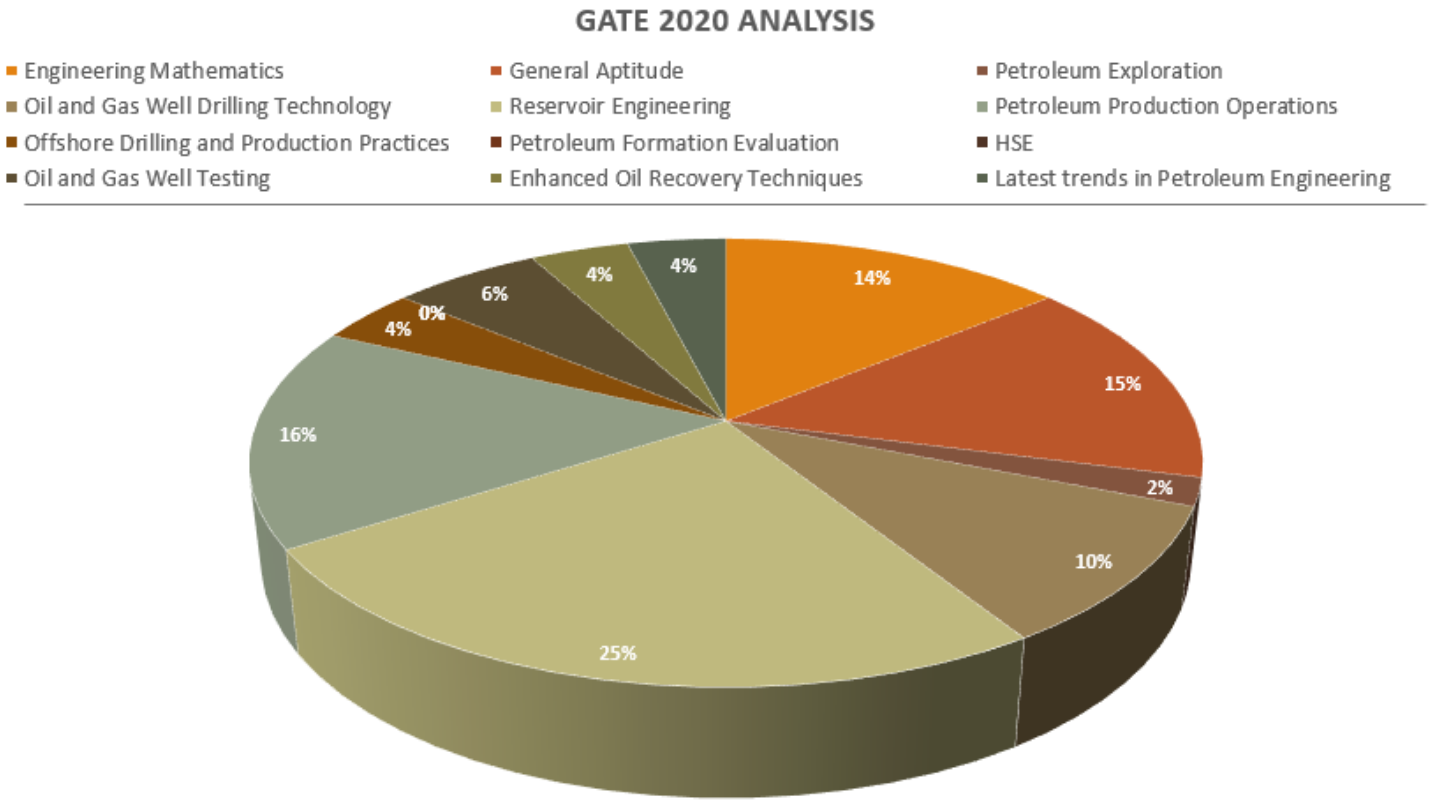
Gate 2020

The Gate 2019 is conducted by Indian Institute of Technology (IIT) Madras.It is the Hardest Paper till date In this Paper the maximum marks is from Reservoir Engineering.

Organizing Institute	IIT Madras
Number of Candidates Registered	
Number of Candidates Appeared	1747
Air 1st Rank Marks (out of 100)	76.67
General/EWS Qualifying Marks (out of 100)	39.8
OBC Qualifying Marks (out of 100)	35.8
SC/ST Qualifying Marks (out of 100)	26.5



SUBJECT	Number of Questions		Total Marks
	1 Mark	2 Mark	
Engineering Mathematics	6	4	14
General Aptitude	5	5	15
Petroleum Exploration	2	0	2
Oil and Gas Well Drilling Technology	4	3	10
Reservoir Engineering	7	9	25
Petroleum Production Operations	4	6	16
Offshore Drilling and Production Practices	0	2	4
Petroleum Formation Evaluation	0	0	0
HSE	0	0	0
Oil and Gas Well Testing	2	2	6
Enhanced Oil Recovery Techniques	0	2	4
Latest trends in Petroleum Engineering	0	2	4
TOTAL	30	35	100

Gate 2020 Question Paper

Q. 1 – Q. 5 carry one mark each

Q1. He is known for his unscrupulous ways. He always sheds _____ tears to deceive people.
a) fox's
b) crocodile's
c) crocodile
d) fox

Q2. Jofra Archer, the England fast bowler, is _____ than accurate.
a) more fast
b) faster
c) less fast
d) more faster

Q3. Select the word that fits the analogy:
Build : Building : : Grow : _____
a) Grown
b) Grew
c) Growth
d) Growed

Q4. I do not think you know the case well enough to have opinions. Having said that, I agree with your other point. What does the phrase "having said that" mean in the given text?
a) as opposed to what I have said
b) despite what I have said
c) in addition to what I have said
d) contrary to what I have said

Q5. Define $[x]$ as the greatest integer less than or equal to x, for each $x \in (-\infty, \infty)$. If $y = [x]$, then area under y for $x \in [1, 4]$ is _____.
a) 1
b) 3
c) 4
d) 6

Q. 6 – Q. 10 carry two marks each.

Q6. Crowd funding deals with mobilization of funds for a project from a large number of people, who would be willing to invest smaller amounts through web-based platforms in the project. Based on the above paragraph, which of the following is correct about crowd funding?

a) Funds raised through unwilling contributions on web-based platforms.
b) Funds raised through large contributions on web-based platforms.
c) Funds raised through coerced contributions on web-based platforms.
d) Funds raised through voluntary contributions on web-based platforms.

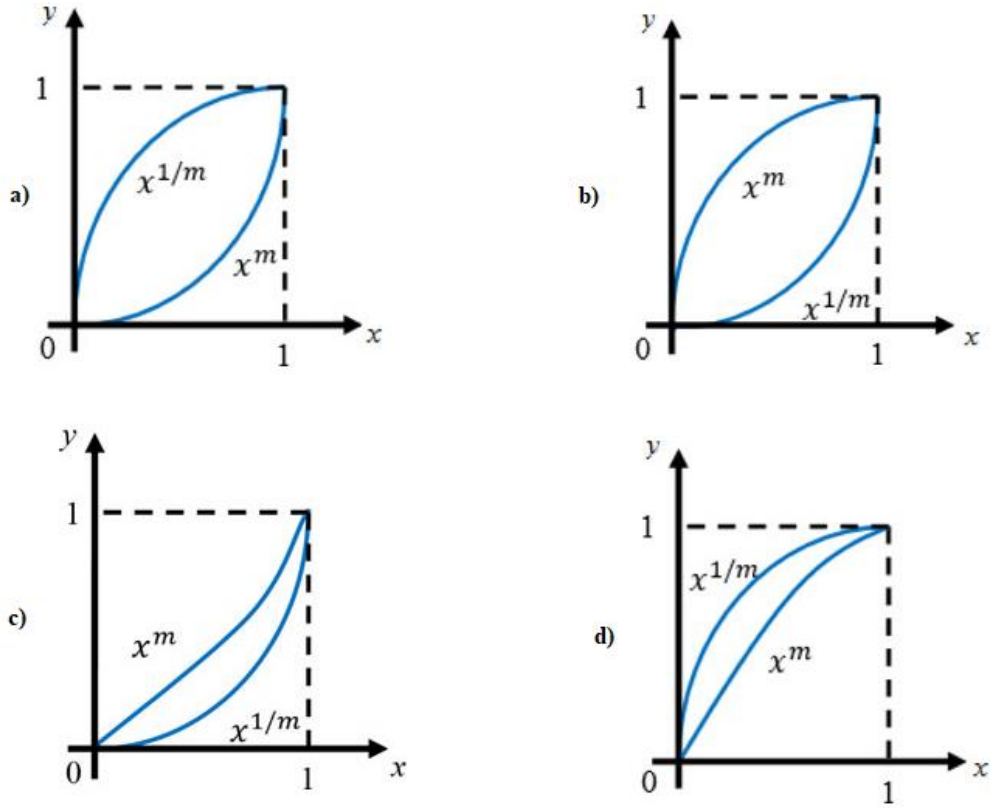
Q7. The sum of the first n terms in the sequence 8, 88, 888, 8888, ... is _____.

a) $\frac{81}{80}(10^n - 1) + \frac{9}{8}n$
b) $\frac{81}{80}(10^n - 1) - \frac{9}{8}n$
c) $\frac{81}{80}(10^n - 1) + \frac{8}{9}n$
d) $\frac{81}{80}(10^n - 1) - \frac{8}{9}n$

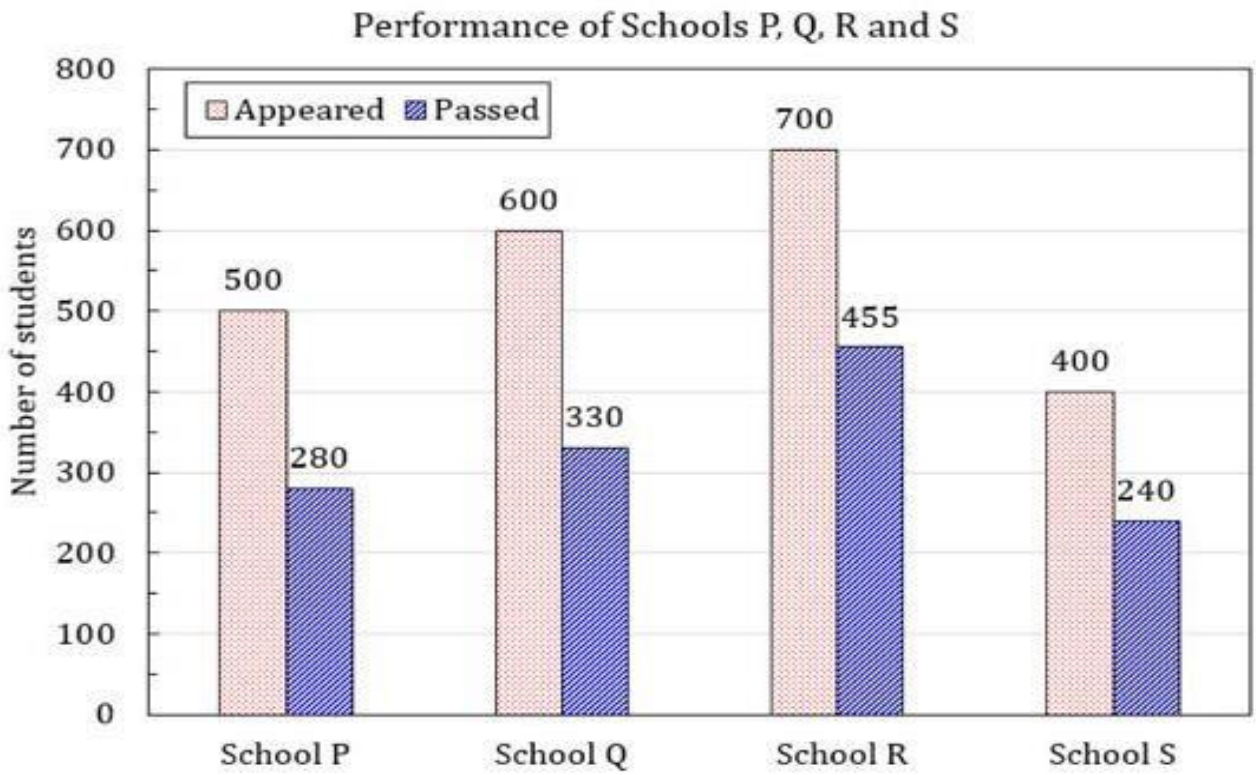
Q8. P, Q, R and S are to be uniquely coded using α and β. If P is coded as αα and Q as αβ, then R and S, respectively, can be coded as _____.

a) βα and αβ
b) ββ and αα
c) αβ and ββ
d) βα and ββ

Q9. Select the graph that schematically represents BOTH $y = x^m$ and $y = x^{1/m}$ properly in the interval $0 \le x \le 1$. For integer values of m, where $m > 1$.



Q10. The bar graph shows the data of the students who appeared and passed in an examination for four schools P, Q, R and S. The average of success rates (in percentage) of these four schools is _____.



a) 58.5%
b) 58.8%
c) 59.0%
d) 59.3%

Q.11 – Q. 35 carry one mark each

Q11. Consider a vector field, $\boldsymbol{A} = 3xz\hat{\imath} + 2xy\hat{\jmath} - yz\hat{k}$, where, $\hat{\imath}$, $\hat{\jmath}$, *and* $\hat{k}$ are the unit vectors along the x, y, and z directions respectively. The divergence of **A** at the point (1, 1, 1) is equal to _____

a) 0
b) 2
c) 3
d) 4
Ans. d

Q12. Inverse Laplace transform of the function, $F(s) = \frac{1}{s^2+s}$, is given by

a) $1 - e^{t}$
b) $1 + e^{t}$
c) $1 - e^{-t}$
d) $1 + e^{-t}$

Q13. The solution of the differential equation, $\frac{dy}{dx}+\frac{y}{x}=x(x\neq 0)$ with the condition y = 1 at x = 1, is given by

a) $y=\frac{2}{3x^2}+\frac{x}{3}$
b) $y=\frac{1}{2x}+\frac{x}{2}$
c) $y=\frac{2}{3}+\frac{x}{3}$
d) $y=\frac{2}{3x}+\frac{x^2}{3}$

Q14. Two complex numbers are given as $z_1 = e^{i\theta 1}$ and $_2 = e^{i\theta 2}$, where $i = \sqrt{-1}$ and θ_1 and θ_2 are the principal arguments. Given $\theta_1 \neq \theta_2$ and $|\theta_1 - \theta_2| \neq \pi$.

If $m=\sqrt{(\cos\theta_1 + \cos\theta_2)^2 + (\sin\theta_1 + \sin\theta_2)^2}$, which one of the following conditions is correct?

a) $2 < m < 3$
b) $0 < m < 2$
c) $m = 2$
d) $m = 0$

Q15. Match the following

P. Gauss-Seidel method	I. Interpolation
Q. Forward Newton Gauss method	II. Non-linear differential equation
R. Runge-Kutta method	III. Linear algebraic equation

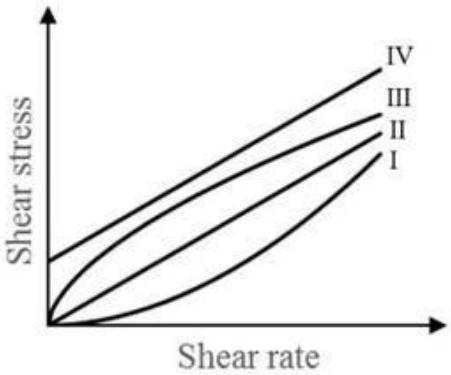
a) P-I, Q-II, R-III

b) P-II, Q-I, R-III

c) P-I, Q-III, R-II

d) P-III, Q-I, R-II

Q16. Shear stress versus shear rate plots for four different fluids are given in the Figure. Which curve represents a pseudo plastic fluid?



a) I b) II c) III d) IV

Q17. Which one of the following is NOT a desired function of a hydraulic fracturing fluid additive?

a) Oxygen scavenging to prevent attack on polymers.

b) Increasing viscosity of fracturing fluid during flow back.

c) Work as a bactericide.

d) Work as a surfactant to facilitate post treatment clean-up.

Q18. Formation Damage could be a result of

i. scale formation near the wellbore

ii. coke formation due to in-situ combustion.

iii. precipitation of asphaltene.

iv. condensate banking

Which one of the following options is correct?

a) (i) and (iv) only
b) (i) and (iii) only
c) (i), (ii) and (iii) only
d) (i), (ii), (iii) and (iv)

Q19. Which of the following statements(s) about gas and water coning in the reservoir is/are correct?

i. Gas and water coning is characterized by downward movement of water and upward movement of gas near the producing wellbore

ii. Gas and water coning is characterized by downward movement of gas and upward movement of water near the producing wellbore

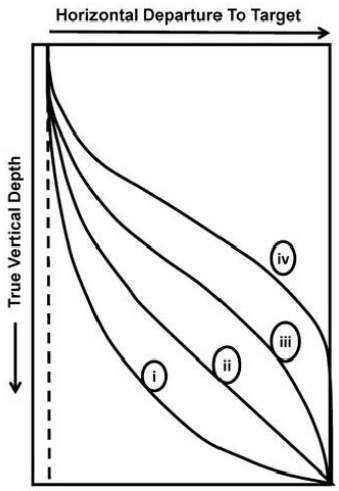
iii. Gas and water coning improves the reservoir's oil recovery efficiency

iv. Gas and water coning is caused when gravitational forces dominate over viscous forces

a) i and iv only

b) ii only
c) ii, iii, and iv only
d) iv only

Q20) Given the Figure



Which one of the following options represents the correct combination of the trajectory number and the corresponding drilling type?

a) i ➔ Build and Hold, ii ➔ Modified S-Type, iii ➔ S-Type, iv ➔ Continuous Build

b) I ➔ Build and Hold, ii ➔ S-Type, iii ➔ Modified S-Type, iv ➔ Continuous Build

c) i ➔ Continuous Build, ii ➔ Build and Hold, iii ➔ Modified S- type, iv ➔ S- type

d) i ➔ Continuous Build, ii ➔ S- type, iii ➔ Modified S-Type, iv ➔ Build and Hold

Q21. A stable geothermal gradient (approx. 250C/km) in the earth's crust will suddenly increase to a higher gradient value, when

a) there is excessive erosion and upliftment

b) there is excessive subsidence and deposition

c) there is excessive subsidence and upliftment simultaneously

d) there is excessive erosion and upliftment simultaneously

Q22. A drawdown test is conducted at a constant flow rate in an oil well for a reservoir with constant compressibility. Which one of the following is valid for semi steady state condition?

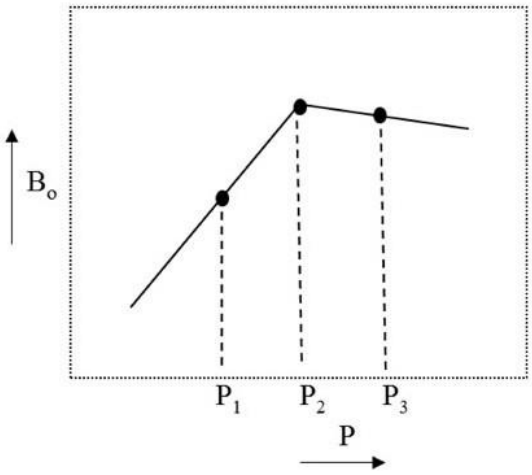
a) Rate of pressure change at the wellbore is less than at the boundary

b) The effect of the outer boundary of the reservoir is felt at the wellbore

c) Reservoir permeability does not affect the wellbore pressure

d) Pressure in the reservoir does not change with time

Q23) Formation volume factor (Bo) versus Pressure (P) plot for an oil is given in the figure.



Match the following with the corresponding pressure given in the figure

I. Bubble Point
II. II. Saturated Oil
III. III. Under-saturated Oil

a) I - P1, II - P2, III - P3

b) I - P1, II - P3, III – P2

c) I – P2, II – P1, III - P3

d) I – P2, II – P3, III – P1

Q24. Which one of the following statements is NOT correct?

a) Flash point of gasoline is lower than that of diesel.

b) Pour point is the temperature at which oil ceases to flow.

c) Higher the Diesel Index of a fuel, higher is its cetane number.

d) Higher the aromatic content of diesel, higher is its aniline point.

Q25. Which one of the following additives is commonly added to drilling fluids to remove hydrogen sulfide?

a) Sodium chloride

b) Calcium chloride

c) Zinc carbonate

d) Bentonite

Q26. Two rigid spherical particles of the same density, with a diameter ratio D1: D2 = 1:2, settle freely through a pool of liquid. The terminal settling velocity is given by the Stoke's law. What is the ratio of their terminal settling velocities, V1 : V2?

a) 1:2

b) 2:1

c) 1:4

d) 4:1

Q27. Which of the following options best represent the correct order of increasing thermal conductivity of the sub-surface formations?

a) Coal < Shale < Dolomite < Evaporite

b) Evaporite < Shale < Coal < Dolomite

c) Coal < Shale < Evaporite < Dolomite

d) Shale < Coal < Evaporite < Dolomite

Q28. Which one of the following options is the correct combination of kerogen Type and the source from which it is derived?

a) Type I - Lacustrine, Type II - Marine, Type III- Terrestrial, Type LY - Varied

b) Type I - Marine, Type II - Terrestrial, Type III - Varied, Type IV - Lacustrine

c) Type I - Lacustrine, Type II - Varied, Type III - Marine, Type IV - Terrestrial

d) Type I - Lacustrine, Type II - Terrestrial, Type III - Marine, Type IV – Varied

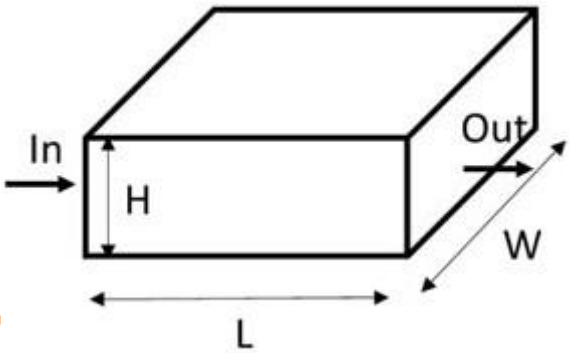
Q29. The number of power outages in a city in a given time interval is a Poisson random variable with a mean of 2 power outages per month. The Poisson distribution is given by

$P(y)=\frac{e^{-\mu}\mu^{y}}{y!}$

The probability of exactly 2 power outages in 2 months (rounded off to two decimal places) is _____

Q30. Anhydrous sodium hydroxide is added to 10 litre of water to raise its pH from 7.0 to 9.0. The molar mass of sodium hydroxide is 40 g/mol. Assuming complete dissociation of sodium hydroxide and zero volume change of mixing, the amount of sodium hydroxide added (rounded off to two decimal places) is ____ mg.

Q31. Consider unidirectional, laminar flow of water through a homogeneous porous media as shown in the figure. Here, H = 100 m, W = 500 m, L = 500 m, permeability of the porous media is 10-12 m2 and the driving pressure drop (across length L) is 106 Pa. Use the viscosity of water as 10-3 Pa.s



At steady state, the volumetric flow rate of water (round off to two decimal places) is given by _____ m3/s.

Q32. A dry gas well is producing a gas stream of the following molar composition: 95% methane and 5% carbon dioxide. The molar mass of the methane is 16 g/mol and that of carbon dioxide is 44 g/mol. Assuming ideal gas behaviour, gas constant R = 8.31 J mol-1 K-1, the gas stream density at 107 Pa and 350 K (rounded off to one decimal place) is _____ kg/m3

Q33. Consider fluid flow through the annular space between two cylindrical tubes. The outer diameter of the inner tube is 40 mm and the inner diameter of the outside tube is 50 mm. The hydraulic mean diameter for fluid flow calculations (round off to one decimal place) is _____ mm.

Q34. A build-up test performed on the well after 1000 hours of oil production. During the shut-in period, the Horner's approximation is valid which results in the following equation relating the shut-in well pressure (Pws) to the shut-in time:

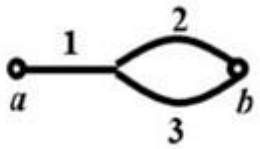
$$\frac{2\pi kh}{q\mu}(P_i - P_{ws}) = \frac{1}{2}\ln X + P_D(t_D) - \frac{1}{2}\ln\frac{4t_D}{\gamma}$$

Here, k is the permeability, h is the reservoir thickness, Pi is the initial reservoir pressure, q is the flow rate during production, μ is the oil viscosity, tD is the dimensionless production time, PD(tD) is the dimensionless pressure at tD, Y is a constant and X is dependent on the shut-in time and the production time.
The value of X after 5 hours of shut-in (rounded off to one decimal place is _____.

Q35. The initial oil production from an offshore well is 1000 STB/day, which decreased to 960 STB/day in 30 days. Using the ''exponential decline model'', the daily production rate after 360 days from the start (rounded off to one decimal place) will be _____ STB/day.

Q. 36 – Q. 65 carry two mark each

Q36. An incompressible fluid flows through a network of pipes as shown in the given Figure. The total pressure drop across points a and b is 2 kPa. The flow rates (in m3/s) in sections 1, 2, and 3 are q1, q2, and q3 respectively. The pressure drops (in kPa) are 4q1, 3q2, and 2q3 across sections 1, 2, and 3 respectively.



For a steady-state flow operation, the system of equations for flow rates is given by,

$$\begin{bmatrix} 4 & 3 & 0 \\ 0 & -3 & 2 \\ 0 & X & -1 \end{bmatrix}\begin{bmatrix} q_1 \\ q_2 \\ q_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ -0.5 \end{bmatrix}$$

The correct option for the numeric value of X is
a) -0.50
b) -1.75
c) –1.00
d) -2.00

Q37. Match the following for Enhanced Oil Recovery operations

P. Surfactant flooding I. Prevent viscous fingering
Q. Polymer flooding II. Decrease oil viscosity
R. Alkali flooding III. Reduce interfacial tension
S. Steam injection IV. Reaction with naphthenic acid

a) P - II, Q – I, R – III, S – IV
b) P - III, Q – I, R – IV, S - II
c) P - III, Q – II, R – IV, S - I
d) P - III, Q – I, R – II, S – IV

Q38. An incompressible fluid is flowing through a tube of radius, R and length, L. The shear rate dependence of the fluid viscosity is given by the power law, $\mu = k\,|\Upsilon|^{n-1}$ where, Υ is the scalar shear rate, k is a constant, and n is the flow behaviour index. Assuming the flow to be steady, laminar and fully developed the velocity profile inside the tube for a pressure drop of Δp applied across the tube is _____

(A)
$$\left(\frac{\Delta p}{2kL}\right)^{\frac{1}{n}}\left(\frac{n}{n+1}\right)R^{\frac{n+1}{n}}\left[1-\left(\frac{r}{R}\right)^{\frac{n+1}{n}}\right]$$

(B)
$$\left(\frac{\Delta p}{2kL}\right)^{\frac{1}{n}}\left(\frac{n+1}{n+2}\right)R^{\frac{n+2}{n+1}}\left[1-\left(\frac{r}{R}\right)^{\frac{n+2}{n+1}}\right]$$

(C)
$$\left(\frac{\Delta p}{2kL}\right)^{\frac{1}{n}}\left(\frac{n}{n+2}\right)R^{\frac{n+2}{n}}\left[1-\left(\frac{r}{R}\right)^{\frac{n+2}{n}}\right]$$

(D)
$$\left(\frac{\Delta p}{8kL}\right)^{n}R^{2}\left[1-\left(\frac{r}{R}\right)^{2n}\right]$$

Q39. The apparent permeability of a core measured using air is Ka, and its absolute permeability measured using an incompressible liquid is K_L. If P_m is the mean air pressure in the core during permeability measurement and c is a positive constant linked to the pore geometry, then K_a and K_L are related as:

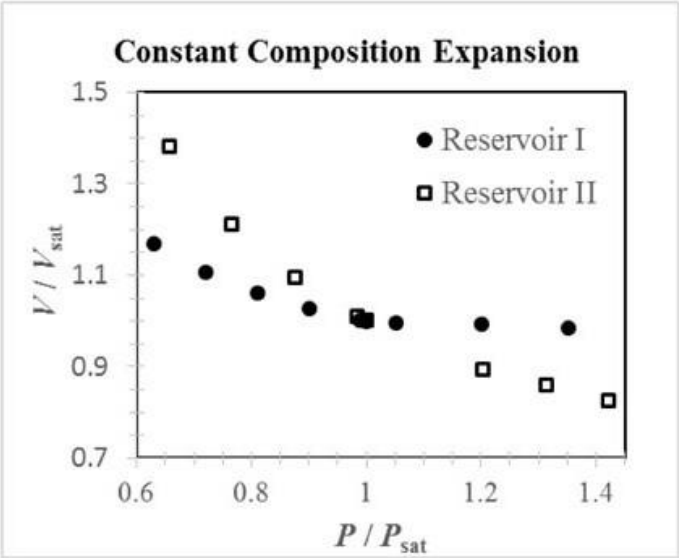
(A) $$K_a = 2K_L - c\left(\frac{1}{P_m}\right)$$

(B) $$K_a^2 = K_L^2 - c(P_m)$$

(C) $$K_a = K_L + c\left(\frac{1}{P_m}\right)$$

(D) $$K_a^2 = K_L^2 + c(P_m)$$

Q40) The plot of volume (V) versus (P) for two reservoir fluids (I and II) obtained in a constant composition expansion (CCE) is shown in the figure. Here, Vsat is saturation volume and Psat is saturation pressure. The measurements were carried out at constant temperature (the measured reservoir temperature) throughout the experiment. Which one of the following statements for the type of reservoir is correct?



a) I is a gas condensate reservoir and II is an oil reservoir
b) I is an oil reservoir and II is a gas condensate reservoir
c) I is a light oil reservoir and II is a heavy oil reservoir
d) I is a dry gas reservoir and II is a gas condensate reservoir

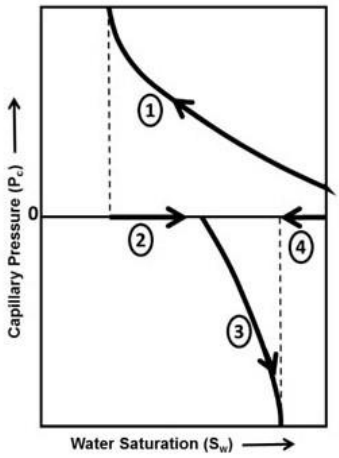
Q41. The following primary and secondary porosity types are prevalent in the subsurface formations:
1. Interparticle
2. Intraparticle
3. Fracture
4. Solution
5. Bedding plain voids

6. Channel

Which one of the following options represents the correct combination?

a) Primary (1, 2, 3); Secondary (4, 5, 6)
b) Primary (1, 2, 5); Secondary (3, 4, 6)
c) Primary (1, 3, 6); Secondary (2, 4, 5)
d) Primary (2, 4, 6); Secondary (1, 3, 5)

Q42. In the given figure, which one of the following options represents the correct combination of drainage and imbibition processes for a water wet rock in the subsurface, as indicated by number 1 to 4?



a) 1- oil displacing water, 2- spontaneous brine imbibition, 3- water displacing oil, 4- spontaneous oil imbibition
b) 1- water displacing oil, 2- spontaneous oil imbibition, 3- spontaneous brine imbibition, 4- oil displacing water
c) 1- spontaneous oil imbibition, 2- spontaneous brine imbibition, 3- water displacing oil, 4- oil displacing water
d) 1- water displacing oil, 2- spontaneous brine imbibition, 3- oil displacing water, 4 - spontaneous oil imbibition

Q43. The following notations are defined for a porous medium:

Φ = porosity,
S_p = surface area of the pore per unit bulk volume of the core,
τ = tortuosity factor for the interconnected porous channel,
C = geometric factor of the pore.

The correct combination for the hydraulic radius (rh) and absolute permeability (k) of a porous medium is

a) $r_h = \frac{\Phi}{S_p}$ and K = $\frac{C\,\Phi^3}{\tau\,{S_p}^2}$

b) $r_h = \frac{\Phi}{S_p}$ and K = $\frac{C\,\Phi^4}{\tau\,{S_p}^2}$

c) $r_h = \frac{\Phi^2}{S_p}$ and K = $\frac{C\,\Phi^2}{\tau\, {S_p}^2}$

d) $r_h = \frac{\Phi^3}{S_p}$ and K = $\frac{C\,\Phi^3}{\tau\, {S_p}^2}$

Q44. Match the following

I. Drag bit	P. Hard formation and reduction in trip time
II. Diamond bit	Q. Excessive pressure loss and extra pumping capacity
III. Jet bit	R. Soft and sticky formation

a) I-P. II-Q, III-R

b) I-R, II-Q, III-P

c) I-Q, II-P, III-R

d) I-R, II-P, III-Q

Q45. Select the correct combination of a floating vessel motion in a horizontal plane (P) and a vertical plane (Q)

a) P: (Surge, Sway, Yaw) and Q:(Heave, Roll, Pitch)

b) P: (Heave, Roll, Pitch) and Q: (Surge, Sway, Yaw)

c) P: (Surge, Roll, Pitch) and Q: (Heave, Sway, Yaw)

d) P: (Surge, Sway, Pitch) and Q: (Heave, Roll, Yaw)

Q46. The equation $x^3 - 3x - 5 = 0x$ is to be solved using the Newton-Raphson method. Starting with an initial guess of 2, the value of x after three iterations (rounded off three decimal places) s _____

Q47. The axis of a cylinder of radius *a* and length *L* is along the z-axis centre of the flat surface at (0, 0, 0). An inextensible string of negligible thickness is wound tightly as a right-handed helix around the curved surface of the cylinder. The two ends of the string are at (a, 0, 0) and (a, 0, L).
The parametric equation8 of the right-handed helix is given by,

$r(\theta) = [a\ cos\theta,\ asin\theta,\ c\theta]$,

Where r is the position vector and θ is in radian.

Given $a = \frac{2}{\pi}\ cm$, $c = \frac{1}{\pi} cm$, $L = 4\ cm$, the total length of the string (rounded off to two decimal places) is_____ cm

Q48. A data set containing n (=10) independent measurements (xi , yi) is to be fitted by a simple linear regression model. The least square estimates of regression coefficients are obtained and the regression estimate is given by y = $\beta_0 + \beta_i\ x$

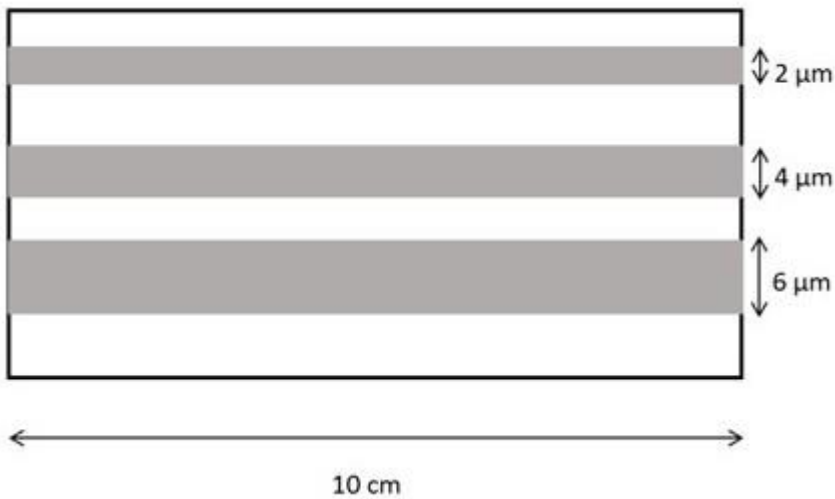
$\beta_0 = \frac{\sum_{i=1}^{n} y_i}{n} - \beta_i \frac{\sum_{i=1}^{n} x_i}{n}$,$\beta_i = \frac{Cov(x,y)}{Var(x)}$

Where, Cov (x, y) is the sample covariance and Var(x) is the sample variance. The values are given below:

$\sum_{i=1}^{10} x_i = 25$, $\sum_{i=1}^{10} y_i = 37$, $\sum_{i=1}^{10} x_i^2 = 108$, $\sum_{i=1}^{10} y_i^2 = 155$ and $\sum_{i=1}^{10} x_i\ y_i = 120$

For the given data set, the unbiased variance for the error ($y_i - \hat{y}_i$) (rounded off to two decimal places) is_____

Q49. A porous medium of 10 cm length is made of three horizontal, cylindrical capillaries of inside diameters 2 µm, 4 µm, and 6 µm as shown in the figure (not to scale)



Oil is being injected in this porous medium that was initially filled completely with water. The interfacial tension between oil and water is 0.025 N/m. Consider water as the completely wetting phase, i.e., contact angle is 0^0. When the pressure drop across the porous medium is 20 kPa, the maximum saturation of oil in the porous medium is 0.643. When the pressure drop is increased to 30 kPa, the maximum oil saturation (rounded off to two decimal places) will be _____ (in fraction)

Q50. A unidirectional, immiscible displacement of an oil is carried out with water in a cylindrical reservoir core sample (Buckley-Leverett theory is applicable). The connate water saturation is 0.25. A fractional flow of water (f_w) vs. water saturation (S_w) curve is drawn for the process. A line drawn from a point (S_w = 0.25, f_w = 0) on the fractional flow curve is tangent at the point (S_w = 0.8, f_w = 0.8) on the curve.

The average water saturation ($S_{w,avg}$) in the core at the time of breakthrough (rounded off to two decimal places) is _____ (in fraction)

Q51. In a hydrate reservoir, the porosity of the porous medium is 0.3 and the solid hydrate saturation is 0.5. Assume that the permeability (in mD) in a porous medium is given by **k =1000** $\frac{\emptyset_e^2}{1-\emptyset_e}$, where, ϕ_e is the effective porosity available for the fluids. The permeability of the hydrate bearing porous medium (rounded off to two decimal places) is _____ mD.

Q52. The slip velocity for a gas-liquid flow in a vertical production well is 0.1 m/s. The superficial velocity of each of the phases is 0.1 m/s. The fractional hold-up of the gas-phase (rounded off to two decimal places) is _____

Q53. A three stage reciprocating compressor is to compress 4 mol/s of methane from 1 bar absolute to 60 bar absolute pressure. The gas temperature is 330 k at the suction. The compression ratio in each stage is equal and the compression is isentropic. The gas behaves C^p as an ideal gas and the ratio of specific-heat capacities ($\frac{C_p}{C_v}$) is 1.4. Take gas constant, R = 8.31 J mol-1 K-1.
The minimum work rate of compression required for the gas (rounded off to two decimal places) is _____ kJ/s.

Q54. In a 1-1 counter flow shell and tube heat exchanger, a liquid process stream (C_P = 2.1KJ Kg^{-1} K^{-1}) is cooled from 430 K to 330 K using water (Cp = 4.2 KJ Kg^{-1} K^{-1}) having an inlet temperature of 280 K. The process stream flows on the shell side at a rate of 1 kg/s and the water on the tube side at a rate of 2.5 kg/s. The overall heat transfer co-efficient is 600 W m^2 k^{-1}, Neglecting the heat loss in the surroundings, the required heat transfer area (rounded off to two decimal places) is _____ m^2.

Q55. A pre-flush of 15 wt% HCL solution (density = 1070 kg/m^3) is used to dissolve dolomite in a sandstone reservoir. The molecular formula, molar mass and density of dolomite are $CaMg(CO_3)_2$, 184.3 g/mol and 2840 kg/m^3, respectively. The molar mass of HCL is 36.5 g/mol.
If the pre-flush has to remove all the dolomite, the volumetric dissolving power of the preflush (rounded off to three decimal places) is_____ (m^3 of dolomite/m^3 of 15 wt% HCL solution)

Q56. A cuboidal wooden block of density 750 kg/m^3, with horizontal dimensions of 2.0 m x 1.0 m and vertical height of 0.8 m, floats in water (density = 1000 kg/m^3). The acceleration due to gravity is 9.81 m/s^2. The distance between centre of gravity and metacentre of the block (rounded off to two decimal places) is _____ m

Q57. It is desired to determine the radius of investigation (r_{inv}) of a low permeability and lowpressure gas reservoir which produces under a constant flow rate. Use the following data:

Absolute permeability (k) = 0.01 mD

Porosity (ϕ) = 0.05

Total isothermal compressibility (C_t) = 200 x 10^{-6} psia^{-1}, and

Viscosity (μ) = 0.05 cP

Assuming transient flow conditions are valid, the radius of investigation (r_{inv}) after 200 hours of gas production (rounded off to one decimal place) is _____ ft.

Q58. Well stimulation is carried out in a homogeneous formation. The well is stimulated up to a radial distance of 54 inch from the surface of the wellbore. The diameter of the wellbore is 12 inch. The permeability enhancement in the stimulated region is found to be 10 times that of the unstimulated region. Assuming steady-state radial flow, the skin factor after stimulation (rounded off to two decimal places) is _____.

Q59. A gas reservoir has a permeability of 1.0 md, which is to be fractured hydraulically to create a 600 m long and 0.30 cm wide fracture of 2 x 10^5 mD permeability around the centre of damage area. The fracture conductivity for the well (rounded off to two decimal places) is _____

Q60. A producing oil well with the drainage to wellbore radius ratio of 2981 is found to have a skin factor of 8. Assume steady state operation and negligible pressure drop in the tubing. The ratio of production rate of the damaged to the 'undamaged' well (rounded off to two decimal places) is _____

Q61. It is desired to prepare a Class H cement slurry having a density of 2100 kg/m^3 using hematite as an additive. The water requirement for the Class H cement is 20 litre/50 kg cement and that for hematite is 3 litre/1000 kg hematite.

Given:

Density of class H cement = 3 125 kg/m^3

Density of hematite = 5000 kg/m^3

Density of water = 1000 kg/m^3

Weight of one sack of cement = 50.0 kg

Assuming zero volume change of mixing, the amount of hematite that should be blended with one sack of cement (rounded off to two decimal places) is ____ kg.

Q62. A gas reservoir without aquifer is at 300 bar (absolute) and 90^{0}C. The GIIP (gas initial in place) is 10^7 m^3 (at surface conditions). Neglect formation and water compressibility.

Given:

Surface pressure = 1 bar (absolute)

Surface Temperature = 25^{0}C

Gas Compressibility factor, Z (at surface condition) = 1

Z (at 300 bar (absolute) and 90^{0}C) = 0.88

Z (at 100 bar (absolute) and 90^{0}C) = 0.83

If the reservoir pressure reduces to 100 bar (absolute) under isothermal conditions, the total volume of gas (at surface conditions) produced from the reservoir (rounded off to two decimal places) is _____ x 10^6 m^3.

Q63. Given the following data of a shale gas formation:

W_{toc} (weight fraction of total organic carbon (TOC)) = 0.10

S_{wr} (total water saturation) = 0.25

ρ_{Toc} (density of TOC) = 1.10 g/cm^3 ρ_m (density of matrix) = 2.65 g/cm^3 ρ_g (density of gas) = 0.35 g/cm^3 ρ_w (density of water) = 1.00 g/cm^3 ρ_b (formation bulk density) = 2.00 g/cm^3

Consider that only water and gas are present in the formation and the following equations apply,

$$\rho_b = \frac{\rho_m \times (1-\varphi_T) + \rho_f \times \varphi_T}{1 - W_{TOC} \times \left(1 - \frac{\rho_m}{\rho_{TOC}}\right)}, \qquad \rho_b = \left(\frac{\rho_{TOC} \times V_{TOC}}{W_{TOC}}\right) + \varphi_T \times \rho_f$$

Where, ρt is the fluid density, Φ_T *is* the total porosity, and V_{TOC} is the volume fraction of TOC.

The volume fraction of TOC (round doff to two decimal places) is

_____.

Q64. Its desired to drill a deviated well with ' build and hold type ' trajectory. The kick off point is at a vertical depth of 1500 ft from the surface and the rate of build is 2°/100 ft. At a true vertical depth (TVD) of 7500 ft, the net horizontal departure to the target is 2500 ft. The total measured depth is _____ ft.

Q65. A cylindrical core sample of 4 inch diameter and 20 inch length is obtained from a consolidated reservoir sand. At the reservoir temperature, the formation water resistivity (R_W) is 0.15 ohm-m whereas the resistance of the core, which is 100% saturated with brine, is 100 ohm. Use the generalized form of the Archie's formula relating Formation Resistivity Factor (F_R) and the porosity (φ), Assume α (tortuosity factor) = 1 and m (cementation factor) = 2

The porosity (in fraction) of the core (rounded off to two decimal places) is _____

Gate 2020 Question Paper and Solutions

Q. 1 – Q. 5 carry one mark each

Q1. He is known for his unscrupulous ways. He always sheds _____ tears to deceive people.
a) fox's
b) crocodile's
c) crocodile
d) fox
Ans: c

Q2. Jofra Archer, the England fast bowler, is _____ than accurate.
a) more fast
b) faster
c) less fast
d) more faster
Ans: a

Q3. Select the word that fits the analogy:
Build : Building : : Grow : _____
a) Grown
b) Grew
c) Growth
d) Growed
Ans: c

Q4. I do not think you know the case well enough to have opinions. Having said that, I agree with your other point. What does the phrase "having said that" mean in the given text?
a) as opposed to what I have said
b) despite what I have said
c) in addition to what I have said
d) contrary to what I have said
Ans: b

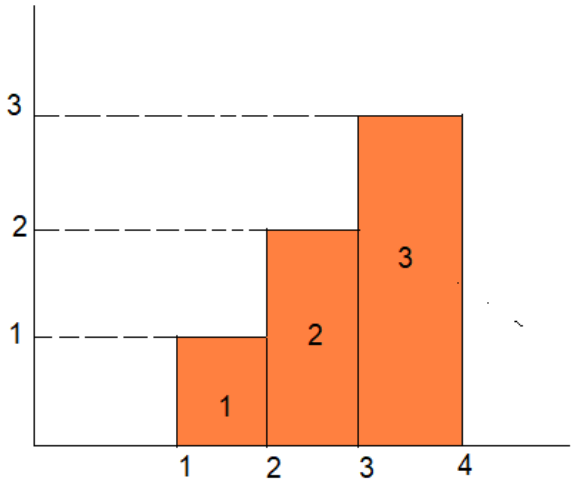
Q5. Define $[x]$ as the greatest integer less than or equal to x, for each $x \in (-\infty, \infty)$. If $y = [x]$, then area under y for $x \in [1, 4]$ is _____.
a) 1
b) 3
c) 4

d) 6

Ans: d

Exp:

The function y = [x] graph is shown below



Area = (1 x 1) + (1 x 2) + (1 x 3) = 6

Q. 6 – Q. 10 carry two marks each.

Q6. Crowd funding deals with mobilization of funds for a project from a large number of people, who would be willing to invest smaller amounts through web-based platforms in the project. Based on the above paragraph, which of the following is correct about crowd funding?

a) Funds raised through unwilling contributions on web-based platforms.

b) Funds raised through large contributions on web-based platforms.

c) Funds raised through coerced contributions on web-based platforms.

d) Funds raised through voluntary contributions on web-based platforms.

Ans: d

Q7. The sum of the first n terms in the sequence 8, 88, 888, 8888, ... is _____.

a) $\frac{81}{80}(10^n - 1) + \frac{9}{8}$n

b) $\frac{81}{80}(10^n - 1) - \frac{9}{8}$n

c) $\frac{81}{80}(10^n - 1) + \frac{8}{9}$n

d) $\frac{81}{80}(10^n - 1) - \frac{8}{9}$n

Ans: d

Exp:

The Sum of the Sequence is given bty

Sum = 8 + 88 + 888 + 8888 + ……

$= \frac{8}{9}(9 + 99 + 999 + 9999 + \ldots\ldots\ldots\ldots..)$

$= \frac{8}{9}(10 - 1 + 100 - 1 + 1000 - 1 + 10{,}000 - 1 + \ldots\ldots\ldots\ldots..)$

$= \frac{8}{9}(10 + 100 + 1000 + 10{,}000 + \ldots\ldots\ldots\ldots.. - (1 + 1 + 1 + \ldots.))$

The Sum of Geometric sequence is given by

$= \frac{8}{9}[\frac{10\,(10^n - 1)}{10-1} - n]$

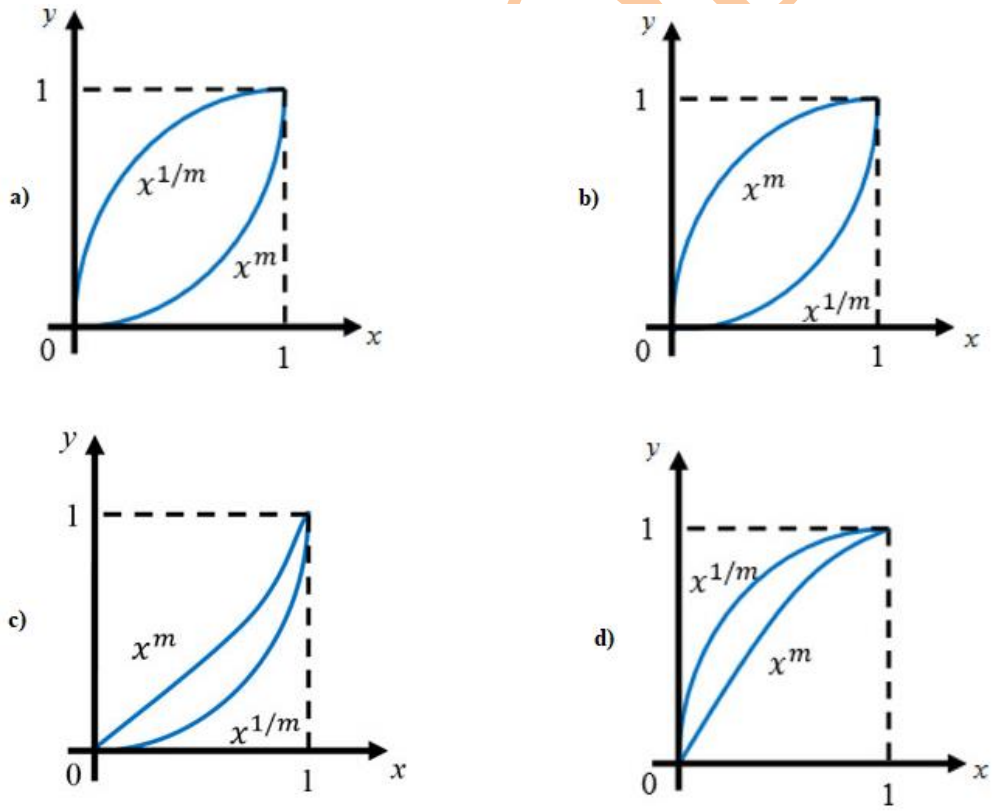
$= \frac{81}{80}(10^n - 1) - \frac{8}{9}n$

Q8. P, Q, R and S are to be uniquely coded using α and β. If P is coded as αα and Q as αβ, then R and S, respectively, can be coded as _____.

a) βα and αβ
b) ββ and αα
c) αβ and ββ
d) βα and ββ

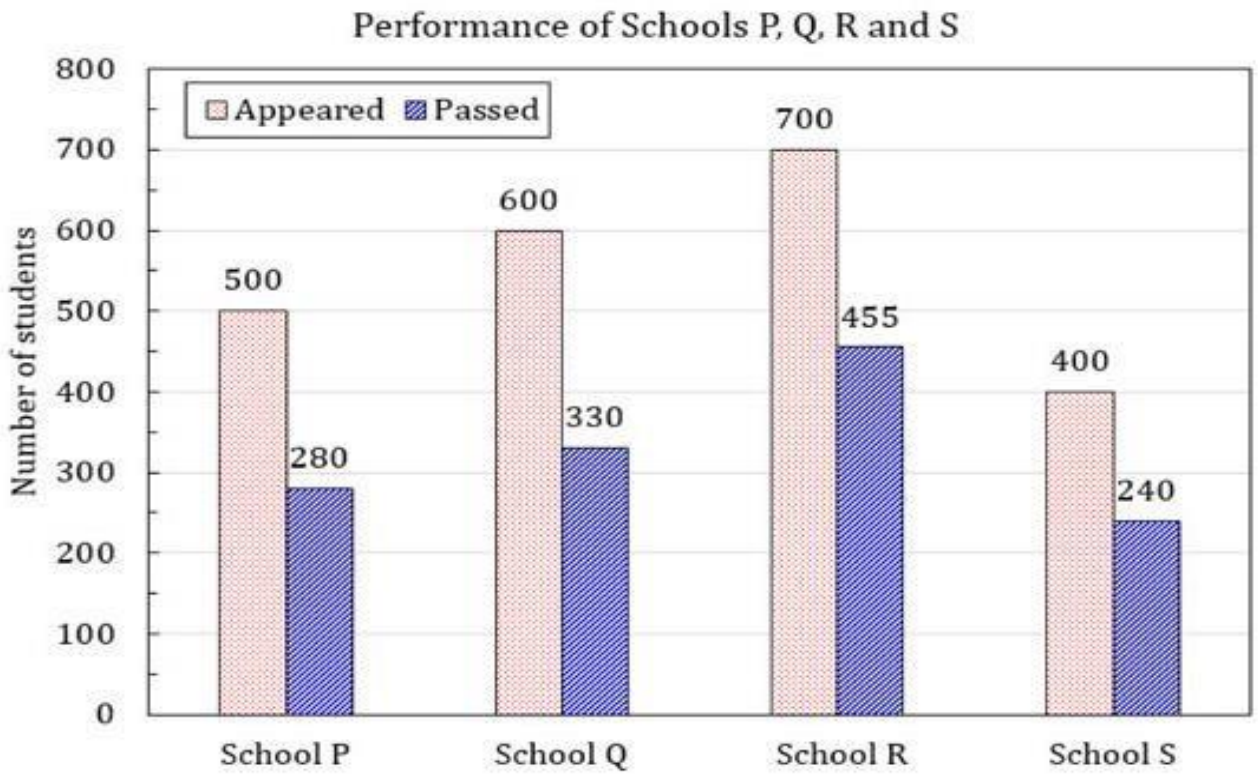
Ans:d

Q9. Select the graph that schematically represents BOTH $y = x^m$ and $y = x^{1/m}$ properly in the interval $0 \le x \le 1$. For integer values of m, where $m > 1$.



Ans:a

Q10. The bar graph shows the data of the students who appeared and passed in an examination for four schools P, Q, R and S. The average of success rates (in percentage) of these four schools is _____.



a) 58.5%
b) 58.8%
c) 59.0%
d) 59.3%

Ans: c

Exp:

They Asked the average of success rates in percentage of these four schools. Not Average Success rate of schools.

So calculate the success of rate of each school and calculate their average

Success rate of school P = 280/500 x 100 = 56
Success rate of school Q = 330/600 x 100 = 55
Success rate of school R = 455/700 x 100 = 65
Success rate of school S = 240/400 x 100 = 60

Average of all schools = (56+55+65+60)/4 = 59

Q.11 – Q. 35 carry one mark each

Q11. Consider a vector field, $\boldsymbol{A} = 3xz\hat{\imath} + 2xy\hat{\jmath} - yz\hat{k}$, where, $\hat{\imath}$, $\hat{\jmath}$, *and* $\hat{k}$ are the unit vectors along the x, y, and z directions respectively. The divergence of **A** at the point (1, 1, 1) is equal to _____

a) 0
b) 2
c) 3
d) 4

Ans: d

Exp:

Div A= 3xzi +2xyj-yzk . $\frac{d}{dx}$i+$\frac{d}{dy}$j+$\frac{d}{dz}$k

= 3z+2x-y

We have to find divergence at point (1,1,1)

=3+2-1

=4

Q12. Inverse Laplace transform of the function, F (s) =$\frac{1}{s^2+s}$, is given by

a)$1 - e^t$

b)$1 + e^t$

c)$1 - e^{-t}$

d) $1 + e^{-t}$

Ans. c

Exp. F (s) =$\frac{1}{s^2+s}$

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

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

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

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

=$1-e^{-t}$

Q13. The solution of the differential equation, $\frac{dy}{dx}+\frac{y}{x}=x(x\neq 0)$with the condition y = 1 at x = 1, is given by

a) $y = \frac{2}{3x^2}+\frac{x}{3}$

b) $y = \frac{1}{2x}+\frac{x}{2}$

c) $y = \frac{2}{3}+\frac{x}{3}$

d) $y = \frac{2}{3x}+\frac{x^2}{3}$

Ans: d

Exp:

Given Differential Equation

$$\frac{dy}{dx}+\frac{y}{x}=x$$

The Integrating factor is given by

$$IF = e^{\int \frac{1}{x} dx}$$

$$IF = e^{\ln x}$$

$$IF = x$$

Multiplying Both sides by Integrating factor we ge

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

$$\frac{dyx}{dx} = x^2$$

$$d\,yx = x^2\,dx$$

$$\int d\,yx = \int x^2\,dx$$

$$yx = \frac{x^3}{3} + c$$

$$y = \frac{x^2}{3} + \frac{c}{x}$$

Given at x = 1 , y = 1

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

The Final Equation is given by

$$y = \frac{2}{3x}+\frac{x^2}{3}$$

Q14. Two complex numbers are given as $z_1 = e^{i\theta 1}$ and $_2 = e^{i\theta 2}$, where $i = \sqrt{-1}$ and θ_1 and θ_2 are the principal arguments. Given $\theta_1 \neq \theta_2$ and $|\theta_1 - \theta_2| \neq \pi$.

If $m = \sqrt{(\cos\theta_1 + \cos\theta_2)^2 + (\sin\theta_1 + \sin\theta_2)^2}$, which one of the following conditions is correct?

a) 2 < m <3
b) 0 < m <2
c) m = 2
d) m = 0

Ans: b

Exp:

Given

$m = \sqrt{(\cos\theta 1 + \cos\theta 2)2 + (\sin\theta 1 + \sin\theta 2)2}$

$m = \sqrt{2 + 2\cos\theta 1 \cos\theta 2 + 2\sin\theta 1 \sin\theta 2}$

$m = \sqrt{2 + 2\cos(\theta 1 - \theta 2)}$

The Range is 0 < m < 2

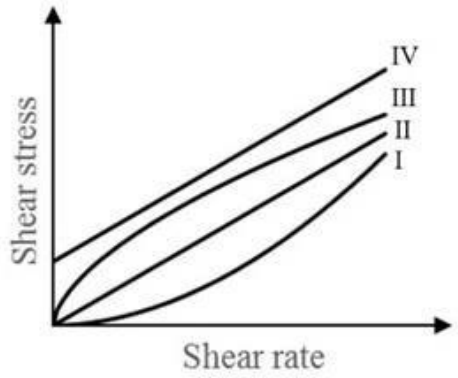
Q15. Match the following

P. Gauss-Seidel method	I. Interpolation
Q. Forward Newton Gauss method	II. Non-linear differential equation
R. Runge-Kutta method	III. Linear algebraic equation

a) P-I, Q-II, R-III
b) P-II, Q-I, R-III
c) P-I, Q-III, R-II
d) P-III, Q-I, R-II

Ans: d

Q16. Shear stress versus shear rate plots for four different fluids are given in the Figure. Which curve represents a pseudo plastic fluid?



a) I b) II c) III d) IV

Ans:c

Q17. Which one of the following is NOT a desired function of a hydraulic fracturing fluid additive?

a) Oxygen scavenging to prevent attack on polymers.

b) Increasing viscosity of fracturing fluid during flow back.

c) Work as a bactericide.

d) Work as a surfactant to facilitate post treatment clean-up.

Ans: b

Q18. Formation Damage could be a result of

i. scale formation near the wellbore

ii. coke formation due to in-situ combustion.

iii. precipitation of asphaltene.

iv. condensate banking

Which one of the following options is correct?

a) (i) and (iv) only
b) (i) and (iii) only
c) (i), (ii) and (iii) only
d) (i), (ii), (iii) and (iv)

Ans: d

Q19. Which of the following statements(s) about gas and water coning in the reservoir is/are correct?

i. Gas and water coning is characterized by downward movement of water and upward movement of gas near the producing wellbore

ii. Gas and water coning is characterized by downward movement of gas and upward movement of water near the producing wellbore

iii. Gas and water coning improves the reservoir's oil recovery efficiency

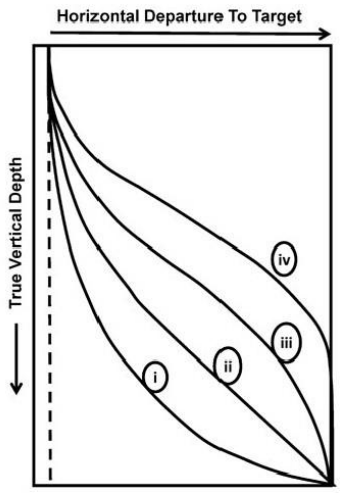
iv. Gas and water coning is caused when gravitational forces dominate over viscous forces

a) i and iv only

b) ii only
c) ii, iii, and iv only
d) iv only

Ans: b

Q20) Given the Figure



Which one of the following options represents the correct combination of the trajectory number and the corresponding drilling type?

a) i ➔ Build and Hold, ii ➔ Modified S-Type, iii ➔ S-Type, iv ➔ Continuous Build

b) I ➔ Build and Hold, ii ➔ S-Type, iii ➔ Modified S-Type, iv ➔ Continuous Build

c) i ➔ Continuous Build, ii ➔ Build and Hold, iii ➔ Modified S- type, iv ➔ S- type

d) i ➔ Continuous Build, ii ➔ S- type, iii ➔ Modified S-Type, iv ➔ Build and Hold

Ans: b

Q21. A stable geothermal gradient (approx. 250C/km) in the earth's crust will suddenly increase to a higher gradient value, when

a) there is excessive erosion and upliftment

b) there is excessive subsidence and deposition

c) there is excessive subsidence and upliftment simultaneously

d) there is excessive erosion and upliftment simultaneously

Ans: a

Q22. A drawdown test is conducted at a constant flow rate in an oil well for a reservoir with constant compressibility. Which one of the following is valid for semi steady state condition?

a) Rate of pressure change at the wellbore is less than at the boundary

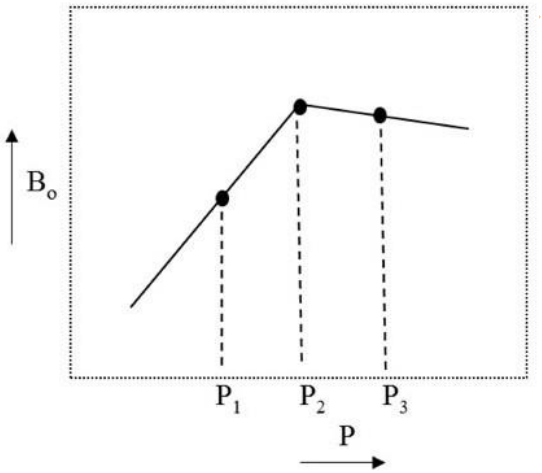
b) The effect of the outer boundary of the reservoir is felt at the wellbore

c) Reservoir permeability does not affect the wellbore pressure

d) Pressure in the reservoir does not change with time

Ans: b

Q23) Formation volume factor (Bo) versus Pressure (P) plot for an oil is given in the figure.



Match the following with the corresponding pressure given in the figure

IV. Bubble Point
V. II. Saturated Oil
VI. III. Under-saturated Oil

a) I - P1, II - P2, III - P3

b) I - P1, II - P3, III – P2

c) I – P2, II – P1, III - P3

d) I – P2, II – P3, III – P1

Ans: c

Q24. Which one of the following statements is NOT correct?

a) Flash point of gasoline is lower than that of diesel.

b) Pour point is the temperature at which oil ceases to flow.

c) Higher the Diesel Index of a fuel, higher is its cetane number.

d) Higher the aromatic content of diesel, higher is its aniline point.

Ans: d

Q25. Which one of the following additives is commonly added to drilling fluids to remove hydrogen sulfide?

a) Sodium chloride

b) Calcium chloride

c) Zinc carbonate

d) Bentonite

Ans: d

Q26. Two rigid spherical particles of the same density, with a diameter ratio D1: D2 = 1:2, settle freely through a pool of liquid. The terminal settling velocity is given by the Stoke's law. What is the ratio of their terminal settling velocities, V1 : V2?

a) 1:2

b) 2:1

c) 1:4

d) 4:1

Ans:c

Exp:

The Settling velocity is given by

Settling velocity= $\frac{gd^2}{18\mu}(s-1)$

$V \alpha d^2$

$V_1/V_2=(1/2)^2=1:4$

Q27. Which of the following options best represent the correct order of increasing thermal conductivity of the sub-surface formations?

a) Coal < Shale < Dolomite < Evaporite

b) Evaporite < Shale < Coal < Dolomite

c) Coal < Shale < Evaporite < Dolomite

d) Shale < Coal < Evaporite < Dolomite

Ans: a

Q28. Which one of the following options is the correct combination of kerogen Type and the source from which it is derived?

a) Type I - Lacustrine, Type II - Marine, Type III- Terrestrial, Type LY - Varied

b) Type I - Marine, Type II - Terrestrial, Type Ill - Varied, Type IV - Lacustrine

c) Type I - Lacustrine, Type II - Varied, Type III - Marine, Type IV - Terrestrial

d) Type I - Lacustrine, Type II - Terrestrial, Type III - Marine, Type IV – Varied

Ans: b

Q29. The number of power outages in a city in a given time interval is a Poisson random variable with a mean of 2 power outages per month. The Poisson distribution is given by

$P(y)=\frac{e^{-\mu}\mu^{y}}{y!}$

The probability of exactly 2 power outages in 2 months (rounded off to two decimal places) is _____

Ans: 0.12 – 0.18

Exp:

The Mean is calculate as

$\mu = 2x2 = 4$

The Poisoons distribution is given by

$P(X) = \frac{\mu^x e^{-\mu}}{x!}$

Where

μ = mean

x = random variable

The probability of exactly 2 power outages in 2 months is given by

$P(X) = \frac{4^2 e^{-4}}{2!} = 0.146$

Q30. Anhydrous sodium hydroxide is added to 10 litre of water to raise its pH from 7.0 to 9.0. The molar mass of sodium hydroxide is 40 g/mol. Assuming complete dissociation of sodium hydroxide and zero volume change of mixing, the amount of sodium hydroxide added (rounded off to two decimal places) is ____ mg.

Ans: 3.85 – 4.10

Exp:

Given

We have to increase the pH from 7 to 9

First calculate the change in the $[OH^-]$ ion concentration in mol/litres

We Know the Product of ion concentration is 10^{-14}

$[H^+][OH^-] = 10^{-14}$

Initially We know $P^H = 7$ and $P^{OH} = 7$

The initial Concentration of OH = 10^{-7} mol/liters

Final $P^H = 9$ and $P^{OH} = 5$

The Final Concentration of OH = 10^{-5} mol/liters

The Change in Concentration due to addition of NaOH = 10^{-5} mol/liters - 10^{-7} mol/liters

Number of moles added = $[10^{-5} - 10^{-7}]$ mol/liters x 10 liters

= 9.9×10^{-5} moles

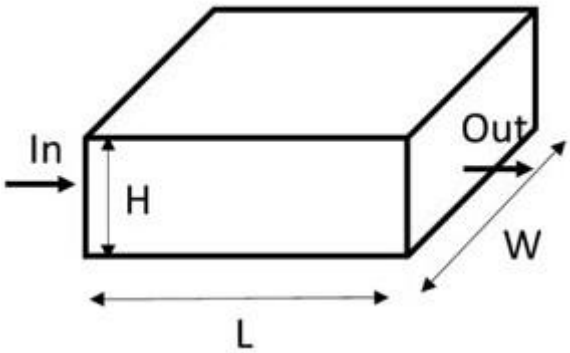
The Amount of mass added = Number of moles added x Molecular weight

= $9.9 \times 10^{-5} \times 40$

= 3.96 x 10-3 grams

= 3.96 mg

Q31. Consider unidirectional, laminar flow of water through a homogeneous porous media as shown in the figure. Here, H = 100 m, W = 500 m, L = 500 m, permeability of the porous media is 10-12 m2 and the driving pressure drop (across length L) is 106 Pa. Use the viscosity of water as 10-3 Pa.s



At steady state, the volumetric flow rate of water (round off to two decimal places) is given by _____ m3/s.

Ans: 0.09-0.12

Exp:

The Volumetric flow rate for water is given by Darcy's law and it is given by

$$q = \frac{KA(p_1 - p_2)}{\mu L}$$

$$= \frac{10^{-12} X 100 X 500 X 10^6}{10^{-3} X 500}$$

= 0.1 m3/s.

Q32. A dry gas well is producing a gas stream of the following molar composition: 95% methane and 5% carbon dioxide. The molar mass of the methane is 16 g/mol and that of carbon dioxide is 44 g/mol. Assuming ideal gas behaviour, gas constant R = 8.31 J mol-1 K-1, the gas stream density at 107 Pa and 350 K (rounded off to one decimal place) is _____ kg/m3

Ans: 59.0-61.0

Exp:

The Average Molecular weight is given by

$$\boldsymbol{M_g} = \sum M_i \, X \, Y_i$$

$$\boldsymbol{M_g} = M_1Y_1 + M_2Y_2$$

$$= 0.95x16 + 0.05x44 = 17.4$$

$$\rho_g = \frac{PMg}{RT} = \frac{10^7 X 17.4}{8.31 X 350} = 59824.65 \text{ g/m}^3 = 59.82 \text{ kg/m3}$$

Q33. Consider fluid flow through the annular space between two cylindrical tubes. The outer diameter of the inner tube is 40 mm and the inner diameter of the outside tube is 50 mm. The hydraulic mean diameter for fluid flow calculations (round off to one decimal place) is _____ mm.

Ans: 9.0-10.5

Exp:

The Hydraulic mean diameter is given by

$$\text{Hydraulic mean diameter} = \frac{4X\ area}{wetted\ perimeter}$$

$$= \frac{4X\frac{\pi(d_{out}^2 - d_{in}^2)}{4}}{\pi(d_{out} + d_{in})}$$

$$= d_{out} - d_{in}$$

$$=10$$

Q34. A build-up test performed on the well after 1000 hours of oil production. During the shut-in period, the Horner's approximation is valid which results in the following equation relating the shut-in well pressure (Pws) to the shut-in time:

$$\frac{2\pi kh}{q\mu}(P_i - P_{ws}) = \frac{1}{2}\ln X + P_D(t_D) - \frac{1}{2}\ln\frac{4t_D}{\gamma}$$

Here, k is the permeability, h is the reservoir thickness, Pi is the initial reservoir pressure, q is the flow rate during production, μ is the oil viscosity, tD is the dimensionless production time, PD(tD) is the dimensionless pressure at tD, Y is a constant and X is dependent on the shut-in time and the production time.
The value of X after 5 hours of shut-in (rounded off to one decimal place is _____.

Ans: 200.5-201.5

Exp:

The Value X for Horner's approximation is given by

$$X = \frac{t_p + \Delta t}{\Delta t}$$

$$= \frac{1000+5}{5}$$

$$=201$$

Q35. The initial oil production from an offshore well is 1000 STB/day, which decreased to 960 STB/day in 30 days. Using the ''exponential decline model'', the daily production rate after 360 days from the start (rounded off to one decimal place) will be _____ STB/day.

Ans: 610-615

Exp:

The flow rate for exponential decline is given by

$q_t = q_i \times e^{-tD_i}$

$960 = 1000 \times e^{-30xD}$

$D = 1.36 \times 10^{-3}$ /day

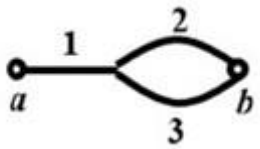
Production rate after 360 days

$q_t = 1000 \times e^{-1.36x0.001x360}$

$= 612.7$ STB/day

Q. 36 – Q. 65 carry two mark each

Q36. An incompressible fluid flows through a network of pipes as shown in the given Figure. The total pressure drop across points a and b is 2 kPa. The flow rates (in m3/s) in sections 1, 2, and 3 are q1, q2, and q3 respectively. The pressure drops (in kPa) are 4q1, 3q2, and 2q3 across sections 1, 2, and 3 respectively.



For a steady-state flow operation, the system of equations for flow rates is given by,

$$\begin{bmatrix} 4 & 3 & 0 \\ 0 & -3 & 2 \\ 0 & X & -1 \end{bmatrix} \begin{bmatrix} q_1 \\ q_2 \\ q_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ -0.5 \end{bmatrix}$$

The correct option for the numeric value of X is

a) -0.50

b) -1.75

c) –1.00

d) -2.00

Ans: b

Exp:

The Above given network of pipes and applying law of conservation of mass we get

Q1 = Q2 + Q3

By multiplying the matrices and equating them we get

4Q1 + 3Q2 = 2

0(Q1) – 3 Q2 + 2 Q3 = 0

0(Q1) + X (Q2) -1(Q3) = - 0.5

$4Q_1 + 3Q_2 = 2$

$3Q2 = 2Q_3$

Solving above two we get

$Q1 = \frac{2-3Q2}{4}$ …… (1)

Q1 = Q2 + Q3
3Q2 =2Q_3
Solving above two get
$Q1 = \frac{5}{2} Q2$ ……. (2)
Solving (1) and (2) we get
$\frac{5}{2} Q2 = \frac{2-3Q2}{4}$
13 Q2 = 2
$Q2 = \frac{2}{13}$
$Q3 = \frac{3}{13}$

Substituting the above two in the below equation
X (Q2) -1(Q3) = - 0.5
$X (\frac{2}{13}) - (\frac{3}{13}) = -0.5$
X = - 1.75

Q37. Match the following for Enhanced Oil Recovery operations

P. Surfactant flooding	I. Prevent viscous fingering
Q. Polymer flooding	II. Decrease oil viscosity
R. Alkali flooding	III. Reduce interfacial tension
S. Steam injection	IV. Reaction with naphthenic acid

a) P - II, Q – I, R – III, S – IV
b) P - III, Q – I, R – IV, S - II
c) P - III, Q – II, R – IV, S - I
d) P - III, Q – I, R – II, S – IV

Ans: b

Q38. An incompressible fluid is flowing through a tube of radius, R and length, L. The shear rate dependence of the fluid viscosity is given by the power law, μ = k |ϒ|n-1 where, ϒ is the scalar shear rate, k is a constant, and n is the flow behaviour index. Assuming the flow to be steady, laminar and fully developed the velocity profile inside the tube for a pressure drop of Δp applied across the tube is _____

(A) $$\left(\frac{\Delta p}{2kL}\right)^{\frac{1}{n}}\left(\frac{n}{n+1}\right)R^{\frac{n+1}{n}}\left[1-\left(\frac{r}{R}\right)^{\frac{n+1}{n}}\right]$$

(B) $$\left(\frac{\Delta p}{2kL}\right)^{\frac{1}{n}}\left(\frac{n+1}{n+2}\right)R^{\frac{n+2}{n+1}}\left[1-\left(\frac{r}{R}\right)^{\frac{n+2}{n+1}}\right]$$

(C) $$\left(\frac{\Delta p}{2kL}\right)^{\frac{1}{n}}\left(\frac{n}{n+2}\right)R^{\frac{n+2}{n}}\left[1-\left(\frac{r}{R}\right)^{\frac{n+2}{n}}\right]$$

(D) $$\left(\frac{\Delta p}{8kL}\right)^{n}R^{2}\left[1-\left(\frac{r}{R}\right)^{2n}\right]$$

Ans: a

Q39. The apparent permeability of a core measured using air is Ka, and its absolute permeability measured using an incompressible liquid is K_L. If P_m is the mean air pressure in the core during permeability measurement and c is a positive constant linked to the pore geometry, then K_a and K_L are related as:

(A) $$K_a = 2K_L - c\left(\frac{1}{P_m}\right)$$

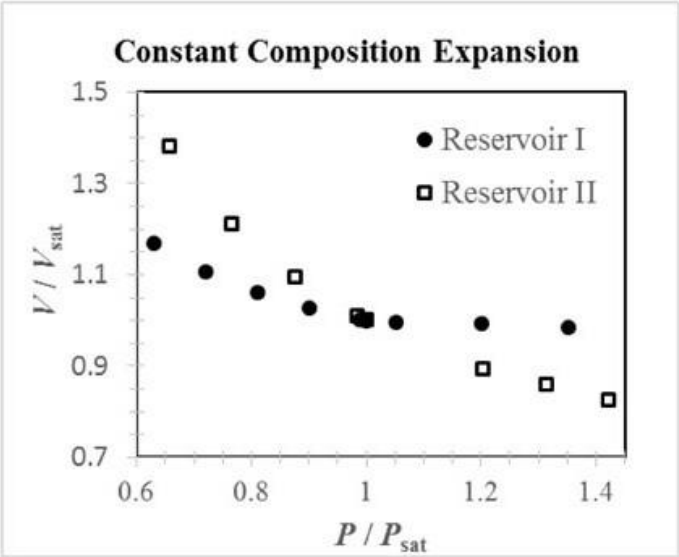
(B) $$K_a^2 = K_L^2 - c(P_m)$$

(C) $$K_a = K_L + c\left(\frac{1}{P_m}\right)$$

(D) $$K_a^2 = K_L^2 + c(P_m)$$

Ans: c

Q40) The plot of volume (V) versus (P) for two reservoir fluids (I and II) obtained in a constant composition expansion (CCE) is shown in the figure. Here, Vsat is saturation volume and Psat is saturation pressure. The measurements were carried out at constant temperature (the measured reservoir temperature) throughout the experiment. Which one of the following statements for the type of reservoir is correct?



a) I is a gas condensate reservoir and II is an oil reservoir
b) I is an oil reservoir and II is a gas condensate reservoir
c) I is a light oil reservoir and II is a heavy oil reservoir
d) I is a dry gas reservoir and II is a gas condensate reservoir

Ans: b

Q41. The following primary and secondary porosity types are prevalent in the subsurface formations:

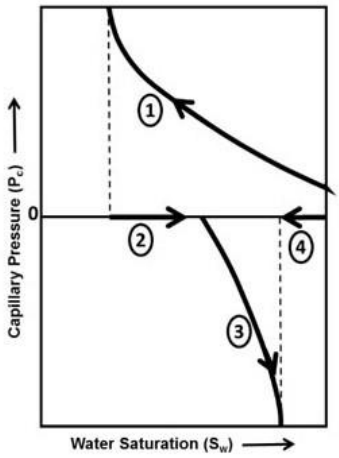
1. Interparticle
2. Intraparticle
3. Fracture
4. Solution
5. Bedding plain voids
6. Channel

Which one of the following options represents the correct combination?

a) Primary (1, 2, 3); Secondary (4, 5, 6)
b) Primary (1, 2, 5); Secondary (3, 4, 6)
c) Primary (1, 3, 6); Secondary (2, 4, 5)
d) Primary (2, 4, 6); Secondary (1, 3, 5)

Ans: b

Q42. In the given figure, which one of the following options represents the correct combination of drainage and imbibition processes for a water wet rock in the subsurface, as indicated by number 1 to 4?



a) 1- oil displacing water, 2- spontaneous brine imbibition, 3- water displacing oil, 4- spontaneous oil imbibition
b) 1- water displacing oil, 2- spontaneous oil imbibition, 3- spontaneous brine imbibition, 4- oil displacing water
c) 1- spontaneous oil imbibition, 2- spontaneous brine imbibition, 3- water displacing oil, 4- oil displacing water
d) 1- water displacing oil, 2- spontaneous brine imbibition, 3- oil displacing water, 4 - spontaneous oil imbibition

Ans: a

Q43. The following notations are defined for a porous medium:

Φ = porosity,
S_p = surface area of the pore per unit bulk volume of the core,
τ = tortuosity factor for the interconnected porous channel,
C = geometric factor of the pore.
The correct combination for the hydraulic radius (rh) and absolute permeability (k) of a porous medium is

a) $r_h = \frac{\Phi}{S_p}$ and K = $\frac{C\,\Phi^3}{\tau\,{S_p}^2}$

b) $r_h = \frac{\Phi}{S_p}$ and K = $\frac{C\,\Phi^4}{\tau\,{S_p}^2}$

c) $r_h = \frac{\Phi^2}{S_p}$ and K = $\frac{C\,\Phi^2}{\tau\,{S_p}^2}$

d) $r_h = \frac{\Phi^3}{S_p}$ and K = $\frac{C\,\Phi^3}{\tau\,{S_p}^2}$

Ans:a

Q44. Match the following

IV. Drag bit	P. Hard formation and reduction in trip time
V. Diamond bit	Q. Excessive pressure loss and extra pumping capacity
VI. Jet bit	R. Soft and sticky formation

a) I-P. II-Q, III-R

b) I-R, II-Q, III-P

c) I-Q, II-P, III-R

d) I-R, II-P, III-Q

Ans: d

Q45. Select the correct combination of a floating vessel motion in a horizontal plane (P) and a vertical plane (Q)

a) P: (Surge, Sway, Yaw) and Q:(Heave, Roll, Pitch)

b) P: (Heave, Roll, Pitch) and Q: (Surge, Sway, Yaw)

c) P: (Surge, Roll, Pitch) and Q: (Heave, Sway, Yaw)

d) P: (Surge, Sway, Pitch) and Q: (Heave, Roll, Yaw)

Ans: a

Q46. The equation $x^3 - 3x - 5 = 0x$ is to be solved using the Newton-Raphson method. Starting with an initial guess of 2, the value of x after three iterations (rounded off three decimal places) s _____

Ans: 2.276-2.281

Exp:

$f(x) = x^3 - 3x - 5$ $f^l(x) = 3x^2 - 3$

The Newton-Raphson method is given by

$$X_{n+1} = X_n - \frac{f(X_n)}{f^l(X_n)}$$

And equation

$f(x) = x^3 - 3x - 5$

The equation after derivative

$f^l(x) = 3x^2 - 3$

Iteration 1: Put n = 0 in (1) and using initial guess (x0) = 2

We get x1= 2.333

Iteration 2: Put n = 1 in (1) and using (x1) = 2.333,
we obtain X2 = 2.280
Iteration 3: Put n = 2 in (1) and using (x1) = 2.280,
we obtain X3 = 2.279

Q47. The axis of a cylinder of radius a and length L is along the z-axis centre of the flat surface at (0, 0, 0). An inextensible string of negligible thickness is wound tightly as a right-handed helix around the curved surface of the cylinder. The two ends of the string are at (a, 0, 0) and (a, 0, L).
The parametric equation8 of the right-handed helix is given by,

$r(\theta) = [a\ cos\theta,\ asin\theta,\ c\theta]$,

where r is the position vector and θ is in radian.

Given $a = \frac{2}{\pi}\ cm$, $c = \frac{1}{\pi} cm$, $L = 4\ cm$, the total length of the string (rounded off to two decimal places) is_____ cm

Ans: 8.8-9.2

Exp:

Given radius (a) = $\frac{2}{\pi}$ cm

Pitch = $2\pi c = 2\pi\ \frac{1}{\pi} = 2$ cm

No of turns = $\frac{L}{p} = \frac{4}{2} = 2$

the total length of the string = Circumference of hexix

Circumference = $2\pi a$

= 4Length of the string

$= \sqrt{c^2 + p^2}$

$= \sqrt{4^2 + 2^2}$

= 8.94

Q48. A data set containing n (=10) independent measurements (xi , yi) is to be fitted by a simple linear regression model. The least square estimates of regression coefficients are obtained and the regression estimate is given by y = $\beta_0 + \beta_i\ x$

$\beta_0 = \frac{\sum_{i=1}^{n} y_i}{n} - \beta_i \frac{\sum_{i=1}^{n} x_i}{n}$,$\beta_i = \frac{Cov(x,y)}{Var(x)}$

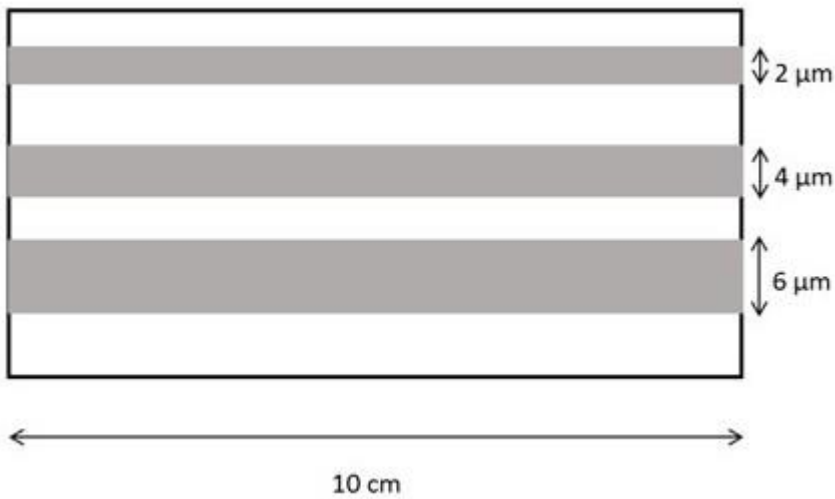
Where, Cov (x, y) is the sample covariance and Var(x) is the sample variance. The values are given below:

$\sum_{i=1}^{10} x_i = 25$, $\sum_{i=1}^{10} y_i = 37$, $\sum_{i=1}^{10} x_i^2 = 108$, $\sum_{i=1}^{10} y_i^2 = 155$ and $\sum_{i=1}^{10} x_i y_i = 120$

For the given data set, the unbiased variance for the error ($y_i - \hat{y}_i$) (rounded off to two decimal places) is_____

Ans: 0.16 – 0.20

Q49. A porous medium of 10 cm length is made of three horizontal, cylindrical capillaries of inside diameters 2 µm, 4 µm, and 6 µm as shown in the figure (not to scale)



Oil is being injected in this porous medium that was initially filled completely with water. The interfacial tension between oil and water is 0.025 N/m. Consider water as the completely wetting phase, i.e., contact angle is 0^0. When the pressure drop across the porous medium is 20 kPa, the maximum saturation of oil in the porous medium is 0.643. When the pressure drop is increased to 30 kPa, the maximum oil saturation (rounded off to two decimal places) will be _____ (in fraction)

Ans: 0.90-0.95

Exp:

The capillary Pressure is given by

$P_c = \frac{2\sigma \cos\theta}{r} = \frac{2\ X\ 0.025\ X1}{r} = \frac{0.05}{r}$

Volume= $\pi r^2 h$

radius	P_c	V_b
1	50	πh
2	25	$9\pi h$
3	16.67	$9\pi h$

When pressure drop of 20 kPa is applied, the oil displaced water from larger pores of radius 3

$S_o = \frac{9\pi h}{14\pi h} = 0.643$

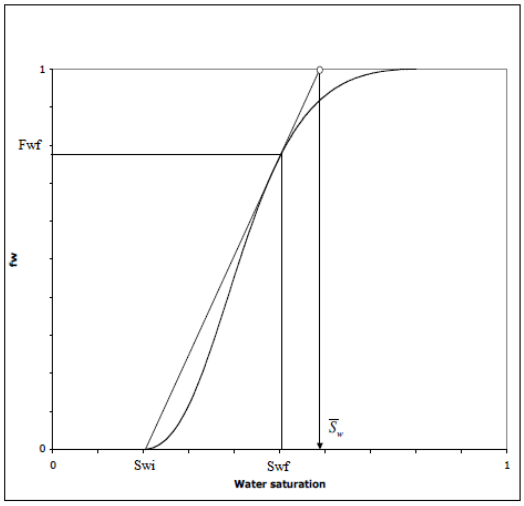
Now, when pressure drop of 30 kPa is applied, oil displaces water from pores with size 3 and 2 Therefore, oil occupy pores of radius 3 and 2

$S_o = \frac{13\pi h}{14\pi h} = 0.928$

Q50. A unidirectional, immiscible displacement of an oil is carried out with water in a cylindrical reservoir core sample (Buckley-Leverett theory is applicable). The connate water saturation is 0.25. A fractional flow of water (f_w) vs. water saturation (S_w) curve is drawn for the process. A line drawn from a point (S_w = 0.25, f_w = 0) on the fractional flow curve is tangent at the point (S_w = 0.8, f_w = 0.8) on the curve.

The average water saturation ($S_{w,avg}$) in the core at the time of breakthrough (rounded off to two decimal places) is _____ (in fraction)

Ans: 0.9-0.96
Exp:



$$\frac{\partial f_w}{\partial S_w} = \frac{f_{wf} - f_{wi}}{S_{wf} - S_{wi}}$$
$$= \frac{0.8 - 0}{0.8 - 0.25}$$

=1.4545

$$\frac{\partial f_w}{\partial S_w} = \frac{f_{wavg} - f_{wi}}{S_{wavg} - S_{wi}}$$

$$1.4545 = \frac{1-0}{S_{wdf} - 0.25}$$

$S_{wavg} = 0.9375$

Q51. In a hydrate reservoir, the porosity of the porous medium is 0.3 and the solid hydrate saturation is 0.5. Assume that the permeability (in mD) in a porous medium is given by **k =1000** $\frac{\phi_e^2}{1-\phi_e}$, where, ϕ_e is the effective porosity available for the fluids. The permeability of the hydrate bearing porous medium (rounded off to two decimal places) is _____ mD.

Ans: 23-28

Exp:

The effective porosity if given by

$\varphi_e = \varphi$ X S_{hyd} = 0.3x0.5 =0.15

$K = 1000 \frac{\varphi_e^2}{1-\varphi_e} = 26.47$ mD

Q52. The slip velocity for a gas-liquid flow in a vertical production well is 0.1 m/s. The superficial velocity of each of the phases is 0.1 m/s. The fractional hold-up of the gas-phase (rounded off to two decimal places) is _____

Ans: 0.36-0.40

Exp:

The Slip Velocity is given by

$VS = Vg - V_l = \frac{V_{sg}}{H_g} - \frac{V_{sl}}{H_l}$

$H_g^2 - 3H_g + 1 = 0$

We get $H_g = 0.38$

Q53. A three stage reciprocating compressor is to compress 4 mol/s of methane from 1 bar absolute to 60 bar absolute pressure. The gas temperature is 330 k at the suction. The compression ratio in each stage is equal and the compression is isentropic. The gas behaves C^p as an ideal gas and the ratio of specific-heat capacities ($\frac{C_p}{C_v}$) is 1.4. Take gas constant, R = 8.31 J mol-1 K-1.

The minimum work rate of compression required for the gas (rounded off to two decimal places) is _____ kJ/s.

Ans: 48 – 57

Exp:

The Work done by a multi stage compressor is given by

$$W = n \frac{\gamma}{\gamma - 1} P1Vi \left(1 - \left(\frac{P2}{P1}\right)^{\frac{\gamma-1}{\gamma n}}\right)$$

$W = n \frac{\gamma}{\gamma-1} xRT (1 - \left(\frac{P2}{P1}\right)^{\frac{\gamma-1}{\gamma n}})$

$W = n \frac{\gamma}{\gamma-1} xRT (1 - \left(\frac{P2}{P1}\right)^{\frac{\gamma-1}{\gamma n}})$

$= 3 \frac{1.4}{1.4-1} 4 \times 8.32 \times 330 (1 - \left(\frac{60+1}{1+1}\right)^{\frac{1.4-1}{1.4 \times 3}})$

= 54,992.5 J/sec

= 54.99 KJ/sec

Q54. In a 1-1 counter flow shell and tube heat exchanger, a liquid process stream (CP = 2.1KJ Kg^{-1} K^{-1}) is cooled from 430 K to 330 K using water (Cp = 4.2 KJ Kg^{-1} K^{-1}) having an inlet temperature of 280 K. The process stream flows on the shell side at a rate of 1 kg/s and the water on the tube side at a rate of 2.5 kg/s. The overall heat transfer co-efficient is 600 W m^2 k^{-1}, Neglecting the heat loss in the surroundings, the required heat transfer area (rounded off to two decimal places) is _____ m^2.

Ans: 3.8-4.5

Exp: Using the heat balance concept

Heat gained = Heat loss

$m_h \times C_p \times (430-330) = m_c \times C_p \times (T_2 - 280)$

$1 \times 2.1 \times 100 = 2.5 \times 4.2 \times (T_2 - 280)$

$T_2 = 300$ k

$LMTD = \frac{(430-330)-(330-280)}{\ln(\frac{430-330}{330-280})} = 83.33$ k

Now Heat duty = U x A x LMTD

$(1 \times 2.1 \times 100) = 600 \times A \times 83.33$

$210 \times 1000 = 600 \times A \times 83.33$

$A = 4.2\ m^2$

Q55. A pre-flush of 15 wt% HCL solution (density = 1070 kg/m^3) is used to dissolve dolomite in a sandstone reservoir. The molecular formula, molar mass and density of dolomite are $CaMg(CO_3)_2$, 184.3 g/mol and 2840 kg/m^3, respectively. The molar mass of HCL is 36.5 g/mol.

If the pre-flush has to remove all the dolomite, the volumetric dissolving power of the preflush (rounded off to three decimal places) is_____ (m^3 of dolomite/m^3 of 15 wt% HCL solution)

Ans: 0.068-0.074

Exp:

The Reaction between Dolomite is given by

$CaMg(CO_3)2 + 4HCL \rightarrow CaCl_2 + MgCl_2 + 2CO_2 + 2H_2O$

Volumetric dissolving power of mineral is

$$V_m = C_a \frac{\vartheta_m \frac{(MW)m}{\rho m}}{\vartheta_a \frac{(MW)a}{\rho a}} = 0.15 \frac{1(184.40)/2840}{4(36.5)/1070} = 0.071$$

Q56. A cuboidal wooden block of density 750 kg/m^3, with horizontal dimensions of 2.0 m x 1.0 m and vertical height of 0.8 m, floats in water (density = 1000 kg/m^3). The acceleration due to gravity is 9.81 m/s^2. The distance between centre of gravity and metacentre of the block (rounded off to two decimal places) is _____ m

Ans: 0.03-0.05

Exp:

The Draft of the Submerged body is found using

Draft(d) = height of the body x $\frac{density\ of\ body}{density\ of\ water}$ = 0.8 x $\frac{750}{1000}$ = 0.6

Centre of Buoyancy from keel (KB) = $\frac{d}{2}$ = 0.3 m

Centre of Gravity from keel (KG) = $\frac{0.8}{2}$ = 0.4 m

GM = BM + KB - KG = (0.55 + 0.3 - 0.4) = 0.45 m

To calculate BM taking height-axis rotation

BM= $\frac{moment\ of\ inertia}{submerged\ volume} = \frac{\frac{1}{12}\ x\ breadth\ x\ length^3}{l\ x\ b\ x\ d}$ = 0.138

GM= BM + KB - KG = (0.138 + 0.3 - 0.4) = 0.038 m

Q57. It is desired to determine the radius of investigation (r_{inv}) of a low permeability and lowpressure gas reservoir which produces under a constant flow rate. Use the following data:

Absolute permeability (k) = 0.01 mD

Porosity (ϕ) = 0.05

Total isothermal compressibility (C_t) = 200 x 10^{-6} psia^{-1}, and

Viscosity (μ) = 0.05 cP

Assuming transient flow conditions are valid, the radius of investigation (r_{inv}) after 200 hours of gas production (rounded off to one decimal place) is _____ ft.

Ans: 55-67

Exp:

The Radius of Investigation is given by

$$r_{inv} = \left(\frac{kt}{948\emptyset\mu c_t}\right)^{\frac{1}{2}}$$

$$= \left(\frac{0.01\ x\ 200}{948\ x\ 0.05\ x\ 0.05\ x\ 200\ x\ 10^{-6}}\right)^{\frac{1}{2}}$$

= 64.69 ft

Q58. Well stimulation is carried out in a homogeneous formation. The well is stimulated up to a radial distance of 54 inch from the surface of the wellbore. The diameter of the wellbore is 12 inch. The permeability enhancement in the stimulated region is found to be 10 times that of the unstimulated region. Assuming steady-state radial flow, the skin factor after stimulation (rounded off to two decimal places) is _____.

Ans: (-1.95)-(-1.2)

Exp: The Skin is given by

r_w = 6 in = 0.5 ft

r_s = (54 + 6) in = 5 ft

$$S = \left[\frac{k}{k_{skin}} - 1\right]\ln\left(\frac{r_{skin}}{r_w}\right)$$

$$= \left[\frac{k}{10k} - 1\right]\ln\left(\frac{5}{0.5}\right)$$

= -2.07

Q59. A gas reservoir has a permeability of 1.0 md, which is to be fractured hydraulically to create a 600 m long and 0.30 cm wide fracture of 2 x 10^5 mD permeability around the centre of damage area. The fracture conductivity for the well (rounded off to two decimal places) is _____.

Ans: 1.8 – 2.2

Exp:

The hydraulic Conductivity is given by

Hydraulic conductivity = $\frac{K_f\ X\ w}{K\ X\ x_f}$

$$=\frac{2\ x\ 10^5\ X\ 0.3\ X\ 0.01}{1\ X\ 600/2}$$

$$= 2$$

Q60. A producing oil well with the drainage to wellbore radius ratio of 2981 is found to have a skin factor of 8. Assume steady state operation and negligible pressure drop in the tubing. The ratio of production rate of the damaged to the 'undamaged' well (rounded off to two decimal places) is _____

Ans: 0.45-0.55

Exp:

The ratio of production rate of the damaged to the 'undamaged' well is given by

$$\frac{q_{damaged}}{q_{undamaged}} = \frac{\left[\ln(\frac{r_e}{r_w})\right]}{\left[\ln(\frac{r_e}{r_w})+S\right]}$$

$$= \frac{\ln 2981}{ln2981+8}$$

$$=0.5$$

Q61. It is desired to prepare a Class H cement slurry having a density of 2100 kg/m^3 using hematite as an additive. The water requirement for the Class H cement is 20 litre/50 kg cement and that for hematite is 3 litre/1000 kg hematite.

Given:

Density of class H cement = 3 125 kg/m^3

Density of hematite = 5000 kg/m^3

Density of water = 1000 kg/m^3

Weight of one sack of cement = 50.0 kg

Assuming zero volume change of mixing, the amount of hematite that should be blended with one sack of cement (rounded off to two decimal places) is ____ kg.

Ans: 9-10.5

Exp:

Let the Amount of Hametatite that should be blended with one sack of cement br X kg

Applying Mass Balance

$$\frac{1\,(Kg\ cement)+X\,(Kg\ HAmatite)+0.4\ litr\ x\ \frac{1\,Kg}{ltr}\ x\ 0.03\ x\ 1}{\frac{1}{3.124}+\frac{X}{5}+0.4+0.003X} = 2.1\ \text{Kg/ltr}$$

Solving we get

X = 9.7 Kg

Q62. A gas reservoir without aquifer is at 300 bar (absolute) and 90^0C. The GIIP (gas initial in place) is 10^7 m^3 (at surface conditions). Neglect formation and water compressibility.

Given:

Surface pressure = 1 bar (absolute)

Surface Temperature = 25^0C

Gas Compressibility factor, Z (at surface condition) = 1

Z (at 300 bar (absolute) and 90^0C) = 0.88

Z (at 100 bar (absolute) and 90^0C) = 0.83

If the reservoir pressure reduces to 100 bar (absolute) under isothermal conditions, the total volume of gas (at surface conditions) produced from the reservoir (rounded off to two decimal places) is _____ x 10^6 m^3.

Ans: 6-7

Exp:

The MBE for a volumetric gas reservoir is given by

$$\frac{P}{Z} = \frac{Pi}{Zi}\left[1 - \frac{Gp}{G}\right]$$

$$\frac{100}{0.83} = \frac{300}{0.88}\left[1 - \frac{Gp}{G}\right]$$

$$0.353 = 1 - \frac{Gp}{G}$$

$$\frac{Gp}{G} = 0.646$$

$$Gp = 0.646\ x\ G$$

Gp = 0.646 x 10^7

= 6.46 X 10^6 m^3

Q63. Given the following data of a shale gas formation:

W_{toc} (weight fraction of total organic carbon (TOC)) = 0.10

S_{wr} (total water saturation) = 0.25

ρ_{Toc} (density of TOC) = 1.10 g/cm^3 ρ_m (density of matrix) = 2.65 g/cm^3 ρ_g (density of gas) = 0.35 g/cm^3 ρ_w (density of water) = 1.00 g/cm^3 ρ_b (formation bulk density) = 2.00 g/cm^3

Consider that only water and gas are present in the formation and the following equations apply,

$$\rho_b = \frac{\rho_m \times (1-\varphi_T) + \rho_f \times \varphi_T}{1 - W_{TOC} \times \left(1 - \frac{\rho_m}{\rho_{TOC}}\right)}, \qquad \rho_b = \left(\frac{\rho_{TOC} \times V_{TOC}}{W_{TOC}}\right) + \varphi_T \times \rho_f$$

Where, ρt is the fluid density, Φ_T *is* the total porosity, and V_{TOC} is the volume fraction of TOC.

The volume fraction of TOC (round doff to two decimal places) is _____.

Ans: 0.15-0.20

Exp:

$\rho_f = \rho_g$ x (1-S_w) + ρ_wx S_w

= 0.35(1-0.25) +1x 0.25

= 0.5125

$$\rho_b = \frac{\rho_m \times (1-\varphi_T) + \rho_f \times \varphi_T}{1 - W_{TOC} \times \left(1 - \frac{\rho_m}{\rho_{TOC}}\right)},$$

$$2 = \frac{2.65(1-\varphi_T) + 1\ X\ \varphi_T}{1 - 0.1\ X\ (1 - \frac{2.65}{1.1})} \quad \varphi_T = 0.17309$$

$$\rho_b = \left(\frac{\rho_{TOC} \times V_{TOC}}{W_{TOC}}\right) + \varphi_T \times \rho_f$$

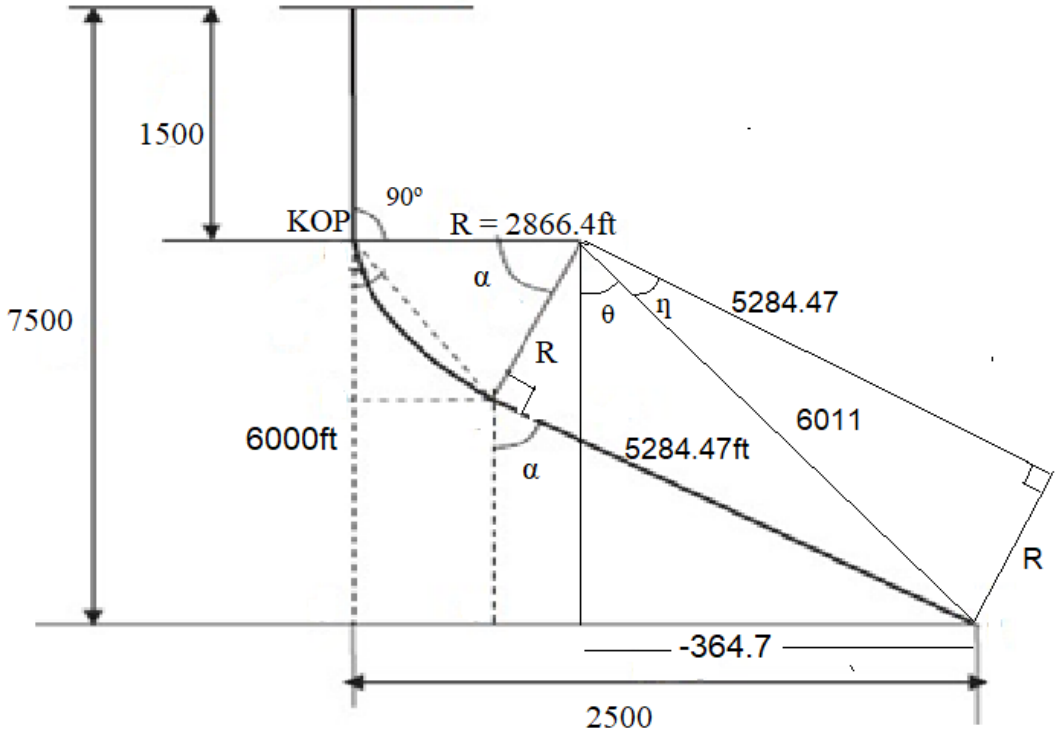
$$2 = \frac{1.1\ X\ V_{TOC}}{0.1} + 0.17309 \text{ X } 0.5125$$

V_{TOc}=0.174

Q64. Its desired to drill a deviated well with ' build and hold type ' trajectory. The kick off point is at a vertical depth of 1500 ft from the surface and the rate of build is 2°/100 ft. At a true vertical depth (TVD) of 7500 ft, the net horizontal departure to the target is 2500 ft. The total measured depth is _____ ft.

Ans: 8000 – 8500

Exp:



The Radius of Curvature is found by using

$R = \frac{18000}{\pi\emptyset} = \frac{18000}{\pi \, x \, 2} = 2864.7$ ft

From Above diagram

The Value of θ found by

$\tan\theta = \frac{-364.7}{6000}$

$\tan\theta = -0.0607$

$\theta = -3.478^{o}$

From Above diagram

The valve of η is found by

$\tan \eta = \frac{2864.7}{5284.5}$

$\eta = 28.46^o$

We know that

$\alpha = \eta + \theta$

$= 28.46 - 3.478$

$= 24.95^o$

$= 25^o$

The Length of the Build up section is found by

$L = \frac{\alpha}{\varphi} x\ 100$

$= \frac{25}{2} x\ 100$

$= 1250$ ft

Therefor the Total Measured depth is

TMD =Length of vertical section + Length of Buildup section + Length of Tangential section

$= 1500 + 1250 + 5284.47$

$= 8034.47$ ft

Q65. A cylindrical core sample of 4 inch diameter and 20 inch length is obtained from a consolidated reservoir sand. At the reservoir temperature, the formation water resistivity (R_W) is 0.15 ohm-m whereas the resistance of the core, which is 100% saturated with brine, is 100 ohm. Use the generalized form of the Archie's formula relating Formation Resistivity Factor (F_R) and the porosity (φ), Assume α (tortuosity factor) = 1 and m (cementation factor) = 2

The porosity (in fraction) of the core (rounded off to two decimal places) is

_____

Ans: 0.28-0.34

Exp:

The resistivity is given by

Resistance (ρ)= Resistivity (Ro) x $\frac{\text{length of core}}{\text{Area of core}}$

$100 = Ro\ x\ \frac{0.508}{8.10\times10^{-3}}$

R=1.59 ohm-m

$R_o = \frac{a}{\emptyset^m} R_w$

$1.59 = \frac{1}{\emptyset^2}(0.15)$

$\emptyset = 0.306$