BRILLIANT® TUTORIALS

BITSAT 2008
MTP 5/QNS

BRILLIANT'S MOCK TEST 5

FOR STUDENTS OF
OUR ONE/TWO-YEAR POSTAL COURSE
TOWARDS

BITSAT, 2008

Test Booklet Code

E

Time: 3 Hours **Maximum Marks: 450**

Read the following instructions carefully:

1. Immediately fill in the particulars on the Answer Book with Blue/Black Ball Point Pen.
2. The Answer Sheet is kept inside this Test Booklet. When you are directed to open the Test Booklet, take out the Answer Sheet and fill in the particulars carefully.
3. The candidate should write their Enrolment No. only in the space provided on the Test Booklet/Answer Sheet.
4. For each correct response, the candidate will get 3 marks. For each incorrect response, one mark will be deducted from the total score. No deduction from the total score, however, will be made if no response is indicated for an item in the Answer Sheet.
5. The test is of 3 hours duration.
6. The test consists of 150 questions.
7. The maximum marks are 450.
8. Use Blue/Black Ball Point Pen only for writing particulars/marking responses on Side – 1 and Side – 2 of the Answer Sheet.
9. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
10. Do not fold or make any stray marks on the Answer Sheet.
11. Use of Electronic/Manual Calculator is prohibited .

Name of the Candidate (in Capitals): .....

Enrolment Number: | | | | | | | | | | | |

PART I: MATHEMATICS

1. If the sides of a triangle are in the ratio $1 : \sqrt{3} : 2$; then the angles opposite to these sides of a triangle are in the ratio

(1) 1 : 3 : 2 **(2)** 3 : 2 : 1

(3) 2 : 3 : 1 **(4)** 1 : 2 : 3

2. If $\sin(\cot^{-1}(x + 1)) = \cos(\tan^{-1} x)$, then x is

(1) $\frac{1}{2}$ **(2)** 0 **(3)** 1 **(4)** $-\frac{1}{2}$

3. If $\sin\theta = \frac{1}{2}$, $\cos\phi = \frac{1}{3}$ (both θ and ϕ are acute angles), then $(\theta + \phi)$ lies in the interval

(1) $\left[\frac{\pi}{3}, \frac{\pi}{2}\right]$ **(2)** $\left[\frac{\pi}{2}, \frac{2\pi}{3}\right]$

(3) $\left[\frac{2\pi}{3}, \frac{5\pi}{6}\right]$ **(4)** $\left[\frac{5\pi}{6}, \pi\right]$

4. $\int_0^{t^2} x\, f(x)\, dx = \frac{2}{5}t^5$, $t > 0$, then $f\left(\frac{4}{25}\right)$ is equal to

(1) $\frac{2}{5}$ **(2)** $\frac{5}{2}$ **(3)** $\frac{5}{3}$ **(4)** 1

5. If f(x) is differentiable and strictly increasing function, then $\lim_{x \to 0} \frac{f(x^2) - f(x)}{f(x) - f(0)}$ is equal to

(1) 2 **(2)** 1 **(3)** – 1 **(4)** 0

6. If x is the first term of a geometric progression with infinite number of terms, whose sum is 5, then

(1) $0 < x < 10$ **(2)** $x \geq 10$

(3) $x < -10$ **(4)** $-10 < x < 0$

SPACE FOR ROUGH WORK

7. The line $2x + \sqrt{6}y = 2$ touches the hyperbola $x^2 - 2y^2 = 4$ at the point

(1) $\left(\frac{1}{2}, \frac{1}{\sqrt{6}}\right)$ **(2)** $(4, -\sqrt{6})$

(3) $(4, \sqrt{6})$ **(4)** $(-2, \sqrt{6})$

8. The least positive value of n for which $(1 + \omega^2)^n = (1 + \omega^4)^2$, where ω is a non-real cube root of unity is

(1) 2 **(2)** 3 **(3)** 6 **(4)** 4

9. A given unit vector is orthogonal to $5\hat{i} + 2\hat{j} + 6\hat{k}$ and coplanar with $\hat{i} - \hat{j} + \hat{k}$ and $2\hat{i} + \hat{j} + \hat{k}$. Then the vector is

(1) $\frac{3\hat{j} - \hat{k}}{\sqrt{10}}$ **(2)** $\frac{\hat{i} - \hat{k}}{\sqrt{2}}$

(3) $\frac{\hat{i} - 3\hat{k}}{\sqrt{10}}$ **(4)** $\frac{\hat{i} - 3\hat{j}}{\sqrt{10}}$

10. If the lines $\frac{x-1}{2} = \frac{y+1}{3} = \frac{z-1}{4}$ and $\frac{x-3}{1} = \frac{y-k}{2} = \frac{z}{1}$ are intersecting each other, then k is

(1) $\frac{2}{9}$ **(2)** $\frac{9}{2}$ **(3)** 1 **(4)** $\frac{3}{2}$

11. If $\log(x + y) - 2xy = 0$, then $y'(0)$ is equal to

(1) 0 **(2)** 1 **(3)** -1 **(4)** $\frac{1}{3}$

12. If the system of equations $2x - y - 4z = 2$, $x - 2y - z = -4$, $x + y + \lambda z = 4$ has no solution, then the value of λ is

(1) 1 **(2)** 2 **(3)** 3 **(4)** -3

13. A fair dice is rolled till the number 1 appears on top face of it. The probability that the dice is thrown even number of times is

(1) $\frac{5}{11}$ **(2)** $\frac{1}{6}$ **(3)** $\frac{5}{6}$ **(4)** $\frac{5}{36}$

SPACE FOR ROUGH WORK

14. Let $P = \begin{bmatrix} \frac{\sqrt{3}}{2} & \frac{1}{2} \\ -\frac{1}{2} & \frac{\sqrt{3}}{2} \end{bmatrix}$, $A = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix}$ and $Q = PAP^T$. Then $P^T Q^{2008} P$ is

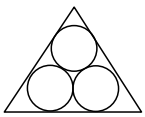
(1) $\frac{1}{4}\begin{bmatrix} 1 & 2008 \\ -2008 & -1 \end{bmatrix}$

(2) $\begin{bmatrix} 1 & 2008 \\ 0 & 1 \end{bmatrix}$

(3) $\begin{bmatrix} 2008 & 1 \\ 1 & 0 \end{bmatrix}$

(4) $\frac{1}{4}\begin{bmatrix} -1 & -2008 \\ 2008 & 1 \end{bmatrix}$

15. If 3 circles of radius 1 are drawn in an equilateral triangle as shown in figure, then area of the triangle will be



(1) $7 + \frac{4\sqrt{3}}{3}$ **(2)** $6 + 4\sqrt{3}$

(3) $10 + 4\sqrt{3}$ **(4)** $8 + \sqrt{3}$

16. If a, b, c are integers and not all are equal, then the least value of $|a + b\omega + c\omega^2|$ is (where ω and ω^2 are non-real cube roots of unity)

(1) 0 **(2)** $\frac{\sqrt{3}}{2}$ **(3)** 1 **(4)** $\frac{1}{\sqrt{3}}$

17. $\int_{-2}^{0} [x^3 + 3x^2 + 3x + 3 + (x + 1)\cos(x + 1)]\,dx$ is equal to

(1) 2 **(2)** 4 **(3)** 1 **(4)** 0

18. A variable plane at a unit distance from origin cuts the axes at A, B, C. If the centroid (x, y, z) of ΔABC satisfies $\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2} = k$, then k is

(1) 3 **(2)** 9 **(3)** 4 **(4)** 6

19. If α and β are the roots of the equation $ax^2 + 2bx + c = 0$, $\Delta = b^2 - ac$ and $\alpha + \beta$, $\alpha^2 + \beta^2$, $\alpha^3 + \beta^3$ are in G.P., then $(a \neq 0)$

(1) $bc \neq 0$ **(2)** $\Delta \neq 0$

(3) $\Delta b = 0$ **(4)** $\Delta c = 0$

SPACE FOR ROUGH WORK

20. The value of
$^{30}C_0\,^{30}C_{10} - {}^{30}C_1\,^{30}C_{11} + {}^{30}C_{20}\,^{30}C_{30}$ is

(1) $^{30}C_{10}$ **(2)** $^{60}C_{20}$ **(3)** $^{60}C_{30}$ **(4)** $^{40}C_{30}$

21. If the graph of the function $x^2 - 4x + \log_3 a$ does not cut the real axis, then the least integral value of 'a' is

(1) 80 **(2)** 81 **(3)** 82 **(4)** 0

22. If the equation $ax^2 - 2bx - 3c = 0$ has no real roots and $4(a - b) > 3c$, then c should be

(1) negative **(2)** non-negative

(3) positive **(4)** zero

23. Given $0 < x < \frac{\pi}{4}$, $\frac{\pi}{4} < y < \frac{\pi}{2}$,

$a = \sum_{k=1}^{\infty} (-1)^k \tan^{2k} x$ and

$b = \sum_{k=1}^{\infty} (-1)^k \cot^{2k} y$, then

$\sum_{k=0}^{\infty} \tan^{2k} x \cot^{2k} y$ is equal to

(1) $a + b - ab$

(2) $\frac{ab}{a + b - 1}$

(3) $\frac{1}{a} + \frac{1}{b} - \frac{1}{ab}$

(4) $\frac{1}{a} + \frac{1}{b} + \frac{1}{ab}$

24. If in an A.P. $a_1, a_2, a_3, \ldots; a_7 = 9$, then $a_1a_2a_7$ is least when the common difference is

(1) $\frac{23}{20}$ **(2)** $\frac{13}{22}$ **(3)** $\frac{43}{20}$ **(4)** $\frac{33}{20}$

25. If $x_n = {}^{n+5}C_4 - \frac{143}{96}\frac{P_{n+5}}{P_{n+3}}$, $n \in N$ and P_k denotes the number of permutation of k things taken all at a time, then the number of negative terms in the sequence $\{x_n\}$ is

(1) 1 **(2)** 2 **(3)** 3 **(4)** 4

SPACE FOR ROUGH WORK

26. If C_n denotes ${}^nC_n$ and S_n denotes the sum to n terms of the A.P. a, a + d, a + 2d, ... then
$aC_0 + (a + d)C_1 + (a + 2d)C_2 + ... (n + 1)$ terms is equal to

(1) $\frac{S_n}{n} 2^n$ **(2)** $\frac{S_{n+1}}{n+1} 2^{n-1}$

(3) $\frac{S_{n+1}}{n+1} 2^n$ **(4)** $\frac{S_n}{n} 2^{n-1}$

27. ${}^{n+1}C_2 + 2\left[{}^2C_2 + {}^3C_2 + {}^4C_2 + \cdots + {}^nC_2\right]$ is equal to

(1) $1^2 + 2^2 + 3^2 + ... + n^2$

(2) $1^3 + 2^3 + 3^3 + ... + n^3$

(3) $1 + 2 + 3 + ... + n$

(4) $1^4 + 2^4 + 3^4 + ... + n^4$

28. The number of positive integral solutions of the equation $x_1 + x_2 + x_3 - x_4 = 0$ with the condition $x_4 \le 10$ is

(1) 120 **(2)** 150 **(3)** 55 **(4)** 65

29. The number of permutations of the word HINDUSTAN such that none of the three patterns HIN, DUS, TAN occurs is

(1) 169194 **(2)** 166680

(3) 169190 **(4)** 166670

30. If $f(x) = (x - \alpha)(x - \beta)(x - \gamma)(x - \delta)$, then the determinant $\begin{vmatrix} \alpha & x & x & x \\ x & \beta & x & x \\ x & x & \gamma & x \\ x & x & x & \delta \end{vmatrix}$ is equal to

(1) $f'(x)$ **(2)** $xf'(x)$

(3) $f(x) + xf'(x)$ **(4)** $f(x) - xf'(x)$

31. If A is a square matrix, then
$\text{Adj}(A^T) - (\text{Adj } A)^T$ is equal to

(1) $2|A|$ **(2)** $2|A|I$

(3) null matrix **(4)** unit matrix

32. If $z + 1 = i\sqrt{3}$ and n is a positive integer but not a multiple of 3, then $z^{2n} + 2^n z^n$ is equal to

(1) 0 **(2)** -1 **(3)** 2^{2n} **(4)** -2^{2n}

SPACE FOR ROUGH WORK

33. If z_1, z_2, z_3, z_4 are represented by the vertices of a quadrilateral taken in order such that $z_1 - z_4 = z_2 - z_3$ and Amp $\left(\frac{z_4 - z_1}{z_2 - z_1}\right) = \frac{\pi}{2}$, then the quadrilateral is a

(1) Rhombus **(2)** Square

(3) Rectangle **(4)** Trapezium

34. $ab \sin x + b\sqrt{1 - a^2} \cos x + c$ where $|a| < 1$ and $b > 0$ lies in the interval

(1) $[b - c, b + c]$ **(2)** $(b + c, b - c)$

(3) $[c - b, c + b]$ **(4)** $(a - b, a + b)$

35. The most general value of x for which $\sin x + \cos x = \min_{a \in R} \{1, a^2 - 4a + 6\}$ are given by

(1) $2n\pi$

(2) $2n\pi + \frac{\pi}{2}$

(3) $n\pi + (-1)^n \frac{\pi}{4} - \frac{\pi}{4}$

(4) $(2n + 1)\pi$

36. If a right angled triangle ABC of maximum area is inscribed in a circle, then $\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} =$

(1) $\frac{\sqrt{2} - 1}{R}$ **(2)** $\frac{\sqrt{2} + 1}{R}$

(3) $\frac{R}{\sqrt{2} + 1}$ **(4)** $\frac{R}{\sqrt{2} - 1}$

37. If $\sqrt{\cos^2 x + \frac{1}{2}} + \sqrt{\sin^2 x + \frac{1}{2}} = 2$, then $x = \frac{1}{2} \sin^{-1}(k)$ where k is equal to

(1) 0 **(2)** 1 **(3)** – 1 **(4)** ± 1

38. If $4a^2 + 3b(4a + 3b) - c^2 = 0$, then the family of straight lines $ax + by + c = 0$ are concurrent at the point

(1) (– 2, 0) **(2)** (2, – 3)

(3) (2, 3) **(4)** (3, 1)

SPACE FOR ROUGH WORK

39. An isosceles triangle ABC is inscribed in a circle $x^2 + y^2 = a^2$ with vertex A(a, 0) and the base angles B and C are equal to 75°, then the coordinates of C which lies in the third quadrant are

(1) $\left(\frac{-\sqrt{3}}{2}a, \frac{-a}{2}\right)$ **(2)** $\left(\frac{-a}{2}, \frac{-\sqrt{3}}{2}a\right)$

(3) $\left(-a, -\sqrt{3}a\right)$ **(4)** $\left(-\sqrt{3}a, -a\right)$

40. The area of the triangle formed by the tangent to the parabola $y = x^2$ at the point whose abscissa is $k \in [1, 3]$, the y-axis and the line $y = k^2$ is greatest if k is equal to

(1) 1 **(2)** 2 **(3)** 3 **(4)** 4

41. AOB, COD are two unequal line segments bisecting at right angles, then the locus of the point P such that PA · PB = PC · PD is a

(1) Circle

(2) Parabola

(3) Ellipse

(4) Rectangular hyperbola

42. The number of real roots of the equation $3x^5 + 15x = 0$, greater than 1 is equal to

(1) 0 **(2)** 1 **(3)** 3 **(4)** 5

43. The number of solutions of the equation $|2x - 1| = 3[x] + 2\{x\}$ where [x] is the greatest integer $\leq x$ and {x} is the fractional part of x is

(1) one **(2)** two **(3)** three **(4)** nil

44. If the derivative of the function

$$\left.\begin{aligned} f(x) &= bx^2 + ax + 4, & x \geq -1 \\ &= ax^2 + b, & x < -1 \end{aligned}\right\}$$

is everywhere continuous and differentiable then the values of a and b are

(1) (2, 3) **(2)** (3, 2)

(3) (– 2, – 3) **(4)** (– 3, – 2)

45. The function $f(t) = \frac{d}{dt}\int_0^t \frac{dx}{1 - \cos t \cos x}$ satisfies the differential equation

(1) $\frac{df}{dt} + 2f(t)\cot t = 0$

(2) $\frac{df}{dt} - 2f(t)\cot t = 0$

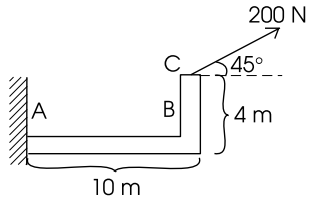
(3) $\frac{df}{dt} + 2f(t) = 0$

(4) $\frac{df}{dt} - 2f(t) = 0$

SPACE FOR ROUGH WORK

PART II: PHYSICS

46. The moment of the force shown about A is



(1) zero **(2)** – 565.68 N-m

(3) 848.528 N-m **(4)** 200 N-m

47. Stationary waves are formed in an acoustic medium by combining two simple harmonic waves in such a way that the point x = 0 is a node. The equation of one of the waves is $y = a \cos(\omega t - kx)$. The equation of the other wave is

(1) $y = a \cos(\omega t + kx)$

(2) $y = a \sin(\omega t + kx)$

(3) $y = -a \cos(\omega t + kx)$

(4) $y = -a \sin(\omega t - kx)$

48. The most suitable material for making an LDR (Light dependent resistor) is a semiconductor material having

(1) $E_g >> h\nu$

(2) $E_g > h\nu$

(3) $E_g = h\nu$

(4) $E_g << h\nu$

49. Match List-I (Polarization process) with List-II (Approximate frequency) and select the correct answer using the codes given below the lists.

	List-I (Polarization process)		**List-II (Approximate frequency)**
A.	Electronic polarization	i	10^2 Hz
B.	Ionic polarization	ii	10^5 Hz
C.	Orientation polarization	iii	10^{13} Hz
D.	Space-charge polarization	iv	10^{15} Hz

SPACE FOR ROUGH WORK

Codes

	A	B	C	D
(1)	i	ii	iii	iv
(2)	iv	iii	ii	i
(3)	i	iii	ii	iv
(4)	iv	ii	iii	i

50. Compare the total energy (E_b) of a bound system such as nucleus with the total energy (E_s) of the separated nucleons:

(1) $E_b < E_s$

(2) $E_b = E_s$

(3) $E_b > E_s$

(4) depends on how heavy the nucleus is

51. When a semiconductor bar is heated at one end, a voltage across the bar is developed. If the heated end is positive, the semiconductor is

(1) p-type

(2) n-type

(3) intrinsic

(4) highly degenerate

52. Given two statements

A: The internal energy of an ideal gas does not change during an isothermal process.

R: The decrease in volume of a gas is compensated by a corresponding increase in pressure when its temperature is kept constant.

(1) Both **A** and **R** are true, and **R** is the correct explanation of A.

(2) Both **A** and **R** are true, but **R** is **NOT** the correct explanation of **A**.

(3) **A** is true, but R is false.

(4) **A** is false but **R** is true

53. Of the following applications, friction is maximized in

(1) Roller and Ball bearings

(2) door hinges

(3) Piston and cylinder

(4) wedges

SPACE FOR ROUGH WORK

54. Electron (E), proton (P), helium nucleus (He^{++}) and deuterium nucleus ($^2H^+$) all have charge as well as mass. The order in which they are arranged in increasing magnitudes of the value of charge to mass ratio is

(1) E, P, He^{++}, $^2H^+$

(2) P, He^{++}, E, $^2H^+$

(3) $^2H^+$, He^{++}, P, E

(4) He^{++}, $^2H^+$, P, E

55. Match the following (choose the correct alternative).

I		II
A.	Aston's mass spectrograph	i. Relativistic variation of mass has no effect
B.	Magnetron	ii. Relativistic variation of mass limits the maximum velocity
C.	Betatron	Iii. Radial electrical field and axial magnetic field
D.	Cyclotron	iv. All particles with same value of e/m brought to a single focus

Codes

	A	B	C	D
(1)	i	iii	ii	iv
(2)	iv	iii	i	ii
(3)	iv	iii	ii	i
(4)	ii	i	iii	iv

56. The technology used for display in PC note-books (lap-top computers) is

(1) Light Emitting Diodes display

(2) Liquid Crystal display

(3) CRT display

(4) Plasma display

SPACE FOR ROUGH WORK

57. Identify Rutherford's discovery of proton:

(1) $_7N^{14} + _2He^4 \longrightarrow _8O^{17} + _1H^1$

(2) $_4Be^9 + _2He^4 \longrightarrow _6C^{13} + _0n^1$

(3) $_6C^{12} + _1H^1 \longrightarrow _7N^{13} + \Delta E$

(4) $_7N^{15} + _1H^1 \longrightarrow _6C^{12} + _2He^4$

58. When a given mass of ice at 0°C is converted to water at the same temperature, OR when an equal amount of water at 100°C is converted to steam at the same temperature, the entropy changes. If the entropy changes are δS_1 and δS_2 in the case of ice and water, respectively, then

(1) δS_1 = gain δS_2 = gain $\delta S_2 < \delta S_1$

(2) δS_1 = gain δS_2 = gain $\delta S_2 < \delta S_1$

(3) δS_1 = loss δS_2 = loss $\delta S_1 < \delta S_2$

(4) δS_1 = gain δS_2 = loss $\delta S_2 > \delta S_1$

59. One mole of an ideal gas expands adiabatically from temperature T_1 to temperature T_2 . The work done by the gas is

(1) $R(T_1 - T_2)$ **(2)** $C_v (T_1 - T_2)$

(3) $C_p(T_1 - T_2)$ **(4)** $\left(\frac{C_p}{C_v}\right)(T_1 - T_2)$

60. Which of the following are the properties of ferromagnetic domains?

i. Permanent magnetisation.

ii. Atomic moments in individual domains are all aligned neither parallel to nor perpendicular to one another below Curie point temperature.

iii. Each domain is magnetically saturated.

iv. Above Curie temperature, domains disrupt.

Select the correct answer using the codes given below.

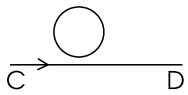
Codes

(1) i and iii **(2)** ii and iv

(3) i, iii and iv **(4)** iii and iv

SPACE FOR ROUGH WORK

61. If a varying current flows in the wire CD placed near a copper ring, what will happen in the wire?



(1) A current will flow in the ring in the clockwise direction

(2) A current will flow in the ring in the anticlockwise direction

(3) No current will be set up

(4) The ring will be attracted to the wire

62. The total intensity of earth's magnetic field (F) is (where V and H are standard components of F)

(1) $V \cdot H$ **(2)** $\sqrt{V^2 + H^2}$

(3) $\frac{V}{H}$ **(4)** $\sqrt{V + H}$

63. Which material among the following possess excellent dielectric properties and good reliability for use in making capacitors?

(1) Silicon monoxide

(2) Silicon dioxide

(3) Tin oxide

(4) Chromium oxide

64. When a metal is heated, electrons are emitted from its surface. These electrons are called

(1) heated electrons

(2) photoelectrons

(3) thermions

(4) positrons

65. When ice melts and becomes water, the ice-water system undergoes a change such that

(1) entropy decreases and internal energy increases

(2) entropy increases and internal energy decreases

(3) entropy and internal energy of the system increase

(4) entropy and internal energy of the system decrease

SPACE FOR ROUGH WORK

66. Dimension of nucleus is of the order of 1 Fermi. With what velocity should electrons move so that it is found inside the nucleus?

(1) 7×10^{11} m/s **(2)** 3×10^{8} m/s

(3) 6×10^{8} m/s **(4)** 1.5×10^{8} m/s

67. Identify the $\bar{\beta}$ decay from the following reactions

(1) ${}_6C^{11} \rightarrow {}_5B^{11} + {}_{-1}e^{0} + \nu$

(2) ${}_1p^{1} \rightarrow {}_0n^{1} + {}_{-1}e^{0} + \nu$

(3) ${}_1p^{1} + \bar{\nu} \rightarrow {}_0n^{1} + {}_{-1}e^{0}$

(4) ${}_0n^{1} \rightarrow {}_1p^{1} + {}_{-1}e^{0} + \bar{\nu}$

68. In any nuclear reaction, energy is released or absorbed and accordingly the Q-value which is our index for the change in the energy is positive or negative. Study the statements given below and identify the correct one(s).

i. In the exoergic reaction — Q is positive — Energy is released

ii. In the exoergic reaction — Q is negative — Energy is absorbed

Iii. In the endoergic reaction — Q is negative — Energy is absorbed

iv. In the endoergic reaction — Q is positive — Energy is released

(1) i and iii **(2)** i and iv

(3) ii and iv **(4)** i only

69. Given two statements:

A: $BaTiO_3$ is a piezoelectric material and is used in a record player .

R: In a piezoelectric transducer, stress induces polarization and an electric field strains the material.

(1) Both **A** and **R** are true, and **R** is the correct explanation of **A.**

(2) Both **A** and **R** are true, but **R** is **NOT** the correct explanation of **A.**

(3) **A** is true, but **R** is false.

(4) **A** is false but **R** is true.

SPACE FOR ROUGH WORK

70. A: When light fails at the junction of a p-n photo diode, its P side becomes positive and N side becomes negative.

R: When a photo diode is short-circuited, the current in the external circuit flows from the P-side to the N-side.

(1) Both **A** and **R** are true, and **R** is the correct explanation of **A**.

(2) Both **A** and **R** are true, but **R** is **NOT** the correct explanation of **A.**

(3) **A** is true, but **R** is false.

(4) **A** is false but **R** is true.

71. Suppose along a narrow cylindrical tube of area of cross-section (A) there is a flow of electrons with a drift vel (v). Then the electric current is

(1) proportional to 1/v and A

(2) proportional to v and 1/A

(3) proportional to 1/v and A

(4) proportional to v and A

72. The Bohr magnetron (μ_B) is directly proportional to e/m ratio of the electron. That is $\mu_B = K\frac{e}{m}$ where K is given by

(1) $h/4\pi$ **(2)** $h/2\pi$ **(3)** h **(4)** 2t

73. Minimum distance between object and its real image formed by a convex lens, in terms of its focal length (f) is

(1) 1.5 f **(2)** 2.5 f **(3)** 2 f **(4)** 4 f

74. Suppose that the earth's angular velocity increases 'n' times the current velocity, a person on the surface of the earth will feel weightless if

(1) n = 17 **(2)** n = 71

(3) n = 1.7 **(4)** n = 0.17

75. The true r.m.s. voltmeter employs two thermocouples in order to

(1) prevent drift

(2) increase the accuracy

(3) increase the sensitivity

(4) cancel out the nonlinear effects of first thermocouple

SPACE FOR ROUGH WORK

76. If a small amount of Cu is added to a Ni conductor, then the

(1) resistivity of Ni will decrease at all temperatures because Cu is a better conductor than Ni

(2) residual resistivity of Ni at low temperatures will increase as Cu atoms act as defect centres

(3) resistivity of Ni will increase at all temperatures as Cu destroys the periodicity of Ni and acts as defects

(4) resistivity of Ni remains unaltered as Cu atoms give the same number of free electrons as Ni atoms

77. A plane EM wave of the form

$\vec{E} = E_0 \cos (2\pi \{(5 \times 10^{14}\ \text{sec}^{-1})\ t - (2.5 \times 10^{6}\ \text{m}^{-1})\ x\})$

represents a wave travelling along

(1) – x direction

(2) + y direction

(3) – y direction

(4) + x direction

78. Given two statements:

A: When an impurity is added to a pure metal, the residual resistivity at zero K is not zero.

R: At absolute zero temperature, lattice vibration ceases to exist.

(1) Both **A** and **R** are true, and **R** is the correct explanation of **A.**

(2) Both **A** and **R** are true, but **R** is **NOT** the correct explanation of **A.**

(3) **A** is true, but **R** is false.

(4) **A** is false but **R** is true.

79. A: Superconducting materials are not good conductors at room temperature as the normal metals are at room temperature.

R: Superconductivity is observable only if the applied magnetic field is below the critical field.

(1) Both **A** and **R** are true, and **R** is the correct explanation of **A.**

(2) Both **A** and **R** are true, but **R** is **NOT** the correct explanation of **A.**

(3) **A** is true, but **R** is false.

(4) **A** is false but **R** is true.

SPACE FOR ROUGH WORK

80. In a parallel resonance circuit formed of L and C, resonance is to be obtained with an oscillator giving an output frequency of ω rad/sec. To obtain resonance, and unity power factor

(1) either one, L, C or ω can be varied

(2) it is better to vary L rather than C or ω

(3) it is better to vary C or ω rather than L

(4) it is best to vary C

81. When a concave lens made of glass is immersed in water it becomes

(1) less convergent

(2) more convergent

(3) less divergent

(4) more divergent

82. An oil immersion objective used in a microscope is based on which of the following functions?

(i) Use of the aplanatic points of a single surface to eliminate spherical aberration

(ii) Use of thicker medium of the same refractive index to increase magnification

(iii) Use of a second lens to enhance the magnification

(iv) Use of special wood oil to eliminate chromatic aberration

(1) (i) and (iv) **(2)** (ii) and (iv)

(3) (ii) and (iii) **(4)** (i), (ii) and (iii)

83. Given two statements:

A: Optical fibres have broader bandwidth compared to conventional copper cables.

R: The information carrying capacity of optical fibres is limited by Rayleigh scattering loss.

(1) Both **A** and **R** are true, and **R** is the correct explanation of **A**.

(2) Both **A** and **R** are true, but **R** is **NOT** the correct explanation of **A**.

(3) **A** is true, but **R** is false.

(4) **A** is false but **R** is true.

SPACE FOR ROUGH WORK

84. An electric dipole of length 2 cm is placed with its axis at an angle of 60° to a uniform electric field of 10^5 N/C. It experiences a torque of $8\sqrt{3}$ N-m. The potential energy of the dipole is

(1) 2 J **(2)** – 4 J

(3) – 8 J **(4)** + 8 J

85. In periodic table, the average atomic mass of magnesium is given as 24.312 u. The average value is based on the relative natural abundance of isotopes earth. The three isotopes and their masses are $^{24}_{12}\text{Mg}\,(23.98504\ \text{u})$, $^{24}_{12}\text{Mg}\,(24.98584\ \text{u})$ and $^{24}_{12}\text{Mg}\,(25.98259\ \text{u})$. The natural abundance of $^{24}_{12}\text{Mg}\,(24.98504\ \text{u})$ is 78.99% by mass. The abundance of $^{24}_{12}\text{Mg}\,(24.98584)$ is

(1) 11.7% **(2)** 21.2

(3) 78.99% **(4)** 50%

SPACE FOR ROUGH WORK

PART III: CHEMISTRY

86. Four different sets of quantum numbers of four electrons are given as

A. 5, 0, 0, $+\frac{1}{2}$ B. 4, 1, + 1, $-\frac{1}{2}$

C. 4, 2, + 2, $+\frac{1}{2}$ D. 4, 0, 0, $-\frac{1}{2}$

Order of energy is

(1) A > B > C > D **(2)** D > C > B > A

(3) C > B > A > D **(4)** B > C > D > A

87. Degenerate orbitals are those in which electrons contain

(1) same orientation

(2) same wavefunction

(3) same energy

(4) same spin

88. Three elements X, Y and Z have electro-negativity 0.7, 1.5 and 3 respectively: Nature bonds in the compounds between these elements XY, YZ and XZ are

(1) ionic

(2) covalent

(3) XY is covalent, but YZ and XZ are ionic

(4) XY and YZ are covalent but XZ is ionic

89. Which of the following statement is correct?

(1) A molecule with polar bonds will always have same dipole moment.

(2) A molecule having polar bond may have zero dipole moment.

(3) A molecule can have dipole moment even if it has no polar covalent bond.

(4) The percentage of ionic character of LiF is 100%.

SPACE FOR ROUGH WORK

90. Correct order of hydration energy is

(1) $Li^+ < Na^+ < K^+ < Rb^+$

(2) $Li^+ < K^+ < Na^+ < Rb^+$

(3) $Rb^+ < K^+ < Na^+ < Li^+$

(4) $Rb^+ < Na^+ < K^+ < Li^+$

91. The set of elements showing inert pair effect is

(1) Na, Mg, N, P **(2)** F, Cl, Br, I

(3) Tl, Pb, Bi **(4)** Pb, Ba, Al, I

92. The **correct** statement among the following is

(1) As^{+5} is an oxidising agent.

(2) Pb^{+4} is reducing agent.

(3) Tl^{+3} is oxidising agent.

(4) H_2SO_4 and HNO_3 are reducing agents.

93. The complex that will not give a precipitate with aqueous silver nitrate solution is

(1) $\left[Pt(NH_3)_4\,Cl_2\right]Cl_2$

(2) $K_2\left[PtCl_6\right]$

(3) $\left[Pt(NH_3)_3\,Cl_3\right]Cl$

(4) $\left[Cr(NH_3)_6\right]Cl_3$

94. The complex ion which can exhibit optical activity is

(1) tran-$\left[Co(NH_3)_4\,Cl_2\right]^+$

(2) $\left[Cr(H_2O)_6\right]^{3+}$

(3) cis-$\left[Co(NH_3)_4\,Cl_2\right]^+$

(4) cis-$\left[Co(en)_2\,(NH_3)_2\right]^{3+}$

95. The volume strength of 1.5 N H_2O_2 solution is

(1) 3.0 **(2)** 4.8 **(3)** 8.4 **(4)** 12

96. 1 mole of N_2H_4 loses 10 mole of electrons and gets converted to a new compound X. Assuming that all the nitrogenation is present in X, then oxidation state of N in the new compound X is

(1) – 3 **(2)** – 2 **(3)** + 3 **(4)** + 4

97. 0.56 g KOH is added to 100 mL of 0.1 N H_2SO_4. The resulting solution will be

(1) neutral **(2)** acidic

(3) basic **(4)** none of these

SPACE FOR ROUGH WORK

98. 0.1 M silver nitrate and 0.2 M aqueous KCl are mixed in equal volume. The molarity of NO_3^- in the solution is

(1) 0.2 M **(2)** 0.15 M

(3) 0.05 M **(4)** 0.1 M

99. The decomposition of limestone in a closed volume vessel is represented as

$$CaCO_{3\,(s)} \rightleftharpoons CaO_{(s)} + CO_{2\,(g)}$$

The pressure exerted by CO_2 is equal to

(1) K_p **(2)** $2K_p$ **(3)** $\sqrt{K_p}$ **(4)** $(K_p)^{1/3}$

100. The strongest acid among the following when they are dissolved in anhydrous acetic acid medium is

(1) H_2SO_4 **(2)** HI

(3) HNO_3 **(4)** $HClO_4$

101. The stronger Lewis acid is

(1) Cs^+ **(2)** Rb^+ **(3)** K^+ **(4)** Mg^{+2}

102. The pH of aqueous solution 10^{-8} M HCl is

(1) 8.0 **(2)** 6.9 **(3)** 13.0 **(4)** – 6.8

103. A gas behaves ideally at

(1) high pressure

(2) high temperature

(3) around its Boyle's temperature

(4) all of the above conditions

104. The type of bonds present in copper sulphate crystals are

(1) ionic bonds

(2) covalent bonds

(3) coordinate bonds

(4) ionic, covalent, coordinate and hydrogen bonds

105. An electrolyte dissolves in a solvent when

(1) its lattice energy is greater than solvation energy

(2) its ionic product exceeds solubility product

(3) the vapour pressure of the solution is equal to the atmospheric pressure

(4) solvation energy is greater than the lattice energy

SPACE FOR ROUGH WORK

106. One mole a gas absorbs 1.2 kJ of heat at constant volume and its temperature is raised from 298 K to 328 K. The values of q, w and Δu are respectively

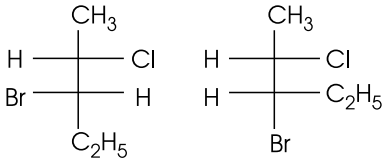
(1) $\Delta u = q = 1.2$ kJ, $w = 0$

(2) $\Delta u = 0$, $q = w = 1.2$ kJ

(3) $\Delta u = 0$, $q = 1.2$ kJ, $w = -1.2$ kJ

(4) $\Delta u = w = 1.2$ kJ, $q = 0$

107. The structures given below are



(1) identical **(2)** enantiomers

(3) diastereomers **(4)** epimers

108. The aromatic compound is one

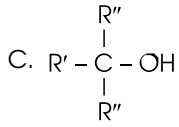
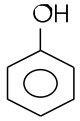
(1) exhibiting conjugation and it must be planar

(2) containing $(2n + 2)\ \pi$ electrons where n may be 0, 1, 2 etc.

(3) undergoing substitution reaction

(4) all of these

109. Match the List I with List II and select the correct answer from the codes given below the lists:

List I	**List II**
A. RCH_2OH	P. Violet colour with neutral $FeCl_3$
B. RCHOH – R′	Q. Immediate turbidity with $ZnCl_2$ and HCl
C. 	R. Ketone is formed when it is passed over hot copper powder
D. 	S. No H_2 evolution with CH_3MgBr in ether
	T. Red colour in Victor Meyer test

Codes

	A	B	C	D
(1)	T	R	Q	P
(2)	S	R	Q	P
(3)	R	S	P	Q
(4)	Q	R	S	T

SPACE FOR ROUGH WORK

110. Match the List I with List II and select the correct answer from the codes given below the lists:

List I	**List II**
A. Schmidt reaction	P. $RCOCl \xrightarrow[H_2]{Pd - BaSO_4} RCHO$
B. Fehling reduction	Q. $RCOOH \xrightarrow{LiAlH_4} RCH_2OH$
C. Wolff-Kishner reaction	R. $RCO - R' \xrightarrow[CH_2OH - CH_2OH]{NH_2 - NH_2} RCH_2R$
D. Rosenmund reduction	S. $R\mathbf{CHO + CuO} \longrightarrow \mathbf{RCOOH}$
	T. $RCOOH \xrightarrow[H_2SO_4]{N_3H} RNH_2$

Codes

	A	B	C	D
(1)	T	S	R	Q
(2)	T	R	Q	S
(3)	T	S	R	P
(4)	P	R	T	S

111. The products A, B and C of the following reactions respectively are

$$C \xleftarrow{HNO_3} Glucose \xrightarrow{Br_2\ water} A$$
$$\downarrow 2P/HI$$
$$B$$

(1) gluconic acid, nC_6H_{14}, glucaric acid

(2) oxalic acid, nC_5H_{12}, tartaric acid

(3) glucaric acid, nC_6H_{14}, gluconic acid

(4) tartaric acid, nC_6H_4, glucaric acid

112. The products A, B and C of the following reaction are respectively

$$C \xleftarrow[(2)\ Acid]{(1)\ CO_2\ (l)} C_2H_5MgBr \xrightarrow{CH_3OH} A$$
$$\text{in ether}$$
$$\downarrow (1)\ CH_3COCH_3,\ (2)\ H^+$$
$$B$$

(1) $C_2H_5 - O - CH_3$, $C_2H_5CH_2OH$, $CH_3CHOH - CH_3$

(2) CH_4, $C_2H_5COH - (CH_3)_2$, C_2H_5COOH

(3) C_2H_6, $(CH_3)_2\ C(OH)\ C_2H_5$, C_2H_5COOH

(4) CH_4,$(CH_3)_2\ COH\ C_2H_5$, CH_3COOH

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113. Match the List I with List II and select the correct answer from the codes given below the lists:

List I	**List II**
A. Smoke	P. Emulsion
B. Milk	Q. Solid solution
C. Butter	R. Aerosol
D. Brass	S. Sol
	T. Gel

Codes

	A	B	C	D
(1)	R	P	S	Q
(2)	R	P	T	Q
(3)	S	P	T	Q
(4)	R	T	S	P

114. Match the List I with List II and select the correct answer from the codes given below the lists:

List I	**List II**
A. Occlusion	P. Removal of suspended matter from water
B. Peptisation	Q. Ultrafilter paper
C. Dialysis	R. Tyndall effect
D. Coagulation	S. Large volume of H_2 is adsorbed by palladium
	T. Ferric hydroxide is washed with water containing dilute ferric chloride

Codes

	A	B	C	D
(1)	S	P	R	T
(2)	P	T	Q	R
(3)	S	Q	R	P
(4)	S	T	Q	P

115. Which is **wrong** about lithium?

(1) Lithium is not affected by air.

(2) Lithium aluminium alloys are heavy.

(3) Lithium combines with nitrogen gives Li_3N.

(4) Lithium chloride is hygroscopy.

SPACE FOR ROUGH WORK

116. Which one is not a fertiliser?

(1) NH_2CONH_2

(2) $(NH_4)_2\,HPO_4$

(3) $Ca_3(PO_4)_2$

(4) $Ca(HPO_4)_2 \cdot CaSO_4$

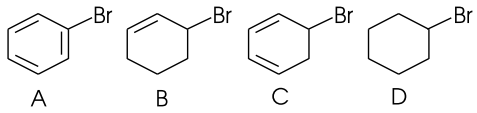
117. $Na_2CO_3 \cdot 10H_2O_{(s)} \xrightarrow{air} Na_2CO_3H_2O_{(s)} + 9H_2O_{(g)}$.

The process is called

(1) deliquescence **(2)** efflorescence

(3) effervescence **(4)** dehydration

118. Arrange the following compounds in order of ease of dehydrohalogenation by alcoholic potash solution.



(1) A < B < C < D **(2)** A < D < B < C

(3) A < B < D < C **(4)** C < D < A < B

119. Arrange in the increasing order of acidic strength of tertiary butanol, isopropanol and ethanol.

(1) Ethanol < isopropanol < tertiary butanol

(2) Tertiary butanol < isopropanol < ethanol

(3) Isopropanol < tertiary butanol < ethanol

(4) Tertiary butanol < ethanol < isopropanol

120. Which equation is **wrong**?

(1) $\Delta G^\circ = -nFE^\circ$

(2) $\Delta G^\circ = -RT\,\ell n\,k$

(3) $E^\circ = \frac{RT}{nF}\log k$

(4) $\Delta G = \Delta G^\circ + RT\,\ell n\,Q$

121. Which one of the following substances has the highest proton affinity?

(1) H_2O **(2)** H_2S

(3) NH_3 **(4)** PBr

SPACE FOR ROUGH WORK

122. Which of the nitrate leave behind its metal on strong heating?

(1) Ferric nitrate

(2) Cupric nitrate

(3) Manganese nitrate

(4) Silver nitrate

123. Among the properties

A. reducing

B. oxidising

C. complexing,

the set of properties shown by CN^- ion towards metal species is

(1) A, B **(2)** B, C

(3) A, C **(4)** A, B, C

124. Identify the **wrong** statement.

(1) Among the constituents of air, O_2, H_2O, CO_2, ozone, nitrogen will not produce green house effect.

(2) Hg^0, Hg^{+2}, Cu^0, Cu^{+2}, Cd^+ are poisonous to living system.

(3) Flexible rubber is hardened by cross polymerisation with ZnO.

(4) $TiCl_4$ with $(C_2H_5)_3$ Al is the Ziegler-Natta catalyst used in the polymerisation of olefin.

125. Choose the incorrect statement among the following.

(1) Synthetic materials like nylon, terrylene are not eaten by white ants; moths etc.

(2) Synthetic dyes are non-poisonous and non-hazardous.

(3) Only high calorific low density fuels are used in rockets.

(4) Enzyme reactions are specific, take place at 30°C at specific pH.

SPACE FOR ROUGH WORK

PART IV: ENGLISH PROFICIENCY AND LOGICAL REASONING

(a) ENGLISH PROFICIENCY

Directions for questions 126 to 128: Read the following passage carefully and answer the questions that follow.

The first of the political causes of war is war itself. Many wars have been fought, among other reasons, for the sake of seizing some strategically valuable piece of territory, or in order to secure a 'natural' frontier, that is to say, a frontier which is easy to defend and from which it is easy to launch attacks upon one's neighbours. Purely military advantages are almost as highly praised by the rulers of nations as economic advantages. The possession of an army, navy and air force is itself a reason for going to a war. We must use our forces now, so runs the militarists argument, in order that we may be in 'a position to use them to better effect next time'.

126. Why have wars been fought?

(1) To use weapons and make room for fresh purchase.

(2) Because people want to show their neighbours that they are strong.

(3) To capture some areas of another country which are of strategic importance.

(4) To teach neighbouring countries a good lesson.

127. What does a 'natural' frontier mean?

(1) An area on the border from where you can keep watch on or attack your enemy.

(2) Some place on the border of a country having beautiful natural scenery.

(3) A borderline that has been naturally chosen by two neighbouring countries.

(4) A sudden gift of land by nature because of sudden change in the course of a river.

128. Which one of the following is correct? 'Military advantages' and 'economic advantages'

(1) are the same for a country

SPACE FOR ROUGH WORK

(2) may or may not be the same but the rulers make them appear to be the same.

(3) are completely different for a country.

(4) go against each other.

Directions for questions 129 to 133: Each question below has a word capitalised followed by four words or phrases numbered 1 to 4. Choose the word that is most opposite to the meaning of the capitalised word.

129. PROTRACT

(1) not to display

(2) to indulge in extravagance

(3) not to be careful about future

(4) to cut short

130. DEBILITATE

(1) to argue **(2)** to strengthen

(3) to guess **(4)** to conspire

131. PERTINACIOUS

(1) irretrievable **(2)** insipid

(3) irresolute **(4)** reproof

132. IMPECUNIOUSNESS

(1) smoothness **(2)** carefree

(3) affluence **(4)** stability

133. INIMICAL

(1) supportive **(2)** inquisitive

(3) lack lustre **(4)** coarse

Directions for questions 134 to 136: Each of the following sentence has a mistake in grammar usage or idiom. Each sentence is broken up into four parts sequentially 1, 2, 3 and 4. Choose the part which has an error and mark accordingly.

134. **(1)** She is a good

(2) artiste who

(3) can able to

(4) dance and sing

135. **(1)** Each of the

(2) six boys in

(3) the class has

(4) finished their task

SPACE FOR ROUGH WORK

136. **(1)** The teacher

(2) observed that

(3) the Earth

(4) moved round the Sun

Directions for questions 137 and 138: Some parts of each of the following sentences, have been jumbled up. Choose the correct sequence to rearrange these parts which are labelled P, Q, R, S so as to produce the correct sentence.

137. (P) As things stand, but a majority still does not have access to English.

(Q) linguistic edge they are equipped with

(R) after globally because of the

(S) Indian professionals are much sought

(1) RSPQ **(2)** SRQP

(3) RSQP **(4)** SRPQ

138. (P) Among the soldier's mindset from fighting

(Q) the doctrine's other directives is the need to reorient

(R) namely terrorists hiding among civilians

(S) the enemy to fighting his own people

(1) PQRS **(2)** QPSR

(3) PQSR **(4)** QPRS

Directions for questions 139 and 140: Choose from among the given alternatives, the word which will substitute the underlined expression in each of the following questions.

139. He predicted that an earthquake was <u>about to happen</u>.

(1) eminent **(2)** imminent

(3) emigrant **(4)** dismal

140. He spoke of his country with the <u>strong emotion</u> of a true patriot.

(1) honour **(2)** ardor

(3) impulse **(4)** hallmark

SPACE FOR ROUGH WORK

(b) LOGICAL REASONING

Directions for questions 141 to 144: In each of the following questions a pair of words with certain relationship between them is given followed by four pairs numbered 1 to 4. Select the pair wherein the words have closest relationship to the original pair.

141. CONFIDENCE : DIFFIDENCE ::

(1) dastard : coward

(2) field : farm

(3) house : garbage

(4) baffle : clarify

142. FLAG : NATION ::

(1) fox : cunning

(2) soldier : war

(3) wine : grapes

(4) cow : herbivorous

143. HORSE : COLT ::

(1) goat : bleat

(2) dawn : twilight

(3) dog : puppy

(4) actor : stage

144. FROGS : CROAK ::

(1) hare : leveret

(2) liquor : intoxication

(3) serpents : hiss

(4) brake : car

Directions for questions 145 to 147: In each question you find a set of six sentences. The first and the sixth sentence are given and labelled M_1 and M_6 respectively. The middle four sentences are jumbled up and labelled PQRS. Find the proper order for the four sentences and mark accordingly.

145. **M_1:** The world government is the only answer to the threat of the Third World War.

M_6: Even if a surrender does take place, it may not last.

(P) The emergence of world government presupposes a surrender of sovereignty by all nations of the world.

(Q) A world government if it is to prevent wars, must be all powerful.

SPACE FOR ROUGH WORK

(R) But a world government seems to be a mere dream under the present circumstances.

(S) Such a surrender is not even remotely possible under the present situation.

(1) QRPS **(2)** PQRS

(3) RPSQ **(4)** PSQR

146. **M_1:** It is wrong to think that city life is altogether unhealthy.

M_2: Life in the countryside is all right as a break from the feverish pace of city life; but the city has far more to offer one who wishes to lead a full, exciting and satisfying life.

(P) Cities are planned in such a way as to provide open space with parks and open grounds for the benefit of the dwellers.

(Q) Perhaps it was so at one time, but nowadays with proper roads, pavements and drainage system, sickness is kept at bay.

(R) Even when sickness does strike, there are doctors and hospitals at hand.

(S) This is not the case in the countryside where people frequently suffer and sometimes die for want of medical facilities.

(1) SRQP **(2)** RQPS

(3) QPRS **(4)** PRSQ

147. **M_1:** A welfare state in the attainment of its objective must avoid coercion or violence.

M_6: A true welfare state can develop only by following the path of peace and democracy.

(P) But communism attains its ends through compulsion, coercion and even bloodshed.

(Q) Communism implies the loss of freedom of expression and action and introduces a regimentation of life.

(R) These are all serious disadvantages which perhaps outweigh the economic gains.

SPACE FOR ROUGH WORK

(S) Communism aims at the welfare state and perhaps the complete form of the welfare state in most respects.

(1) QRSP **(2)** RSPQ

(3) SPQR **(4)** PQSR

Directions for question 148: Study the following number sequence and answer the question below it.

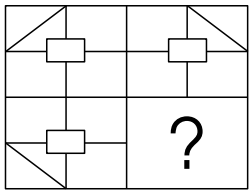
5 6 8 6 7 6 5 6 5 6 8 5 9 6 5 6 9 6 8 6 5 5 6 8 6 5 9 5 6 9 5 6 8.

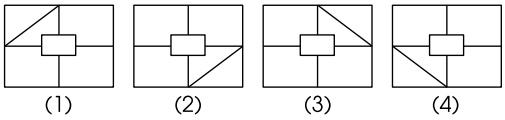
148. Which number has the second least frequency?

(1) 6 **(2)** 7 **(3)** 8 **(4)** 9

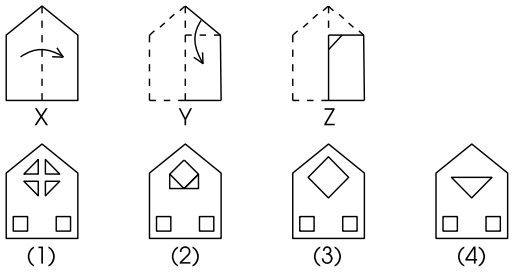
Directions for questions 149 and 150: In the following question; a part of the figure is missing. Choose from the given alternatives 1, 2, 3 and 4, the right figure to fit in the missing place.

149.





150. In the following question a set of three figures X, Y, Z showing a sequence in which a paper is folded and finally cut is given. Below that there is a set of answer figures marked (1, 2, 3 and 4) showing the design the paper actually acquires when it is unfolded is given. Choose the correct alternative which resembles the unfolded piece of paper.



SPACE FOR ROUGH WORK

SPACE FOR ROUGH WORK

BRILLIANT'S MOCK TEST 5

FOR STUDENTS OF

OUR ONE/TWO-YEAR POSTAL COURSE

TOWARDS

BITSAT, 2008

SOLUTIONS

PART I: MATHEMATICS

1. (4) $a : b : c = 1 : \sqrt{3} : 2$

$\equiv \frac{1}{2} : \frac{\sqrt{3}}{2} : 1$

$= \sin A : \sin B : \sin C$

$\Rightarrow A = \frac{\pi}{6}, B = \frac{\pi}{3}, C = \frac{\pi}{2}$

$\Rightarrow A : B : C = 1 : 2 : 3$

2. (4) $\sin(\cot^{-1}(x + 1)) = \cos(\tan^{-1} x)$

$\Rightarrow \frac{1}{\sqrt{(x + 1)^2 + 1}} = \frac{1}{\sqrt{1 + x^2}}$

$\Rightarrow (x + 1)^2 = x^2$

$\Rightarrow 2x = -1$

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

3. (2) $\theta = \frac{\pi}{6}$ and $\frac{\pi}{3} < \phi < \frac{\pi}{2}$

$\Rightarrow \frac{\pi}{2} < \theta + \phi < \frac{2\pi}{3}$

4. (1) Given $\int_0^{t^2} x\, f(x)\, dx = \frac{2}{5}t^5, t > 0$

Differentiating both sides with respect to t,

$t^2 f(t^2)\, 2t = \frac{2}{5} \cdot 5t^4$

$\Rightarrow f(t^2) = t$

$\Rightarrow f\left(\frac{4}{25}\right) = \frac{2}{5}$

5. (3) $\lim_{x \to 0} \frac{f(x^2) - f(x)}{f(x) - f(0)}$

$= \lim_{x \to 0} \frac{2x\, f'(x^2) - f'(x)}{f'(x)}$

$= \lim_{x \to 0} 2x\left[\frac{f'(x^2)}{f'(x)} - 1\right] = -1$

6. (1) $\frac{x}{1-r} = 5 \Rightarrow r = 1 - \frac{x}{5} \in (-1, 1)$

$\Rightarrow x \in (0, 10)$

7. (2) Comparing $2x + \sqrt{6}y = 2$ with $xx_1 - 2yy_1 = 4$, we get $x_1 = 4, y_1 = -\sqrt{6}$

8. (2) $(-\omega)^n = (-\omega^2)^n \Rightarrow \omega^n = 1$

$\Rightarrow$ least value of $n = 3$

9. (1) Required vector $= \pm \frac{\vec{a} \times \vec{n}}{|\vec{a} \times \vec{n}|}$,

where $\vec{a} = 5\hat{i} + 2\hat{j} + 6\hat{k}$ and

$\vec{n} = (\hat{i} - \hat{j} + \hat{k}) \times (2\hat{i} + \hat{j} + \hat{k})$

Solving, the required vector

$= \pm \frac{(3\hat{j} - \hat{k})}{\sqrt{10}}$

10. (2) Let $\frac{x-1}{2} = \frac{y+1}{3} = \frac{z-1}{4} = \lambda$

and $\frac{x-3}{1} = \frac{y-k}{2} = \frac{z}{1} = \mu$

$\Rightarrow 2\lambda + 1 = \mu + 3;$

$3\lambda - 1 = 2\mu + k; 4\lambda + 1 = \mu$

$\Rightarrow k = \frac{9}{2}$

11. (2) $\log(x + y) - 2xy = 0$

When $x = 0, y = 1$

$\frac{1}{x+y}\left[1 + \frac{dy}{dx}\right] - 2\left[y + x\frac{dy}{dx}\right] = 0$

$\Rightarrow \left(\frac{1}{x+y} - 2y\right) = \left(2x - \frac{1}{x+y}\right)\frac{dy}{dx}$

$\Rightarrow y'(0) = \frac{1-2}{0-1} = 1$

12. (4) $2x - y - 4z = 2$ ... (1)

$x - 2y - z = -4$ ... (2)

$x + y + \lambda z = 4$ .... (3)

Solving (1) and (2),

$x + y - 3z = 6$ ... (4)

If $\lambda = -3$, the system is inconsistent, since equations (3) and (4) are equations of parallel planes.

13. (1) P (dice is thrown even number of times till 1 appears)

$= \frac{5}{6} \times \frac{1}{6} + \frac{5}{6} \times \frac{5}{6} \times \frac{5}{6} \times \frac{1}{6} + \left(\frac{5}{6}\right)^5 \times \frac{1}{6} + \cdots \infty$

$= \frac{5}{11}$

14. (2) As $PP^T = I = P^TP$

$\Rightarrow P^T = P^{-1}$

$\Rightarrow Q^n = PA^n P^{-1}$

$\Rightarrow Q^{2008} = PA^{2008} P^{-1}$

$\Rightarrow P^T Q^{2008} P = A^{2008} = \begin{bmatrix} 1 & 2008 \\ 0 & 1 \end{bmatrix}$

15. (2) Side of the equilateral triangle

$= 2 + (2 \times \sqrt{3}) = 2(1 + \sqrt{3})$

$\Rightarrow$ required area $= \frac{\sqrt{3}}{4} \times 4(1 + \sqrt{3})^2$

$= 6 + 4\sqrt{3}$

16. (3) $|a + b\omega + c\omega^2|^2$

$= (a + b\omega + c\omega^2)(a + b\omega^2 + c\omega)$

$= a^2 + b^2 + c^2 - ab - ac - bc$

$= \frac{1}{2}[(a - b)^2 + (b - c)^2 + (c - a)^2]$

≥ 1

as a, b, c are not all equal.

17. (2) As $\int_2^0 (x + 1)\cos(x + 1)\,dx$

$= \int_{-1}^{1} t \cos t\,dt = 0$

$\Rightarrow I = \int_2^0 (x^3 + 3x^2 + 3x + 3)\,dx$

$= \left[\frac{x^4}{4} + \frac{3x^3}{3} + \frac{3x^2}{2} + 3x\right]_2^0$

$= 4$

18. (2) Let the equation of plane be $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$

Distance from the origin is 1.

$\Rightarrow \frac{1}{a^2} + \frac{1}{b^2} + \frac{1}{c^2} = 1$

Centroid of ΔABC $\left(\frac{a}{3}, \frac{b}{3}, \frac{c}{3}\right)$ satisfies this condition if and only if,

$\frac{1}{x^2} + \frac{1}{y^2} + \frac{1}{z^2} = 9 \Rightarrow k = 9.$

19. (4) $\alpha + \beta = \frac{-2b}{a}$, $\alpha\beta = \frac{c}{a}$. It is given that $(\alpha^2 + \beta^2)^2 = (\alpha + \beta)(\alpha^3 + \beta^3)$

$\Rightarrow [(\alpha + \beta)^2 - 2\alpha\beta]^2 = (\alpha + \beta)[(\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)]$

$\Rightarrow (2b^2 - ac)^2 = b^2(4b^2 - 3ac)$

$\Rightarrow (2\Delta + ac)^2 = (\Delta + ac)(4\Delta + ac)$

$\Rightarrow \Delta ac = 0 \Rightarrow \Delta c = 0$ (as $a \neq 0$)

20. (1) Equating the coefficients of x^{40} from both sides of
$(1 + x)^{30}(1 - x)^{30} = (x^2 - 1)^{30}$,
we get the result.

21. (3) The graph of the function
$x^2 - 4x + \log_3 a$
does not cut the real axis.

$\Rightarrow$ the roots of $x^2 - 4x + \log_3 a = 0$ are imaginary.

$\Rightarrow \log_3 a > 4$

$\Rightarrow a > 81$

$\Rightarrow$ the least integral value of a is 82.

22. (1) $f(x) \equiv ax^2 - 2bx - 3c = 0$ has non-real roots.

$\Rightarrow a^2 f(2) f(0) > 0$

$\Rightarrow (4(a - b) - 3c)(-3c) > 0$

$\Rightarrow$ c is negative
($\because$ Given $4(a - b) > 3c$)

23. (2) $a = 1 - \tan^2 x + \tan^4 x - \tan^6 x + \ldots \infty$

$= (1 + \tan^2 x)^{-1} = \cos^2 x$

$b = 1 - \cot^2 y + \cot^4 y - \cot^6 y + \ldots \infty$

$= (1 + \cot^2 y)^{-1} = \sin^2 y$

$\sum_{k=0}^{\infty} \tan^{2k} x \cot^{2k} y$

$= 1 + \tan^2 x \cot^2 y + \tan^4 x \cot^4 y + \ldots \infty$

$= (1 - \tan^2 x \cot^2 y)^{-1}$

$= \dfrac{\cos^2 x \sin^2 y}{\cos^2 x \sin^2 y - \sin^2 x \cos^2 y}$

$= \dfrac{ab}{ab - (1 - b) \times (1 - a)}$

$= \dfrac{ab}{a + b - 1}$

24. (4) $a_7 = a + 6d = 9 \Rightarrow a = 9 - 6d$ (where a is the first term and d is the common difference of the A.P.)

$\therefore a_1 a_2 a_7 = 9(9 - 6d)(9 - 6d + d)$

$= 9(81 - 99d + 30d^2)$

$= 270\left[\left(d - \dfrac{33}{20}\right)^2 - \dfrac{9}{400}\right]$

which is least, when $d = \dfrac{33}{20}$

25. (3) $x_n = n + {}^5C_4 - \dfrac{143}{96}\dfrac{P_{n+5}}{P_{n+3}}$, $n \in N$ and P_k denotes the number of permutations of k things taken all at a time

$= \dfrac{(n + 4)(n + 5)}{96}$ [$4(n^2 + 5n + 6) - 143$]

$= \dfrac{(n + 4)(n + 5)}{96}(4n^2 + 20n - 119]$,

which is negative

x_n is negative,

when $4n^2 + 20n - 199 < 0$

$\Rightarrow (2n - 7)(2n + 17) < 0$

$\Rightarrow -\dfrac{17}{2} < n < \dfrac{7}{2}$ and $n \in N$

i.e., $n = -8, -7, \ldots 0, 1, 2, 3$ and $n \in N$.

Hence n = 1, 2, 3

x_n is negative for 3 values of n.

26. (3) $(1 + x)^n = C_0 + C_1 x + C_2 x^2 + \ldots + C_n x^n$

$\Rightarrow n(1 + x)^{n-1} = C_1 + 2 \cdot C_2 x + \ldots + n \cdot C_n x^n$ ... (1)

$\Rightarrow n \cdot 2^{n-1} = C_1 + 2 \cdot C_2 + 3 \cdot C_3 + \ldots + n \cdot C_n$

$= aC_0 + (a + d)C_1 + (a + 2d)C_2 + \ldots$ (n + 1) terms

$= a(C_0 + C_1 + C_2 + \ldots + C_n) + d(C_1 + 2 \cdot C_2 + 3 \cdot C_3 + \ldots + n \cdot C_n)$

$= a \cdot 2^n + d \cdot n\, 2^{n-1}$

$= \dfrac{2^n}{n + 1} \cdot \dfrac{n + 1}{2}(2a + nd)$

$= \dfrac{S_{n+1}}{n + 1} 2^n$

27. (1) ${}^{n+1}C_2 + 2({}^2C_2 + {}^3C_2 + {}^4C_2 + \ldots + {}^nC_2)$

$= {}^{n+1}C_2 + 2({}^3C_3 + {}^3C_2 + {}^4C_2 + \ldots + {}^nC_2)$

$= {}^{n+1}C_2 + 2({}^4C_3 + {}^4C_2 + \ldots + {}^nC_2)$

$= {}^{n+1}C_2 + 2({}^5C_3 + {}^5C_2 + \ldots)$

$= {}^{n+1}C_2 + 2\,{}^{n+1}C_3$

$= {}^{n+2}C_3 + {}^{n+1}C_3$

$= \frac{(n+2)(n+1)n}{6} + \frac{(n+1)(n)(n-1)}{6}$

$= \frac{n(n+1)(2n+1)}{6}$

$= 1^2 + 2^2 + 3^2 + \ldots + n^2$

28. (1) Given $x_4 \le 10$, $x_1 + x_2 + x_3 = x_4$

$\because$ x_1, x_2, x_3 should be positive integers, $3 \le x_4 \le 10$

$\Rightarrow$ required to find the number of positive integral solutions of the equation $x_1 + x_2 + x_n = n$, where $3 \le n \le 10$

$= {}^2C_2 + {}^3C_2 + {}^4C_2 + \ldots + {}^9C_2$

$= {}^3C_3 + {}^3C_2 + {}^4C_2 + \ldots + {}^9C_2$

$= {}^4C_3 + {}^4C_2 + \ldots + {}^9C_2 = {}^{10}C_3 = 120$

29. (1) (a) Total number of permutations

$= \frac{9!}{2}$, since N is repeated.

(b) Number of permutations in which 'HIN' comes as a block = 7!

Number of permutations in which 'TAN' comes as a block = 7!

Number of permutations in which 'DUS' comes as a block = $\frac{7!}{2}$

(c) This includes both 'HIN' and 'TAN' comes as blocks = 5! same is true for the other two pairs.

(d) Number of permutations in which all three blocks come = 3!

$\therefore$ required number of permutations

$= (a) - \{(b) - (c) + (d)\}$

$= \frac{9!}{2} - \left\{7! + 7! + \frac{7!}{2} - 3(5!) + 3!\right\}$

$= 169194$

30. (4) $\begin{vmatrix} \alpha & x & x & x \\ x & \beta & x & x \\ x & x & \gamma & x \\ x & x & x & \delta \end{vmatrix}$

$= \begin{vmatrix} \alpha & x-\alpha & x-\alpha & x-\alpha \\ x & \beta-x & 0 & 0 \\ x & 0 & \gamma-x & 0 \\ x & 0 & 0 & \delta-x \end{vmatrix}$

$= \alpha(\beta - x)(\gamma - x)(\delta - x)$
$- x[(x-\alpha)(x-\gamma)(x-\delta)$
$+ (x-\alpha)(x-\beta)(x-\delta)$
$+ (x-\alpha)(x-\beta)(x-\gamma)]$

$= (x-\alpha)(x-\beta)(x-\gamma)(x-\delta)$
$- x[(x-\alpha)(x-\beta)(x-\gamma)$
$+ (x-\alpha)(x-\beta)(x-\delta)$
$+ (x-\alpha)(x-\gamma)(x-\delta)$
$+ (x-\beta)(x-\gamma)(x-\delta)]$

$= f(x) - xf'(x)$

31. (3) For example, let $A = \begin{bmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \\ a_3 & b_3 & c_3 \end{bmatrix}$

$$A^T = \begin{bmatrix} a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \\ c_1 & c_2 & c_3 \end{bmatrix}$$

$$\Rightarrow \text{Adj } (A^T) = \begin{bmatrix} A_1 & B_1 & C_1 \\ A_2 & B_2 & C_2 \\ A_3 & B_3 & C_3 \end{bmatrix}, \quad \ldots (1)$$

where the capital letters denote the cofactors of the corresponding small letters (with the same suffix)

Also, Adj A = Transpose of the matrix formed by the cofactors of elements of $A = \begin{bmatrix} A_1 & A_2 & A_3 \\ B_1 & B_2 & B_3 \\ C_1 & C_2 & C_3 \end{bmatrix}$

$$\Rightarrow (\text{Adj } A)^T = \begin{bmatrix} A_1 & B_1 & C_1 \\ A_2 & B_2 & C_2 \\ A_3 & B_3 & C_3 \end{bmatrix} \quad \ldots (2)$$

From (1) and (2),

$(\text{Adj } A^T) - (\text{Adj } A)^T = 0$

32. (4) $z = -1 + i\sqrt{3} = 2\omega$, where ω is a cube root of unity.

$\Rightarrow z^{2n} + 2^n z^n = 2^{2n} (\omega^{2n} + \omega^n)$

$= 2^{2n} (\omega^2 + \omega)$

irrespective of whether n is of the form 3m + 1 or 3m + 2

$= -2^{2n}$

33. (3) $\text{Amp}\left(\frac{z_4 - z_1}{z_2 - z_1}\right) = \frac{\pi}{2}$

$\Rightarrow \angle BAD = 90^\circ$ and $z_3 - z_4 = z_2 - z_1$

$\Rightarrow \frac{z_1 + z_3}{2} = \frac{z_2 + z_4}{2}$

$\Rightarrow$ diagonals bisect each other

$\Rightarrow$ ABCD is a rectangle.

34. (3) $b(a \sin x + \sqrt{1 - a^2} \cos x) + c$

$= b \sin (x + \alpha) + c$, where $a = \cos \alpha$, $\sqrt{1 - a^2} = \sin \alpha$

Now, $-b \le b \sin (x + \alpha) \le b$

Hence, $c - b \le b \sin (x + \alpha) + c \le c + b$

35. (3) $a^2 - 4a + 6 = (a - 2)^2 + 2 \ge 2$, for all values of a.

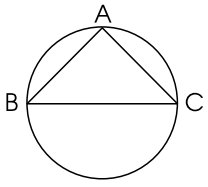
$\sin x + \cos x = \min \{1, a^2 - 4a + 6\}$

$= 1$

$\Rightarrow \sin\left(\frac{\pi}{4} + x\right) = \sin \frac{\pi}{4}$

$\Rightarrow x = n\pi + (-1)^n \frac{\pi}{4} - \frac{\pi}{4}$

36. (2) Area of the right angled triangle is maximum, when ΔABC is isosceles.



$\Rightarrow$ the sides are $\sqrt{2}R$, $\sqrt{2}R$, $2R$

$\Rightarrow s = \frac{2R(1+\sqrt{2})}{2} = R(1+\sqrt{2})$ and

$\Delta = \frac{1}{2} AB \cdot AC = R^2$

$\therefore \frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} = \frac{3s-(a+b+c)}{\Delta}$

$= \frac{s}{\Delta} = \frac{1+\sqrt{2}}{R}$

37. (4) The given equation

$\Rightarrow \cos^2 x + \frac{1}{2} + \sin^2 x + \frac{1}{2} + 2\sqrt{\left(\cos^2 x + \frac{1}{2}\right)\left(\sin^2 x + \frac{1}{2}\right)}$

$= 4$

$\Rightarrow \left(\cos^2 x + \frac{1}{2}\right)\left(\sin^2 x + \frac{1}{2}\right) = 1$

$\Rightarrow \cos^2 x \sin^2 x = \frac{1}{4}$

$\Rightarrow \sin 2x = \pm 1$

$\Rightarrow x = \frac{1}{2}\sin^{-1}(\pm 1)$

$\Rightarrow k = \pm 1$

38. (3) $4a^2 + 3b(4a + 3b) - c^2 = 0$

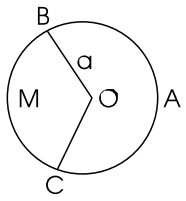
$\Rightarrow (2a + 3b)^2 - c^2 = 0$

$\Rightarrow (2a + 3b - c)(2a + 3b + c) = 0$

$\Rightarrow$ the family of lines $ax + by - c = 0$ are concurrent at (2, 3) and the family of lines $ax + by + c = 0$ are concurrent at the point $(-2, -3)$.

39. (1) $CM = MB = a\cos 60° = \frac{a}{2}$

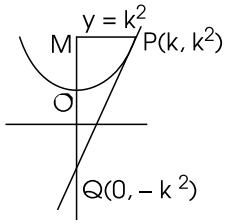
$OM = a\sin 60° = \frac{\sqrt{3}}{2}a$



The coordinates of the vertex lying in the third quadrant are $\left(-\frac{\sqrt{3}}{2}a, -\frac{a}{2}\right)$

40. (3) The equation of the tangent at $P(k, k^2)$ on the parabola $y = x^2$ is $kx = \frac{1}{2}(y + k^2)$

$\Rightarrow$ the tangent meets the y-axis at $(0, -k^2)$



Area of $\Delta MPQ = \frac{1}{2} MP \cdot MQ$

$= \frac{1}{2} k \cdot 2k^2 = k^3$

In [0, 3], k^3 increases

$\Rightarrow$ the maximum area of the triangle is when $k = 3$.

41. (4) Taking O as the origin, AB, CD as the x and y-axes, the coordinates of A, B, C, D can be taken as (a, 0), (– a, 0), (0, c), (0, – c)

For any point P(x, y),

$$PA \cdot PB = PC \cdot PD$$

$$\Rightarrow [(x - a)^2 + y^2][(x + a)^2 + y^2]$$

$$= [(x - c)^2 + y^2][(x + c)^2 + y^2]$$

Simplifying, $2(x^2 - y^2) = a^2 - c^2$, which is a rectangular hyperbola ($a \neq c$)

42. (1) $f(x) = 3x^5 + 15x$

$\Rightarrow f'(x) = 15(x^4 + 1) > 0$ for all real x.

$\Rightarrow$ f(x) is an increasing function of x.

$\therefore f(1) = 18 \Rightarrow f(x) \geq f(1) = 18 \ \forall \ x \geq 1$

$\Rightarrow$ f(x) does not have real roots in the interval $[1, \infty)$

43. (1) $|2x - 1| = 2([x] + \{x\}) + [x]$

$$= 2x + [x]$$

If x is negative, RHS is negative, but the LHS is non-negative.

$\Rightarrow x \geq 0$.

If $x \geq \frac{1}{2}$, $|2x - 1| = 2x - 1 = 2x + [x]$

$\Rightarrow [x] = -1$

$\Rightarrow$ x is negative.

This is not possible.

$\therefore 0 \leq x < \frac{1}{2}$

$\Rightarrow [x] = 0$ and $|2x - 1| = 1 - 2x$

$\therefore$ the equation reduces to $1 - 2x = 2x$

$\Rightarrow x = \frac{1}{4}$

The number of solutions for the given equation is 1.

44. (1) $$f(x) = \begin{cases} ax^2 + b; & x < -1 \\ bx^2 + ax + 4; & x \geq -1 \end{cases}$$

$$\Rightarrow f'(x) = \begin{cases} 2ax, & x < -1 \\ 2bx + a, & x \geq -1 \end{cases}$$

f(x) is continuous at x = – 1

$$\Rightarrow \lim_{x \to -1^-} f(x) = \lim_{x \to -1^+} f(x)$$

$\Rightarrow a + b = b - a + 4$

$\Rightarrow a = 2$

f(x) is differentiable at x = – 1

$\Rightarrow$ LHD at x = 1

= RHD at x = – 1

$$-2a = -2b + a$$

$\Rightarrow b = 3$

45. (1) $$f(t) = \frac{d}{dt} \int_0^t \frac{dx}{1 - \cos t \cos x}$$

$$= \frac{1}{1 - \cos^2 t} = \operatorname{cosec}^2 t$$

$\Rightarrow f'(t) = -2 \operatorname{cosec}^2 t \cdot \cot t$

$$= -2 f(t) \cot t$$

i.e., $\frac{df}{dt} + 2 f(t) \cot t = 0$

PART II: PHYSICS

46. (3) $M_A = -(200 \cos 45°) \times (4) + (200 \sin 45°)(10)$

$= 848.528$ N-m

47. (3)

48. (4)

49. (2)

50. (1)

51. (2)

52. (1)

53. (4)

54. (3)

55. (2)

56. (2)

57. (1)

58. (1)

59. (2)

60. (3)

61. (1)

62. (2)

63. (2)

64. (3)

65. (3)

66. (1)

67. (4)

68. (1)

69. (4)

70. (2)

71. (4)

72. (1)

73. (4)

74. (1)

75. (1)

76. (3)

77. (4)

78. (1)

79. (1)

80. (4)

81. (3)

82. (4)

83. (2)

84. (3) $\tau = PE \sin\theta$

$= q(2a) E \sin\theta$

$8\sqrt{3} = q \times 0.02 \times 10^5 \times \sin 60°$

$\Rightarrow q = 8 \times 10^{-3}$ C

P.E. $= -pE \cos\theta$

$= -q(2a) \cos\theta$

$= -8 \times 10^{-3} \times 0.02 \times 10^5 \times \cos 60°$

$= -8$ J

85. (2) Let the abundance of

$^{24}_{12}Mg\ (24.98584)$ be x and that of

$^{24}_{12}Mg\ (25.98259)$ be y

$$\therefore\ 24.312 = \left[\frac{\begin{array}{r}23.98504 \times 78.99 \\ +\ 24.98584 \times x \\ +\ 25.98259 \times y\end{array}}{100}\right]$$

$\Rightarrow 2431.2 = 1895.58 + 24.98\ x + 25.98\ y$

$\Rightarrow 24.98\ x + 25.98\ y$

$= 2431.20 - 1894.58$

$\Rightarrow 24.98\ x + 25.98\ y$

$= 536.62$ ... (i)

Also, clearly

$x - y = 100 - 78.99$

$= 21.01$ ... (ii)

Solving (i) and (ii)

$x = 21.2$

PART III: CHEMISTRY

86. (3) The electrons A is (5s), B(4p), C(4d) and (4s) respectively.

Energy level is 4d > 4p > 5s > 4s.

87. (3)

88. (4) If electronegativity difference between the combined element is greater than 1.7 it will be ionic and less than 1.7 will be covalent.

Element	X	Y	Z
Electronegativity	0.7	1.5	3.0

ΔEN is XY = 0.8 covalent,

YZ = 1.5 covalent

XZ = 2.3 ionic

89. (2)

90. (3)

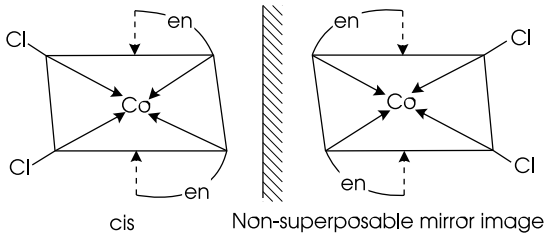
91. (3)

92. (2)

93. (2) $K_2[PtCl_6] \overset{H_2O}{\rightleftharpoons} 2K^+ + [PtCl_6]^{-2}$

There is no chloride ion in solution to form AgCl precipitate.

94. (4)



95. (3) Volume strength = 5.6 × Normality

= 5.6 × 1.5

= 8.4

96. (1) $\overset{+4}{\underset{+4}{N_2}}\ \overset{+2}{\underset{-4}{H_4}}$

2N = + 4 – 10 = – 6

2N = – 6

N = – 3

97. (2) $2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O$

Normality of KOH = $\frac{0.56 \times 1000}{56 \times 100}$

= 0.1 N

Number of equivalent of KOH

= 100 × 0.1 N = 10×10^{-3}

Number of equivalent of H_2SO_4

= 100 × 0.1 N = 10×10^{-3}

1×10^{-3} equivalent KOH reacts with 0.5×10^{-3} equivalent of H_2SO_4 to give 0.5×10^{-3} equivalent of K_2SO_4

Unused $H_2SO_4 = 0.5 \times 10^{-3}$ equivalent

Hence, solution will be acidic.

98. (3) $AgNO_{3(aq)} + KCl_{(aq)} \longrightarrow AgCl_{(s)} + KNO_{3(aq)}$

1 M + 1 M $\longrightarrow$ 1 M + 1 M

Limiting reagent is $AgNO_3$

0.1 M + 0.2 M $\longrightarrow$ 0.1 M + 0.1 M (of equal volumes)

Number of moles of KNO_3 and NO_3^- in the solution is 0.1 M

Volume of the solution = 2V

Molarity of $NO_3^- = \frac{0.1\ M}{2V} = 0.05\ M$

99. (1) $CaCO_{3\,(s)} \rightleftharpoons CaO_{(s)} + CO_{2\,(g)}$

$K_p = pCO_2$

100. (4) $HClO_4$ in CH_3COOH medium shows the highest ionisation among all the mineral acids.

101. (4) Smaller the size of cation, greater will be the attraction of electrons.

102. (2) $HCl \longrightarrow H^+ + Cl^-$

10^{-8} M $\longrightarrow$ (10^{-8} M)

$H_2O \longrightarrow H^+ + OH^-$

(10^{-7} M)

Total H^+ ion concentrations

$= 10^{-7} + 10^{-8}\ M = 1.1 \times 10^{-7}$ M/L

$pH = -\log H^+ = -\log [1.1 \times 10^{-7}]$

$= -[-7.000 + 0.042]$

$= -[-6.958] = 6.958$

103. (4) **104. (4)** **105. (4)**

106. (1) At constant volume, $\Delta u = 0$, no work is done, the entire heat absorbed increases heat content of the system.

107. (3) **108. (4)** **109. (1)**

110. (3) **111. (1)** **112. (3)**

113. (2) **114. (4)** **115. (2)**

116. (3) $Ca_3(PO_4)_2$ is insoluble in water.

117. (2)

118. (2) Conjugated system is more stable than non-conjugated system due to resonance.

119. (2) Acidic strength of alcohol follow the order 1° > 2° > 3°.

120. (3)

121. (3) $H_3N: \rightarrow H^+ \rightarrow \left[H-\underset{\displaystyle H}{\overset{\displaystyle H}{\underset{|}{\overset{|}{N}}}}-H \right]^+$

122. (4) $AgNO_{3(s)} \xrightarrow{\Delta} Ag_{(s)} + NO_{2(g)} + \frac{1}{2}O_2\,(g)$

123. (3) **124. (3)** **125. (2)**

PART IV: ENGLISH PROFICIENCY AND LOGICAL REASONING

(a) ENGLISH PROFICIENCY

126. (3) 127. (1) 128. (2) 129. (4) 130. (2)

131. (3) 132. (3) 133. (1) 134. (3) 135. (4)

136. (4) 137. (2) 138. (2) 139. (2) 140. (2)

(b) LOGICAL REASONING

141. (4) 142. (1) 143. (3) 144. (3) 145. (1)

146. (3) 147. (3) 148. (4) 149. (2) 150. (3)