BRILLIANT® TUTORIALS
IIT-JEE CLASSROOM CENTRE

SOLUTIONS TO IIT-JEE 2008
Paper-II (Code: 0)

INSTRUCTIONS

Question paper format:

1. The question paper consists of 3 parts (Part I: Mathematics, Part II: Physics, Part III: Chemistry. Each part has 4 sections.
2. **Section I** contains 9 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **only one is correct.**
3. **Section II** contains 4 questions. Each question contains STATEMENT-1 (Assertion) and STATEMENT-2 (Reason).

   Bubble (A) if both the statements are TRUE and STATEMENT-2 is the correct explanation of STATEMENT-1.

   Bubble (B) if both the statements are TRUE but STATEMENT-2 is NOT the correct explanation of STATEMENT-1.

   Bubble (C) if STATEMENT-1 is TRUE and STATEMENT-2 is FALSE.

   Bubble (D) if STATEMENT-1 is FALSE and STATEMENT-2 is TRUE.
4. **Section III** contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **only one is correct.**
5. **Section IV** contains 3 questions. Each question contains statements given in 2 columns. Statements in the first column have to be matched with statements in the second column. The answers to these questions have to be appropriately bubbled in the ORS as per the instructions given at the beginning of the section.

Marking Scheme:

1. For each question in **Section I**, you will be **awarded 3 marks** if you have darkened only the bubble corresponding to the correct answer and **zero mark** if no bubble is darkened. In all other cases, **minus one (–1) mark** will be awarded.
2. For each question in **Section II,** you will be **awarded 3 marks** if you darken only the bubble corresponding to the correct answer and **zero mark** if no bubble is darkened. In all other cases, **minus one (–1) mark** will be awarded.
3. For each question in **Section III,** you will be **awarded 4 marks** if you darken only the bubble corresponding to the correct answer and **zero mark** if no bubble is darkened. In all other cases, **minus one (–1) mark** will be awarded.
4. For each question in **Section IV,** you will be **awarded 6 marks** if you darken. ALL the bubbles corresponding ONLY to the correct answer or **awarded 1 mark each** for correct bubbling of answer in any row. **No negative mark will be awarded for an incorrectly bubbled answer.**

SOLUTIONS TO IIT-JEE 2008
MATHEMATICS: Paper-II (Code: 0)

SECTION – I
Straight Objective Type

This section contains 9 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

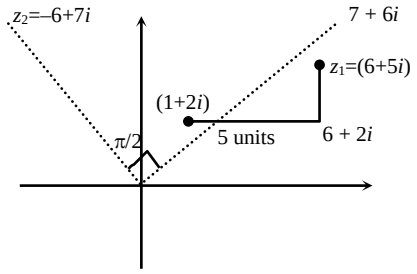
Note: Questions with (*) mark are from syllabus of class XI.

***1.** A particle *P* starts from the point $z_0 = 1+2i$, where $i = \sqrt{-1}$. It moves first horizontally away from origin by 5 units and then vertically away from origin by 3 units to reach a point z_1. From z_1 the particle moves $\sqrt{2}$ units in the direction of the vector $\hat{i}+\hat{j}$ and then it moves through an angle $\frac{\pi}{2}$ in anticlockwise direction on a circle with centre at origin, to reach a point z_2. The point z_2 is given by

(A) $6+7i$ (B) $-7+6i$ (C) $7+6i$ (D) $-6+7i$

Sol.: $\frac{z_2}{7+6i} = e^{i\pi/2}$

$z_2 = -6+7i$



Correct choice: (D)

2. Let the function $g:(-\infty,\infty)\to\left(-\frac{\pi}{2},\frac{\pi}{2}\right)$ be given by $g(u) = 2\tan^{-1}\left(e^u\right)-\frac{\pi}{2}$. Then, *g* is

(A) even and is strictly increasing in $(0,\infty)$

(B) odd and is strictly decreasing in $(-\infty,\ \infty)$

(C) odd and is strictly increasing in $(-\infty,\ \infty)$

(D) neither even nor odd, but is strictly increasing in $(-\infty,\ \infty)$

Sol.: $g(u) = 2\tan^{-1}\left(e^u\right)-\frac{\pi}{2}$

$g'(u) = \frac{2e^u}{1+e^{2u}} > 0 \ \Rightarrow\ g(u)$ is increasing function

$g(-u) = 2\tan^{-1}\left(e^{-u}\right)-\frac{\pi}{2} = 2\cot^{-1}\left(e^u\right)-\frac{\pi}{2} = 2\left(\frac{\pi}{2}-\tan^{-1}e^u\right)-\frac{\pi}{2} = \frac{\pi}{2}-2\tan^{-1}e^u = -g(u)$

$g(u)$ is odd function.

Correct choice: (C)

***3.** Consider a branch of the hyperbola $x^2-2y^2-2\sqrt{2}x-4\sqrt{2}y-6=0$ with vertex at the point *A*. Let *B* be one of the end points of its latus rectum. If *C* is the focus of the hyperbola nearest to the point *A*, then the area of the triangle *ABC* is

(A) $1-\sqrt{\frac{2}{3}}$ (B) $\sqrt{\frac{3}{2}}-1$ (C) $1+\sqrt{\frac{2}{3}}$ (D) $\sqrt{\frac{3}{2}}+1$

Sol.: $\frac{\left(x-\sqrt{2}\right)^2}{4}-\frac{\left(y+\sqrt{2}\right)^2}{2}=1;\quad a=2,\ b=\sqrt{2},\ e=\sqrt{\frac{3}{2}}$

Area of $\Delta = \frac{1}{2}a(e-1)\times\frac{b^2}{a} = \sqrt{\frac{3}{2}}-1$

Correct choice: (B)

4. The area of the region between the curves $y=\sqrt{\frac{1+\sin x}{\cos x}}$ and $y=\sqrt{\frac{1-\sin x}{\cos x}}$ bounded by the lines $x = 0$ and $x=\frac{\pi}{4}$ is

(A) $\int_0^{\sqrt{2}-1} \frac{t}{(1+t^2)\sqrt{1-t^2}}\,dt$ (B) $\int_0^{\sqrt{2}-1} \frac{4t}{(1+t^2)\sqrt{1-t^2}}\,dt$

(C) $\int_0^{\sqrt{2}+1} \frac{4t}{(1+t^2)\sqrt{1-t^2}}\,dt$ (D) $\int_0^{\sqrt{2}+1} \frac{t}{(1+t^2)\sqrt{1-t^2}}\,dt$

Sol.: $\int_0^{\pi/4}\left(\sqrt{\frac{1+\sin x}{\cos x}}-\sqrt{\frac{1-\sin x}{\cos x}}\right)dx=\int_0^{\pi/4}\left(\sqrt{\frac{\tan(x/2)+1}{1-\tan(x/2)}}-\sqrt{\frac{1-\tan(x/2)}{1+\tan(x/2)}}\right)dx$

$=\int_0^{\pi/4}\frac{2\tan(x/2)}{\sqrt{1-\tan^2(x/2)}}dx \quad \tan\left(\frac{x}{2}\right)=t;\ \frac{1}{2}\sec^2\left(\frac{x}{2}\right)dx=dt$

$=\int_0^{\sqrt{2}-1}\frac{4t\,dt}{(1+t^2)\sqrt{1-t^2}}$

Correct choice: (B)

***5.** Consider three points $P=(-\sin(\beta-\alpha), -\cos\beta)$, $Q=(\cos(\beta-\alpha), \sin\beta)$ and $R=(\cos(\beta-\alpha+\theta), \sin(\beta-\theta))$, where $0<\alpha,\ \beta,\ \theta<\frac{\pi}{4}$. Then

(A) P lies on the line segment RQ (B) Q lies on the line segment PR

(C) R lies on the line segment QP (D) P, Q, R are non-collinear

Sol.: Consider $\Delta=\begin{vmatrix}1 & 1 & 1\\ -\sin(\beta-\alpha) & \cos(\beta-\alpha) & \cos(\beta-\alpha+\theta)\\ -\cos\beta & \sin\beta & \sin(\beta-\theta)\end{vmatrix}$. Now, $C_3\to C_3-(C_1\sin\theta+C_2\cos\theta)$

$\Delta=\begin{vmatrix}1 & 1 & 1-(\sin\theta+\cos\theta)\\ -\sin(\beta-\alpha) & \cos(\beta-\alpha) & 0\\ -\cos\beta & \sin\beta & 0\end{vmatrix}=(1-(\sin\theta+\cos\theta))(\cos(2\beta-\alpha))\neq 0$

$\Rightarrow$ Points are non collinear.

Correct choice: (D)

6. An experiment has 10 equally likely outcomes. Let A and B be two non-empty events of the experiment. If A consists of 4 outcomes, the number of outcomes that B must have so that A and B are independent, is

(A) 2, 4 or 8 (B) 3, 6 or 9 (C) 4 or 8 (D) 5 or 10

Sol.: Given that $n(S)=10;\ n(A)=4$

For independent event $\frac{n(A\cap B)}{n(S)}=\frac{n(A)}{n(S)}\times\frac{n(B)}{n(S)}$

$\Rightarrow\ n(S).n(A\cap B)=n(A).n(B)$

$10\ n(A\cap B)=4.n(B)$

$\Rightarrow\ 5.n(A\cap B)=2.n(B)$

$\Rightarrow\ n(B)$ can be only 5 or 10 ($n(A\cap B)$, $n(B)$ being integers)

Correct choice: (D)

7. Let two non-collinear unit vectors $\hat{a}$ and $\hat{b}$ form an acute angle. A point P moves so that at any time t the position vector $\overrightarrow{OP}$ (where O is the origin) is given by $\hat{a}\cos t + \hat{b}\sin t$. When P is farthest from origin O, let M be the length of $\overrightarrow{OP}$ and $\hat{u}$ be the unit vector along $\overrightarrow{OP}$. Then

(A) $\hat{u} = \dfrac{\hat{a}+\hat{b}}{\left|\hat{a}+\hat{b}\right|}$ and $M = \left(1+\hat{a}.\hat{b}\right)^{\frac{1}{2}}$

(B) $\hat{u} = \dfrac{\hat{a}-\hat{b}}{\left|\hat{a}-\hat{b}\right|}$ and $M = \left(1+\hat{a}.\hat{b}\right)^{\frac{1}{2}}$

(C) $\hat{u} = \dfrac{\hat{a}+\hat{b}}{\left|\hat{a}+\hat{b}\right|}$ and $M = \left(1+2\hat{a}.\hat{b}\right)^{\frac{1}{2}}$

(D) $\hat{u} = \dfrac{\hat{a}-\hat{b}}{\left|\hat{a}-\hat{b}\right|}$ and $M = \left(1+2\hat{a}.\hat{b}\right)^{\frac{1}{2}}$

Sol.: $|\hat{u}| = \left|\hat{OP}\right|_{\max}$; $\left|\overrightarrow{OP}\right| = \left|\hat{a}\cos t + \hat{b}\sin t\right|$

$$\left|\overrightarrow{OP}\right|^2 = \sin^2 t + \cos^2 t + 2\hat{a}.\hat{b}\sin t\cos t$$

$$\left|\hat{OP}\right|_{\max} = \sqrt{1+\hat{a}.\hat{b}}$$

Maximum occurs when $\sin t = \cos t = \dfrac{1}{\sqrt{2}}$ i.e., $\dfrac{\hat{a}+\hat{b}}{\sqrt{2}}$. Hence unit vector along this is $\dfrac{\hat{a}+\hat{b}}{\left|\hat{a}+\hat{b}\right|}$

Correct choice: (A)

8. Let $I = \int \dfrac{e^x}{e^{4x}+e^{2x}+1}dx$, $J = \int \dfrac{e^{-x}}{e^{-4x}+e^{-2x}+1}dx$. Then, for an arbitrary constant C, the value of $J - I$ equals

(A) $\dfrac{1}{2}\log\left(\dfrac{e^{4x}-e^{2x}+1}{e^{4x}+e^{2x}+1}\right)+C$

(B) $\dfrac{1}{2}\log\left(\dfrac{e^{2x}+e^{x}+1}{e^{2x}-e^{x}+1}\right)+C$

(C) $\dfrac{1}{2}\log\left(\dfrac{e^{2x}-e^{x}+1}{e^{2x}+e^{x}+1}\right)+C$

(D) $\dfrac{1}{2}\log\left(\dfrac{e^{4x}+e^{2x}+1}{e^{4x}-e^{2x}+1}\right)+C$

Sol.: $J - I = \int \dfrac{e^{3x}-e^{x}}{e^{4x}+e^{2x}+1}dx$ (Let $e^x = t$)

$$= \int \frac{\left(t^2-1\right)}{t^4+t^2+1}dt = \int \frac{\left(1-\frac{1}{t^2}\right)dt}{\left(t+\frac{1}{t}\right)^2-1} \text{ ; let } t+\frac{1}{t} = u;\ \left(1-\frac{1}{t^2}\right)dt = du$$

$$\int \frac{du}{u^2-1} = \frac{1}{2}\ln\left|\frac{u-1}{u+1}\right| = \frac{1}{2}\ln\left|\frac{e^x+\frac{1}{e^x}-1}{e^x+\frac{1}{e^x}+1}\right| + C = \frac{1}{2}\ln\left(\frac{e^{2x}-e^{x}+1}{e^{2x}+e^{x}+1}\right)+C$$

Correct choice: (C)

9. Let $g(x) = \log f(x)$ where $f(x)$ is a twice differentiable positive function on $(0, \infty)$ such that $f(x+1) = xf(x)$. Then, for $N = 1, 2, 3, ...$, $g''\left(N+\dfrac{1}{2}\right) - g''\left(\dfrac{1}{2}\right) =$

(A) $-4\left\{1+\dfrac{1}{9}+\dfrac{1}{25}+.....+\dfrac{1}{(2N-1)^2}\right\}$

(B) $4\left\{1+\dfrac{1}{9}+\dfrac{1}{25}+.....+\dfrac{1}{(2N-1)^2}\right\}$

(C) $-4\left\{1+\dfrac{1}{9}+\dfrac{1}{25}+.....+\dfrac{1}{(2N+1)^2}\right\}$

(D) $4\left\{1+\dfrac{1}{9}+\dfrac{1}{25}+.....+\dfrac{1}{(2N+1)^2}\right\}$

Sol.: $g'(x)=\frac{1}{f(x)}.f'(x)$ and $\ln f(x+1)=\ln x+\ln f(x)$

$$\frac{f'(x+1)}{f(x+1)}-\frac{f'(x)}{f(x)}=\frac{1}{x}$$

$$g'(x+1)-g'(x)=\frac{1}{x}$$

$$g''(x+1)-g''(x)=-\frac{1}{x^2}$$

$$g''\left(\frac{3}{2}\right)-g''\left(\frac{1}{2}\right)=-\frac{1}{(1/2)^2}$$

$$g''\left(\frac{5}{2}\right)-g''\left(\frac{3}{2}\right)=-\frac{1}{(3/2)^2}$$

… … …

… … …

$$g''\left(N+\frac{1}{2}\right)-g'\left(N-\frac{1}{2}\right)=-\frac{1}{\left(N-\frac{1}{2}\right)^2}$$

Adding them all

$$=-4\left[\frac{1}{1}+\frac{1}{9}+\frac{1}{25}+\frac{1}{(2N-1)^2}\right]$$

Correct choice: (A)

SECTION – II
Reasoning Type

This section contains 4 reasoning type questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

***10.** Suppose four distinct positive numbers a_1, a_2, a_3, a_4 are in G.P. Let $b_1=a_1$, $b_2=b_1+a_2$, $b_3=b_2+a_3$ and $b_4=b_3+a_4$.

STATEMENT–1: The numbers b_1, b_2, b_3, b_4 are neither in A.P. nor in G.P.

and

STATEMENT–2: The numbers b_1, b_2, b_3, b_4 are in H.P.

(A) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is** a correct explanation for STATEMENT–1.

(B) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is NOT** a correct explanation for STATEMENT–1.

(C) STATEMENT–1 is True, STATEMENT–2 is False.

(D) STATEMENT–1 is False, STATEMENT–2 is True.

Sol.: Let $a_2=a_1.r$, $a_3=a_1.r^2$ and $a_4=a_1.r^3$, where $r\neq 0$ and 1

Thus $b_1=a_1$, $b_2=a_1(1+r)$, $b_3=a_1\left(1+r+r^2\right)$ and $b_4=a_1\left(1+r+r^2+r^3\right)$

$$\text{Now } \frac{b_1-b_2}{b_2-b_3}=\frac{a_1(1-1-r)}{a_1\left(1+r-1-r-r^2\right)}=\frac{-r}{-r^2}=\frac{1}{r}\neq\begin{cases}\frac{b_1}{b_1}\Rightarrow b_1, b_2, b_3 \text{ do not form an A.P.}\\ \frac{b_1}{b_2}\Rightarrow b_1, b_2, b_3 \text{ do not form an G.P.}\\ \frac{b_1}{b_3}\Rightarrow b_1, b_2, b_3 \text{ do not form a H.P.}\end{cases}$$

Correct choice: (C)

***11.** Let *a, b, c, p, q* be real numbers. Suppose α, β are the roots of the equation $x^2+2px+q=0$ and α, $\frac{1}{\beta}$ are the roots of the equation $ax^2+2bx+c=0$, where $\beta^2 \notin \{-1, 0, 1\}$.

STATEMENT–1: $(p^2-q)(b^2-ac)\geq 0$.

and

STATEMENT–2: $b \neq pa$ or $c \neq qa$.

(A) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is** a correct explanation for STATEMENT–1.
(B) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is NOT** a correct explanation for STATEMENT–1.
(C) STATEMENT–1 is True, STATEMENT–2 is False.
(D) STATEMENT–1 is False, STATEMENT–2 is True.

Sol.: $\beta^2=\frac{\alpha\beta}{(\alpha/\beta)}=\frac{aq}{c}\neq 1,\ -1$ and 0

None of *a* and *q* can be zero and $aq \neq c,\ aq \neq -c$

Since α is the common root, hence

$\alpha^2+2p\alpha+q=0$ …(i) and $a\alpha^2+2b\alpha+c=0$ …(ii)

From equation (i) and (ii) $\Rightarrow\ 2(ap-b)\alpha+(aq-c)=0$

For a definite value of α, $ap-b\neq 0$; $\therefore\ ap\neq b$. i.e., statement-2 is correct.

Since nature of α and β is not given and $a, b, c, p, q, \in R$. It means α and β both will be real simultaneously or non-real simultaneously.

Therefore discriminants of both given equation will be of same sign.

$\Delta_1.\Delta_2 \geq 0$

$4(p^2-q).4(b^2-ac)\geq 0 \ \Rightarrow\ (p^2-q)(b^2-ac)\geq 0$

$\therefore$ Statement-1 is also correct, which can not be explained by statement-2.

Correct choice: (B)

***12.** Consider $L_1: 2x+3y+p-3=0;\ L_2: 2x+3y+p+3=0$, where *p* is a real number, and $C: x^2+y^2+6x-10y+30=0$.

STATEMENT–1: If line L_1 is a chord of circle *C*, then line L_2 is not always a diameter of circle *C*.

and

STATEMENT–2: If line L_1 is a diameter of circle *C*, then line L_2 is not a chord of circle *C*.

(A) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is** a correct explanation for STATEMENT–1.
(B) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is NOT** a correct explanation for STATEMENT–1.
(C) STATEMENT–1 is True, STATEMENT–2 is False.
(D) STATEMENT–1 is False, STATEMENT–2 is True.

Sol.: Centre of the circle is $(-3, 5)$

Radius, *r* = 2

Distance between the given lines $\frac{6}{\sqrt{13}}\approx 1.8 < r$ (greatest limiting distance between a diameter and a chord)

Correct choice: (C)

13. Let a solution $y = y(x)$ of the differential equation $x\sqrt{x^2-1}\,dy - y\sqrt{y^2-1}\,dx = 0$ satisfy $y(2) = \frac{2}{\sqrt{3}}$.

STATEMENT–1: $y(x) = \sec\left(\sec^{-1}x - \frac{\pi}{6}\right)$.

and

STATEMENT–2: $y(x)$ is given by $\frac{1}{y} = \frac{2\sqrt{3}}{x} - \sqrt{1-\frac{1}{x^2}}$.

(A) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is** a correct explanation for STATEMENT–1.

(B) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is NOT** a correct explanation for STATEMENT–1.

(C) STATEMENT–1 is True, STATEMENT–2 is False.

(D) STATEMENT–1 is False, STATEMENT–2 is True.

Sol.: $\sec^{-1}(y) = \sec^{-1}(x) + c$. At $x = 2,\ y = \frac{2}{\sqrt{3}} \Rightarrow c = \frac{\pi}{6} - \frac{\pi}{3} = -\frac{\pi}{6}$

$$y = \sec\left(\sec^{-1}(x) - \frac{\pi}{6}\right)$$

$$\Rightarrow \quad \frac{1}{y} = \cos\left(\sec^{-1}(x)\right).\frac{\sqrt{3}}{2} + \sin\left(\sec^{-1}(x)\right).\frac{1}{2} \quad \Rightarrow \quad \frac{1}{y} = \frac{\sqrt{3}}{2x} + \frac{1}{2}\sqrt{1-\frac{1}{x^2}}$$

Correct choice: (C)

SECTION – III
Linked Comprehension Type

This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 14 to 16

Consider the function $f : (-\infty, \infty) \to (-\infty, \infty)$ defined by $f(x) = \frac{x^2 - ax + 1}{x^2 + ax + 1},\ 0 < a < 2$.

14. Which of the following is true?

(A) $(2+a)^2 f''(1) + (2-a)^2 f''(-1) = 0$

(B) $(2-a)^2 f''(1) - (2+a)^2 f''(-1) = 0$

(C) $f'(1)f'(-1) = (2-a)^2$

(D) $f'(1)f'(-1) = -(2+a)^2$

Sol.: $f(x) = \frac{x^2 - ax + 1}{x^2 + ax + 1};\ 0 < a < 2$

$$f'(x) = \frac{2a\left(x^2-1\right)}{\left(x^2+ax+1\right)^2}$$

$$\left(x^2+ax+1\right)^2 f'(x) = 2a\left(x^2-1\right) \Rightarrow \left(x^2+ax+1\right)^2 f''(x) + 2\left(x^2+ax+1\right).(2x+a).f'(x) = 4ax \quad \ldots(i)$$

From $x = -1$ in equation (i) $\Rightarrow (2-a)^2 f''(-1) + 0 = -4a$ …(ii)

From $x = 1$ in equation (i) $\Rightarrow (2+a)^2 f''(1) + 0 = 4a$ …(iii)

Adding equation (ii) and (iii) $\Rightarrow (2+a)^2 f''(1) + (2-a)^2 f''(-1) = 0$

Correct choice: (A)

15. Which of the following is true?

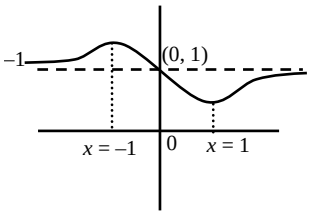
(A) $f(x)$ is decreasing on $(-1, 1)$ and has a local minimum at $x = 1$

(B) $f(x)$ is increasing on $(-1, 1)$ and has a local maximum at $x = 1$

(C) $f(x)$ is increasing on $(-1, 1)$ but has neither a local maximum nor a local minimum at $x = 1$

(D) $f(x)$ is decreasing on $(-1, 1)$ but has neither a local maximum nor a local minimum at $x = 1$

Sol.: $f(x) = 1 - \dfrac{2a}{\left(x + \dfrac{1}{x} + a\right)}$.



Correct choice: (A)

16. Let $g(x) = \displaystyle\int_0^{e^x} \frac{f'(t)}{1+t^2}\, dt$. Which of the following is true?

(A) $g'(x)$ is positive on $(-\infty, 0)$ and negative on $(0, \infty)$

(B) $g'(x)$ is negative on $(-\infty, 0)$ and positive on $(0, \infty)$

(C) $g'(x)$ changes sign on both $(-\infty, 0)$ and $(0, \infty)$

(D) $g'(x)$ does not change sign on $(-\infty, \infty)$

Sol.: $g(x) = \displaystyle\int_0^{e^x} \frac{f'(t)}{1+t^2} dt$; $\therefore \quad g'(x) = \frac{f'\left(e^x\right).e^x}{1+\left(e^x\right)^2} = \frac{2a\left(e^{2x}-1\right)e^x}{\left(e^{2x}+ae^x+1\right)^2\left(1+e^{2x}\right)} = \frac{2ae^x}{1+e^{2x}} \cdot \frac{e^{2x}-1}{\left(e^{2x}+ae^x+1\right)^2}$

Now $g'(x) > 0$ for $e^{2x} - 1 > 0 \;\Rightarrow\; x > 0$

$g'(x) < 0$ for $e^{2x} - 1 < 0 \;\Rightarrow\; x < 0$

Correct choice: (B)

Paragraph for Question Nos. 17 to 19

Consider the lines

$$L_1 : \frac{x+1}{3} = \frac{y+2}{1} = \frac{z+1}{2};\; L_2 : \frac{x-2}{1} = \frac{y+2}{2} = \frac{z-3}{3}.$$

17. The unit vector perpendicular to both L_1 and L_2 is

(A) $\dfrac{-\hat{i}+7\hat{j}+7\hat{k}}{\sqrt{99}}$ (B) $\dfrac{-\hat{i}-7\hat{j}+5\hat{k}}{5\sqrt{3}}$ (C) $\dfrac{-\hat{i}+7\hat{j}+5\hat{k}}{5\sqrt{3}}$ (D) $\dfrac{7\hat{i}-7\hat{j}-\hat{k}}{\sqrt{99}}$

Sol.: Vector perpendicular to both L_1 and L_2 is $= \pm \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 1 & 2 \\ 1 & 2 & 3 \end{vmatrix} = \pm[\hat{i}(3-4) + \hat{j}(2-9) + \hat{k}(6-1)] = \pm[-\hat{i} - 7\hat{j} + 5\hat{k}]$

Unit vector perpendicular to L_1 and L_2 is $\pm\left(\dfrac{-\hat{i}-7\hat{j}+5\hat{k}}{\sqrt{1^2+7^2+5^2}}\right) = \pm\left(\dfrac{-\hat{i}-7\hat{j}+5\hat{k}}{5\sqrt{3}}\right)$

Correct choice: (B)

18. The shortest distance between L_1 and L_2 is

(A) 0 (B) $\dfrac{17}{\sqrt{3}}$ (C) $\dfrac{41}{5\sqrt{3}}$ (D) $\dfrac{17}{5\sqrt{3}}$

Sol.: Shortest distance between L_1 and L_2 is $\left|\left(\frac{-\hat{i}-7\hat{j}+5\hat{k}}{5\sqrt{3}}\right)\cdot\left((-1-2)\hat{i}+(-2+2)\hat{j}+(-1-3)\hat{k}\right)\right| = \left|\frac{+3-20}{5\sqrt{3}}\right| = \frac{17}{5\sqrt{3}}$

Correct choice: (D)

19. The distance of the point $(1, 1, 1)$ from the plane passing through the point $(-1, -2, -1)$ and whose normal is perpendicular to both the lines L_1 and L_2 is

(A) $\frac{2}{\sqrt{75}}$ (B) $\frac{7}{\sqrt{75}}$ (C) $\frac{13}{\sqrt{75}}$ (D) $\frac{23}{\sqrt{75}}$

Sol.: Equation of plane is $-1(x+1)-7(y+2)+5(z+1)=0$

$-x-7y+5z-10=0$

Distance of (1, 1, 1) from $-x-7y+5z-10=0$ is $\left|\frac{-1-7+5-10}{\sqrt{1^2+7^2+5^2}}\right| = \frac{13}{\sqrt{75}}$

Correct choice: (C)

SECTION – IV
Matrix–Match Type

This section contains 3 questions. Each question contains statements given in two columns which have to be matched. Statements in **Column I** are labeled as A, B, C and D whereas statements in **Column II** are labeled as p, q, r, and s. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct matches are A–q, A–r, B–s, C–r, C–s and D–q, then the correctly bubbled 4 × 4 matrix should be as follows:

	p	q	r	s
A	○	●	●	○
B	●	○	○	●
C	○	○	●	●
D	○	●	○	○

***20.** Consider the lines given by $L_1 : x+3y-5=0$; $L_2 : 3x-ky-1=0$ and $L_3 : 5x+2y-12=0$.

Match the Statements/ Expressions in **Column I** with the Statements/ Expressions in **Column II** and indicate your answer by darkening the appropriate bubbles in the 4 × 4 matrix given in the ORS.

Column I	Column II
(A) L_1, L_2, L_3 are concurrent, if	(p) $k=-9$
(B) One of L_1, L_2, L_3 is parallel to at least one of the other two, if	(q) $k=-\frac{6}{5}$
(C) L_1, L_2, L_3 form a triangle, if	(r) $k=\frac{5}{6}$
(D) L_1, L_2, L_3 do not form a triangle, if	(s) $k=5$

Sol.: **A-s** L_1, L_2, L_3 are concurrent if $\begin{vmatrix} 1 & 3 & -5 \\ 3 & -k & -1 \\ 5 & 2 & -12 \end{vmatrix} = 0 \Rightarrow 1(12k+2)-3(-36+5)-5(6+5k)=0 \Rightarrow -13k+65=0$

$\Rightarrow k=5$

B-p, q L_1 and L_3 are non parallel therefore either L_2 is parallel to L_1 or L_2 is parallel to L_3.

$\Rightarrow \quad -\frac{1}{3}=\frac{3}{k} \Rightarrow k=-9$ or $-\frac{5}{2}=\frac{-3}{k} \Rightarrow k=-\frac{6}{5}$

C-r For (p), (q), (s) no triangle is possible.

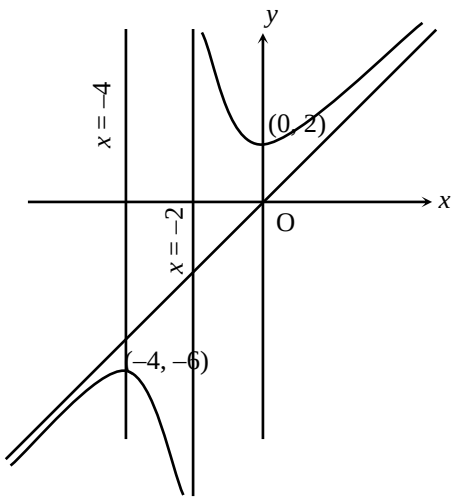
Therefore (r) is the correct match.

D-p, q, s

***21.** Match the Statement/ Expressions in **Column I** with the Statement/ Expression in **Column II** and indicate your answer by darkening the appropriate bubbles in the 4 × 4 matrix given in the ORS.

Column I		Column II
(A)	The minimum value of $\frac{x^2+2x+4}{x+2}$ is	(p) 0
(B)	Let A and B be 3 × 3 matrices of real numbers, where A is symmetric, B is skew-symmetric, and $(A+B)(A-B)=(A-B)(A+B)$. If $(AB)^t=(-1)^k AB$, where $(AB)^t$ is the transpose of the matrix AB, then the possible values of k are	(q) 1
(C)	Let $a=\log_3\log_3 2$. An integer k satisfying $1<2^{\left(-k+3^{-a}\right)}<2$, must be less than	(r) 2
(D)	If $\sin\theta=\cos\varphi$, then the possible values of $\frac{1}{\pi}\left(\theta\pm\varphi-\frac{\pi}{2}\right)$ are	(s) 3

Sol.: **A-**



Clearly minimum value does not exist.

B-q, s $A=A^t$ and $B=-B^t$

Given $(A+B)(A-B)=(A-B)(A+B)$

$A^2+BA-AB-B^2=A^2-BA+AB-B^2 \Rightarrow AB=BA$

and $(AB)^t=(-1)^k AB \Rightarrow B^tA^t=(-1)^k AB \Rightarrow -BA=(-1)^k BA$

$\Rightarrow$ k is an odd integer. Therefore k = 1, 3.

C-r, s $a=\log_3\log_3 2 \Rightarrow \log_2 3=3^{-a}$

Given $1<2^{\left(-k+3^{-a}\right)}<2 \Rightarrow 1<2^{-k}.3<2 \Rightarrow \frac{1}{3}<2^{-k}<\frac{2}{3} \Rightarrow \frac{3}{2}<2^k<3 \Rightarrow k=1$

D-p, r $\sin\theta=\cos\varphi \Rightarrow \cos\left(\frac{\pi}{2}-\theta\right)=\cos\varphi \Rightarrow \frac{\pi}{2}-\theta=2n\pi\pm\varphi$

$\Rightarrow \theta\pm\varphi-\frac{\pi}{2}=-2n\pi \Rightarrow \frac{1}{\pi}\left(\theta\pm\varphi-\frac{\pi}{2}\right)=-2n,\ n\in I$

So, $\frac{1}{\pi}\left(\theta\pm\varphi-\frac{\pi}{2}\right)=0,\ 2$.

***22.** Consider all possible permutations of the letters of the word ENDEANOEL.
Match the Statement/ Expressions in **Column I** with the Statement/ Expression in **Column II** and indicate your answer by darkening the appropriate bubbles in the 4 × 4 matrix given in the ORS.

Column I		Column II	
(A)	The number of permutations containing the word ENDEA is	(p)	$5\,!$
(B)	The number of permutations in which the letter E occurs in the first and the last positions is	(q)	$2 \times 5\,!$
(C)	The number of permutations in which none of the letters D, L, N occurs in the last five positions is	(r)	$7 \times 5\,!$
(D)	The number of permutations in which the letters A, E, O occur only in odd positions is	(s)	$21 \times 5\,!$

Sol.: **A-p** ENDEA N O E L
Required number of permutations = 5 !

B-s E NDEANOL E

Required number of permutations = $\frac{7!}{2!} = 21(5\,!)$

C-q DLNN E E E A O

Required number of permutations = $\frac{4\,!}{2\,!} \times \frac{5\,!}{3\,!} = 2 \times 5\,!$

D-q Required number of permutations = $\frac{5\,!}{3\,!} \times \frac{4\,!}{2\,!} = 2 \times 5!$

PHYSICS: Paper-II (Code: 0)

PART II

SECTION – I
Straight Objective Type

This section contains 9 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

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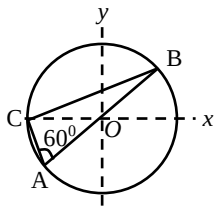
23. Consider a system of three charges $\frac{q}{3}, \frac{q}{3}$ and $-\frac{2q}{3}$ placed at points A, B and C, respectively, as shown in the figure. Take O to be the centre of the circle of radius R and angle CAB = 60^0

Figure:



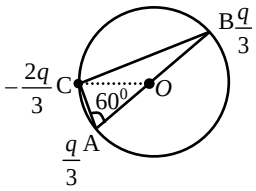
(A) The electric field at point O is $\frac{q}{8\pi\varepsilon_0 R^2}$ directed along the negative x-axis

(B) The potential energy of the system is zero

(C) The magnitude of the force between the charges at C and B is $\frac{q^2}{54\pi\varepsilon_0 R^2}$

(D) The potential at point O is $\frac{q}{12\pi\varepsilon_0 R}$

Sol.: $\left|\vec{F}_{BC}\right| = \frac{K\frac{q}{3}\frac{2q}{3}}{\left(2R\frac{\sqrt{3}}{2}\right)^2} = \frac{q^2}{54\pi\varepsilon_0 R^2}$



Correct choice: (C)

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24. A radioactive sample S1 having an activity of 5 μCi has twice the number of nuclei as another sample S2 which has an activity of 10 μCi. The half lives of S1 and S2 can be

(A) 20 years and 5 years, respectively

(B) 20 years and 10 years, respectively

(C) 10 years each

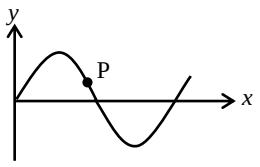
(D) 5 years each

Sol.: $\frac{\lambda_1}{\lambda_2} = \frac{A_1}{N_1}\cdot\frac{N_2}{A_2} = \frac{5}{2N_2}\cdot\frac{N_2}{10}$; $\frac{\lambda_1}{\lambda_2} = \frac{5}{20}$, $T_{1/2} \propto \frac{1}{\lambda}$

Correct choice: (A)

***25.** A transverse sinusoidal wave moves along a string in the positive x-direction at a speed of 10 cm/s. The wavelength of the wave is 0.5 m and its amplitude is 10 cm. At a particular time t, the snap-shot of the wave is shown in figure. The velocity of point P when its displacement is 5 cm is

Figure:



(A) $\frac{\sqrt{3}\,\pi}{50}\hat{j}$ m/s

(B) $-\frac{\sqrt{3}\,\pi}{50}\hat{j}$ m/s

(C) $\frac{\sqrt{3}\,\pi}{50}\hat{i}$ m/s

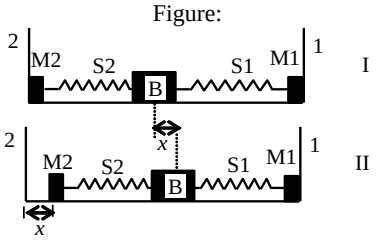
(D) $-\frac{\sqrt{3}\,\pi}{50}\hat{i}$ m/s

Sol.: The slope at point P is negative, and $v_p = -v$ (slope)

Correct choice: (A)

***26.** A block (B) is attached to two unstretched springs S1 and S2 with spring constants k and 4 k, respectively (see figure I). The other ends are attached to identical supports M1 and M2 not attached to the walls. The springs and supports have negligible mass. There is no friction anywhere. The block B is displaced towards wall 1 by a small distance x (figure II) and released. The block returns and moves a maximum distance y towards wall 2. Displacements x and y are measured with respect to the equilibrium position of the block B. The ratio $\frac{y}{x}$ is

Figure:



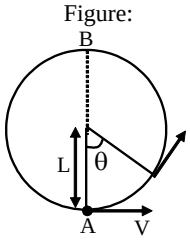
(A) 4 (B) 2 (C) $\frac{1}{2}$ (D) $\frac{1}{4}$

Sol.: By conservation of mechanical energy $\frac{1}{2}kx^2 = \frac{1}{2}(4k)y^2$ $\therefore$ $\frac{y}{x} = \frac{1}{2}$

Correct choice: (C)

***27.** A bob of mass M is suspended by a massless string of length L. The horizontal velocity V at position A is just sufficient to make it reach the point B. The angle θ at which the speed of the bob is half of that at A, satisfies

Figure:



(A) $\theta = \frac{\pi}{4}$ (B) $\frac{\pi}{4} < \theta < \frac{\pi}{2}$

(C) $\frac{\pi}{2} < \theta < \frac{3\pi}{4}$ (D) $\frac{3\pi}{4} < \theta < \pi$

Sol.: By conservation of mechanical energy

$$\frac{1}{2}mv^2 = \frac{1}{2}m\left(\frac{v}{2}\right)^2 + mgL(1-\cos\theta) \text{ and } v^2 = 5gL$$

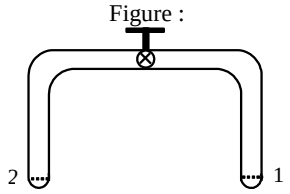
$$\cos\theta = -\frac{7}{8}$$

$\therefore$ $\frac{3\pi}{4} < \theta < \pi$

Correct choice: (D)

***28.** A glass tube of uniform internal radius (r) has a valve separating the two identical ends. Initially, the valve is in a tightly closed position. End 1 has a hemispherical soap bubble of radius r. End 2 has sub-hemispherical soap bubble as shown in figure. Just after opening the valve,

Figure :



(A) air from end 1 flows towards end 2. No change in the volume of the soap bubbles
(B) air from end 1 flows towards end 2. Volume of the soap bubble at end 1 decreases
(C) no change occurs
(D) air from end 2 flows towards end 1. Volume of the soap bubble at end 1 increases

Sol.: Since radius of curvature of sub-hemispherical surface is more than that of hemispherical surface and $\Delta P \propto \frac{1}{R}$.

Correct choice: (B)

***29.** A vibrating string of certain length ℓ under a tension T resonates with a mode corresponding to the first overtone (third harmonic) of an air column of length 75 cm inside a tube closed at one end. The string also generates 4 beats per second when excited along with a tuning fork of frequency n. Now when the tension of the string is slightly increased the number of beats reduces to 2 per second. Assuming the velocity of sound in air to be 340 m/s, the frequency n of the tuning fork in Hz is

(A) 344 (B) 336 (C) 117.3 (D) 109.3

Sol.: $f = \frac{3v}{4l} = \frac{3\times 340}{4\times 0.75} = 340$ Hz

$|f - n| = 4$

n = 344 Hz or 336 Hz

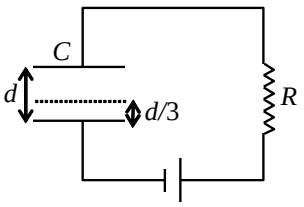
Since on increasing tension, f increases and number of beats decreases,

$\therefore$ n = 344 Hz

Correct choice: (A)

30. A parallel plate capacitor C with plates of unit area and separation d is filled with a liquid of dielectric constant K = 2. The level of liquid is $\frac{d}{3}$ initially. Suppose the liquid level decreases at a constant speed V, the time constant as a function of time t is

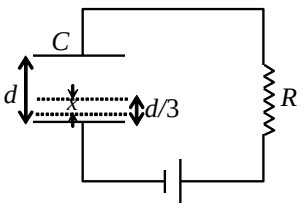
Figure:



(A) $\frac{6\varepsilon_0 R}{5d+3Vt}$ (B) $\frac{(15d+9Vt)\varepsilon_0 R}{2d^2-3dVt-9V^2t^2}$

(C) $\frac{6\varepsilon_0 R}{5d-3Vt}$ (D) $\frac{(15d-9Vt)\varepsilon_0 R}{2d^2+3dVt-9V^2t^2}$

Sol.: Let at any time t, the level has fallen by a distance x (= Vt)

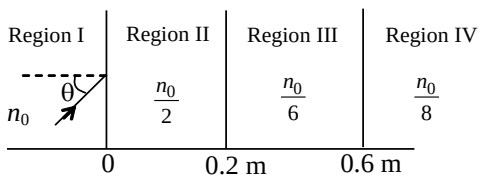


Time constant (τ) = RC_{eq}

$$= R\left(\frac{\varepsilon_0 A}{\frac{2d}{3}+x+\frac{d/3-x}{2}}\right) = \frac{6\varepsilon_0 R}{5d+3Vt}$$

Correct choice: (A)

31. A light beam is traveling from Region I to Region IV (Refer Figure). The refractive index in Regions I, II, III and IV are n_0, $\frac{n_0}{2}$, $\frac{n_0}{6}$ and $\frac{n_0}{8}$, respectively. The angle of incidence θ for which the beam just misses entering Region IV is



(A) $\sin^{-1}\left(\frac{3}{4}\right)$ (B) $\sin^{-1}\left(\frac{1}{8}\right)$ (C) $\sin^{-1}\left(\frac{1}{4}\right)$ (D) $\sin^{-1}\left(\frac{1}{3}\right)$

Sol.: $n_0 \sin\theta = \frac{n_0}{8}\sin\frac{\pi}{2} \Rightarrow \theta = \sin^{-1}\left(\frac{1}{8}\right)$

Correct choice: (B)

SECTION – II
Reasoning Type

This section contains 4 reasoning type questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

***32.** STATEMENT–1

For an observer looking out through the window of a fast moving train, the nearby objects appear to move in the opposite direction to the train, while the distant objects appear to be stationary.

and

STATEMENT–2

If the observer and the object are moving at velocities $\vec{V}_1$ and $\vec{V}_2$ respectively with reference to a laboratory frame, the velocity of the object with respect to the observer is $\vec{V}_2 - \vec{V}_1$.

(A) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is** a correct explanation for STATEMENT–1.
(B) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is NOT** a correct explanation for STATEMENT–1.
(C) STATEMENT–1 is True, STATEMENT–2 is False.
(D) STATEMENT–1 is False, STATEMENT–2 is True.

Sol.: **Correct choice: (B)**

***33.** STATEMENT–1

It is easier to pull a heavy object than to push it on a level ground.

and

STATEMENT–2

The magnitude of frictional force depends on the nature of the two surfaces in contact.

(A) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is** a correct explanation for STATEMENT–1.
(B) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is NOT** a correct explanation for STATEMENT–1.
(C) STATEMENT–1 is True, STATEMENT–2 is False.
(D) STATEMENT–1 is False, STATEMENT–2 is True.

Sol.: **Correct choice: (B)**

34. STATEMENT–1

For practical purposes, the earth is used as a reference at zero potential in electrical circuits.

and

STATEMENT–2

The electrical potential of a sphere of radius R with charge Q uniformly distributed on the surface is given by $\frac{Q}{4\pi\varepsilon_0 R}$.

(A) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is** a correct explanation for STATEMENT–1.
(B) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is NOT** a correct explanation for STATEMENT–1.
(C) STATEMENT–1 is True, STATEMENT–2 is False.
(D) STATEMENT–1 is False, STATEMENT–2 is True.

Sol.: **Correct choice: (B)**

35. STATEMENT–1

The sensitivity of a moving coil galvanometer is increased by placing a suitable magnetic material as a core inside the coil.

and

STATEMENT–2

Soft iron has a high magnetic permeability and cannot be easily magnetized or demagnetized.

(A) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is** a correct explanation for STATEMENT–1.

(B) STATEMENT–1 is True, STATEMENT–2 is True; STATEMENT–2 **is NOT** a correct explanation for STATEMENT–1.

(C) STATEMENT–1 is True, STATEMENT–2 is False.

(D) STATEMENT–1 is False, STATEMENT–2 is True.

Sol.: **Correct choice: (C)**

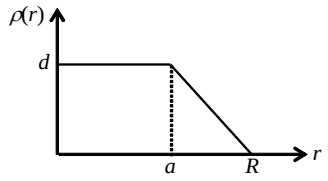
SECTION – III
Linked Comprehension Type

This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 36 to 38

The nuclear charge (Ze) is non-uniformly distributed within a nucleus of radius R. The charge density $\rho(r)$ [charge per unit volume] is dependent only on the radial distance r from the centre of the nucleus as shown in figure. The electric field is only along the radial direction

Figure:



36. The electric field at $r = R$ is

(A) independent of a

(B) directly proportional to a

(C) directly proportional to a^2

(D) inversely proportional to a

Sol.: At $r = R$, $E = \dfrac{kZe}{R^2}$ which is constant.

Correct choice: (A)

37. For $a = 0$, the value of d (maximum value of ρ as shown in the figure) is

(A) $\dfrac{3Ze}{4\pi R^3}$ (B) $\dfrac{3Ze}{\pi R^3}$ (C) $\dfrac{4Ze}{3\pi R^3}$ (D) $\dfrac{Ze}{3\pi R^3}$

Sol.: Total charge $q = \displaystyle\int_0^R 4\pi r^2 (dr)\left(d - \frac{d}{R}r\right) = \frac{\pi d R^3}{3} = Ze \quad \therefore \quad d = \frac{3Ze}{\pi R^3}$

Correct choice: (B)

38. The electric field within the nucleus is generally observed to be linearly dependent on r. This implies

(A) $a = 0$ (B) $a = \dfrac{R}{2}$ (C) $a = R$ (D) $a = \dfrac{2R}{3}$

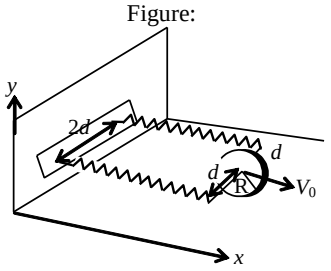
Sol.: The electric field inside a spherical charge distribution is linearly dependent on distance from centre when charge density is uniform. Hence $a = R$.

Correct choice: (C)

Paragraph for Question Nos. 39 to 41

A uniform thin cylindrical disk of mass M and radius R is attached to two identical massless springs of spring constant k which are fixed to the wall as shown in the figure. The springs are attached to the axle of the disk symmetrically on either side at a distance d from its centre. The axle is massless and both the springs and the axle are in a horizontal plane. The unstretched length of the each spring is L. The disk is initially at its equilibrium position with its centre of mass (CM) at a distance L from the wall. The disk rolls without slipping with velocity $\vec{V}_0 = V_0\hat{i}$. The coefficient of friction is μ.

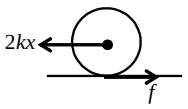
Figure:



***39.** The net external force acting on the disk when its centre of mass is at displacement x with respect to its equilibrium position is

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

Sol.: For linear motion $f - 2kx = Ma$



For rotational motion, $-fR = \left(\frac{MR^2}{2}\right)\alpha$ and $a = \alpha R$

Solving, $a = -\frac{4kx}{3M}$

Therefore the net external force, $F = Ma = -\frac{4kx}{3}$

Correct choice: (D)

***40.** The centre of mass of the disk undergoes simple harmonic motion with angular frequency ω equal to

(A) $\sqrt{\frac{k}{M}}$ (B) $\sqrt{\frac{2k}{M}}$ (C) $\sqrt{\frac{2k}{3M}}$ (D) $\sqrt{\frac{4k}{3M}}$

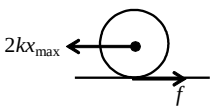
Sol.: $\omega = \sqrt{\frac{4K}{3M}}$

Correct choice: (D)

***41.** The maximum value of V_0 for which the disk will roll without slipping is

(A) $\mu g\sqrt{\frac{M}{k}}$ (B) $\mu g\sqrt{\frac{M}{2k}}$ (C) $\mu g\sqrt{\frac{3M}{k}}$ (D) $\mu g\sqrt{\frac{5M}{2k}}$

Sol.: $\because \quad f_{\max} = \mu Mg$



$\mu Mg - 2kx_{\max} = Ma_{cm}$ and $-(\mu Mg)R = \frac{1}{2}\left(MR^2\right)\left(\frac{a_{cm}}{R}\right)$

On solving above equations we get, $kx_{\max} = \frac{3}{2}\mu Mg$ … (i)

Applying conservation of mechanical energy

$\frac{1}{2}MV_0^2 + \frac{1}{2}\left(\frac{1}{2}MR^2\right)\left(\frac{V_0}{R}\right)^2 = \frac{1}{2}\left(\frac{1}{2}kx_{\max}^2\right)$ … (ii)

Solving (i) and (ii) we get $V_0 = \mu g\sqrt{\frac{3M}{K}}$

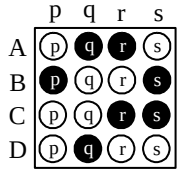
Correct choice: (C)

SECTION – IV

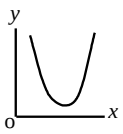
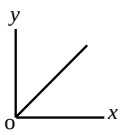
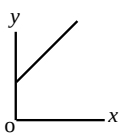
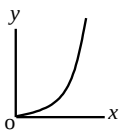
Matrix–Match Type

This section contains 3 questions. Each question contains statements given in two columns, which have to be matched. Statements in **Column I** are labelled as A, B, C and D whereas statements in **Column II** are labelled as p,q. r and s. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct matches are A–q, A–r, B–p, B–s, C–r, C–s and D–q, then the correctly bubbled matrix will look like the following:

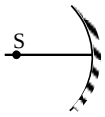
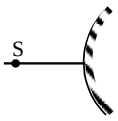


***42.** **Column I** gives a list of possible set of parameters measured in some experiments. The variations of the parameters in the form of graphs are shown in **Column II**. Match the set of parameters given in **Column I** with the graphs given in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I		Column II	
(A)	Potential energy of a simple pendulum (*y* axis) as a function of displacement (*x* axis)	(p)	
(B)	Displacement (*y* axis) as a function of time (*x* axis) for a one dimensional motion at zero or constant acceleration when the body is moving along the positive *x*-direction	(q)	
(C)	Range of a projectile (*y* axis) as a function of its velocity (*x* axis) when projected at a fixed angle	(r)	
(D)	The square of the time period (*y* axis) of a simple pendulum as a function of its length (*x* axis)	(s)	

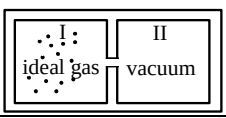
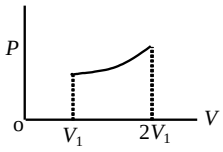
Sol.: **(A) – (p); (B) – (q),(s) ; (C) – (s); (D) – (q)**

43. An optical component and an object S placed along its optic axis are given in **Column I**. The distance between the object and the component can be varied. The properties of images are given in **Column II**. Match all the properties of images from **Column II** with the appropriate components given in **Column I**. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I		Column II	
(A)		(p)	Real image
(B)		(q)	Virtual image
(C)		(r)	Magnified image
(D)		(s)	Image at infinity

Sol.: **(A) – (p),(q),(r),(s); (B) – (q) ; (C) – (p), (q), (r), (s); (D) – (p),(q),(r),(s)**

***44.** **Column I** contains a list of processes involving expansion of an ideal gas. Match this with **Column II** describing the thermodynamic change during this process. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I		Column II	
(A)	An insulated container has two chambers separated by a valve. Chamber I contains an ideal gas and the Chamber II has vacuum. The valve is opened. 	(p)	The temperature of the gas decreases
(B)	An ideal monoatmic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^2}$, where V is the volume of the gas	(q)	The temperature of the gas increases or remains constant
(C)	An ideal monoatomic gas expands to twice its original volume such that its pressure $P \propto \frac{1}{V^{4/3}}$, where V is its volume	(r)	The gas loses heat
(D)	An ideal monoatomic gas expands such that its pressure P and volume V follows the behaviour shown in the graph. 	(s)	The gas gains heat

Sol.: (A) For free expansion, $dW = 0$, $dQ = 0$ and $dU = 0$.

$\therefore$ Temperature remains constant.

(B) PV^2 = constant $\Rightarrow TV$ = constant or $T \propto \frac{1}{V}$

$C = C_V + \frac{R}{1-n} = \frac{3R}{2} - R = \frac{R}{2}$ $(\because n = 2)$

$dQ = nCdT$, since $dT < 0$ and $C > 0$, $dQ < 0$

(C) $PV^{4/3}$ = constant $\Rightarrow TV^{1/3}$ = constant or $T \propto \frac{1}{V^{1/3}}$

$C = C_V + \frac{R}{1-n} = \frac{3R}{2} - 3R = -\frac{3R}{2}$ $(\because n = 4/3)$

$dQ = nCdT$, since $dT < 0$ and $C < 0$, $dQ > 0$

(D) $T_2 > T_1$

$\therefore$ $dU > 0$ and $dW > 0$

$\therefore$ $dQ > 0$

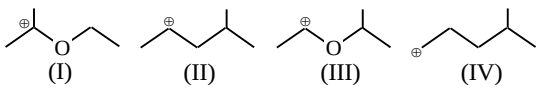
(A) – (q); (B) – (p),(r) ; (C) – (p), (s); (D) – (q), (s)

CHEMISTRY: Paper-II (Code: 0)

SECTION – I
Straight Objective Type

This section contains 9 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

***45.** The correct stability order for the following species is

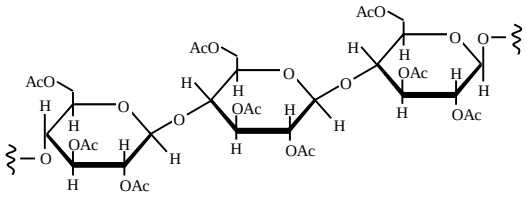


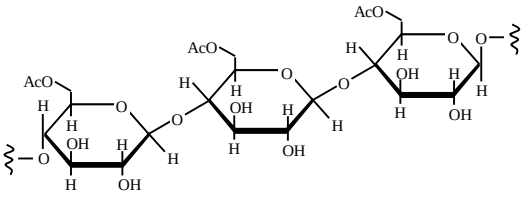
(I) (II) (III) (IV)

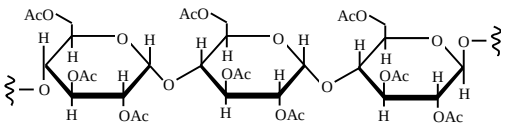
(A) (II) > (IV) > (I) > (III) (B) (I) > (II) > (III) > (IV)
(C) (II) > (I) > (IV) > (III) (D) (I) > (III) > (II) > (IV)

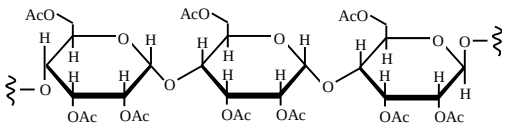
Sol.: The correct stability order of the given species is (I) > (III) > (II) > (IV).
Structure (I) is stabilised by resonance and hyperconjugation due to 6 α–H atoms. Structure (III) is stabilised by resonance and hyperconjugation due to 3 α–H atoms. Structure(II) is stabilised by hyperconjugation due to 5 α–H atoms. Structure (IV) is stabilised by hyperconjugation due to 2 α–H atoms.
Correct choice: (D)

46. Cellulose upon acetylation with excess acetic anhydride/H_2SO_4 (catalytic) gives cellulose triacetate whose structure is

(A) 

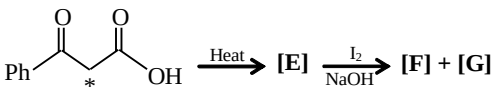
(B) 

(C) 

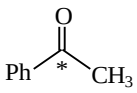
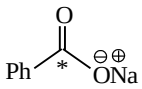
(D) 

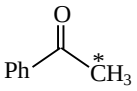
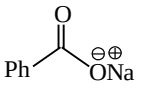
Sol.: Cellulose is a polymer of β(D) glucose. The product cellulose triacetate should have three acetate substituents in each of its repeat unit.
Correct choice: (A)

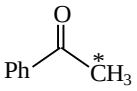
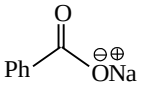
47. In the following reaction sequence, the correct structures of **E**, **F** and **G** are

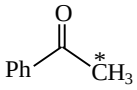
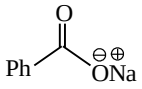


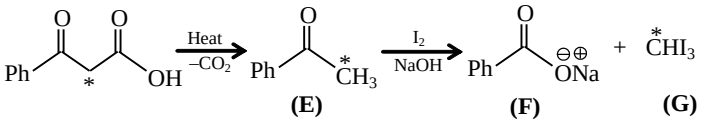
(* implies ^{13}C labelled carbon)

(A) **E** =  **F** =  **G** = CHI_3

(B) **E** =  **F** =  **G** = CHI_3

(C) **E** =  **F** =  **G** = $\overset{*}{C}HI_3$

(D) **E** =  **F** =  **G** = $\overset{*}{C}H_3I$

Sol.: 

(E) **(F)** **(G)**

Correct choice: (C)

48. Among the following, the coloured compound is

(A) CuCl (B) $K_3[Cu(CN)_4]$ (C) CuF_2 (D) $[Cu(CH_3CN)_4]BF_4$

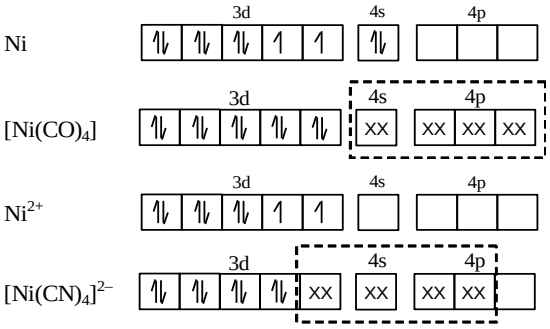
Sol.: CuF_2 is coloured because Cu^{2+} ion has one unpaired electron in the 3d subshell. Rest of the compounds are not coloured because Cu^+ present in each compound has completely filled 3d subshell.

Correct choice: (C)

49. Both $[Ni(CO)_4]$ and $[Ni(CN)_4]^{2-}$ are diamagnetic. The hybridisations of nickel in these complexes, respectively, are

(A) sp^3, sp^3 (B) sp^3, dsp^2 (C) dsp^2, sp^3 (D) dsp^2, dsp^2

Sol.:



The hybridisation of Ni in $[Ni(CO)_4]$ is sp^3 and in $[Ni(CN)_4]^{2-}$ is dsp^2.

Correct choice: (B)

50. The IUPAC name of $[Ni(NH_3)_4]$ $[NiCl_4]$ is

(A) Tetrachloronickel(II)-tetraamminenickel(II)

(B) Tetraamminenickel(II)-tetrachloronickel(II)

(C) Tetraamminenickel(II)-tetrachloronickelate(II)

(D) Tetrachloronickel(II)-tetraamminenickelate(0)

Sol.: Tetraamminenickel(II)-tetrachloronickelate(II)

Correct choice: (C)

51. Electrolysis of dilute aqueous NaCl solution was carried out by passing 10 milli ampere current. The time required to liberate 0.01 mol of H_2 gas at the cathode is (1 Faraday = 96500 C mol^{-1})

(A) 9.65×10^4 sec (B) 19.3×10^4 sec (C) 28.95×10^4 sec (D) 38.6×10^4 sec

Sol.: $I = 10 \times 10^{-3} = 10^{-2}$ amp

$Q = 0.01 \times 2F = 0.02\ F = 0.02 \times 96500$ C

$$t = \frac{Q}{I} = \frac{0.02 \times 96500}{10^{-2}} = 19.3 \times 10^4 \text{ sec.}$$

Correct choice: (B)

52. Among the following, the surfactant that will form micelles in aqueous solution at the lowest molar concentration at ambient conditions is

(A) $CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$ (B) $CH_3(CH_2)_{11}OSO_3^-Na^+$

(C) $CH_3(CH_2)_6COO^-Na^+$ (D) $CH_3(CH_2)_{11}N^+(CH_3)_3Br^-$

Sol.: Those surfactant molecules will be able to form associated colloids (micelles) readily which have greater hydrophobic interactions. Thus critical micellar concentration (CMC) will be lowest for such surfactant molecules. The hydrophobic end is biggest in $CH_3(CH_2)_{15}N^+(CH_3)_3Br^-$.

Correct choice: (A)

***53.** Solubility product constants (K_{sp}) of salts of types MX, MX_2 and M_3X at temperature 'T' are 4.0×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15}, respectively. Solubilities (mol dm^{-3}) of the salts at temperature 'T' are in the order

(A) $MX > MX_2 > M_3X$ (B) $M_3X > MX_2 > MX$ (C) $MX_2 > M_3X > MX$ (D) $MX > M_3X > MX_2$

Sol.: K_{sp} of MX = 4.0×10^{-8}

Solubility of MX = $(4.0 \times 10^{-8})^{1/2} = 2 \times 10^{-4}$ M

K_{sp} of $MX_2 = 3.2 \times 10^{-14}$

Solubility of $MX_2 = \left(\frac{3.2\times10^{-14}}{4}\right)^{1/3} = 2 \times 10^{-5}$ M

K_{sp} of $M_3X = 2.7 \times 10^{-15}$

Solubility of $M_3X = \left(\frac{2.7\times10^{-15}}{27}\right)^{1/4} = 10^{-4}$ M.

$\therefore$ The decreasing order of their solubilities is $MX > M_3X > MX_2$.

Correct choice: (D)

SECTION – II
Reasoning Type

This section contains 4 reasoning type questions. Each question has 4 choices (A), (B), (C) and (D) out of which **ONLY ONE** is correct.

---

54. STATEMENT-1: Aniline on reaction with $NaNO_2$/HCl at 0°C followed by coupling with β–naphthol gives a dark blue coloured precipitate.

and

STATEMENT-2: The colour of the compound formed in the reaction of aniline with $NaNO_2$/HCl at 0°C followed by coupling with β–naphthol is due to the extended conjugation.

(A) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 **is** a correct explanation for STATEMENT-1.

(B) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 **is NOT** a correct explanation for STATEMENT-1.

(C) STATEMENT-1 is True, STATEMENT-2 is False.

(D) STATEMENT-1 is False, STATEMENT-2 is True.

Sol.: STATEMENT-1 is false because the coupling of diazonium salt with β–naphthol gives orange red coloured precipitate. STATEMENT-2 is true.

Correct choice: (D)

55. STATEMENT-1: $[Fe(H_2O)_5NO]SO_4$ is paramagnetic.

and

STATEMENT-2: The Fe in $[Fe(H_2O)_5NO]SO_4$ has three unpaired electrons.

(A) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 **is** a correct explanation for STATEMENT-1.

(B) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 **is NOT** a correct explanation for STATEMENT-1.

(C) STATEMENT-1 is True, STATEMENT-2 is False.

(D) STATEMENT-1 is False, STATEMENT-2 is True.

Sol.: $[Fe(H_2O)_5NO]SO_4$ has ligand NO in +1 oxidation state and metal Fe in +1 state. Since Fe^+ has 3 unpaired electrons, the complex is paramagnetic. STATEMENT-2 is true and is the correct explanation of STATEMENT-1.

Correct choice: (A)

56. STATEMENT-1: The geometrical isomers of the complex $[M(NH_3)_4Cl_2]$ are optically inactive.

and

STATEMENT-2: Both geometrical of the complex $[M(NH_3)_4Cl_2]$ possess axis of symmetry.

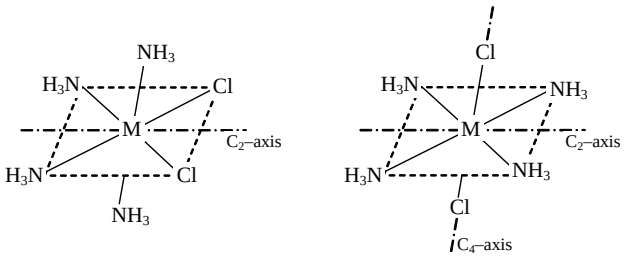
(A) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 **is** a correct explanation for STATEMENT-1.

(B) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 **is NOT** a correct explanation for STATEMENT-1.

(C) STATEMENT-1 is True, STATEMENT-2 is False.

(D) STATEMENT-1 is False, STATEMENT-2 is True.

Sol.: The two geometrical isomers of $[M(NH_3)_4Cl_2]$ are optically inactive as both of them have plane of symmetry. The trans isomer has C_2 and C_4 axes of symmetry whereas the cis isomer has C_2 axis of symmetry. A molecule may be optically active even if it has axis of symmetry. Both the statements are true but the STATEMENT-2 is not the correct explanation of STATEMENT-1.



Correct choice: (B)

***57.** STATEMENT-1: There is a natural asymmetry between converting work to heat and converting heat to work.

and

STATEMENT-2: No process is possible in which the sole result is the absorption of heat from a reservoir and its complete conversion into work.

(A) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 **is** a correct explanation for STATEMENT-1.

(B) STATEMENT-1 is True, STATEMENT-2 is True; STATEMENT-2 **is NOT** a correct explanation for STATEMENT-1.

(C) STATEMENT-1 is True, STATEMENT-2 is False.

(D) STATEMENT-1 is False, STATEMENT-2 is True.

Sol.: Both the statements are true and STATEMENT-2 is the correct explanation of STATEMENT-1.

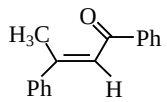
Correct choice: (A)

SECTION – IV
Linked Comprehension Type

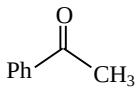
This section contains 2 paragraphs. Based upon each paragraph, 3 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 58 to 60

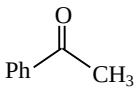
A tertiary alcohol **H** upon acid catalysed dehydration gives a product **I**. Ozonolysis of **I** leads to compounds **J** and **K**. Compound **J** upon reaction with KOH gives benzyl alcohol and a compound **L**, whereas **K** on reaction with KOH gives only **M**.

M = 

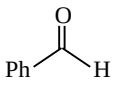
58. Compound **H** is formed by the reaction of

(A) 

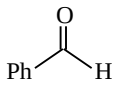
+ PhMgBr

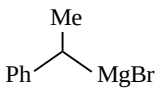
(B) 

+ $PhCH_2MgBr$

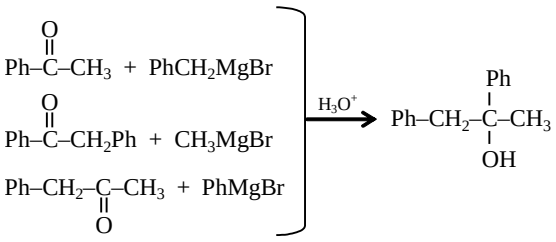
(C) 

+ $PhCH_2MgBr$

(D) 

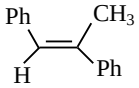
+ 

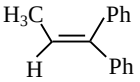
Sol.: The compound (H) is $Ph–CH_2–\underset{\displaystyle OH}{\overset{\displaystyle Ph}{\underset{|}{\overset{|}{C}}}}–CH_3$. This being a tertiary alcohol can be prepared through the reaction of ketone with a Grignard reagent followed by hydrolysis via any of three possible routes.

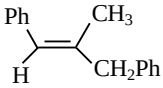


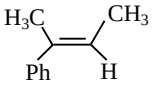
Correct choice: (B)

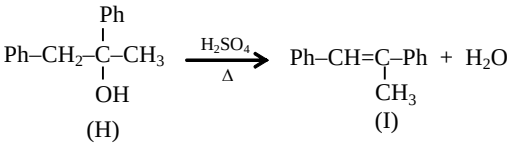
59. The structure of compound **I** is

(A) 

(B) 

(C) 

(D) 

Sol.: 

(H) (I)

Correct choice: (A)

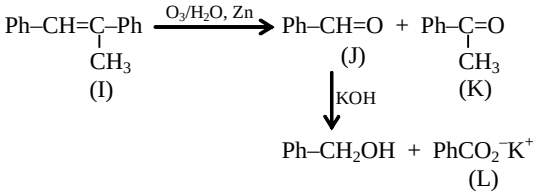
60. The structures of compounds **J**, **K** and **L**, respectively, are

(A) $PhCOCH_3$, $PhCH_2COCH_3$ and $PhCH_2COO^-K^+$

(B) PhCHO, $PhCH_2CHO$ and $PhCOO^-K^+$

(C) $PhCOCH_3$, $PhCH_2CHO$ and $CH_3COO^-K^+$

(D) PhCHO, $PhCOCH_3$ and $PhCOO^-K^+$

Sol.: 

Correct choice: (D)

Paragraph for Question Nos. 61 to 63

In hexagonal systems of crystals, a frequently encountered arrangement of atoms is described as a hexagonal prism. Here, the top and bottom of the cell are regular hexagons and three atoms are sandwiched in between them. A space-filling model of this structure, called hexagonal close-packed (HCP), is constituted of a sphere on a flat surface surrounded in the same plane by six identical spheres as closely as possible. Three spheres are then placed over the first layer so that they touch each other and represent the second layer. Each one of these three spheres touches three spheres of the bottom layer. Finally, the second layer is covered with a third layer that is identical to the bottom layer in relative position. Assume radius of every sphere to be 'r'.

61. The number of atoms in this HCP unit cell is

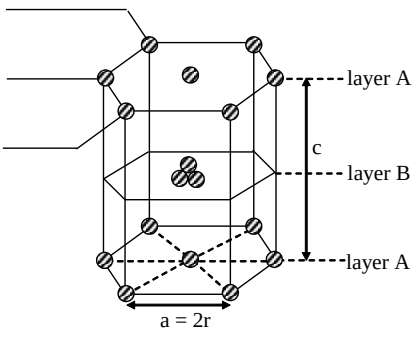
(A) 4

(B) 6

(C) 12

(D) 17

Sol.:



The number of effective atoms in the above hcp unit cell = $\left(12\times\frac{1}{6}\right)+\left(2\times\frac{1}{2}\right)+(3\times1)=6.$

Correct choice: (B)

62. The volume of this HCP unit cell is

(A) $24\sqrt{2}\,r^3$ (B) $16\sqrt{2}\,r^3$

(C) $12\sqrt{2}\,r^3$ (D) $\frac{64}{3\sqrt{3}}r^3$

Sol.: Volume of unit cell = area of the base × height of unit cell = $6\times\frac{\sqrt{3}\,a^2\times h}{4}$

$$= 6\times\frac{\sqrt{3}\,a^2}{4}\times\sqrt{\frac{8}{3}}a = 3\sqrt{2}\,a^3 = 3\sqrt{2}\times(2r)^3 = 24\sqrt{2}\,r^3$$

Correct choice: (A)

63. The empty space in this HCP unit cell is

(A) 74% (B) 47.6%

(C) 32% (D) 26%

Sol.: Packing fraction = $\frac{6\times\frac{4}{3}\pi r^3}{24\sqrt{2}\,r^3} = \frac{\pi}{3\sqrt{2}} = 0.74$

So, void fraction = 0.26 = **26%**.

Correct choice: (D)

SECTION – IV

Matrix–Match Type

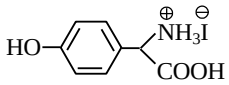
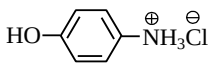
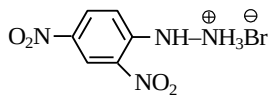
This section contains 3 questions. Each question contains statements given in two columns which have to be matched. Statements A, B, C, D in **Column I** have to be matched with statements (p, q, r, s) in **Column II**. The answers to these questions have to be appropriately bubbled as illustrated in the following example.

If the correct matches are A–q, A–r, B–p, B–s, C–r, C–s and D–q, then the correctly bubbled 4 × 4 matrix should be as follows:

	p	q	r	s
A	○	●	●	○
B	●	○	○	●
C	○	○	●	●
D	○	●	○	○

---

64. Match the compounds in **Column I** with their characteristic test(s)/reaction(s) given in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I	**Column II**
(A) $H_2N–\overset{\oplus}{N}H_3\overset{\ominus}{Cl}$	(p) sodium fusion extract of the compound gives Prussian blue colour with $FeSO_4$
(B) 	(q) gives positive $FeCl_3$ test
(C) 	(r) gives white precipitate with $AgNO_3$
(D) 	(s) reacts with aldehydes to form the corresponding hydrazone derivative

Sol.: (A)– (r), (s) ; (B)–(p), (q) ; (C)–(p), (q), (r) ; (D)–(p), (s)

65. Match the conversions in **Column I** with the type(s) of reaction(s) given in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I	**Column II**
(A) $PbS \longrightarrow PbO$	(p) roasting
(B) $CaCO_3 \longrightarrow CaO$	(q) calcination
(C) $ZnS \longrightarrow Zn$	(r) carbon reduction
(D) $Cu_2S \longrightarrow Cu$	(s) self reduction

Sol.: (A)– (p) ; (B)–(q) ; (C)–(p), (r) ; (D)–(p), (r), (s)

***66.** Match the entries in **Column I** with the correctly related quantum number(s) in **Column II**. Indicate your answer by darkening the appropriate bubbles of the 4 × 4 matrix given in the ORS.

Column I	**Column II**
(A) Orbital angular momentum of the electron in a hydrogen-like atomic orbital	(p) Principal quantum number
(B) A hydrogen-like one electron wave function obeying Pauli principle	(q) Azimuthal quantum number
(C) Shape, size and orientation of hydrogen-like atomic orbitals	(r) Magnetic quantum number
(D) Probability density of electron at the nucleus in hydrogen-like atom	(s) Electron spin quantum number

Sol.: (A)–(q) ; (B)–(p), (q), (r), (s) ; (C)–(p), (q), (r) ; (D)– (p), (q), (r)

Paper-II

Code → Q. No. ↓	0	1	2	3	4	5	6	7	8	9
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2	C	B	D	A	B	C	D	D	A	C
3	B	D	B	C	D	A	C	D	A	A
4	B	D	C	D	C	B	D	A	C	B
5	D	B	A	D	A	C	B	C	B	D
6	D	C	A	B	A	D	D	A	D	D
7	A	A	B	B	C	D	C	D	B	D
8	C	A	D	D	B	D	A	C	D	B
9	A	C	D	C	D	B	A	B	D	C
10	C	C	C	B	C	B	C	C	C	C
11	B	C	C	C	B	C	C	C	C	C
12	C	B	C	C	C	C	C	B	C	B
13	C	C	B	C	C	C	B	C	B	C
14	A	B	A	B	A	B	A	B	A	B
15	A	D	A	D	A	D	A	D	A	D
16	B	C	B	C	B	C	B	C	B	C
17	B	A	B	A	B	A	B	A	B	A
18	D	A	D	A	D	A	D	A	D	A
19	C	B	C	B	C	B	C	B	C	B
20A	s	*	s	*	p	p	s	*	s	*
20B	p, q	q, s	p, q	q, s	s	s	p, q	q, s	p, q	q, s
20C	r	r, s	r	r, s	q	q	r	r, s	r	r, s
20D	p, q, s	p, r	p, q, s	p, r	q	q	p, q, s	p, r	p, q, s	p, r
21A	*	p	p	p	s	*	p	p	p	p
21B	q, s	s	s	s	p, q	q, s	s	s	s	s
21C	r, s	q	q	q	r	r, s	q	q	q	q
21D	p, r	q	q	q	p, q, s	p, r	q	q	q	q
22A	p	s	*	s	*	s	*	s	*	s
22B	s	p, q	q, s	p, q	q, s	p, q	q, s	p, q	q, s	p, q
22C	q	r	r, s	r	r, s	r	r, s	r	r, s	r
22D	q	p, q, s	p, r	p, q, s	p, r	p, q, s	p, r	p, q, s	p, r	p, q, s

*** correct match not available.**

Paper-II

Code → / Q. No. ↓	0	1	2	3	4	5	6	7	8	9
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25	A	B	A	A	D	A	A	B	A	B
26	C	C	A	D	A	A	B	A	A	C
27	D	A	A	B	B	A	C	A	A	D
28	B	A	B	C	A	C	D	B	C	B
29	A	A	C	A	A	B	A	C	C	C
30	A	B	B	C	A	D	A	A	B	A
31	B	A	D	A	C	C	B	A	D	A
32	B	C	B	B	B	B	B	C	B	C
33	B	B	C	B	B	B	C	B	B	B
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36	A	D	A	D	A	D	A	D	A	D
37	B	D	B	D	B	D	B	D	B	D
38	C	C	C	C	C	C	C	C	C	C
39	D	A	D	A	D	A	D	A	D	A
40	D	B	D	B	D	B	D	B	D	B
41	C	C	C	C	C	C	C	C	C	C
42A	p	p,q,r,s	p	p,q,r,s	p	q	p	p,q,r,s	p	p,q,r,s
42B	q,s	q	q,s	q	q,s	p,r	q,s	q	q,s	q
42C	s	p,q,r,s	s	p,q,r,s	s	p,s	s	p,q,r,s	s	p,q,r,s
42D	q	p,q,r,s	q	p,q,r,s	q	q,s	q	p,q,r,s	q	p,q,r,s
43A	p,q,r,s	q	q	q	q	p,q,r,s	q	q	q	q
43B	q	p,r	p,r	p,r	p,r	q	p,r	p,r	p,r	p,r
43C	p,q,r,s	p,s	p,s	p,s	p,s	p,q,r,s	p,s	p,s	p,s	p,s
43D	p,q,r,s	q,s	q,s	q,s	q,s	p,q,r,s	q,s	q,s	q,s	q,s
44A	q	p	p,q,r,s	p	p,q,r,s	p	p,q,r,s	p	p,q,r,s	p
44B	p,r	q,s	q	q,s	q	q,s	q	q,s	q	q,s
44C	p,s	s	p,q,r,s	s	p,q,r,s	s	p,q,r,s	s	p,q,r,s	s
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Paper-II

Code → / Q. No. ↓		0	1	2	3	4	5	6	7	8	9
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58		B	B	B	B	B	B	B	B	B	B
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61		B	B	B	B	B	B	B	B	B	B
62		A	A	A	A	A	A	A	A	A	A
63		D	D	D	D	D	D	D	D	D	D
64	A	r,s	p	r,s	p	r,s	q	r,s	p	r,s	p
	B	p,q	q	p,q	q	p,q	p,q,r,s	p,q	q	p,q	q
	C	p,q,r	p,r	p,q,r	p,r	p,q,r	p,q,r	p,q,r	p,r	p,q,r	p,r
	D	p,s	p,r,s	p,s	p,r,s	p,s	p,q,r	p,s	p,r,s	p,s	p,r,s
65	A	p	q	q	q	q	p	q	q	q	q
	B	q	p,q,r,s	p,q,r,s	p,q,r,s	p,q,r,s	q	p,q,r,s	p,q,r,s	p,q,r,s	p,q,r,s
	C	p,r	p,q,r	p,q,r	p,q,r	p,q,r	p,r	p,q,r	p,q,r	p,q,r	p,q,r
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66	A	q	r,s	p	r,s	p	r,s	p	r,s	p	r,s
	B	p,q,r,s	p,q	q	p,q	q	p,q	q	p,q	q	p,q
	C	p,q,r	p,q,r	p,r	p,q,r	p,r	p,q,r	p,r	p,q,r	p,r	p,q,r
	D	p,q,r	p,s	p,r,s	p,s	p,r,s	p,s	p,r,s	p,s	p,r,s	p,s

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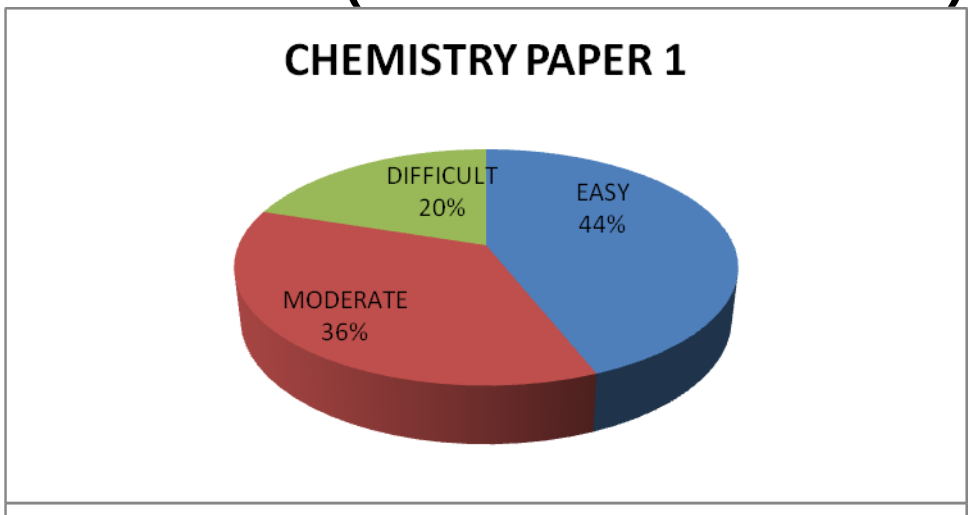

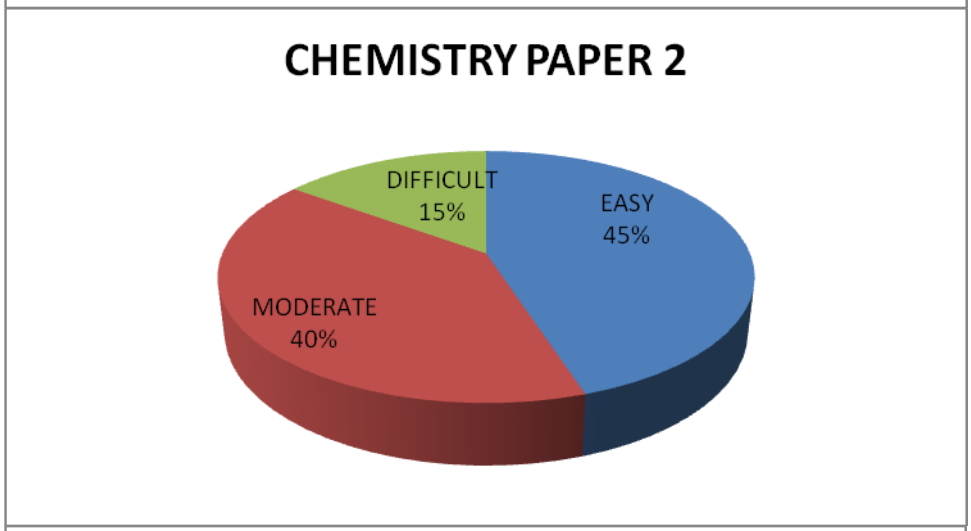

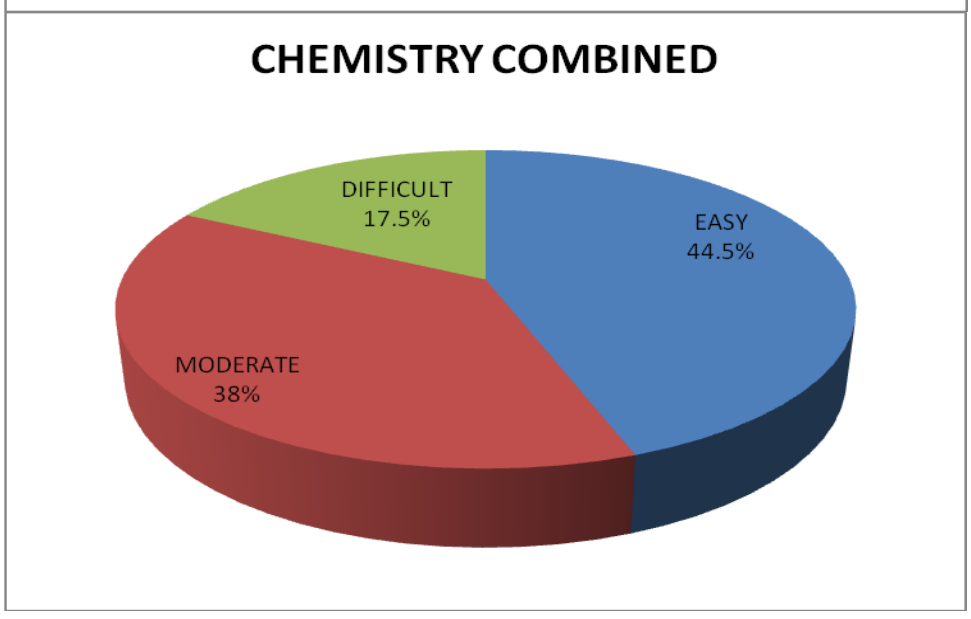

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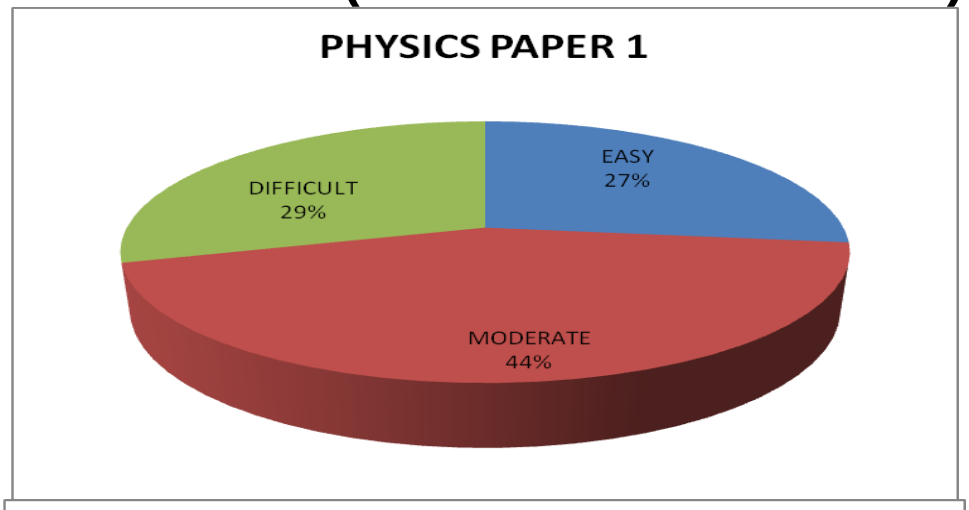

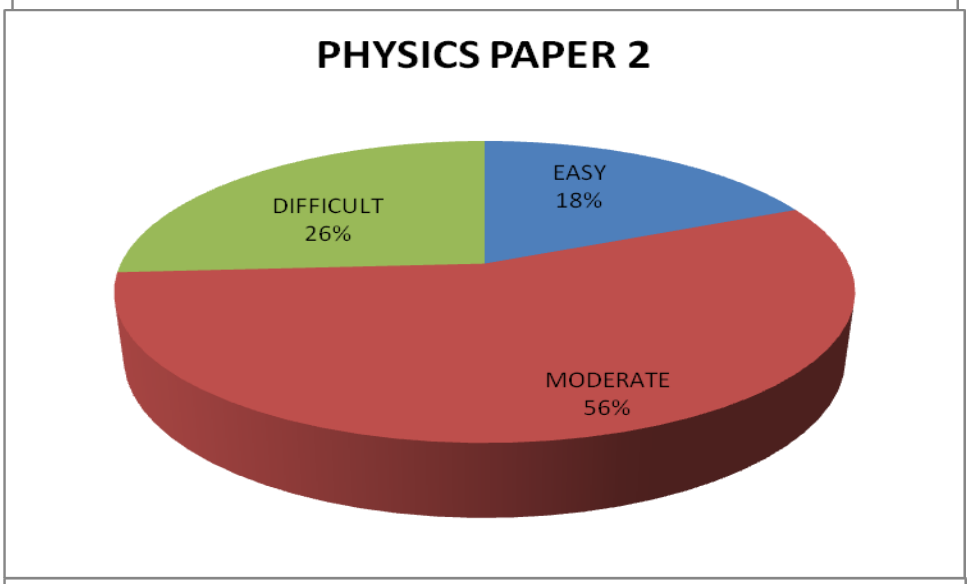

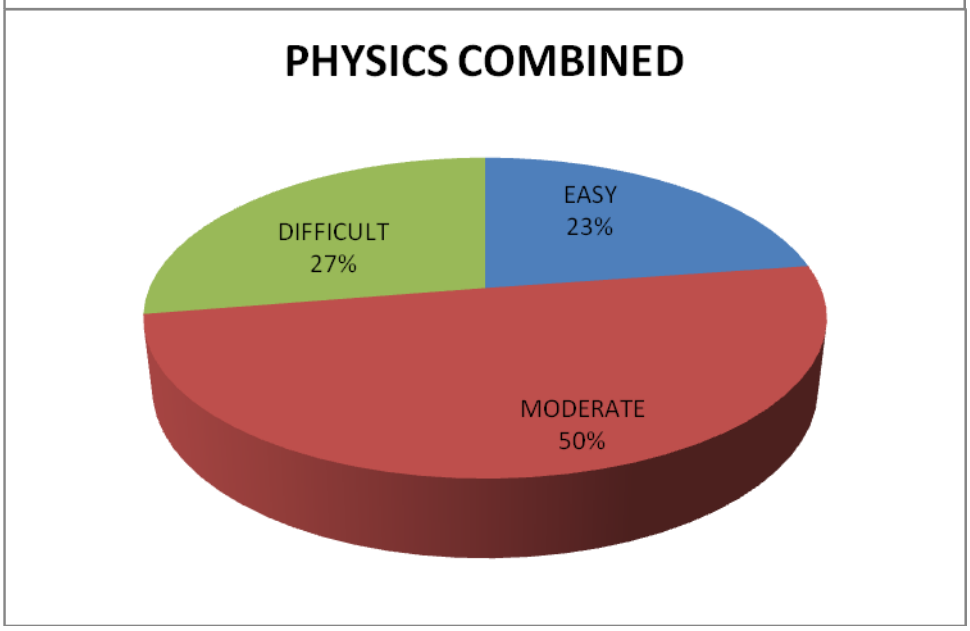

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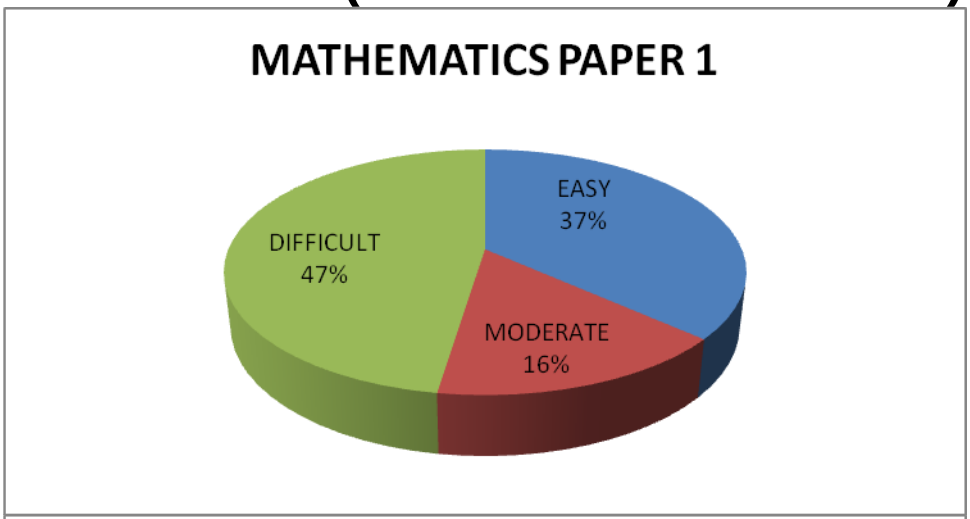
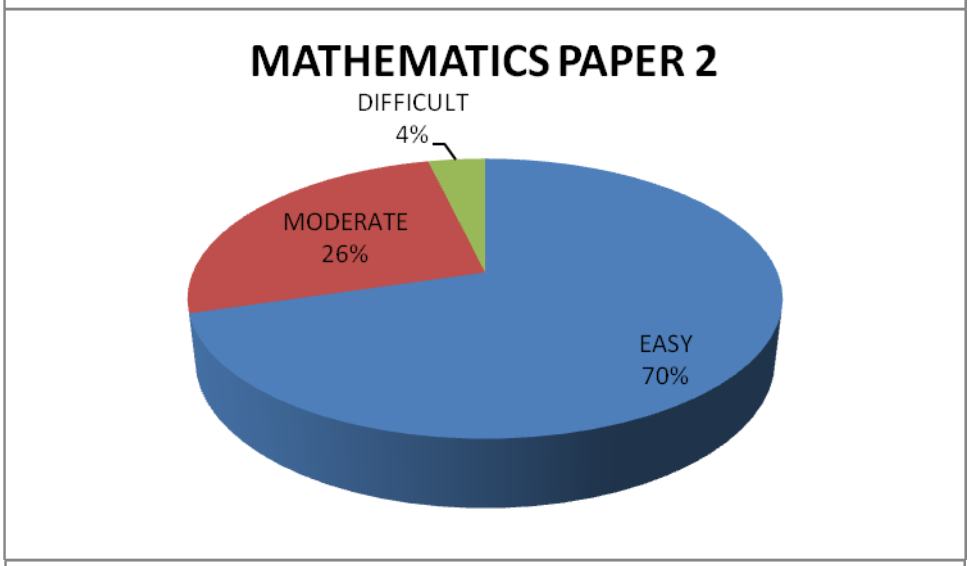
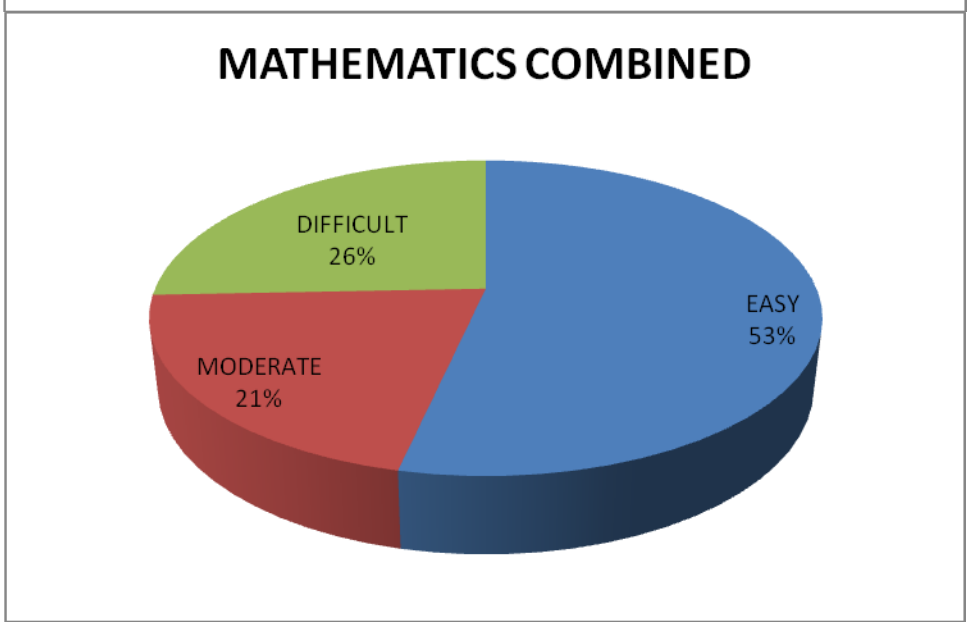
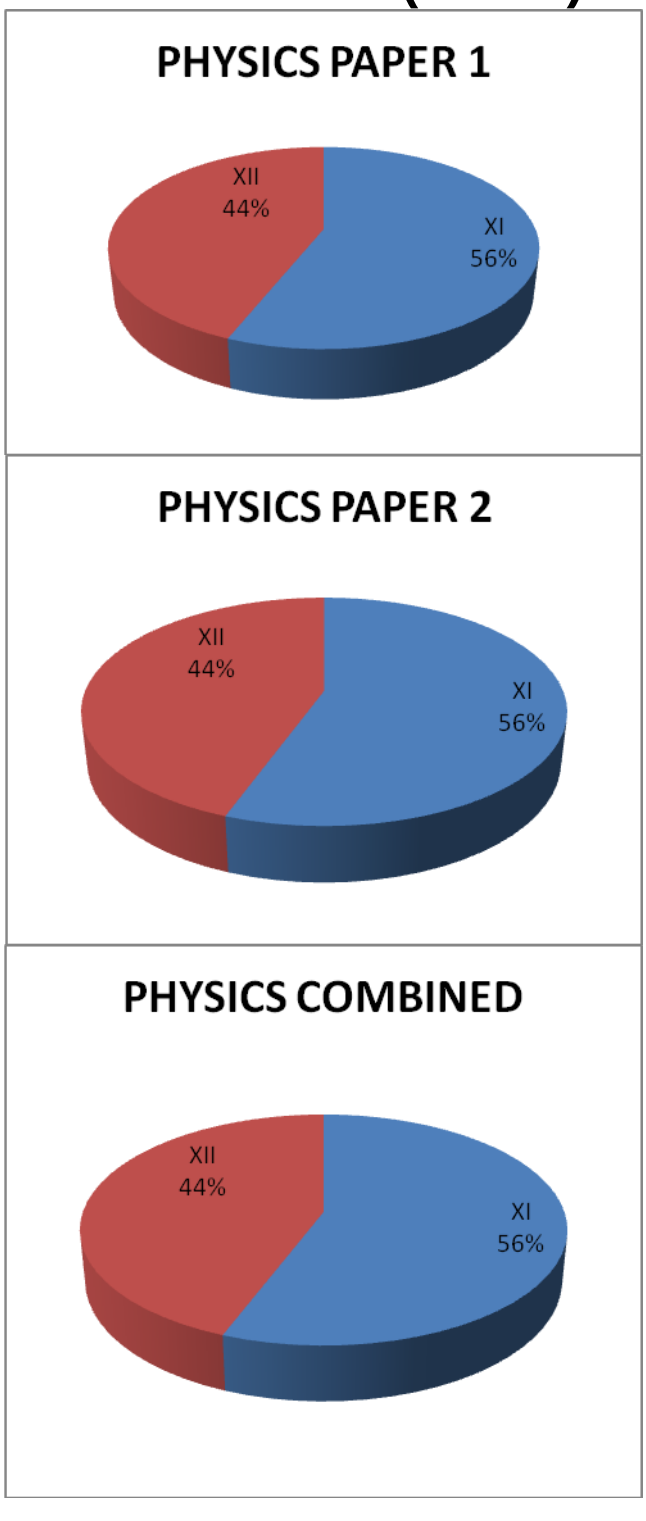


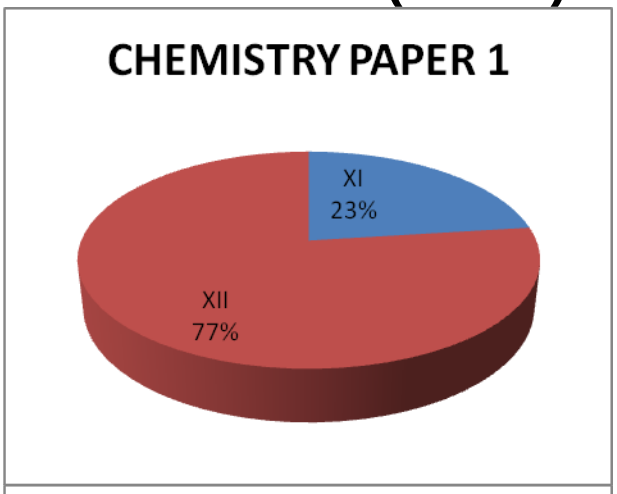


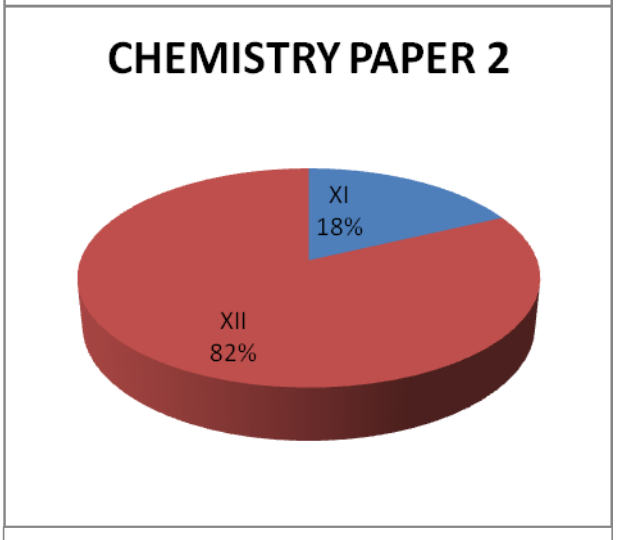


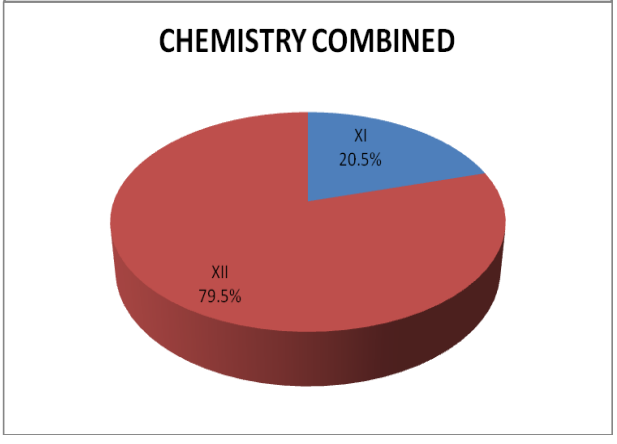
BREAK UP 2 (XI-XII)



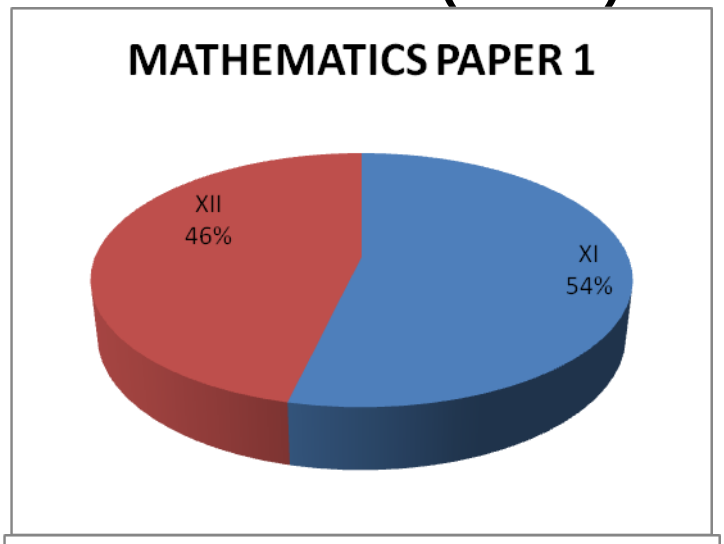
BREAK UP 2 (XI-XII)

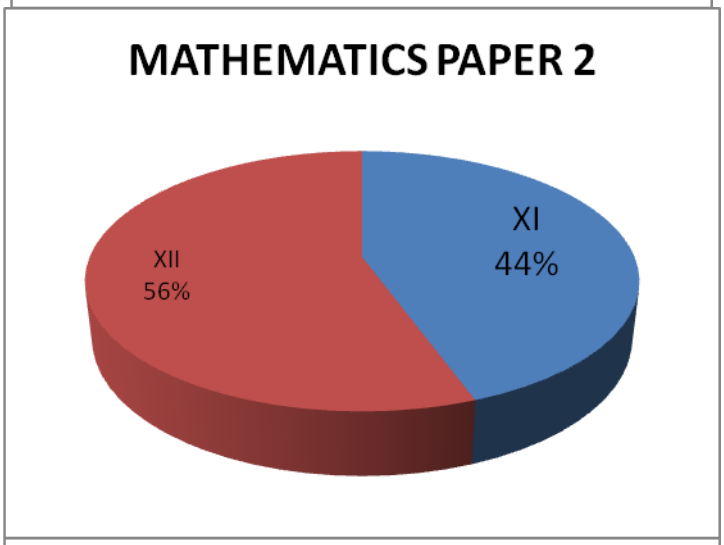


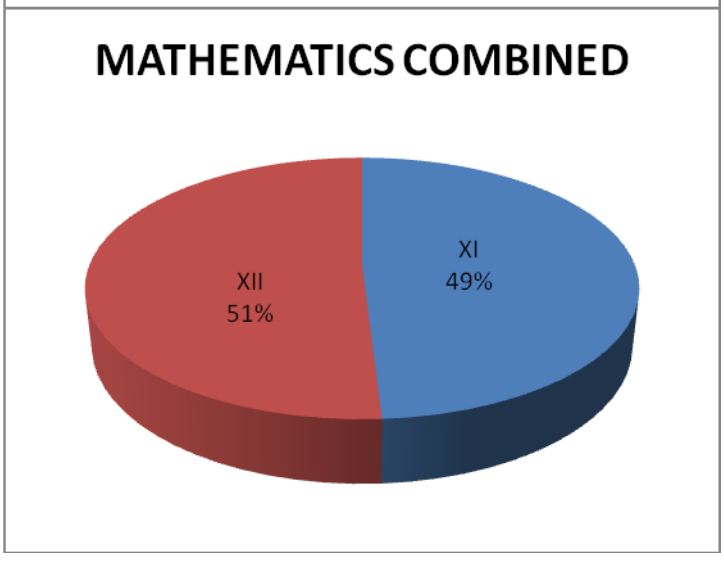




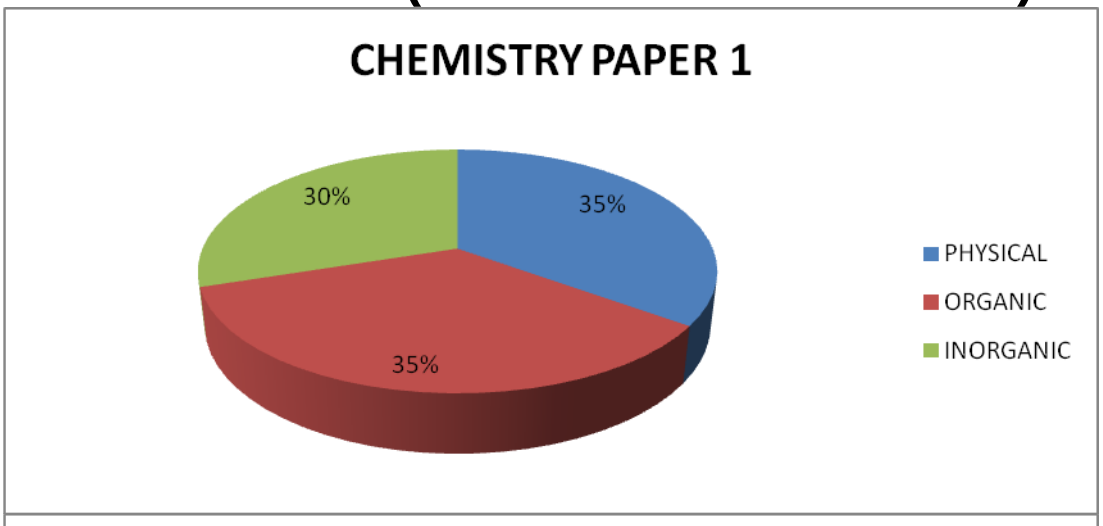
BREAK UP 2 (XI-XII)

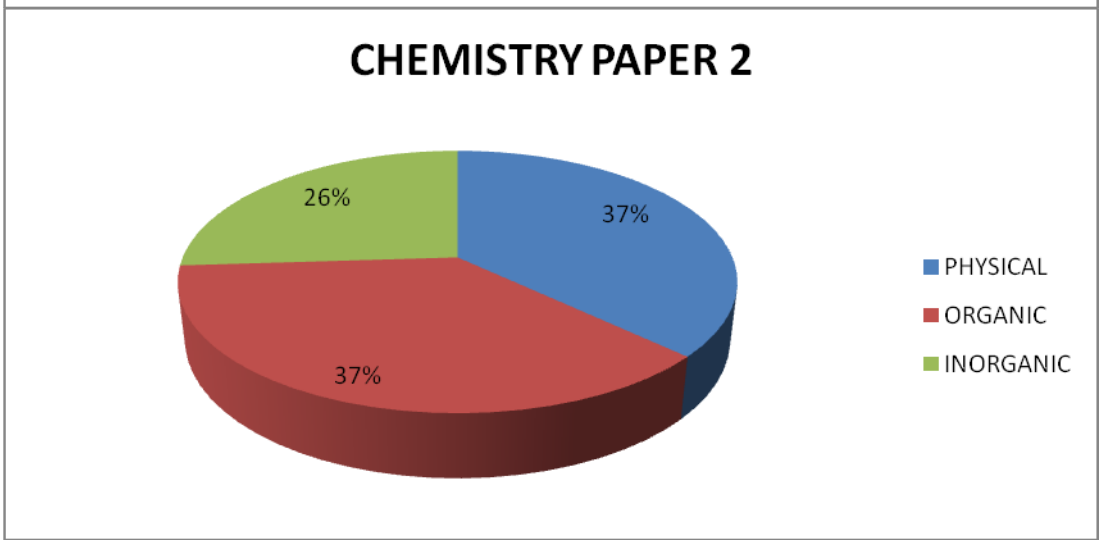


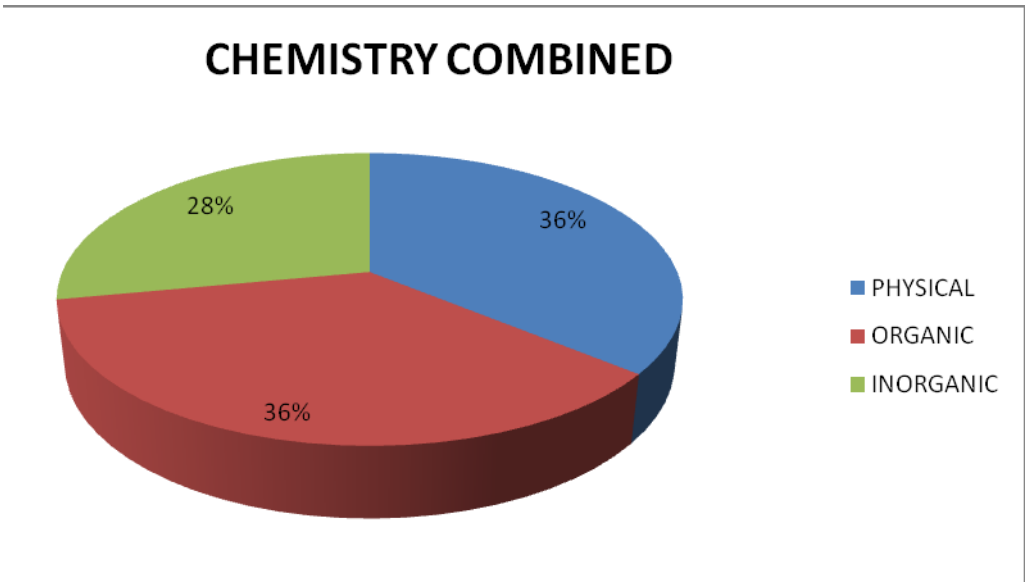




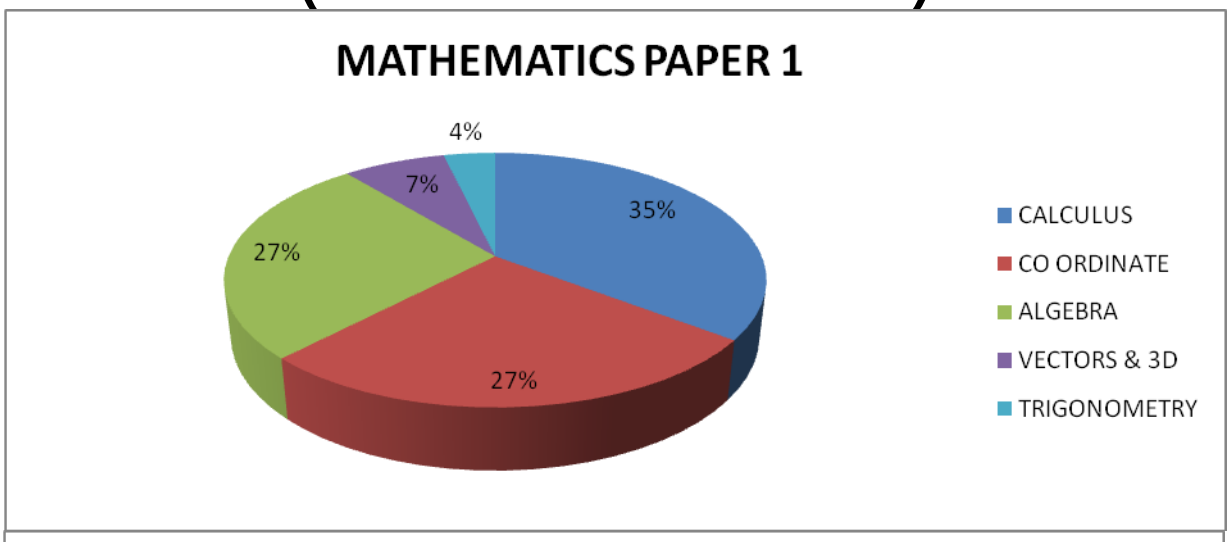
BREAK UP 3 (TOPICWISE/PARTWISE)

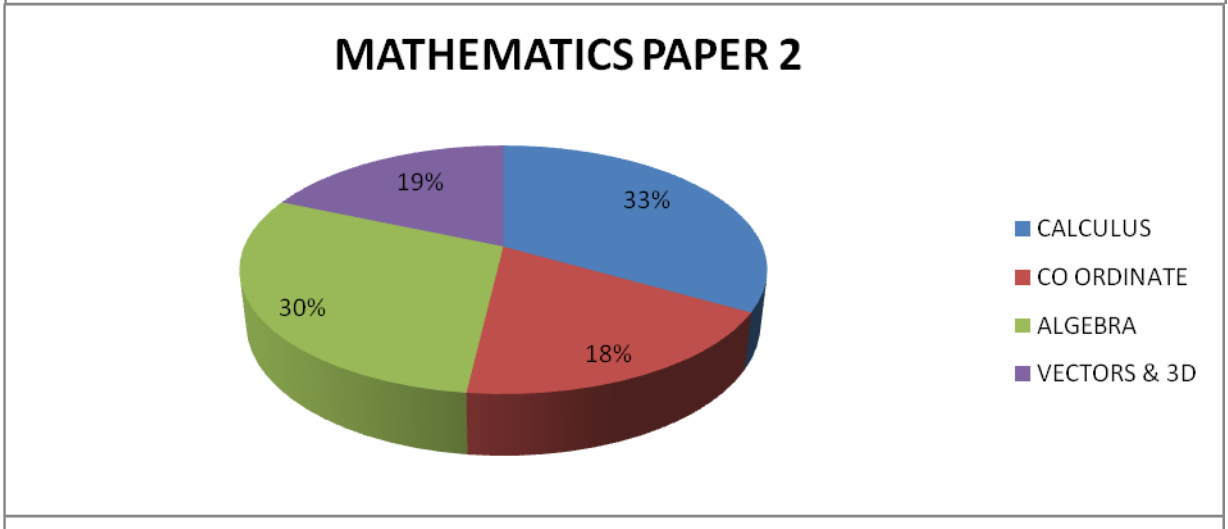


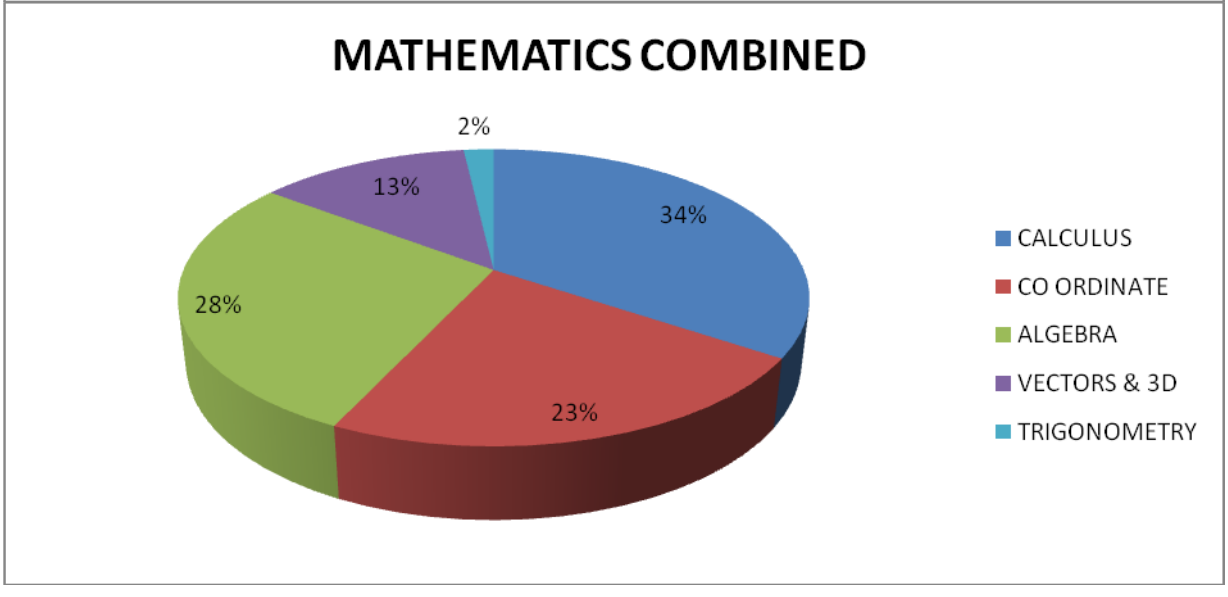




BREAK UP 3
(TOPICWISE/PARTWISE)







BREAK UP 3
(TOPICWISE/PARTWISE)