<div align="right">**10×4=40**</div>

1. The solution of the diameter of the ellipse $2x^2 + 3y^2 = 6$, which bisects all chords parallel to $3x + 4y = 5 \; is$
      (a) $9y - 8x = 0$
      (b) $8y - 9x = 0$
      (c) $4x + 3y = 6$
      (d) $8y + 9x = 0$.

2. The value of $(3x + 4i)^{-1/2} + (3x - 4i)^{-1/2}$ is

      (a) $\dfrac{4}{3}$

      (b) $\dfrac{5}{4}$

      (c) $\dfrac{3}{4}$

      (d) $\dfrac{4}{5}$.

3. A function $f(x)$ is defined by the equations

$$
\begin{aligned}
f(x) &= 0 & &\text{for } x^2 > 1 \\
&= 1 & &\text{for } x^2 < 1 \\
&= \frac{1}{2} & &\text{for } x^2 = 1.
\end{aligned}
$$

The function $f(x)$ is

      (a) continuous at $x = \pm 1$
      (b) discontinuous at $x = \pm 1$
      (c) differentiable at $x = \pm 1$
      (d) differentiable at $x = \pm 2$.

4. $\lim_{x \to \infty} \frac{15x^7 + 12x + 17}{5x^7 + 9x^2 + 12}$ is equal to

      (a) 0

      (b) 2

      (c) 3

      (d) 4.

5. If $\sqrt{1 - x^2} + \sqrt{1 - y^2} = a(x - y)$, the value of $\frac{dy}{dx}$ is

      (a) $\sqrt{\frac{1 - y^2}{1 - x^2}}$

      (b) $\sqrt{\frac{1 - x^2}{1 - y^2}}$

      (c) $\sqrt{\frac{1 - y}{1 - x}}$

      (d) $\sqrt{\frac{1 - x}{1 - y}}$.

6. The function $f(x) = \sin x (1 + \cos x)$ has

      (a) a minimum at $x = \pi$

      (b) a minimum at $x = \frac{1}{3}\pi$

      (c) neither a maximum nor a minimum at $x = \frac{1}{3}\pi$

      (d) a maximum at $x = \frac{1}{3}\pi$.

7. $\int \frac{\sin x}{\sqrt{1 + \sin x}} dx$ is equal to

      (a) $\sqrt{2} \, \log \tan \left(\frac{\pi}{8} + \frac{x}{4} \right)$

      (b) $\sqrt{2} \, \log \tan \left(\frac{\pi}{4} + \frac{x}{8} \right)$

      (c) $2 \sin \frac{x}{2} - 2 \cos \frac{x}{2}$

      (d) $2 \cos \frac{\pi}{2} - 2 \sin \frac{\pi}{2}$.

8. $\lim_{n\to\infty} \left[\tan 0 + \tan\frac{\pi}{4n} + \tan\frac{2\pi}{4n} + \cdots + \tan\frac{n\pi}{4n}\right]$ is equal to

(a) $\frac{3}{\pi}\log 2$

(b) $\frac{\pi}{2}\log 3$

(c) $\frac{2}{\pi}\log 2$

(d) $\log 3$.

9. If $A = \begin{bmatrix} 1 & 2 & 3 \\ 1 & 3 & 5 \\ 1 & 5 & 12 \end{bmatrix}$, then A^{-1} is

(a) $\begin{bmatrix} \frac{11}{3} & -3 & \frac{1}{3} \\ -\frac{7}{3} & 3 & -\frac{2}{3} \\ \frac{2}{3} & -1 & \frac{1}{3} \end{bmatrix}$

(b) $\begin{bmatrix} 11 & -9 & 1 \\ -7 & 9 & -2 \\ -2 & -3 & 1 \end{bmatrix}$

(c) $\begin{bmatrix} 6 & -5 & 1 \\ -6 & 8 & -2 \\ 2 & -3 & 1 \end{bmatrix}$

(d) $\begin{bmatrix} 3 & -\frac{5}{2} & \frac{1}{2} \\ -2 & 4 & -1 \\ 1 & -\frac{3}{2} & \frac{1}{2} \end{bmatrix}$.

10. The values of δ and μ for which the following system of equations

$$x + y + z = 6$$
$$x + 2y + 3z = 10$$
$$x + 2y + \delta z = \mu$$

have an infinite number of solutions are

(a) $\delta = 10$ and $\mu = 10$
(b) $\delta = 3$ and $\mu = 10$
(c) $\delta = 3$ and $\mu \neq 10$
(d) $\delta \neq 3$ and μ may have any value.

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11. A volcanic bomb of mass m is ejected vertically upward with an initial velocity of w_o. Given negligible air resistance and g: acceleration due to gravity, the altitude (h) the volcanic bomb attains is

    (a) $h = w_o^2/2g$
    (b) $h = w_o^2/2gm$
    (c) $h = w_o/2g$
    (d) $h = w_o/g$

12. In making hydraulic models it is generally considered to be very important to observe Froude number scaling. The Froude number is given as $F_r = \dfrac{U}{\sqrt{gd}}$ (U-velocity, d-density). What does Froude scaling imply about the velocity, if the scale of the model is 1/100 that of the original.

    (a) 1/1
    (b) 1/10
    (c) 1/100
    (d) 1/1000.

13. Consider the stress matrix $\left[\sigma_{i,j}\right] = \begin{pmatrix} 4 & 2 & 0 \\ 2 & -6 & 0 \\ 0 & 0 & 8 \end{pmatrix}$.

The principal stresses $(\sigma_1, \sigma_2, \sigma_3)$ are proportional to the determinant of the stress matrices, then principal stresses are given by:

    (a) 8, 4.385, -6.385
    (b) 8, 2.385, -6.385
    (c) 6, 4.385, -6.385
    (d) 8, 4.385, -1.385.

14. A spherical boulder (specific weight 27000 Nm^{-3}; diameter 2.0 m) is observed to have half of its volume projecting out of a debris flow. The specific weight of the debris flow matrix is 20000 Nm^{-3}. What percentage of the total weight of the boulder is supported by buoyancy?

    (a) 27 percent
    (b) 47 percent
    (c) 37 percent
    (d)   0 percent.

15. Assume a plate moving at a velocity of 70 mm yr^{-1}, and an asthenosphere with a thickness of 200 km, viscosity μ of 10^{19} Pa s, a base having zero velocity and zero pressure gradient in the direction of movement. What is the shear stress at the base of the lithosphere?

    (a) 0.100 MPa
    (b) 0.099 MPa
    (c) 0.001 MPa
    (d) 0.111 MPa.

16. A coal seam is encountered in three bore holes (A, B & C) at depths of 100 m (A), 50 m (B) and 100 m (C) respectively. A, B and C are situated on the vertices of an equilateral triangle with sides of 100 m each. The true dip of the coal seam is

    (a) $\tan^{-1}(1)$
    (b) $\tan^{-1}(\sqrt{3})$
    (c) $\tan^{-1}(1/\sqrt{3})$
    (d) $\tan^{-1}(2/\sqrt{3})$.

17. Two quartz veins which were originally at right angles to each other are affected by a parallel sided ductile shear zone of width w. If one of the veins (I) was perpendicular to the shear zone wall before deformation, and the two veins make an angle of 30° with each other after shearing, the displacement of vein I across the shear zone is given by

(a) $w \tan 30°$
(b) $\tan 30°/w$
(c) $w / \tan 60°$
(d) $w / \tan 30°$.

18. Consider a tetragonal mineral prism with long axis of the prism as the z-axis, and diagonals of the prism cross-section as x-axis and y-axis. If the width of each prism face is given by 'a', the equation of the normal to the prism face is given by:

(a) $x + y = \frac{a}{\sqrt{2}}$
(b) $x - y = \frac{a}{\sqrt{2}}$
(c) $x + y = a$
(d) $x - y = 0$.

19. The equatorial radius of the Earth is 6378 km, while the polar radius is 6357 km. Assume shape of the Earth as an oblate spheroid. A ship sails along the equator between longitudes 70°E and 80°E. Another ship, starting from the same point, sails along 70°E meridian between latitudes 0° and 10°N. The difference in distance (km) travelled by the two ships is given by

(a) $2\pi . \frac{21}{360}$

(b) $2\pi . 21$

(c) $2\pi . \frac{21}{36}$

(d) $2\pi . \frac{21}{6}$.

20. A geologist makes a mistake in recording the latitude and longitude of the corners of a rectangular area bounded by parallels of latitude and longitude. He has recorded the corners of the area as P (S 15°00´: W 78°00´), Q (S 15°00´: W 77°45´), R (S 15°15´: W 78°00´), and S (S 15°15´: W

78°05′). If PQ and PS are NOT diagonals of the rectangle, which of the following inference is correct with respect to error in recording?

(a) Either P or Q is incorrect
(b) Either Q or R is incorrect
(c) Either Q or S is incorrect
(d) Either R or S is incorrect.

21. Five hundred chert pebbles measured on a beach have mean sphericity of 0.71, standard deviation is 0.08. How many pebbles are expected to have sphericity values greater than 0.79, assuming the distribution is normal?

(a) 92
(b) 79
(c) 40
(d) 57.

22. Your colleague has reported the following percentages of clasts present in a sandstone sample: Quartz – 35.0%, K Feldspar – 27.5%, Plagioclase – 20.0%, Mica – 17.5%.
If your colleague claims that the values are accurate up to one decimal place then what is the minimum number of grains measured?

(a) 1000
(b) 924
(c) 40
(d) 100.

23. The axes of trough cross strata are oriented at 355°, 350°, 005°, 285°, 075°, 010°, 0°. What is the approximate mean paleocurrent direction?

(a) North
(b) South
(c) North-west
(d) North-east.

24. What is the slope of the land surface where the contours of 500m interval are separated by 1 cm in a 1:50000 scale toposheet?

      (a) 30°
      (b) 45°
      (c) 60°
      (d) 15°.

25. The length and width measurements of six well-preserved Mollusca shells are given in the following table:

Sp. No.	Width (cm)	Length (cm)
1	1	4
2	6	39
3	1.5	5.25
4	8.5	75.25
5	3	12
6	9	84

Which of the following statements is most appropriate for this data set?

      (a) There is a linear correlation between the length and width measurements.
      (b) The length and width measurements are negatively correlated.
      (c) There is no correlation between the length and width measurements.
      (d) There is a non-linear correlation between the length and width measurements.

26. The following table gives the relation between pairs of data values (X_i, Y_i) for i = 1,........,5

$$X_i - 1, 2, 3, 4, 5$$
$$Y_i - 2, 4, 6, 8, 10$$

All the points lie on Y = bX with slope b and correlation coefficient r. The values of b and r will be

(a) r = 2, b = 1
(b) r = 1, b = 2
(c) r = 2, b = 2
(d) r = 1, b = 12.

27. 200 g sample of Lawrencium was left in a container from 8.00 AM one morning until 2.00 PM next afternoon. If the remaining mass of Lawrencium was 25 g, what is the half-life of Lawrencium?

(a) 30 hours
(b) 10 hours
(c) 5 hours
(d) 1 day.

28. Of the cladograms shown below, which one shows a different evolutionary history from the others?
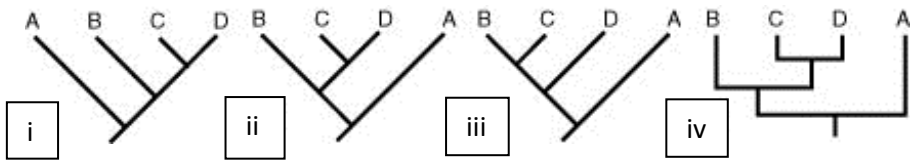
(a) i
(b) ii
(c) iii
(d) iv.

29. Consider the following reaction $2H^+ + 2e^- \rightleftharpoons H_2$ (g). The Nernst equation for this reaction would be (given, RT/F = 0.0257 V at 25°C)

(a) Eh = 0.000 – 0.0592pH
(b) Eh = 2.000 + 0.0592pH
(c) Eh = 1.000 – 0.0592pH
(d) Eh = 1.000 + 0.0592pH

30. As per the data given below, approximately what percentage of localities has either *Nummulites* or *Discocyclina?*

Fossil present	Localities
Nummulites	241
Discocyclina	361
Alveolina	129
Pallatispira	45
Globorotalia	63
Non	84

(a) 65
(b) 26
(c) 39
(d) 75.