

General Instructions

- (i) This question paper contains 65 questions. All questions are compulsory.
- (ii) It comprises 33 single-correct multiple-choice questions, 14 multiple-correct questions and 18 numerical / integer-type questions.
- (iii) Attempt every question; detailed solutions are provided in the companion solutions booklet.
- (iv) For multiple-correct questions, all correct options must be selected to earn full marks.
- (v) For numerical questions, report the answer rounded exactly as asked.

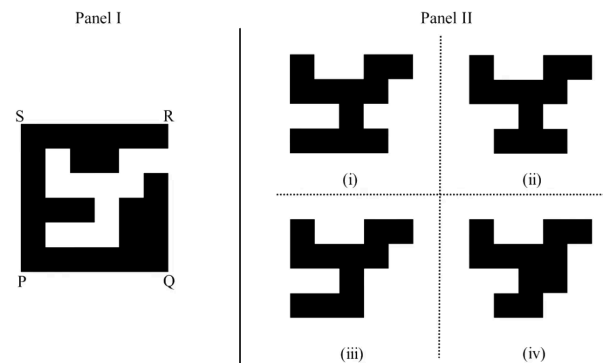
1. Expedite, Hasten, Hurry, _____

Fill the blank by choosing a word with a meaning similar to that of the words given above.

- (A) Accelerate
- (B) Retard
- (C) Provide
- (D) Disable

...

2. A black square PQRS has been cut into two parts. One part of it is shown in Panel I. Which one of the shapes in Panel II is the other part?



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

...

3. A day can only be cloudy or sunny. The probability of a day being cloudy is 0.5, independent of the condition on other days. What is the probability that in any given four days, there will be three cloudy days and one sunny day?

- (A) $\frac{1}{4}$
- (B) $\frac{3}{4}$
- (C) $\frac{2}{3}$
- (D) $\frac{3}{8}$

...

4. The values of Stock A and Stock B on a particular day are Rs. 50 and Rs. 80, respectively. An investor invests Rs. 100 in Stock A and Rs. 80 in Stock B. He sells all the stocks the next day when the value of Stock A is Rs. 55 and Stock B is Rs. 70. The profit made by the investor is Rs.

- (A) 0
- (B) 5
- (C) 10
- (D) 20

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5. 'When it is raining, peacocks dance.'

Based only on this sentence, which one of the following options is necessarily true?

- (A) Peacocks dance only when it is raining.
- (B) When peacocks dance, it is raining.
- (C) When peacocks are not dancing, it is not raining.
- (D) When it is not raining, peacocks do not dance.

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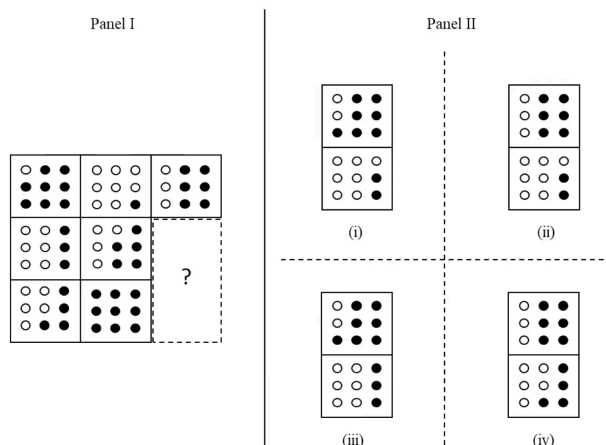
6. Water : P :: Food : Q

Choose the P and Q combination from the options below to form a meaningful analogy.

- (A) P = Thirst; Q = Hunger
- (B) P = Drink; Q = Hunger
- (C) P = Thirst; Q = Satiated
- (D) P = Wet; Q = Critic

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7. Two tiles are missing in Panel I. Which one of the options in Panel II is the appropriate choice for the missing tiles?



Panel I is a 3 by 3 arrangement of tiles, where each tile is itself a 3 by 3 array of filled and hollow circles; the bottom two tiles in the rightmost column are missing and marked with a question mark. Panel II shows four candidate two-tile stacks labelled (i), (ii), (iii) and (iv) that could fill the missing space.

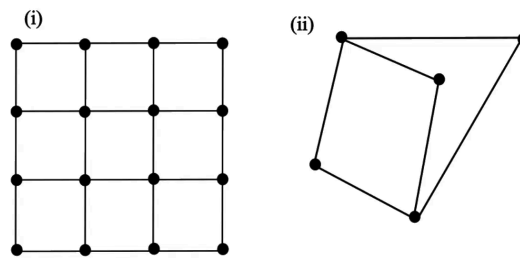
- (A) (i)
- (B) (ii)
- (C) (iii)
- (D) (iv)

...

8. Figures (i) and (ii) represent intercity highway systems. The black dots represent cities and the line segments between them represent intercity highways.

A salesperson needs to make a trip. She needs to start from a city, visit each of the remaining cities exactly once, and finally return to the same city from which she started.

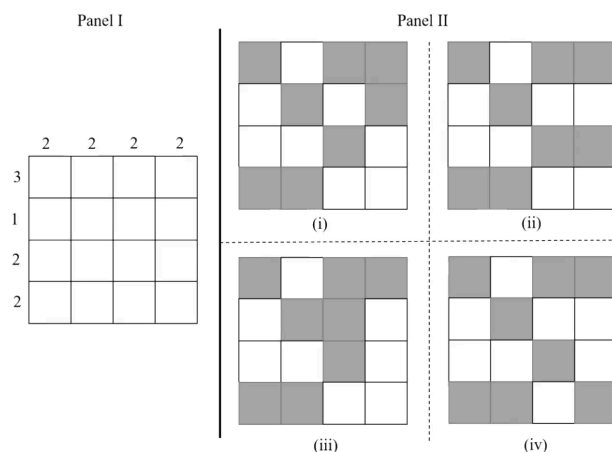
Which one of the following options is then true?



- (A) Such a trip is possible for (i), but not for (ii).
- (B) Such a trip is possible for (ii), but not for (i).
- (C) Such a trip is possible for both (i) and (ii).
- (D) Such a trip is possible neither for (i) nor for (ii).

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9. The figure in Panel I below is a grid of cells with four rows and four columns. The numbers on the top and on the left represent the number of cells that are to be shaded in that column and row, respectively. Which one of the options shown in Panel II below represents the grid shaded correctly?



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

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10. An unbiased six-faced dice whose faces are marked with numbers 1, 2, 3, 4, 5, and 6 is rolled twice in succession and the number on the top face is recorded each time. The probability that the sum of the two recorded numbers is a prime number is _____

- (A) $\frac{3}{36}$
 (B) $\frac{13}{36}$
 (C) $\frac{15}{36}$
 (D) $\frac{19}{36}$

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11. Two identical cubic dice are rolled simultaneously. Which of the following is the probability that at least one of the face values of the two dice is greater than 3?

- (A) $\frac{1}{2}$
- (B) $\frac{3}{4}$
- (C) $\frac{1}{4}$
- (D) $\frac{3}{8}$

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12. Which of the following options is CORRECT for the eigenvalues λ of the given matrix?

$$\begin{bmatrix} 8 & 0 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & 7 \end{bmatrix}$$

- (A) $\lambda = 1, 1, 1$
- (B) $\lambda = 8, 5, 7$
- (C) $\lambda = 0, 0, 0$
- (D) $\lambda = 40, 1, 35$

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13. For a given matrix $A = \begin{bmatrix} 4 & 4 \\ 0 & 4 \\ -4 & 4 \end{bmatrix}$, and A^T representing its transpose, which of the following options is the CORRECT representation of $A^T A$?

- (A) $\begin{bmatrix} 4 & 0 \\ 0 & -4 \end{bmatrix}$
- (B) $\begin{bmatrix} 32 & 0 \\ 0 & 48 \end{bmatrix}$
- (C) $\begin{bmatrix} 32 & 0 \\ 0 & 0 \\ 0 & 48 \end{bmatrix}$
- (D) $\begin{bmatrix} 4 & 0 \\ 0 & 0 \\ 0 & -4 \end{bmatrix}$

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14. Given two vectors $\vec{U}$ and $\vec{V}$, which of the following options is CORRECT for the expansion of divergence, $\nabla \cdot (\vec{U} + \vec{V})$?

- (A) $\nabla \times \vec{U} + \nabla \times \vec{V}$
- (B) $\nabla \times \vec{U} - \nabla \times \vec{V}$
- (C) $\nabla \cdot \vec{U} + \nabla \cdot \vec{V}$
- (D) $\nabla \cdot \vec{U} - \nabla \cdot \vec{V}$

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15. Which of the following is the basic mechanism of hydrocyclones and centrifuges used for solids control in a drilling operation?

- (A) Screening
- (B) Forced settling
- (C) Chemical flocculation
- (D) Dilution

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16. Which of the following is the role of stabilizer subs in the rotary drilling process?

- (A) To prevent the drill-string from falling into the wellbore
- (B) To keep casing equidistant from the wellbore wall
- (C) To assist in keeping the drill collars centralized
- (D) To isolate the wellbore fluid from the subsurface formations

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17. For a single-phase dry gas reservoir having a well producing only dry gas, E represents gas expansion factor and B_g represents gas formation volume factor. Which of the following options is CORRECT?

- (A) $E \propto \frac{1}{B_g}$
- (B) $E \propto B_g$
- (C) $E \propto B_g^2$
- (D) $E \propto B_g^3$

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18. Choose the correct option by matching the entries in Group X with their description in Group Y.

Group X	Group Y
(P) Gas hydrate	(I) Gas is mostly present in adsorbed state
(Q) Oil shale	(II) Sedimentary rock contains kerogen
(R) Coal bed methane	(III) Oil recovered from shale
(S) Shale oil	(IV) Gas is present inside the cages formed by water molecules

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

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19. Which of the following statements is NOT CORRECT in the context of offshore operational environment?

- (A) The motion of ocean's surface can be due to energy transfer from wind to water.
- (B) Lunar tides are caused by the moon.
- (C) Solar tides are caused by the sun.
- (D) The motion of ocean's surface can be due to energy transfer from water to wind.

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20. Which of the following has the most proppant carrying capacity during hydraulic fracturing process?

- (A) Pentane
- (B) Cross-linked gel
- (C) Slickwater
- (D) Untreated formation brine

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21. A circular shaped reservoir has an external radius r_e . A well of radius r_w lies at the centre of the reservoir. The part of the reservoir around the wellbore, up to a radius r_s , is damaged due to drilling and completion operations, where $r_w < r_s < r_e$. This formation damage causes an additional pressure drop, $\Delta p(r)$, that varies with the radial distance r from the well. Which of the following statements is TRUE about the additional pressure drop at the radial location r_s due to the formation damage?

- (A) $\Delta p(r_s) = \Delta p(r_w)$
- (B) $\Delta p(r_s) = 0$
- (C) $\Delta p(r_s) = 2 \Delta p(r_w)$
- (D) $\Delta p(r_s) = 4 \Delta p(r_w)$

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22. In a drawdown test conducted on a well, p_D , t_D and C_D denote the dimensionless pressure, the dimensionless time and the dimensionless wellbore storage coefficient, respectively. In the early time of the drawdown test, the fluid produced at the surface results purely from the unloading (expansion) of fluid already stored in the wellbore, and no fluid from the formation has reached the well yet. This period is called the pure wellbore storage period. For this period, which of the following relationships is CORRECT?

- (A) $t_D = p_D C_D$
- (B) $C_D = p_D t_D$
- (C) $p_D = t_D C_D$
- (D) $t_D = p_D + C_D$

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23. Which of the following is/are conventional Enhanced Oil Recovery (EOR) method(s)?

- (A) Water flooding
- (B) In situ combustion
- (C) Surfactant flooding
- (D) Steam flooding

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24. Which of the following improve(s) the productivity index of a vertical well producing from an oil reservoir?

- (A) Hydraulic fracturing
- (B) Increasing the perforation length
- (C) Increasing the skin factor
- (D) Reducing the oil viscosity by steam injection

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25. Which of the following methods is/are used to separate water from a crude oil water emulsion?

- (A) Heating
- (B) Centrifugation
- (C) Addition of interfacial tension reducing agents
- (D) Electrostatic coalescence

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26. Which of the following statements is/are CORRECT about the water injection well platforms?

- (A) These are meant for injection of gas through the injection well.
- (B) Metering devices are not required to determine injection rate of injection wells.
- (C) Metering devices are required to determine injection rate of injection wells.
- (D) Firefighting and life-saving equipment should be present on the platform.

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27. Which of the following options is/are representing the rheological behavior of a conventional drilling fluid?

- (A) Dilatant
- (B) Pseudoplastic
- (C) Thixotropic
- (D) Rheopectic

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28. Pressure (p) as function of radius (r) and time (t) can be found from the analytical solution of radial diffusivity equation for homogenous and isotropic reservoir following Darcy law. For this solution, if dp/dt is treated as constant, which of the following correctly describe(s) the state(s) of pressure change?

- (A) Transient
- (B) Pseudo-steady
- (C) Steady
- (D) Unsteady

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29. Which of the following statements is/are CORRECT about the floating production, storage, and offloading systems (FPSOs)?

- (A) Existing tankers cannot be converted into FPSOs.
- (B) FPSOs can be selected in the absence of any pipeline infrastructure.
- (C) FPSOs cannot process the produced fluids.
- (D) FPSOs can be used for the storage of produced crude oil.

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30. For a radioactive material, if N is the number of nuclei present at time t , and λ is decay constant, which of the following is/are CORRECT representation(s) of the rate of decay?

- (A) $-\frac{dN}{dt} = \lambda N^2$
- (B) $-\frac{dN}{dt} = \lambda N$
- (C) $-\frac{dN}{dt} = \frac{\lambda}{N^2}$
- (D) $-\frac{dN}{dt} = \frac{\lambda}{N}$

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31. Which of the following logging methods is/are NOT used for investigation in Cement Bond Logging (CBL)?

- (A) Gamma ray
- (B) Neutron
- (C) Electrical
- (D) Acoustic wave

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32. The solution of the given expression is _____.

$$\lim_{x \rightarrow \pi/2} \frac{\sin(\cos x) - \cos x}{\pi/2 - x}$$

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33. A circular reservoir with a well in the centre is producing oil at a constant rate under pseudo steady state. The rate of pressure change measured at the wellbore is 1.0 psi/day. Pressure at the external radius of the reservoir at a certain time was 3500 psi. After 500 days, the pressure (in psi) at the external radius will be _____.

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34. When 92 ml of distilled water (density = 1.0 g/cm³) is mixed with 23 grams of NaCl salt, the density of the resultant brine solution is 1.15 g/cm³. The volume of the brine solution (in ml) is _____.

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35. An oil has a density of 50 lbm/ft³ at Standard Temperature and Pressure (STP) conditions. The density of the oil (in °API) is _____.
[Given: water density is 62.4 lbm/ft³ at STP]

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36. Which of the following is the correct representation of the given expression?

$$\frac{(1+i)^8}{(1-i)^6}$$

- (A) $2e^{-i\pi/2}$
- (B) -1
- (C) $2e^{i\pi/2}$
- (D) 1

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37. The values of a function $f(x)$ at three different values of x are given below:

$$f(0.90) = 7.75, f(1.00) = 9.00, f(1.10) = 10.35.$$

Using the central difference approximation method, which is the CORRECT estimate of the first differential $f'(1.00)$ and second differential $f''(1.00)$ respectively?

- (A) 10.00 and 13.00
- (B) 13.00 and 10.00
- (C) 10.00 and 10.00
- (D) 13.00 and 13.00

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38. Consider a random continuous variable x and its cumulative distribution function $F(x)$. Which of the following options describes the Probability Density Function (PDF) of x ?

- (A) $\frac{d}{dx}F(x)$
- (B) $\frac{d^2}{dx^2}F(x)$
- (C) $\int F(x) dx$
- (D) $\int \frac{1}{F(x)} dx$

• • •

39. Choose the CORRECT match of sedimentary rocks in GROUP X with their processes/mechanisms of formation in GROUP Y.

GROUP X

GROUP Y

(P) Evaporite	(I) Physical process mainly consisting of lithification/cementation of deposition
(Q) Sandstone	(II) Chemical process and depositions by marine living organisms
(R) Limestone	(III) Anaerobic deposition of organic materials in mud bed
(S) Siltstone	(IV) Evaporation and precipitation of marine water

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

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40. Which of the following logging methods in a borehole will provide the highest depth of investigation for a given marine formation?

- (A) Neutron
- (B) Sonic
- (C) Density
- (D) Resistivity

• • •

41. Choose the CORRECT match of fire detection systems in **GROUP X** with their working mechanisms in **GROUP Y**.

GROUP X

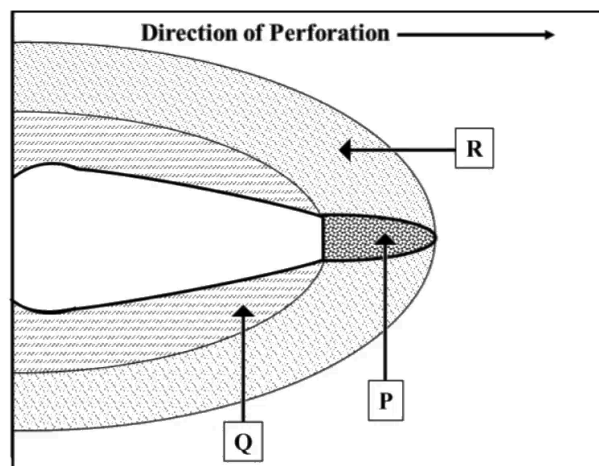
- (P) Fusible plug loops
- (Q) Thermal and smoke detection system
- (R) Gas detection system

GROUP Y

- (I) Detects rise in temperature caused by fire and visible/invisible particles of combustion
 - (II) Functions based on drop in pressure that activates fire shutdown
 - (III) Detects flammables
- (A) P-I; Q-II; R-III
 - (B) P-II; Q-I; R-III
 - (C) P-III; Q-I; R-II
 - (D) P-II; Q-III; R-I

...

42.



The sectional view of three different damaged regions (marked P, Q and R) near the vicinity of a perforation is shown in the figure above. Choose the correct option matching the entries in **GROUP X** with the corresponding terms in **GROUP Y**.

GROUP X

P

Q

R

GROUP Y

(I) Grain fracturing

(II) Charge and core debris

(III) Compacted pulverized zone

(A) P-I; Q-II; R-III

(B) P-II; Q-III; R-I

(C) P-I; Q-III; R-II

(D) P-II; Q-I; R-III

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43. Real gas pseudo pressure is used to derive the diffusivity equation for a highly compressible fluid, for which viscosity μ and gas compressibility factor Z are functions of pressure p . Which of the following represents the partial derivative of the real gas pseudo pressure with respect to time t ?

- (A) $\left(\frac{2p}{\mu Z}\right) \frac{\partial p}{\partial t}$
- (B) $\left(\frac{p^2}{2\mu Z}\right) \frac{\partial p}{\partial t}$
- (C) $\left(\frac{\mu Z}{2p}\right) \frac{\partial p}{\partial t}$
- (D) $\left(\frac{2\mu Z}{p^2}\right) \frac{\partial p}{\partial t}$

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44. Stokes' law is used to calculate the settling rate of barite in drilling fluid for two batches, P and Q. The particle size of batch P is 75 micrometers and the particle size of batch Q is 25 micrometers. The particle settling rate in the drilling fluid for batch P is _____ times that for batch Q.

- (A) Four
- (B) Nine
- (C) Two
- (D) One

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45. Which of the following approaches is/are used to get the response of a Formation Micro Scanner (FMS) log?

- (A) Optical
- (B) Electrical
- (C) Thermal
- (D) Nuclear

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46. Which of the following conditions is/are inferred using cross plots of neutron porosity (ϕ_N) and density porosity (ϕ_D)?

- (A) Gas zone
- (B) Shale distribution
- (C) Water zone
- (D) Oil zone

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47. Which of the following is/are obtained using a core sample?

- (A) Porosity
- (B) Pore size distributions
- (C) Absolute permeability
- (D) Reservoir boundary

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48. Pressure change and derivative type curves (Bourdet type curves) are used in well test analysis. Which of the following statements is/are CORRECT about these type curves?

- (A) These curves are on Log-Log plot
- (B) Horizontal axis is for dimensionless time t_D
- (C) All derivative type curves merge in the middle time region
- (D) Vertical axis is for dimensionless pressure P_D only

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49. Which of the following is/are objective(s) of a safety system in offshore production platforms?

- (A) To prevent leak or overflow of hydrocarbons
- (B) To prevent ignition of hydrocarbons released on the platform
- (C) To prevent water coning in the reservoir
- (D) To prevent gas coning in the reservoir

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50. A wellbore has true vertical depth (TVD) of 10000 ft. The pore pressure of formation fluid in the permeable stratum at bottom of wellbore is 6500 psig. Which is/are the acceptable average static mud density value(s) (in lbm/gal) to prevent flow of formation fluid into wellbore?

[Given: 1 lbm/gal mud = 0.052 psi/ft]

- (A) 13.8
- (B) 11.3
- (C) 11.8
- (D) 13.2

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51. Which of the following statements is/are CORRECT about the skin factor?

- (A) Successful hydraulic fracturing increases the skin factor
- (B) Successful hydraulic fracturing decreases the skin factor
- (C) Formation damage near the wellbore increases the skin factor
- (D) Formation damage near the wellbore decreases the skin factor

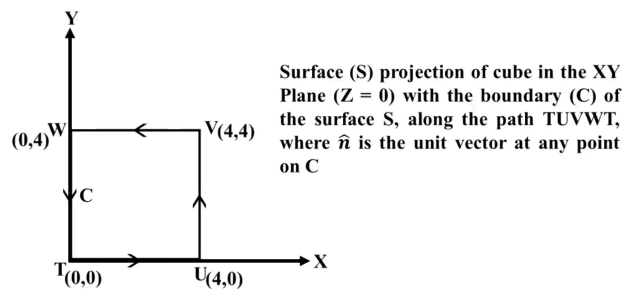
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52. Consider a vector function $\vec{F} = (y - z + 2)\hat{i} + (yz + 8)\hat{j} - xz\hat{k}$, on the surface (S) in the XY plane at $z = 0$ (as shown in the figure).

Considering Stokes theorem for space, the ABSOLUTE value of the surface integral

$$\iint_S (\nabla \times \vec{F}) \cdot \hat{n} dS$$

is _____. (Answer in integer)



(Consider $\hat{i}$, $\hat{j}$, $\hat{k}$, and $\hat{n}$ as unit vectors)

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53. For a given reservoir of porosity $\phi = 0.1$, the water saturation is equal to the irreducible water saturation. The BVI (Bulk Volume Irreducible) water saturation was estimated as 0.04 using NMR (Nuclear Magnetic Resonance) log.

The permeability, k in mD, is estimated using the relation

$$k = 10^4 \phi^4 \left(\frac{FFI}{\phi - FFI} \right)^2$$

, where FFI is the Free Fluid Index.

Based on this information, the permeability (in mD) is _____.

(Rounded off to two decimal places)

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54. The Inflow Performance Relationship (IPR) for a vertical well in a single-phase oil reservoir was found to be linear. The flowing bottomhole pressures are 4000 psi and 1000 psi at oil flow rates of 200 STB/day and 600 STB/day, respectively.

At the flowing bottomhole pressure of 2875 psi, the value of flow rate (in STB/day) is _____. (Answer in integer)

[STB: Stock Tank Barrel]

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55. A matrix acidizing job is planned on a sandstone pay zone at a depth of 7000 ft without formation breakdown, by keeping a safety margin of 250 psi with the help of a coil tubing unit. Consider the fracture gradient of 0.7 psi/ft, average specific gravity of the injection fluid as 1.065, and frictional pressure drop of 200 psi.

The maximum surface injection pressure (in psi) is _____.

(Rounded off to one decimal place)

[Given: Hydrostatic gradient (psi/ft) = $0.433 \times \text{Specific Gravity}$]

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56. A drawdown test is analyzed to find the permeability and skin factor of a reservoir using a semi-log plot, where the flowing bottomhole pressure (in psi) is plotted on a linear scale against time (in hours). The flow rate is 1500 STB/day, the oil formation volume factor is 1.2 RB/STB, and the oil viscosity is 1 cP. The thickness of the producing bed is 10 ft. The slope of the straight line fitting the data in the middle time region of the semi-log plot is 60 psi/log cycle.

The permeability of the reservoir (in mD) is _____ (rounded off to one decimal place).

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57. A conventional Sucker Rod Pumping (SRP) unit is used to lift 25 API oil from a depth of 5000 ft. During operation, the maximum and minimum values of the polished rod load are recorded as 14300 lbf and 5200 lbf respectively.

The ideal counterbalance load (in lbf) is _____ (answer in integer).

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58. Matthews-Brons-Hazebroek (MBH) plots are used to calculate the Dietz shape factor (C_A) for reservoirs of various shapes. The MBH plot for a right-angled triangle reservoir with the well located at the centre shows a reading of dimensionless pressure $P_D(\text{MBH}) = 3.0$, at a modified dimensionless time $t_{DA} = 1.0$.

The Dietz shape factor of this right-angled triangle reservoir is _____ (rounded off to one decimal place).

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59. A drilling fluid following the power law model is circulated in a wellbore at a rate of 600 gal/min. The internal diameter (D_i) of the drill pipe is 4.276 inches, and the power law flow behaviour index n for the fluid is 0.67.

The wall shear rate is given by

$$\dot{\gamma}_w = \left(\frac{3n + 1}{4n} \right) \frac{8V}{D_i}$$

where V is the average velocity of the drilling fluid inside the drill pipe.

[Given: 1 gallon = 3785.4 cm³, 1 inch = 2.54 cm]

The wall shear rate (in s⁻¹) is _____ (rounded off to one decimal place).

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60. The upper limit of the scale of dial reading for a rotational oilfield viscometer is 300 degrees. At a rotational speed of 100 RPM, the highest possible effective (apparent) viscosity that can be measured on this viscometer (in cP) is _____ (rounded off to one decimal place).

[Given: 1 degree dial reading = 5.11 dynes/cm², and 1 RPM = 1.703 s⁻¹]

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61. Three wells are located at the corners of an equilateral triangle inside an infinite acting reservoir. The reservoir is horizontal, homogeneous, isotropic, and of uniform thickness. The initial reservoir pressure is 3000 psi. If only one well had been producing under transient flow conditions, the pressure at the centre of the equilateral triangle would have dropped by 100 psi after 60 days. If all three wells start producing simultaneously under transient flow conditions at the same rate, then after 60 days, the pressure (in psi) at the centre of the triangle is _____.

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62. Oil is produced from an undersaturated oil reservoir that has no initial gas cap. The reservoir rock compressibility and connate water saturation effects are considered negligible. There is no water influx into the reservoir and no water production. The initial oil formation volume factor was 1.24 RB/STB. After producing the reservoir for a short period, while the reservoir pressure is still above the bubble point pressure, the oil formation volume factor changed to 1.25 RB/STB. The calculated oil recovery factor (in fraction, rounded to three decimal places) is _____.

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63. One dimensional oil flow occurs in a horizontal porous medium of length 2000 ft, with a constant cross sectional area of 6000 ft² and absolute permeability of 50 mD. The oil has a viscosity of 2 cP and flows along the length of the medium. The pressure at the inlet is 2500 psig and at the outlet is 2200 psig. Using Darcy's equation for single phase, linear flow, the flow rate of oil (in bbl/day, rounded to one decimal place) is _____. [1 bbl = 5.61 ft³]

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64. A gas reservoir has a bulk volume of 10000 ft³, a connate water saturation of 0.2, and a porosity of 0.2. No oil is present in the reservoir. The gas formation volume factor B_g is 0.005 RCF/SCF. The volume of gas in place (in SCF) is _____ x 10⁴. [RCF: Reservoir Cubic Feet; SCF: Standard Cubic Feet]

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65. A drill string in a wellbore is composed of 6000 ft of drill pipe with an internal diameter of 4.67 inches. Drilling fluid is pumped at a rate of 80 cycles per minute, with a pump factor of 0.21 bbl/cycle. The amount of drilling fluid held in the drill collar and drill bit assembly may be assumed negligible. The time required to circulate the drilling fluid from the surface to the drill bit (in minutes, rounded to two decimal places) is _____. [1 bbl = 5.61 ft³]