



Question Paper Name: GATE 2017 Paper

Duration: 180

Total Marks: 100



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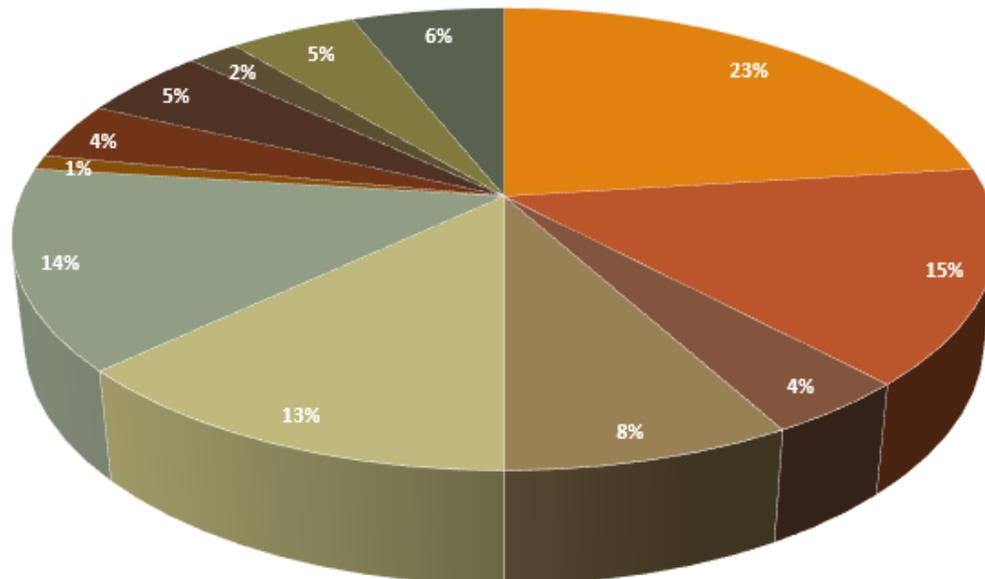
## Gate 2017

The Gate 2017 is conducted by Indian Institute of Technology (IIT) Roorkee. In this maximum and equal marks are allotted to Reservoir engineering and Petroleum Production Operations.

Organizing Institute	IIT Roorkee
Number of Candidates Registered	1964
Number of Candidates Appeared	1622
Air 1 <sup>st</sup> Rank Marks (out of 100)	90
General/EWS Qualifying Marks (out of 100)	51.1
OBC Qualifying Marks (out of 100)	45.9
SC/ST Qualifying Marks (out of 100)	34.0

### GATE 2017 ANALYSIS

- Engineering Mathematics
- Oil and Gas Well Drilling Technology
- Offshore Drilling and Production Practices
- Oil and Gas Well Testing
- General Aptitude
- Reservoir Engineering
- Petroleum Formation Evaluation
- Enhanced Oil Recovery Techniques
- Petroleum Exploration
- Petroleum Production Operations
- HSE
- Latest trends in Petroleum Engineering





SUBJECT	Number of Questions		Total Marks
	1 Mark	2 Mark	
Engineering Mathematics	11	6	23
General Aptitude	5	5	15
Petroleum Exploration	2	1	4
Oil and Gas Well Drilling Technology	2	3	8
Reservoir Engineering	3	5	13
Petroleum Production Operations	2	6	14
Offshore Drilling and Production Practices	1	0	1
Petroleum Formation Evaluation	0	2	4
HSE	1	2	5
Oil and Gas Well Testing	0	1	2
Enhanced Oil Recovery Techniques	1	2	5
Latest trends in Petroleum Engineering	2	2	6
<b>TOTAL</b>	<b>30</b>	<b>35</b>	<b>100</b>



## Gate 2017 Question Paper

1. The ninth and tenth of this month are Monday and Tuesday .  
(A) Figuratively  
(B) Retrospectively  
(C) Respectively  
(D) Rightfully
2. It is to read this year's textbook the last Year's.  
(A) Easier, than  
(B) Most easy, than  
(C) Easier, from  
(D) Easiest, from
3. A rule states that in order to drink beer, one must be over 18 years old. In a bar, there are 4 People. P is 16 years old, Q is 25 Years old, R is drinking milkshake, and S is drinking a beer, what must be checked to ensure that the rule is being followed?  
(A) Only P's drink  
(B) Only P's drink and S's age  
(C) Only S's age  
(D) Only P's drink. Qs drink and S's age
4. Fatima starts from point P, goes north for 3 km and then East for 4 km to reach point Q. she then turns to face point P and goes 15 km in that direction. She then goes North for 6 km. How far is she from point P, and in which direction should she go to reach point P?  
(A) 8 km, East  
(B) 12 km, North  
(C) 6 km , East  
(D) 10 km, North
5. 500 students are taking one or more course out of chemistry, Physics and Mathematics. Registration records indicate course enrolment as follows: Chemistry (329), Physics (186), and Mathematics (295), Chemistry and Physics (83), Chemistry and Mathematics (217),and Physics and mathematics (63).How many students are talking all 3 subjects?  
(A) 37  
(B) 43  
(C) 47  
(D) 53



6. "If You Are looking for a history of India or for an account of the rise and fall of the British Raj, or for the reason of the cleaving of the subcontinent into two mutually antagonistic parts and the effects this mutilation will have in the respective sections, and ultimately on Asia, you will not find it in these pages: for though I have spent a lifetime ill the country. I lived too near the seat of events, and was too intimately associated with the actors, to get the perspective needed for the impartial recording of these matters."

Which of the following statements best reflects the author's opinion?

- (A) An intimate association does not allow for the necessary perspective.
- (B) Matters are recorded with all impartial perspective.
- (C) An intimate association offers an impartial perspective.
- (D) Actors are typically associated with the impartial recording of matters.

7. Each of P,Q,R,S,W,X,Y, and Z has been married at most once. X and Y are married and have two children P and Q. Z is the Grandfather of the daughter S of P. Further. Z and W are married and are parents of R.

Which one of the following must necessarily be FALSE?

- (A) X is the mother -in- law of R
- (B) P and R not married to each other
- (C) P is a son of X and Y
- (D) Q cannot be married to R

8. 1200 men and 500 women can build a bridge in 2 weeks. 900 men and 250 women will take 3 weeks to build the same bridge. How many men will be needed to build the bridge in one week?

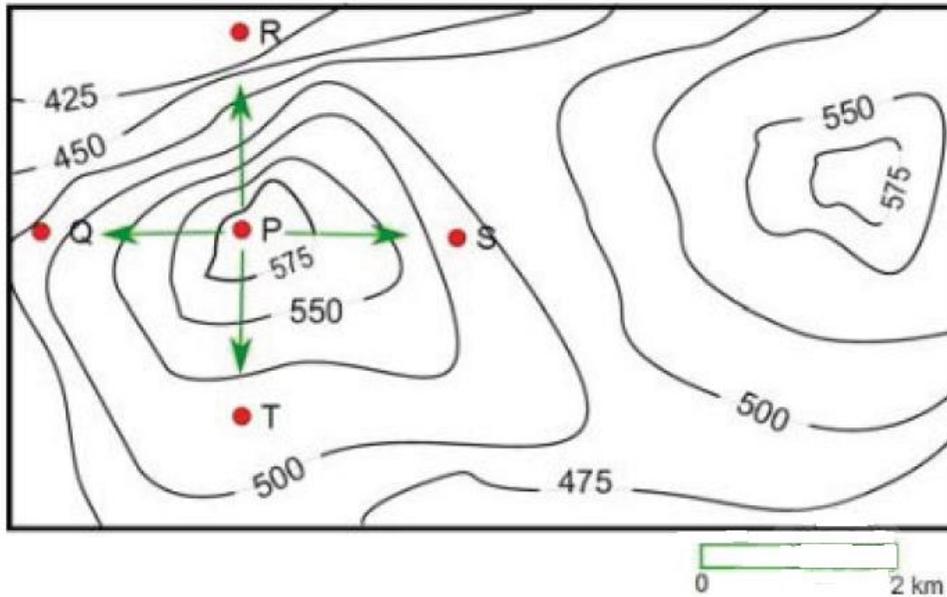
- (A) 3000
- (B) 3300
- (C) 3600
- (D) 3900

9. The number of 3-digit numbers such that the digit 1 is never to the immediate right of 2 is

- (A) 781
- (B) 791
- (C) 881
- (D) 891



10. A contour line joins locations having the same height above the mean sea level. The following is a contour plot of a geographical region. Contour lines are shown at 25 m in this plot.



Which of the following is the steepest path leaving from P?

- (A) P to Q
- (B) P to R
- (C) P to S
- (D) P to T

11. If  $\frac{d^2y}{dx^2} + f(x, y) = 0$  is to be solved using the conditions  $y(0) = a$  and  $y(1) = b$ , which of the

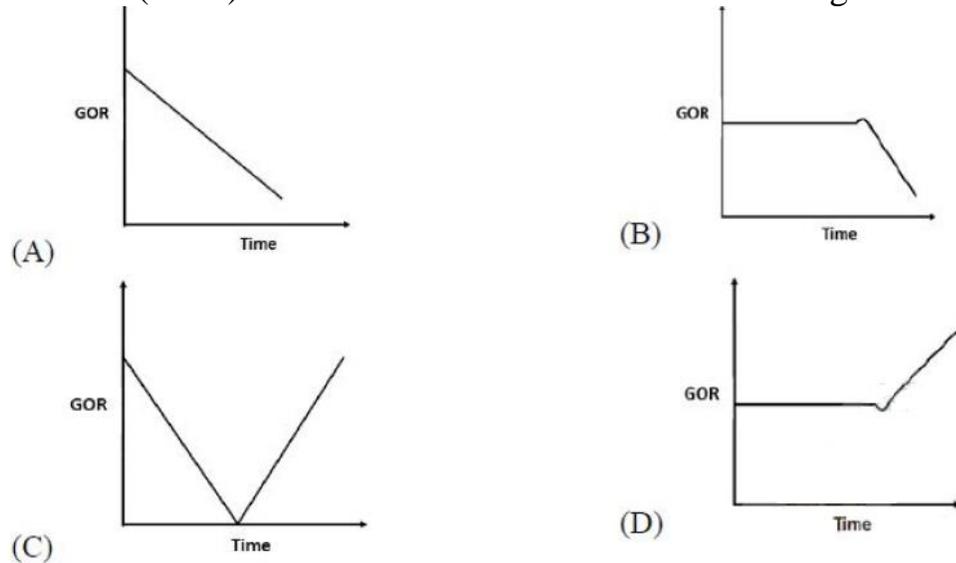
- following numerical method (s) can be used?
- (A) Euler with shooting method
  - (B) Euler without Shooting method
  - (C) 4th order Runge-kutta with shooting method
  - (D) Both ( A ) and ( C )

12. The numerical method used to find the root of a non-linear algebraic equation, that converges quadratically, is:

- (A) Bisection method
- (B) Regula-falsi method ( Method of false position )
- (C) Newton-Raphson method
- (D) None of above



13. Which one of the following curves shows a typical behavior of the production gas oil ratio (GOR) with time of a reservoir under solution gas drive?



- (A) A
- (B) B
- (C) C
- (D) D

14. A student has written following possible causes of lost circulation during a drilling operation.

- (i) High salinity in the reservoir
  - (ii) Fracture in the reservoir
  - (iii) A fault encountered during drilling
  - (iv) Low viscosity of the reservoir fluid
- which of above statements are correct?

- (A) (i), (iv)
- (B) (ii), (iii)
- (C) (i), (iii)
- (D) (ii), (iv)

15. For water depth less than 8 m. which one of the following drilling vessels is the most suitable and economical?

- (A) Semi –submersible rig
- (B) Jack-up rig
- (C) Drilling barges
- (D) Drill ship



16. Which one of the following statements is correct for pseudo-steady condition in a confined reservoir?

- (A) The pressure decline stop in the reservoir
- (B) The pressure declines at the same rate across the reservoir
- (C) The boundary pressure does not change
- (D) The pressure starts increasing in the reservoir

17. The roots of the equation

$$\frac{d^3y}{dx^3} - 6 \frac{d^2y}{dx^2} + 11 \frac{dy}{dx} - 6y = 0$$

- (A) 1,1,2
- (B) 1,2,3
- (C) 1,3,4
- (D) 1,2,4

18. The differential equation  $2xydx + (1+x^2) dy=0$ , in which x is an independent and y is the dependent variable is:

- (A) An ordinary differential equation of second order
- (B) A first order nonlinear differential equation
- (C) An exact differential equation
- (D) A partial differential equation

19. For the two matrices  $X = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ ,  $Y = \begin{bmatrix} 7 & 0 \\ 8 & -1 \end{bmatrix}$  the product YX will be.

- (A)  $\begin{bmatrix} 7 & 14 & 21 \\ 4 & 11 & 18 \end{bmatrix}$
- (B)  $\begin{bmatrix} 4 & 11 & 18 \\ 7 & 14 & 21 \end{bmatrix}$
- (C)  $\begin{bmatrix} 7 & 14 & 18 \\ 14 & 11 & 21 \end{bmatrix}$
- (D)  $\begin{bmatrix} 7 & 14 & 21 \\ 18 & 5 & 6 \end{bmatrix}$

20. As per the Bharat IV norms, the maximum permissible limit of sulfur in diesel in ppm is:

- (A) 10
- (B) 50
- (C) 100
- (D) 500



21. The amount of methane gas evolved at  $0^{\circ}\text{C}$  and 1 atm from the dissociation of 1  $\text{m}^3$  of methane gas hydrate is approximately:
- (A) Equal to the volume of gas hydrate
  - (B) 10 times the volume of gas hydrates
  - (C) 160 times the volume of gas hydrates
  - (D) 300 times the volume of gas hydrates
22. For a centrifugal pump, the head developed by the pump is proportional to the:
- (A) Speed of the impeller rotation
  - (B) Square of speed of the impeller rotation
  - (C) Cubic power of speed of the impeller rotation
  - (D) Square root of speed of the impeller rotation
23. Which of these is a must of petroleum generation and accumulation?
- (A) Source rocks
  - (B) Porous reservoir rocks
  - (C) Impermeable cap rocks
  - (D) All of the above
24. The problem of viscosity fingering is encountered when:
- (A) A low viscosity fluid is injected in a high viscosity fluid
  - (B) A high viscosity fluid is injected in a low viscosity fluid
  - (C) A fluid of equal viscosity but lower density is injected in a fluid of higher density
  - (D) None of the above
25. Which of these is NOT a sedimentary rock?
- (A) Shale
  - (B) Sandstone
  - (C) Carbonate
  - (D) None of the above
26. If  $5x+2iy-ix+7y=2+3i$ , where  $i = \sqrt{-1}$  the value of two real numbers  $[x,y]$  are respectively:
- (A) -1,1
  - (B) 1,-1
  - (C) 1,1
  - (D) -1,-1



27. Pick the INCORRECT inequality, where  $Z_1$ ,  $Z_2$  and  $Z_3$  are complex numbers

- (A)  $|Z_1 + Z_2| \leq |Z_1| + |Z_2|$ .
- (B)  $|Z_1 - Z_2| \geq |Z_1| - |Z_2|$ .
- (C)  $|Z_1 - Z_2| \leq |Z_1| - |Z_2|$
- (D)  $|Z_1 + Z_2 + Z_3| \leq |Z_1| + |Z_2| + |Z_3|$

28. Which of the following is NOT true? ( $i = \sqrt{-1}$ )

- (A)  $\cos \theta = \frac{e^{i\theta} + e^{-i\theta}}{2}$
- (B)  $e^{i\theta} = \cos \theta + i \sin \theta$
- (C)  $\sin \theta = \frac{e^{i\theta} - e^{-i\theta}}{2i}$
- (D)  $\cos \theta = \frac{e^{i\theta} + e^{-i\theta}}{2i}$

29. Which of the following is a potential environment threat due to the cement–plug deterioration in an abandoned oil well?

- (A) Well bore could leak oil reservoir fluids into ground water
- (B) Oil reservoir fluids could flow to the surface and contaminate surface soil
- (C) Oil reservoir fluids could discharge into navigable waters
- (D) All of the above

30. \_\_\_ is a mode of flame propagation in a per-mixed gas and drives a leading shock front into the quiescent unburnt gas at the supersonic velocity, immediately followed by a combustion zone.

- (A) Deflagration
- (B) Fire
- (C) Detonation
- (D) Ignition

31. Bio-Gas (BG), Coal Bed Methane (CBM) and methane Gas Hydrate ), if arranged in the order of increasing methane content, the correct order is:

- (A) BG, CBM ,MGH
- (B) CBM , BG , MGH
- (C) CBM, MGH , BG
- (D) BG, MGH ,CBM



32. The even –values for the matrix  $\begin{bmatrix} 1 & 3 \\ 4 & 2 \end{bmatrix}$  are:

- (A) 2 and 5
- (B) -2 and -5
- (C) -2 and 5
- (D) None of the above

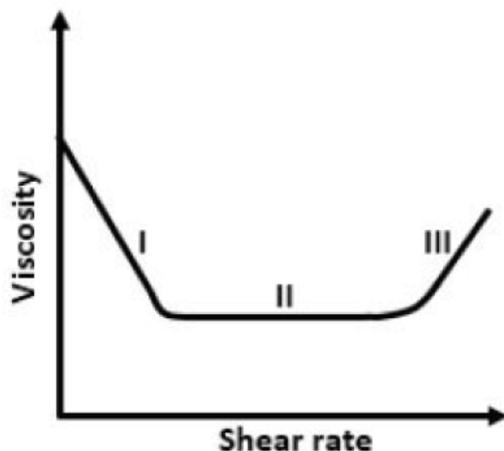
33. Match of following:

- |               |                        |
|---------------|------------------------|
| [P] Sandstone | [I] Clastic rocks      |
| [Q] Limestone | [II] Non-clastic rocks |
| [R] Shale     |                        |
| [S] Gypsum    |                        |
- (A) P-I,Q-I,R-II,S-II
  - (B) P-II, Q-II, R-I , S-I
  - (C) P-I, Q-II,R-I, S-II
  - (D) P-II,Q-I,R-II,S-I

34. Match the following EOR techniques and the principal behind them:

- |                         |  |
|-------------------------|--|
| [P] Surfactant flooding | (I) lower the viscosity of oil phase             |
| [Q] Polymer flooding    | (II) increase the viscosity of the aqueous phase |
| [R] Stem Flooding       | (III) Lower the oil – water interfacial tension  |
| [S] Sea water flooding  | (IV) influence the wettability of the rock       |
- (A) P-I, Q-II, R-III, S- IV
  - (B) P-II, Q-III, R-IV, S-I
  - (C) P-III, Q-II, R-I, S-IV
  - (D) P-III, Q-I, R-II, S-IV

35. The viscosity –shear rate curve for a fluid is shown in the following plot. Which one of the following options best describes the behavior of the fluid in the regions I, II and III , respectively ?





- (A) Newtonian, Shear thinning, Shear thickening
- (B) Shear thinning, Newtonian, Shear thickening
- (C) Shear thickening, Newtonian, Shear thickening
- (D) Shear thinning, Shear thickening, Newtonian

36. The value of constant  $a$  for which:  $(x) = ax^2, 0 \leq x \leq 5$  and  $0$ , otherwise is a valid probability density function, is (given  $a \geq 0$ ):

- (A)  $1/125$
- (B)  $3/125$
- (C)  $6/125$
- (D)  $9/125$

37.

$$Z = \frac{3i^{(30)} - i^{(19)}}{2i - 1}$$

where  $i = \sqrt{-1}$  would simplify to :

- (A)  $1-i$
- (B)  $1$
- (C)  $-i$
- (D)  $1+i$

38. Match the following:

- [ P ] Gamma ray log ( I ) Water saturation
  - [ Q ] Resistivity log ( II ) Acoustic waves
  - [ R ] Cement bond log ( III ) Permeability
  - [ S ] NMR log ( IV ) lithology
- (A) P-IV, Q-I, R-II, S-III
  - (B) P-I, Q-II, R-III, S-IV
  - (C) P-I, Q-III, R-II, S-IV
  - (D) P-IV, Q-II, R-I, S-III

39. Match the following:

- [ P ] Coal bed methane ( I ) Requires natural or artificial fractures
  - [ Q ] Tight gas ( II ) exists in Solid phase
  - [ R ] Gas hydrate ( III ) Gas adsorbed on surface in micro-pores
  - [ S ] Associated gas ( IV ) Dissolved in Crude Oil
- (A) P-I, Q-II, R-III, S-IV
  - (B) P-IV, Q-II, R-I, S-III
  - (C) P-III, Q-I, R-II, S-IV
  - (D) P-IV, Q-I, R-II, S-III



40. Match the following in the context of treatment of oil spills:

- [P] Boom (I) Use of chemical fertilizers to enhance the rate of oil degradation by microbes  
[Q] Adsorbent (II) Mechanized equipment for removing floating oil from water surface  
[R] Skimmer (III) Floating physical barrier to divert oil to recovery area  
[S] Biostimulation (IV) Oleophilic material to attract oil, which can be removed subsequently

- (A) P-I, Q-IV, R-II, S-III  
(B) P-III, Q-IV, R-II, S-I  
(C) P-III, Q-II, R-IV, S-I  
(D) P-I, Q-III, R-IV, S-II

41. Match the following

- [P] Aquifer (I) Slows down the movement of water and not good for Water (or CO<sub>2</sub>) injection  
[Q] Aquitard (II) Evaporate rocks, such as halides or anhydrite, retarding upward movement of water /CO<sub>2</sub>  
[R] Aquicludes (III) preferentially stores CO<sub>2</sub>; but not water  
(IV) Rocks with sufficient permeability to conduct water, into which water (or CO<sub>2</sub>) may be injected

- (A) P-I, Q-III, R-IV  
(B) P-IV, Q-I, R-III  
(C) P-IV, Q-I, R-II  
(D) P-IV, Q-II, R-III

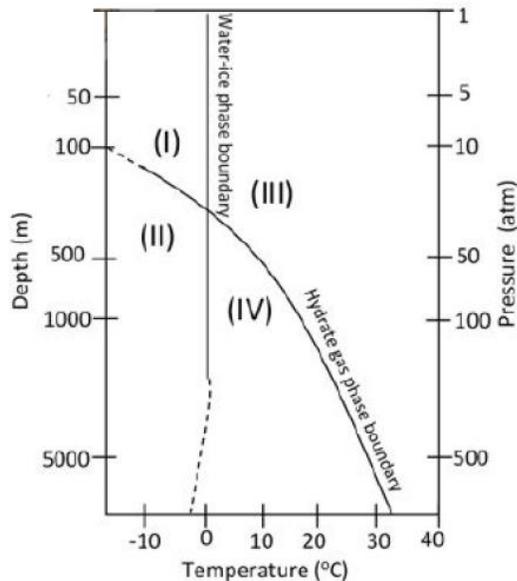
42. Synthetic Aperture Radar (SAR), used for oil spill monitoring and detection, is based on the :

- (A) Dampening effect oil has capillary and short ocean surface waves, as seen in the radar backscatter signal.  
(B) Radar backscatter signal only from navigating ships.  
(C) Frequency change in the radar backscatter signal from flights over the sea.  
(D) Physical sample collection from random locations on the high seas.



43 . The adjacent figure shows the phase diagram of free methane gas and methane hydrate for a pure water and pure methane system. Match the zones marked ( I ) , ( II ) , ( III ) , and ( IV ) with different states of phase listed below:

- [P] Methane hydrate + water + gas
- [Q] Methane gas + water
- [R] Methane gas + ice
- [S] Methane hydrate +ice + gas



- (A) I-R, II-S, III-P, IV-Q
- (B) I-R, II-Q, III-P, IV-S
- (C) I-R, II-S, III-Q, IV-P
- (D) I-R, II-P, III-S, IV -Q

44. If a vector  $v$  has components  $V_x = 1$ ,  $V_y = 2$  and  $V_z = 3$  , then its magnitude is \_\_\_\_

45.

The value of  $\lim_{x \rightarrow 0} \left( \frac{(2+x)^4 - 16}{x} \right)$  is \_\_\_\_\_.

46. The ° API of a crude oil of density 950 kg/m<sup>3</sup> is (write answer with two decimal places)



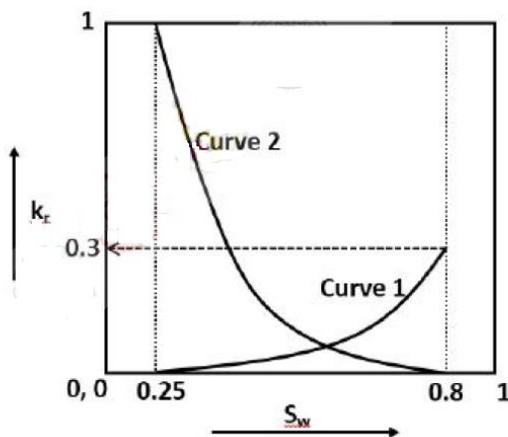
47. The unbiased sample variance for the set of numbers:  $S = \{40, 45, 50, 55, 60\}$  is. (write answer with one decimal place )

48. For a velocity field given by  $v = yi - xj + 0k$ , calculate the curl of vector  $v$  if the calculated vector is  $ai + bj + ck$ , then the value of  $c$  is .

49. Single step integration (step Size = 0.5) of  $I = \int_0^1 x^2 e^x dx$ , evaluated numerically using the Simpson's 1/3 rule is . (Write answer with three decimal places)

50. Solve  $dy/dx = -y$  numerically from  $x = 0$  to  $x = 1$  using explicit forward first order Euler method with initial condition of  $y [0] = 1$  and step size  $[h]$  of 0.2. The absolute value of error in  $y [1]$  calculated using analytical and numerical solution is % (Calculate the error using analytical solution as the basis and use three decimal places).

51. Relative permeability curves are shown in the following figure for a water oil system in a porous medium.  $S_w$  is water saturation and  $k_r$  is relative permeability. Curve 1 is relative permeability of water and curve 2 is relative permeability of oil. Assuming the porous medium is at irreducible water saturation initially, the maximum possible recovery of oil by water flooding is \_\_\_\_\_ % . (Write answer with one decimal place)



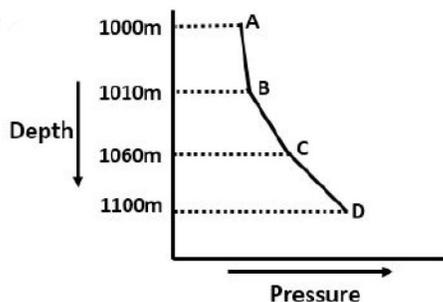
52. An oil reservoir of  $1000 m^2$  area and thickness of 10 m has a porosity of 30%. The connate water saturation is 20%. Initial formation volume factor  $B = 1.2$  reservoir  $m^3$  / stock tank  $m^3$ . Assuming average oil flow rate of  $2 m^3$ / day (at Surface condition), the life of reservoir is \_\_\_\_\_ days.



53. A self – flowing production well of depth 3,000 m having oil with density  $850 \text{ kg/m}^3$  is shut – in for workover job. The shut – in pressure at the surface is  $70 \times 10^5 \text{ N/m}^2$ . The density of mud required to kill the well will be  $\text{kg/m}^3$ . ( $g = 9.81 \text{ ms}^2$ . Write answer with one decimal place)

54. In a directional well, the kick off point has a true vertical depth (TVD) of 1000 m and the end of buildup section has a TVD of 1200 m. The buildup section for directional drilling has horizontal displacement of 200 m, after which the tangent section has inclination  $45^\circ$  . A driller monitors the well from the surface location of the well and sees that the horizontal departure of 1000 m. The TVD of the deepest point of the well is meters.

55. The figure below shows the pressure measured in a well different depths, AB is gas cap, B is gas oil contact and C is water – oil contact. Density of gas in gas cap is  $2 \text{ kg/m}^3$  , oil density is  $800 \text{ kg/m}^3$  and Water Density is  $1000 \text{ kg/m}^3$ .The Difference between pressure at point D and point B ( $P_D - P_B$ ) is  $\times 10^5 \text{ N/m}^2$  , ( use  $g = 9.81 \text{ m/s}^2$  , write answer with one decimal place )



56. A laboratory air –brine capillary pressure of  $1.20 \times 10^5 \text{ N/m}^2$  has been measured in a reservoir core sample at residual water saturation. The air-brine surface tension  $0.070 \text{ N/m}$ , and brine oil interfacial tension for the reservoir fluid is  $0.025 \text{ N/m}$ . The density values of brine and oil are  $1080 \text{ kg/m}^3$  and  $780 \text{ kg/m}^3$  respectively. Take  $g = 9.81 \text{ m/s}^2$  , and assume identical wetting preferences for the core sample and reservoir. The height of the water – oil transition zone (up to the point of reservoir where connate water saturation is reached) from the free water level is meters. (Write answer with two decimal places)

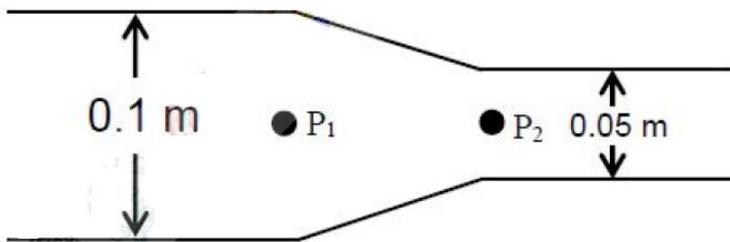
57. The temperature time profile for a system is given as follows:

$\frac{dT}{dt} + 5T = 500$  Where T is temperature in  $^\circ\text{C}$ . The temperature of the system after 1 hour is  $^\circ\text{C}$ . (Write answer with two decimal places)



58. A porous medium is blended with three types of sediment fractions, fine pebble gravel with porosity ( $\phi_{pebble} = 38\%$ ), sand ( $\phi_{sand} = 32\%$ ) and fine sand ( $\phi_{fine-sand} = 30\%$ ). The three sediments are mixed in such proportions that the sand fill the pore volume of fine pebbles completely and the fine sand fills the pore volume of sand completely. The total porosity of such an irregular system is % (Write answer with two decimal places)

59. Oil of density  $900\text{ kg/m}^3$  is flowing at  $100\text{ m}^3/\text{day}$  through horizontal pipeline having a diameter reduction from  $0.1\text{ m}$  to  $0.05\text{ m}$  as shown in the following figure. The Kinetic energy pressure drop ( $P_1 - P_2$ ) caused by the diameter change is  $\text{N/m}^2$ . (assume frictional losses to be negligible, write answer with one decimal place)



60. A well of radius  $0.25\text{ m}$  is drilled. Mud invasion in the formation caused a skin radius of  $2\text{ m}$  and reduced the permeability of the damaged zone to  $30\text{ mD}$ . Well test revealed that the skin factor of the damaged zone is  $2.3$ . The permeability of the unaffected formation will be  $\text{mD}$ . (Write answer with one decimal place)

61. The average reservoir pressure and fracture gradient of petroleum formation at a depth of  $4,000\text{ m}$  are  $30,000\text{ kN/m}^2$  and  $16\text{ (kN/m}^2)/\text{m}$  respectively. The density of the formation is  $2290\text{ kg/m}^3$ . If the reservoir pressure declines to  $20,000\text{ kN/m}^2$  after a few years of production the fracture gradient of the formation is \_\_\_\_\_ ( $\text{kN/m}/\text{m}$ ). (write answer with one decimal place)

62. The Sonic log travel time in a loosely consolidated formation is  $260\text{ }\mu\text{s}/\text{m}$ . The matrix and fluid travel times are  $130\text{ }\mu\text{s}/\text{m}$  and  $618\text{ }\mu\text{s}/\text{m}$ , respectively. A correction factor of  $1.0$  may be used in a Wyllie time average equation for simplification. The calculated formation porosity using the Wyllie time average equation is %. (Write answer with two decimal places)



63. An Oil emulsion having 15% water cut by water is being treated in a horizontal heater- treater unit at the rate of 6000 kg/hr. The inlet temperature of the emulsion is  $30^{\circ}\text{C}$  and operating temperature of the heater – treater is  $40^{\circ}\text{C}$ . The specific heat capacity of water and oil are  $1 \text{ kcal/kg}^{\circ}\text{C}$  and  $0.5 \text{ kcal/kg}^{\circ}\text{C}$ , respectively Assuming 10% of the total heat input is lost of the surroundings the total heat energy required to break the emulsion in the heater- treater unit is kcal/hr.

(Write answer with one decimal place)

64. An oil well has a flowing bottom hole pressure of 3000 psi and the reservoir has an average pressure of 3250 psi. A pressure build –up test reveals that the slope of the straight line portion of homers plot is 38.5 psi/cycle and skin factor of the well is 3. The flow efficiency of this well is

(Write answer two decimal places)

65. A pressure charged , casing pressure operated gas lift valve is installed at a depth of 2000 m and the bellow pressure of this valve is  $50 \times 10^5 \text{ N/m}^2$  under operating conditions. The tubing pressure is  $30 \times 10^5 \text{ N/m}^2$  at the valve depth. The area of the bellow and the port are 6 and  $0.6 \text{ cm}^2$  respectively. The opening pressure gas lift valve under the opening condition is \_\_\_\_\_  $\times 10^5 \text{ N/ m}^2$  (Write answer with one decimal place)



## Gate 2017 Question Paper and Solutions

1. The ninth and tenth of this month are Monday and Tuesday \_\_\_\_\_ .

- (A) Figuratively
- (B) Retrospectively
- (C) Respectively
- (D) Rightfully

Ans: C

2. It is \_\_\_\_\_ to read this year's textbook \_\_\_\_\_ the last Year's.

- (A) Easier, than
- (B) Most easy, than
- (C) Easier, from
- (D) Easiest, from

Ans: A

3. A rule states that in order to drink beer, one must be over 18 years old. In a bar, there are 4 People. P is 16 years old, Q is 25 Years old, R is drinking milkshake, and S is drinking a beer, what must be checked to ensure that the rule is being followed?

- (A) Only P's drink
- (B) Only P's drink and S's age
- (C) Only S's age
- (D) Only P's drink. Qs drink and S's age

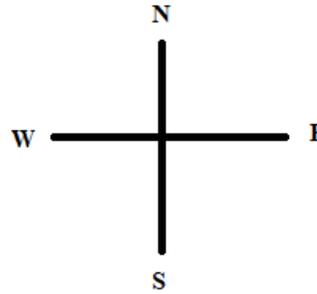
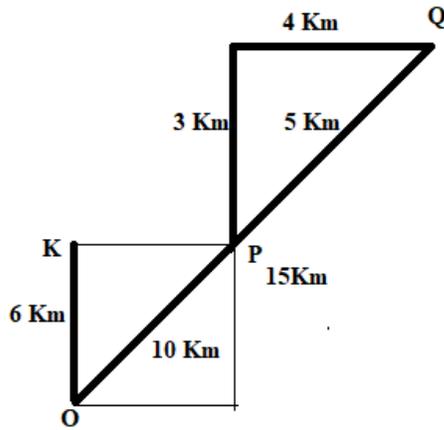
Ans: B

4. Fatima starts from point P, goes north for 3 km and then East for 4 km to reach point Q. she then turns to face point P and goes 15 km in that direction. She then goes North for 6 km. How far is she from point P, and in which direction should she go to reach point P?

- (A) 8 km, East
- (B) 12 km, North
- (C) 6 km , East
- (D) 10 km, North

Ans:A

Exp:



$$KP^2 + 6^2 = 10^2$$

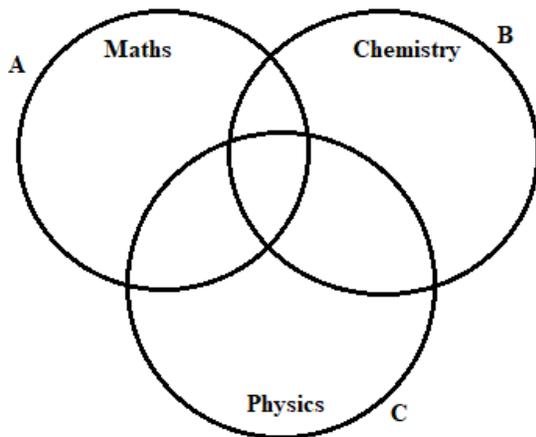
$$KP = \sqrt{100 - 36} = 8\text{km}$$

5. 500 students are taking one or more course out of chemistry, Physics and Mathematics. Registration records indicate course enrolment as follows: Chemistry (329), Physics (186), and Mathematics (295), Chemistry and Physics (83), Chemistry and Mathematics (217), and Physics and mathematics (63). How many students are talking all 3 subjects?

- (A) 37
- (B) 43
- (C) 47
- (D) 53

Ans:D

Exp:



$$P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cup B) - P(B \cup C) - P(C \cup A) + P(A \cap B \cap C)$$

$$500 = 295 + 329 + 186 - 217 - 83 - 63 - P(A \cap B \cap C)$$

$$P(A \cap B \cap C) = 53$$



6. "If You Are looking for a history of India or for an account of the rise and fall of the British Raj, or for the reason of the cleaving of the subcontinent into two mutually antagonistic parts and the effects this mutilation will have in the respective sections, and ultimately on Asia, you will not find it in these pages: for though I have spent a lifetime ill the country. I lived too near the seat of events, and was too intimately associated with the actors, to get the perspective needed for the impartial recording of these matters."

Which of the following statements best reflects the author's opinion?

- (A) An intimate association does not allow for the necessary perspective.
- (B) Matters are recorded with all impartial perspective.
- (C) An intimate association offers an impartial perspective.
- (D) Actors are typically associated with the impartial recording of matters.

Ans:A

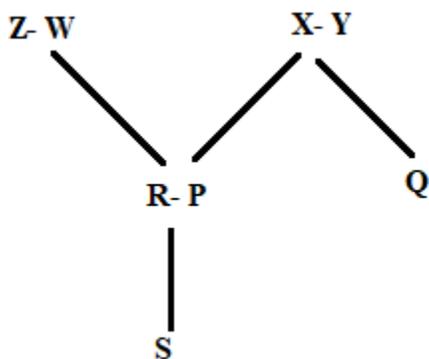
7. Each of P,Q,R,S,W,X,Y, and Z has been married at most once. X and Y are married and have two children P and Q. Z is the Grandfather of the daughter S of P. Further. Z and W are married and are parents of R.

Which one of the following must necessarily be FALSE?

- (A) X is the mother -in- law of R
- (B) P and R not married to each other
- (C) P is a son of X and Y
- (D) Q cannot be married to R

Ans:D

Exp:





8. 1200 men and 500 women can build a bridge in 2 weeks. 900 men and 250 women will take 3 weeks to build the same bridge. How many men will be needed to build the bridge in one week?

- (A) 3000
- (B) 3300
- (C) 3600
- (D) 3900

Ans:C

Exp:

$$(1200 M + 500 W) 2 = (900 M + 250 W) 3 = (aM)1$$

$$(1200 M + 500 W) 2 = (900 M + 250 W) 3$$

$$2400 M + 1000 W = 2700 M + 750 W$$

$$250 W = 300 M$$

$$W = 1.2 M$$

$$(900 M + 250 W) 3 = (aM)1$$

$$(900 M + 250 \times 1.2 M) 3 = (aM)1$$

$$3600 M = a M$$

$$a = 3600$$

9. The number of 3-digit numbers such that the digit 1 is never to the immediate right of 2 is

- (A) 781
- (B) 791
- (C) 881
- (D) 891

Ans:C

Exp:

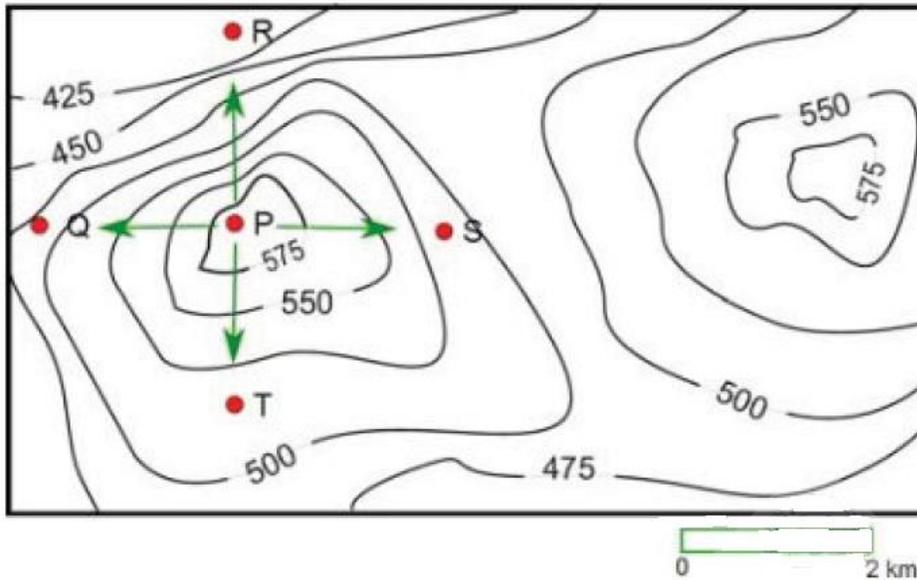
We have total 900 three digit numbers from 100-999.

We have numbers in which 1 is immediate right to 2 are 210-219, 121, 221, 321, 421, 521, 621, 721, 821, 921. = 19 cases

So we have numbers in which 1 is never immediate right of 2 =  $900 - 19 = 881$  numbers.



10. A contour line joins locations having the same height above the mean sea level. The following is a contour plot of a geographical region. Contour lines are shown at 25 m in this plot.



Which of the following is the steepest path leaving from P?

- (A) P to Q
- (B) P to R
- (C) P to S
- (D) P to T

Ans:B

11. If  $\frac{d^2y}{dx^2} + f(x, y) = 0$  is to be solved using the conditions  $y(0) = a$  and  $y(1) = b$ , which of the

- following numerical method (s) can be used?
- (A) Euler with shooting method
  - (B) Euler without Shooting method
  - (C) 4th order Runge-kutta with shooting method
  - (D) Both ( A ) and ( C )

Ans:D

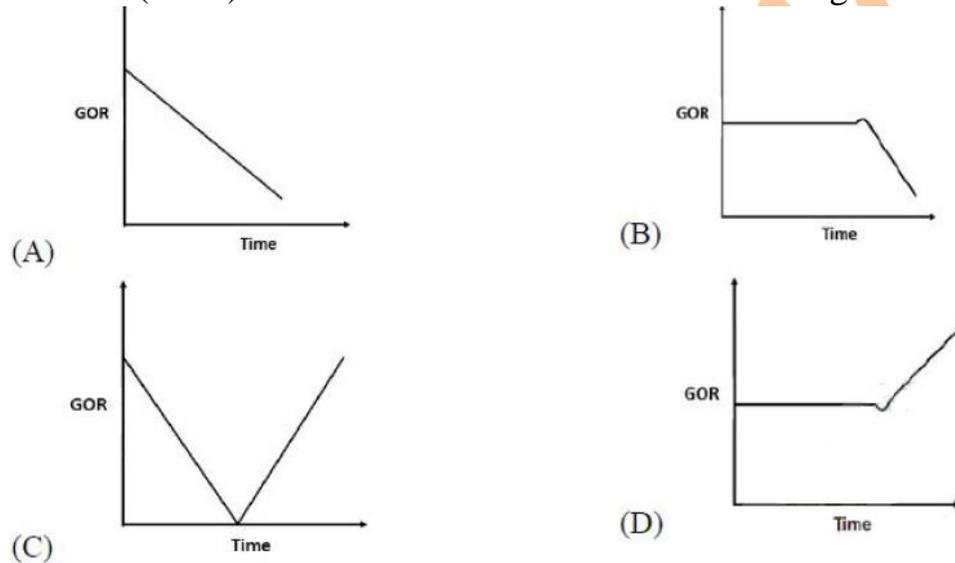


12. The numerical method used to find the root of a non-linear algebraic equation, that converges quadratically, is:

- (A) Bisection method
- (B) Regula-falsi method ( Method of false position )
- (C) Newton-Raphson method
- (D) None of above

Ans:C

13. Which one of the following curves shows a typical behavior of the production gas oil ratio (GOR) with time of a reservoir under solution gas drive?



- (A) A
- (B) B
- (C) C
- (D) D

Ans:D

14. A student has written following possible causes of lost circulation during a drilling operation.

- (i) High salinity in the reservoir
  - (ii) Fracture in the reservoir
  - (iii) A fault encountered during drilling
  - (iv) Low viscosity of the reservoir fluid
- which of above statements are correct?

- (A) (i), (iv)
- (B) (ii), (iii)



(C) (i), (iii)

(D) (ii), (iv)

Ans:B

15. For water depth less than 8 m. which one of the following drilling vessels is the most suitable and economical?

(A) Semi –submersible rig

(B) Jack-up rig

(C) Drilling barges

(D) Drill ship

Ans:C

16. Which one of the following statements is correct for pseudo-steady condition in a confined reservoir?

(A) The pressure decline stop in the reservoir

(B) The pressure declines at the same rate across the reservoir

(C) The boundary pressure does not change

(D) The pressure starts increasing in the reservoir

Ans:B

17. The roots of the equation

$$\frac{d^3y}{dx^3} - 6\frac{d^2y}{dx^2} + 11\frac{dy}{dx} - 6y = 0$$

(A) 1,1,2

(B) 1,2,3

(C) 1,3,4

(D) 1,2,4

Ans:B

Exp:

$$\text{let } \frac{d}{dx} = D$$

$$(D^3 - 6D^2 + 11D - 6) Y = 0$$

Solving  $D^3 - 6D^2 + 11D - 6 = 0$  equation we get 1,2,3.



18. The differential equation  $2xydx + (1+x^2) dy=0$ , in which  $x$  is an independent and  $y$  is the dependent variable is:

- (A) An ordinary differential equation of second order
- (B) A first order nonlinear differential equation
- (C) An exact differential equation
- (D) A partial differential equation

Ans:C

Exp:

let  $2xydx + (1+x^2) dy=0$  be compared with  $M dx + N dy = 0$

$$M = 2xy$$

$$N = (1+x^2)$$

For it to be exact differential equation the following criteria has to be satisfied

$$\frac{\partial M}{\partial y} = \frac{\partial N}{\partial x}$$

$$\frac{\partial}{\partial y} (2xy) = \frac{\partial}{\partial x} (1+x^2)$$

$$2x = 2x$$

So it is an exact differential equation

19. For the two matrices  $X = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$ ,  $Y = \begin{bmatrix} 7 & 0 \\ 8 & -1 \end{bmatrix}$  the product  $YX$  will be.

(A)  $\begin{bmatrix} 7 & 14 & 21 \\ 4 & 11 & 18 \end{bmatrix}$

(B)  $\begin{bmatrix} 4 & 11 & 18 \\ 7 & 14 & 21 \end{bmatrix}$

(C)  $\begin{bmatrix} 7 & 14 & 18 \\ 14 & 11 & 21 \end{bmatrix}$

(D)  $\begin{bmatrix} 7 & 14 & 21 \\ 18 & 5 & 6 \end{bmatrix}$

Ans:A

Exp:

$$\begin{aligned} YX &= \begin{bmatrix} 7 & 0 \\ 8 & -1 \end{bmatrix} \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix} \\ &= \begin{bmatrix} 7+0 & 14+0 & 21+0 \\ 8-4 & 16-5 & 24-6 \end{bmatrix} \\ &= \begin{bmatrix} 7 & 14 & 21 \\ 4 & 11 & 18 \end{bmatrix} \end{aligned}$$



20. As per the Bharat IV norms, the maximum permissible limit of sulfur in diesel in ppm is:

- (A) 10
- (B) 50
- (C) 100
- (D) 500

Ans:B

21. The amount of methane gas evolved at 0°C and 1 atm from the dissociation of 1 m<sup>3</sup> of methane gas hydrate is approximately:

- (A) Equal to the volume of gas hydrate
- (B) 10 times the volume of gas hydrates
- (C) 160 times the volume of gas hydrates
- (D) 300 times the volume of gas hydrates

Ans:C

22. For a centrifugal pump, the head developed by the pump is proportional to the:

- (A) Speed of the impeller rotation
- (B) Square of speed of the impeller rotation
- (C) Cubic power of speed of the impeller rotation
- (D) Square root of speed of the impeller rotation

Ans:B

23. Which of these is a must of petroleum generation and accumulation?

- (A) Source rocks
- (B) Porous reservoir rocks
- (C) Impermeable cap rocks
- (D) All of the above

Ans:D

24. The problem of viscosity fingering is encountered when:

- (A) A low viscosity fluid is injected in a high viscosity fluid
- (B) A high viscosity fluid is injected in a low viscosity fluid
- (C) A fluid of equal viscosity but lower density is injected in a fluid of higher density
- (D) None of the above

Ans:A



25. Which of these is NOT a sedimentary rock?

- (A) Shale
- (B) Sandstone
- (C) Carbonate
- (D) None of the above

Ans:D

26. If  $5x+2iy-ix+7y=2+3i$ , where  $i = \sqrt{-1}$  the value of two real numbers  $[x,y]$  are respectively:

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

Ans:A

Exp:

$$5x+2iy-ix+7y=2+3i$$

$$(5x+7y) + (-x+2y)i = 2 + 3i$$

$$5x + 7y = 2$$

$$-x + 2y = 3$$

Solving the above two equations we get

$$[x,y] = [-1,1]$$

27. Pick the INCORRECT inequality, where  $Z_1, Z_2$  and  $Z_3$  are complex numbers

- (A)  $|Z_1 + Z_2| \leq |Z_1| + |Z_2|$ .
- (B)  $|Z_1 - Z_2| \geq |Z_1| - |Z_2|$ .
- (C)  $|Z_1 - Z_2| \leq |Z_1| - |Z_2|$
- (D)  $|Z_1 + Z_2 + Z_3| \leq |Z_1| + |Z_2| + |Z_3|$

Ans:C

28. Which of the following is NOT true? ( $i = \sqrt{-1}$ )

(A)  $\cos \theta = \frac{e^{i\theta} + e^{-i\theta}}{2}$

(B)  $e^{i\theta} = \cos \theta + i \sin \theta$

(C)  $\sin \theta = \frac{e^{i\theta} - e^{-i\theta}}{2i}$

(D)  $\cos \theta = \frac{e^{i\theta} + e^{-i\theta}}{2i}$

Ans:D



29. Which of the following is a potential environment threat due to the cement–plug deterioration in an abandoned oil well?

- (A) Well bore could leak oil reservoir fluids into ground water
- (B) Oil reservoir fluids could flow to the surface and contaminate surface soil
- (C) Oil reservoir fluids could discharge into navigable waters
- (D) All of the above

Ans:D

30. \_\_\_ is a mode of flame propagation in a per-mixed gas and drives a leading shock front into the quiescent unburnt gas at the supersonic velocity, immediately followed by a combustion zone.

- (A) Deflagration
- (B) Fire
- (C) Detonation
- (D) Ignition

Ans:C

31. Bio-Gas (BG). Coal Bed Methane (CBM) and methane Gas Hydrate (MGH), if arranged in the order of increasing methane content, the correct order is:

- (A) BG, CBM ,MGH
- (B) CBM , BG , MGH
- (C) CBM, MGH , BG
- (D) BG, MGH ,CBM

Ans:A or D

32. The eigen –values for the matrix  $\begin{bmatrix} 1 & 3 \\ 4 & 2 \end{bmatrix}$  are:

- (A) 2 and 5
- (B) -2 and -5
- (C) -2 and 5
- (D) None of the above

Ans:C

Exp:

To find eigen values determinant of  $A-\lambda I = 0$

$$\begin{vmatrix} 1-\lambda & 3 \\ 4 & 2-\lambda \end{vmatrix} = 0$$

$$(1-\lambda)(2-\lambda)-12 = 0$$

$$2-\lambda-2\lambda + \lambda^2-12 = 0$$

$$\lambda^2- 3\lambda -10 = 0$$

$$\lambda^2+ 2\lambda - 5\lambda -10 = 0$$



$$\lambda(\lambda+2) - 5(\lambda+2) = 0$$
$$\lambda = -2 \text{ and } 5$$

33. Match of following:

- [P] Sandstone                      [I] Clastic rocks  
[Q] Limestone                    [II] Non-clastic rocks  
[R] Shale

- [S] Gypsum  
(A) P-I, Q-I, R-II, S-II  
(B) P-II, Q-II, R-I, S-I  
(C) P-I, Q-II, R-I, S-II  
(D) P-II, Q-I, R-II, S-I

Ans:C

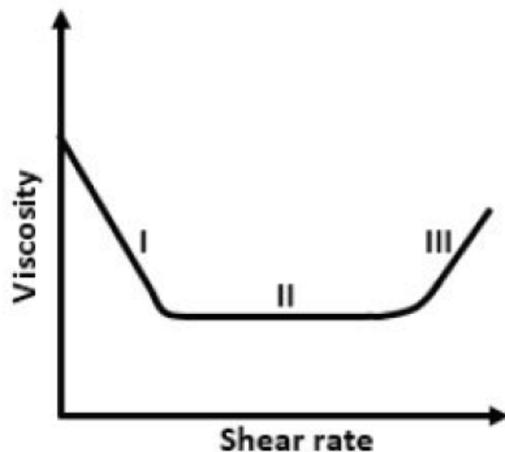
34. Match the following EOR techniques and the principal behind them:

- [P] Surfactant flooding            (I) lower the viscosity of oil phase  
[Q] Polymer flooding            (II) increase the viscosity of the aqueous phase  
[R] Steam Flooding              (III) Lower the oil – water interfacial tension  
[S] Sea water flooding          (IV) influence the wettability of the rock

- (A) P-I, Q-II, R-III, S-IV  
(B) P-II, Q-III, R-IV, S-I  
(C) P-III, Q-II, R-I, S-IV  
(D) P-III, Q-I, R-II, S-IV

Ans:C

35. The viscosity –shear rate curve for a fluid is shown in the following plot. Which one of the following options best describes the behavior of the fluid in the regions I, II and III , respectively ?





- (A) Newtonian, Shear thinning, Shear thickening
- (B) Shear thinning, Newtonian, Shear thickening
- (C) Shear thickening , Newtonian , Shear thickening
- (D) Shear thinning , Shear thickening , Newtonian

Ans:B

36. The value of constant a for which:  $(x) = ax^2, 0 \leq x \leq 5$  and 0, otherwise is a valid probability density function , is ( given  $a \geq 0$  ) :

- (A) 1/125
- (B) 3/125
- (C) 6/125
- (D) 9/125

Ans:B

Exp:

$$\int_0^5 a x^2 dx = 1$$

$$\frac{a}{3} 5^3 = 1$$

$$a = \frac{3}{125}$$

37.

$$Z = \frac{3i^{(30)} - i^{(19)}}{2i-1}$$

where  $i = \sqrt{-1}$  would simplify to :

- (A) 1-i
- (B) 1
- (C) -i
- (D) 1+i

Ans:D

Exp:

$$i^{30} = (i^2)^{15} = (-1)^{15} = -1$$

$$i^{19} = i^{18} i = (i^2)^9 i = (-1)^9 i = -i$$

$$Z = \frac{3 i^{30} - i^{19}}{2i-1} = \frac{-3+i}{2i-1}$$

$$Z = \frac{-3+i}{2i-1} \times \frac{2i+1}{2i+1} = \frac{-6i-3-2+i}{-5} = 1 + i$$



38. Match the following:

- [ P ] Gamma ray log ( I ) Water saturation  
[ Q ] Resistivity log ( II ) Acoustic waves  
[ R ] Cement bond log ( III ) Permeability  
[ S ] NMR log ( IV ) lithology  
(A) P-IV , Q – I , R- II , S-III  
(B) P-I, Q-II, R- III, S-IV  
(C) P-I , Q- III, R-II, S-IV  
(D) P- IV, Q-II, R-I, S-III

Ans:A

39. Match the following:

- [ P ] Coal bed methane (I) Requires natural or artificial fractures  
[ Q ] Tight gas ( II ) exists in Solid phase  
[ R ] Gas hydrate ( III ) Gas adsorbed on surface in micro- pores  
[ S ] Associated gas ( IV ) Dissolved in Crude Oil  
(A) P-I, Q-II, R-III, S- IV  
(B) P-IV , Q-II, R-I , S-III  
(C) P-III, Q-I, R-II, S-IV  
(D) P-IV, Q-I, R-II, S-III

Ans:C

40. Match the following in the context of treatment of oil spills:

- [P] Boom (I) Use of chemical fertilizers to enhance the rate of oil degradation by microbes  
[Q] Adsorbent (II) Mechanized equipment for removing floating oil from water surface  
[R] Skimmer (III) Floating physical barrier to divert oil to recovery area  
[S] Biostimulation (IV) Oleophilic material to attract oil, which can be removed subsequently  
(A) P-I, Q-IV, R-II, S-III  
(B) P-III, Q-IV , R-II, S-I  
(C) P-III, Q-II,R-IV, S-I  
(D) P-I, Q-III, R- IV, S-II

Ans:B



41. Match the following

- [P] Aquifer (I) Slows down the movement of water and not good for Water (or CO<sub>2</sub>) injection
- [Q] Aquitard (II) Evaporate rocks, such as halides or anhydrite, retarding upward movement of water /CO<sub>2</sub>
- [R] Aquicludes (III) preferentially stores CO<sub>2</sub>; but not water  
(IV) Rocks with sufficient permeability to conduct water, into which water (or CO<sub>2</sub>) may be injected

- (A) P-I, Q-III, R-IV  
(B) P-IV, Q-I, R-III  
(C) P-IV, Q-I, R-II  
(D) P-IV, Q-II, R-III

Ans:C

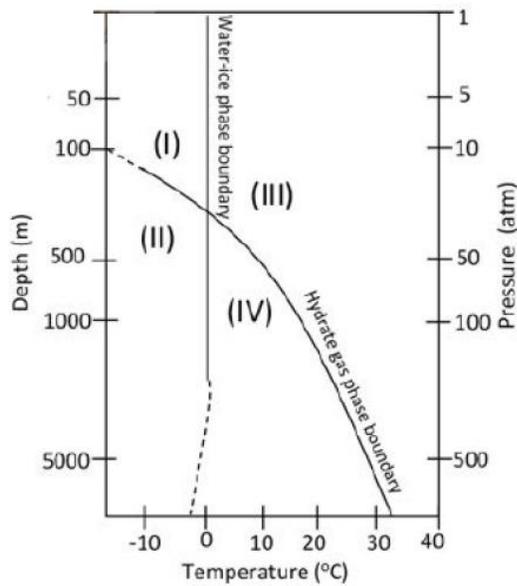
42. Synthetic Aperture Radar (SAR), used for oil spill monitoring and detection, is based on the :

- (A) Dampening effect oil has capillary and short ocean surface waves, as seen in the radar backscatter signal.
- (B) Radar backscatter signal only from navigating ships.
- (C) Frequency change in the radar backscatter signal from flights over the sea.
- (D) Physical sample collection from random locations on the high seas.

Ans:A

43. The adjacent figure shows the phase diagram of free methane gas and methane hydrate for a pure water and pure methane system. Match the zones marked ( I ), ( II ), ( III ), and ( IV ) with different states of phase listed below:

- [P] Methane hydrate + water + gas
- [Q] Methane gas + water
- [R] Methane gas + ice
- [S] Methane hydrate + ice + gas



- (A) I-R, II-S, III-P, IV-Q
- (B) I-R, II-Q, III-P, IV-S
- (C) I-R, II-S, III-Q, IV-P
- (D) I-R, II-P, III-S, IV-Q

Ans:C

44. If a vector  $v$  has components  $V_x = 1, V_y = 2$  and  $V_z = 3$ , then its magnitude is \_\_\_\_

Ans:3.742

Exp:

$$\begin{aligned}
 |V| &= \sqrt{v_x^2 + v_y^2 + v_z^2} \\
 &= \sqrt{1 + 4 + 9} \\
 &= \sqrt{14} = 3.742
 \end{aligned}$$

45.

The value of  $\lim_{x \rightarrow 0} \left( \frac{(2+x)^4 - 16}{x} \right)$  is \_\_\_\_\_.

Ans:

Exp:

$$\lim_{x \rightarrow 0} \left( \frac{(2+x)^4 - 16}{x} \right) = \frac{0}{0}$$

It is in indeterminate form.

Applying L hospital rule

$$\lim_{x \rightarrow 0} \left( \frac{(2+x)^4 - 16}{x} \right) = \lim_{x \rightarrow 0} \frac{4(2+x)^3}{1} = 32$$



46. The ° API of a crude oil of density 950 kg/m<sup>3</sup> is (write answer with two decimal places)

Ans: 17.45

Exp:

$$\text{Specific gravity of oil} = \frac{\text{density of oil}}{\text{density of water}} = \frac{950}{1000} = 0.950$$

$$\text{API}^\circ = \frac{141.5}{\text{Specific gravity of oil}} - 131.5 = \frac{141.5}{0.950} - 131.5 = 17.45$$

47. The unbiased sample variance for the set of numbers: S = {40, 45, 50, 55, 60} is.( write answer with one decimal place )

Ans:

Exp:

$$\text{Mean (Xm)} = \frac{40+45+50+55+60}{5} = \frac{250}{5} = 50$$

$$\text{Variance} = \frac{(Xi-Xm)^2}{n-1} = \frac{10^2+5^2+5^2+10^2}{4} = \frac{250}{4} = 62.5$$

48. For a velocity field given by  $v = yi - xj + 0k$ , calculate the curl of vector v if the calculated vector is

$ai + bj + ck$ , then the value of c is .

Ans:

Exp:

Curl of vector v is

$$\begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ y & -x & 0 \end{vmatrix} = i(0) + j(0) + k(-2)$$

$$C = -2$$

49. Single step integration (step Size =0.5) of  $I = \int_0^1 x^2 e^x dx$ , evaluated numerically using the simpson's 1/3 rule is . (Write answer with three decimal places)

Ans:0.728

Exp:

$$h = 0.5$$

x	0	0.5	1
f(x)	0	$0.25e^{0.5}$ = 0.4122	e

$$\int_0^1 x^2 e^x dx, = \frac{h}{3} [f(0) + 4f(0.5) + f(1)] = \frac{0.5}{3} [0 + 4 \times 0.4122 + e] = 0.728$$



50. Solve  $dy/dx = -y$  numerically from  $x = 0$  to  $x = 1$  using explicit forward first order Euler method with initial condition of  $y [0] = 1$  and step size  $[h]$  of 0.2. The absolute value of error in  $y [1]$  calculated using analytical and numerical solution is % (Calculate the error using analytical solution as the basis and use three decimal places).

Ans:10.93

Exp:

$$\begin{aligned}y_1 &= y_0 + h f(x_0, y_0) \\ &= 1 + 0.2 [-1] \\ &= 0.8\end{aligned}$$

$$\begin{aligned}y_2 &= y_1 + h f(x_1, y_1) \\ &= 0.8 + 0.2 (-0.8) \\ &= 0.64\end{aligned}$$

$$y_3 = 0.64 + 0.2 (-0.64) = 0.512$$

$$y_4 = 0.512 + 0.2 (-0.512) = 0.4096$$

$$y_5 = 0.4096 + 0.2 (-0.4096) = 0.32768 \text{ (approximate value)}$$

$$dy/dx = -y$$

$$dy/y = -dx$$

$$\ln y = -x + c$$

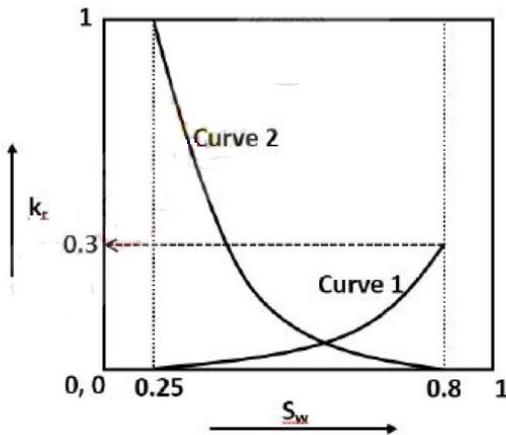
$$\text{Given } y [0] = 1$$

$$c = 0$$

$$y = e^{-x} = e^{-1} = 0.36788 \text{ (actual value)}$$

$$\text{ERROR} = \frac{|\text{Actual value} - \text{approximate value}|}{\text{actual value}} = \frac{|0.36788 - 0.32768|}{0.36788} = 10.93\%$$

51. Relative permeability curves are shown in the following figure for a water oil system in a porous medium.  $S_w$  is water saturation and  $kr$  is relative permeability. Curve 1 is relative permeability of water and curve 2 is relative permeability of oil. Assuming the porous medium is at irreducible water saturation initially, the maximum possible recovery of oil by water flooding is \_\_\_\_\_ %.  
(Write answer with one decimal place)



Ans:73.33%

Exp:

$$S_{wc} = 0.25$$

$$S_{oi} = 1 - S_{wc} = 0.75$$

$$S_{or} = 1 - S_w = 1 - 0.8 = 0.2$$

$$\text{Maximum possible recovery} = 1 - \frac{S_{or}}{S_{oi}} = 1 - \frac{0.2}{0.75} = 0.7333 = 73.33\%$$

52. An oil reservoir of 1000 m<sup>2</sup> area and thickness of 10 m has a porosity of 30%. The connate water saturation is 20%. Initial formation volume factor B = 1.2 reservoir m<sup>3</sup> / stock tank m<sup>3</sup>. Assuming average oil flow rate of 2 m<sup>3</sup>/ day (at Surface condition), the life of reservoir is \_\_\_\_\_ days.

Ans:1000

Exp:

$$\begin{aligned} \text{Volume of oil in reservoir conditions} &= A \times h \times \phi \times S_o = 1000 \times 10 \times 0.3 \times (1-0.2) \\ &= 2400 \text{ m}^3 \end{aligned}$$

$$\text{Volume of oil at surface conditions} = 2400/B_o = 2400/1.2 = 2000\text{m}^3$$

$$\text{Life of the reservoir} = \text{Volume of oil at surface conditions} / \text{surface flow rate} = 2000\text{m}^3/2\text{m}^3/\text{day} = 1000\text{days}$$

53. A self – flowing production well of depth 3,000 m having oil with density 850 kg/m<sup>3</sup> is shut – in for workover job. The shut – in pressure at the surface is 70 x 10<sup>5</sup> N/m<sup>2</sup>. The density of mud required to kill the well will be kg/m<sup>3</sup>. (g = 9.81 ms<sup>-2</sup>. Write answer with one decimal place)

Ans:1088.1

Exp:

$$\begin{aligned} \text{Bottom hole pressure} &= \text{Hydrostatic pressure} + \text{Shutin pressure} \\ &= \rho_o \times g \times H + P_{shutin} \\ &= 850 \times 9.8 \times 3000 + 70 \times 10^5 \end{aligned}$$



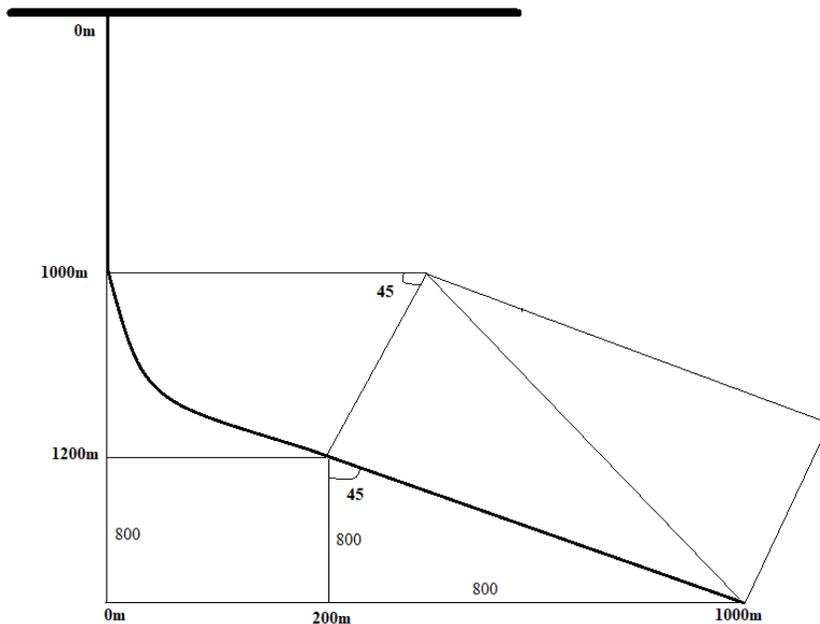
$$= 319.9 \times 10^5$$

$$\text{Kill mud weight} = \frac{319.9 \times 10^5}{9.8 \times 3000} = 1088.1 \text{ kg/m}^3$$

54. In a directional well, the kick off point has a true vertical depth (TVD) of 1000 m and the end of buildup section has a TVD of 1200 m. The buildup section for directional drilling has horizontal displacement of 200 m, after which the tangent section has inclination 45°. A driller monitors the well from the surface location of the well and sees that the horizontal departure of 1000 m. The TVD of the deepest point of the well is meters.

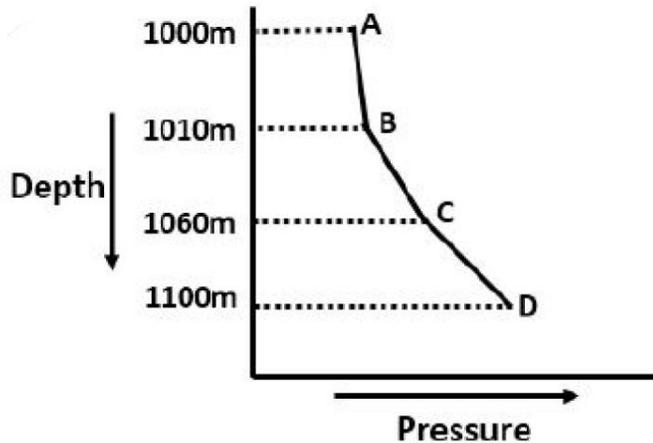
Ans:2000

Exp:



TVD of the deepest point of the well = 1200 m + 800 m = 2000m

55. The figure below shows the pressure measured in a well different depths, AB is gas cap, B is gas oil contact and C is water – oil contact. Density of gas in gas cap is 2 kg/m<sup>3</sup>, oil density is 800 kg/m<sup>3</sup> and Water Density is 1000 kg/m<sup>3</sup>. The Difference between pressure at point D and point B (  $P_D - P_B$  ) is  $\times 10^5$  N/m<sup>2</sup>, ( use  $g = 9.81$  m/s<sup>2</sup>, write answer with one decimal place )



Ans:7.8

Exp:

$$\begin{aligned}P_D - P_B &= \rho_o \times g \times h_1 + \rho_w \times g \times h_2 \\&= 800 \times 9.8 \times (1060-1010) + 1000 \times 9.8 \times (1100-1060) \\&= 800 \times 9.8 \times 50 + 1000 \times 9.8 \times 40 \\&= 392000 + 392000 \\&= 782000 \text{ N/m}^2 \\&= 7.82 \times 10^5 \text{ N/m}^2\end{aligned}$$

56. A laboratory air-brine capillary pressure of  $1.20 \times 10^5 \text{ N/m}^2$  has been measured in a reservoir core sample at residual water saturation. The air-brine surface tension  $0.070 \text{ N/m}$ , and brine oil interfacial tension for the reservoir fluid is  $0.025 \text{ N/m}$ . The density values of brine and oil are  $1080 \text{ kg/m}^3$  and  $780 \text{ kg/m}^3$  respectively. Take  $g = 9.81 \text{ m/s}^2$ , and assume identical wetting preferences for the core sample and reservoir. The height of the water-oil transition zone (up to the point of reservoir where connate water saturation is reached) from the free water level is meters. (Write answer with two decimal places)

Ans:14.58

Exp:

$$P_c \text{ air-brine} = 1.2 \times 10^5 \text{ N/m}^2$$

$$\sigma_{\text{air-brine}} = 0.070 \text{ N/m}$$

$$\sigma_{\text{oil-brine}} = 0.025 \text{ N/m}$$

$$\begin{aligned}P_c \text{ oil-brine} &= \frac{\sigma_{\text{oil-brine}}}{\sigma_{\text{air-brine}}} \times P_c \text{ air-brine} \\&= \frac{0.025}{0.070} \times 1.2 \times 10^5 \text{ N/m}^2 \\&= 0.4286 \times 10^5 \text{ N/m}^2\end{aligned}$$



$$\begin{aligned} P_c \text{ oil-brine} &= \Delta\rho \times g \times h \\ &= (1080-780) \times 9.8 \times h \\ &= 2940 h \end{aligned}$$

Comparing both terms we get  
 $2940 h = 0.4286 \times 10^5 \text{ N/m}^2$   
 $h = 14.578 = 14.58\text{m}$

57. The temperature time profile for a system is given as follows:

$\frac{dT}{dt} + 5T = 500$ , Where T is temperature in  $^{\circ}\text{C}$  and t is time in hours. The initial conditions are  $T(0) = 500^{\circ}\text{C}$ . The temperature of the system after 1 hour is  $^{\circ}\text{C}$ . (Write answer with two decimal places)

Ans: 102.70

Exp:

$$\frac{dT}{dt} + 5T = 500$$

Multiplying on both sides by the integral factor i.e.  $e^{5t}$

$$e^{5t} \frac{dT}{dt} + 5Te^{5t} = 500e^{5t}$$

$$\frac{d}{dt}(Te^{5t}) = 500e^{5t}$$

$$Te^{5t} = \int 500e^{5t} dt$$

$$Te^{5t} = 500 \frac{e^{5t}}{5} + C$$

$$Te^{5t} = 100 e^{5t} + C$$

Given

$$T(0) = 500^{\circ}\text{C}$$

$$500 = 100 + C$$

$$C = 400$$

$$Te^{5t} = 100 e^{5t} + 400$$

$$T = 100 + 400 e^{-5t}$$

At  $t = 1\text{hr}$

$$T = 102.695$$

58. A porous medium is blended with three types of sediment fractions, fine pebble gravel with porosity ( $\phi_{\text{pebble}} = 38\%$ ), sand ( $\phi_{\text{sand}} = 32\%$ ) and fine sand ( $\phi_{\text{fine-sand}} = 30\%$ ). The three sediments are mixed in such proportions that the sand fill the pore volume of fine pebbles completely and the fine sand fills the pore volume of sand completely. The total porosity of such an irregular system is % (Write answer with two decimal places)

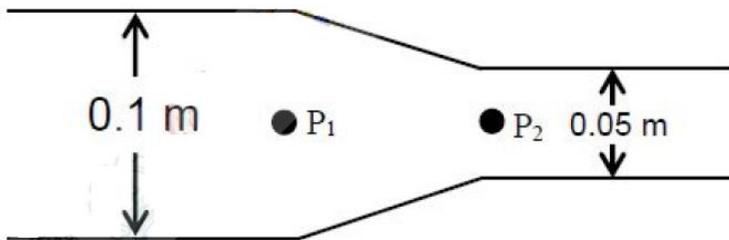


Ans:3.65

Exp:

$$\begin{aligned} \text{Total Porosity} &= \phi_{\text{pebble}} \times \phi_{\text{Sand}} \times \phi_{\text{fine-sand}} \\ &= 0.38 \times 0.32 \times 0.3 \\ &= 0.03648 \\ &= 3.65\% \end{aligned}$$

59. Oil of density  $900 \text{ kg/m}^3$  is flowing at  $100 \text{ m}^3/\text{day}$  through horizontal pipeline having a diameter reduction from  $0.1 \text{ m}$  to  $0.05 \text{ m}$  as shown in the following figure. The Kinetic energy pressure drop ( $P_1 - P_2$ ) caused by the diameter change is  $\text{N/m}^2$ . (assume frictional losses to be negligible, write answer with one decimal place)



Ans:146.5

Exp:

From Bernoulli's Equation

$$P_1 + \frac{1}{2} \rho v_1^2 + Z_1 = P_2 + \frac{1}{2} \rho v_2^2 + Z_2 + Z_f$$

Assuming no frictional losses and same elevation

$$P_1 + \frac{1}{2} \rho v_1^2 = P_2 + \frac{1}{2} \rho v_2^2$$

$$P_1 - P_2 = \frac{1}{2} \rho [v_2^2 - v_1^2]$$

$$V = \frac{Q}{A} = \frac{100 \text{ m}^3/\text{day}}{\pi/4 d^2 \text{ m}^2} = \frac{127.324}{d^2} \text{ m/day} = \frac{127.324}{d^2} \frac{1}{24 \times 60 \times 60} \text{ m/sec} = 0.001474 \frac{1}{d^2} \text{ m/sec}$$

$$V_1 = 0.001474 \frac{1}{0.1^2} \text{ m/sec} = 0.1474 \text{ m/sec}$$

$$V_2 = 0.001474 \frac{1}{0.05^2} \text{ m/sec} = 0.5895 \text{ m/sec}$$

$$P_1 - P_2 = \frac{1}{2} 900 \text{ kg/m}^3 [0.5895^2 - 0.1474^2] \text{ m}^2/\text{sec}^2 = 146.58 \text{ N/m}^2$$

60. A well of radius  $0.25 \text{ m}$  is drilled. Mud invasion in the formation caused a skin radius of  $2 \text{ m}$  and reduced the permeability of the damaged zone to  $30 \text{ mD}$ . Well test revealed that the skin factor of the damaged zone is  $2.3$ . The permeability of the unaffected formation will be  $\text{mD}$ .

(Write answer with one decimal place)

Ans:63.2



Exp:

$$S = \left( \frac{K}{K_{skin}} - 1 \right) \ln\left(\frac{r_{skin}}{r_w}\right)$$

$$2.3 = \left( \frac{K}{30} - 1 \right) \ln\left(\frac{2}{0.25}\right)$$

$$K = 63.182 \text{ md}$$

61. The average reservoir pressure and fracture gradient of petroleum formation at a depth of 4,000 m are 30,000 kN/m<sup>2</sup> and 16 (kN/m<sup>2</sup>) / m respectively. The density of the formation is 2290 kg/m<sup>3</sup>. If the reservoir pressure declines to 20,000 kN/m<sup>2</sup> after a few years of production the fracture gradient of the formation is \_\_\_\_\_ (kN/m) /m.

( write answer with one decimal place )

Ans: 14.87

Exp:

$$FG = K \left( \frac{\sigma}{D} - \frac{P}{D} \right) + \frac{P}{D}$$

Here K = Matrix stress coefficient,

$\sigma$  = Vertical matrix pressure & P = reservoir pressure.

$$\Rightarrow \sigma = \rho gh = 2290 \cdot 10 \cdot 4000 = 91600 \text{ kN/m}^2$$

$$\Rightarrow 16 = K \left( \frac{91600}{4000} - \frac{30000}{4000} \right) + \frac{30000}{4000}$$

$$\Rightarrow K = 0.552$$

Thus Fracture gradient when reservoir declines to 20,000 kN/m<sup>2</sup> is

$$\Rightarrow FG = 0.552 \left( \frac{91600}{4000} - \frac{20000}{4000} \right) + \frac{20000}{4000} = 14.87 \text{ (kN/m)/m}$$

62. The Sonic log travel time in a loosely consolidated formation is 260  $\mu$ s /m .The matrix and fluid travel times are 130  $\mu$ s/m and 618  $\mu$ s/m, respectively. A correction factor of 1.0 may be used in a Wyllie time average equation for simplification. The calculated formation porosity using the Wyllie time average equation is %. (Write answer with two decimal places)

Ans: 26.64

Exp

$$\phi = \frac{\Delta t_{log} - \Delta t_{mat}}{\Delta t_{fluid} - \Delta t_{mat}} = \frac{260 - 130}{618 - 130} = 0.2664$$

63. An Oil emulsion having 15% water cut by water is being treated in a horizontal heater- treater unit at the rate of 6000 kg/hr. The inlet temperature of the emulsion is 30°C and operating temperature of the heater – treater is 40°C. The specific heat capacity of water and oil are 1 kcal/kg°C and 0.5 kcal/kg°C, respectively Assuming 10% of the total heat input is lost of the surroundings the total heat energy required to



break the emulsion in the heater- treater unit is kcal/hr.

(Write answer with one decimal place)

Ans: 38333.33

Exp:

Output Heat = Heat to oil + heat to water

$$= m_o S_o \Delta T + m_w S_w \Delta T$$

$$= 0.85 \times 6000 \text{ kg/hr} \times 0.5 \text{ Kcal/kg.}^\circ\text{C} \times (40 - 30)^\circ\text{C} + 0.15 \times 6000 \text{ kg/hr} \times 1$$

Kcal/kg. $^\circ\text{C} \times (40 - 30)^\circ\text{C}$

$$= 25500 + 9000 \text{ Kcal/hr}$$

$$= 34500 \text{ Kcal/hr.}$$

Given 10% of heat lost to the surroundings then efficiency is 90%

$$0.9 = \frac{\text{Output heat}}{\text{Input heat}}$$

$$\text{Input heat} = \frac{34500 \text{ Kcal/hr}}{0.9} = 38333.33 \text{ kcal/hr.}$$

64. An oil well has a flowing bottom hole pressure of 3000 psi and the reservoir has an average pressure of 3250 psi. A pressure build-up test reveals that the slope of the straight line portion of horners plot is 38.5 psi/cycle and skin factor of the well is 3.

The flow efficiency of this well is

(Write answer two decimal places)

Ans:0.60

Exp:

$$FE = \frac{J_{\text{actual}}}{J_{\text{ideal}}}$$

$$\Delta P_{\text{skin}} = 0.87 m_s = 0.87 \times 38.5 \times 3 = 100.485 \text{ psi}$$

$$\Delta P_{\text{actual}} = 3250 - 3000 = 250 \text{ psi}$$

$$\Delta P_{\text{ideal}} = \Delta P_{\text{actual}} - \Delta P_{\text{skin}} = 250 - 100.485 = 149.515 \text{ psi}$$

$$FE = \frac{J_{\text{actual}}}{J_{\text{ideal}}} = \frac{\Delta P_{\text{ideal}}}{\Delta P_{\text{actual}}} = \frac{149.515}{250} = 0.598$$

65. A pressure charged , casing pressure operated gas lift valve is installed at a depth of 2000 m and the bellow pressure of this valve is  $50 \times 10^5 \text{ N/m}^2$  under operating conditions. The tubing pressure is  $30 \times 10^5 \text{ N/m}^2$  at the valve depth. The area of the bellow and the port are 6 and  $0.6 \text{ cm}^2$  respectively. The opening pressure gas lift valve under the opening condition is \_\_\_\_\_  $\times 10^5 \text{ N/ m}^2$  (Write answer with one decimal place)

Ans:52.22

Exp:



$$R = \frac{Ap}{Ab} = \frac{0.6}{6} = 0.1$$

$$P_c = \frac{P_b - P_t R}{1 - R} = \frac{50 - 30 \times 0.1}{1 - 0.1} \times 10^5 = 52.22 \times 10^5 \text{ N/ m}^2$$

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