

No.: 120560995

This booklet contains 24 printed pages.

PAPER - 1 : MATHEMATICS, PHYSICS & CHEMISTRY

Test Booklet Code

Do not open this Test Booklet until you are asked to do so.

Read carefully the Instructions on the Back Cover of this Test Booklet.

C**Important Instructions :**

1. Immediately fill in the particulars on this page of the Test Booklet with *Blue/Black Ball Point Pen*. *Use of pencil is strictly prohibited.*
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 test is of **3 hours** duration.
4. The Test Booklet consists of **90** questions. The maximum marks are **360**.
5. There are *three* parts in the question paper A, B, C consisting of **Mathematics, Physics and Chemistry** having 30 questions in each part of equal weightage. Each question is allotted **4 (four)** marks for each correct response.
6. *Candidates will be awarded marks as stated above in instruction No. 5 for correct response of each question. $\frac{1}{4}$ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.*
7. There is only one correct response for each question. Filling up more than one response in each question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.
8. Use *Blue/Black Ball Point Pen only* for writing particulars/markings responses on *Side-1* and *Side-2* of the Answer Sheet. *Use of pencil is strictly prohibited.*
9. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc., except the Admit Card inside the examination hall/room.
10. Rough work is to be done on the space provided for this purpose in the Test Booklet only. This space is given at the bottom of each page and in 3 pages (Pages 21 - 23) at the end of the booklet.
11. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. *However, the candidates are allowed to take away this Test Booklet with them.*
12. The CODE for this Booklet is **C**. Make sure that the CODE printed on *Side-2* of the Answer Sheet is the same as that on this booklet. In case of discrepancy, the candidate should immediately report the matter to the Invigilator for replacement of both the Test Booklet and the Answer Sheet.
13. **Do not fold or make any stray marks on the Answer Sheet.**

Name of the Candidate (in Capital letters): SAKSHI MATHURRoll Number : in figures

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: in words Two crore forty nine Lakh two thousand eight hundred forty nineExamination Centre Number:

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Name of Examination Centre (in Capital letters): A ONE SECONDARY SCHOOL UNIVERSITY ROAD AYAZCandidate's Signature: Sakshi Invigilator's Signature: Amid

PART A – MATHEMATICS

1. The equation $e^{\sin x} - e^{-\sin x} - 4 = 0$ has :

- (1) infinite number of real roots.
- (2) no real roots.
- (3) exactly one real root.
- (4) exactly four real roots.

2. Let \hat{a} and \hat{b} be two unit vectors. If the vectors $\vec{c} = \hat{a} + 2\hat{b}$ and $\vec{d} = 5\hat{a} - 4\hat{b}$ are perpendicular to each other, then the angle between \hat{a} and \hat{b} is :

- (1) $\frac{\pi}{6}$
- (2) $\frac{\pi}{2}$
- (3) $\frac{\pi}{3}$
- (4) $\frac{\pi}{4}$

$$c \cdot d = 0$$

$$5a^2 - 8b^2 = 0$$

3. A spherical balloon is filled with 4500π cubic meters of helium gas. If a leak in the balloon causes the gas to escape at the rate of 72π cubic meters per minute, then the rate (in meters per minute) at which the radius of the balloon decreases 49 minutes after the leakage began is :

- (1) $9/7$
- (2) $7/9$
- (3) $2/9$
- (4) $9/2$

4. **Statement 1 :** The sum of the series $1 + (1 + 2 + 4) + (4 + 6 + 9) + (9 + 12 + 16) + \dots + (361 + 380 + 400)$ is 8000.

Statement 2 : $\sum_{k=1}^n (k^3 - (k-1)^3) = n^3$,

for any natural number n .

- (1) Statement 1 is false, Statement 2 is true.
- (2) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1.
- (3) Statement 1 is true, Statement 2 is true; Statement 2 is **not** a correct explanation for Statement 1.
- (4) Statement 1 is true, Statement 2 is false.

5. The negation of the statement

“If I become a teacher, then I will open a school”, is :

- (1) I will become a teacher and I will not open a school.
- (2) Either I will not become a teacher or I will not open a school.
- (3) Neither I will become a teacher nor I will open a school.
- (4) I will not become a teacher or I will open a school.

6. If the integral

$$\int \frac{5 \tan x}{\tan x - 2} dx = x + a \ln |\sin x - 2 \cos x| + k$$

then a is equal to :

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

*stand
tanx - 2*

7. **Statement 1 :** An equation of a common tangent to the parabola $y^2 = 16\sqrt{3}x$ and the ellipse $2x^2 + y^2 = 4$ is $y = 2x + 2\sqrt{3}$.

Statement 2 : If the line $y = mx + \frac{4\sqrt{3}}{m}$,

($m \neq 0$) is a common tangent to the parabola $y^2 = 16\sqrt{3}x$ and the ellipse $2x^2 + y^2 = 4$, then m satisfies $m^4 + 2m^2 = 24$.

- (1) Statement 1 is false, Statement 2 is true.
 (2) Statement 1 is true, Statement 2 is true, Statement 2 is a correct explanation for Statement 1.
 (3) Statement 1 is true, Statement 2 is true, Statement 2 is **not** a correct explanation for Statement 1.
 (4) Statement 1 is true, Statement 2 is false.

8. Let $A = \begin{pmatrix} 1 & 0 & 0 \\ 2 & 1 & 0 \\ 3 & 2 & 1 \end{pmatrix}$. If u_1 and u_2 are

column matrices such that $Au_1 = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix}$ and

$Au_2 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}$, then $u_1 + u_2$ is equal to :

(1) $\begin{pmatrix} -1 \\ 1 \\ 0 \end{pmatrix}$

(2) $\begin{pmatrix} -1 \\ 1 \\ -1 \end{pmatrix}$

(3) $\begin{pmatrix} -1 \\ -1 \\ 0 \end{pmatrix}$

(4) $\begin{pmatrix} 1 \\ -1 \\ -1 \end{pmatrix}$

9. If n is a positive integer, then

$(\sqrt{3} + 1)^{2n} - (\sqrt{3} - 1)^{2n}$ is :

- (1) an irrational number
 (2) an odd positive integer
 (3) an even positive integer
 (4) a rational number other than positive integers

10. If 100 times the 100th term of an AP with non zero common difference equals the 50 times its 50th term, then the 150th term of this AP is :

- (1) -150
 (2) 150 times its 50th term
 (3) 150
 (4) zero

11. In a ΔPQR , if $3 \sin P + 4 \cos Q = 6$ and $4 \sin Q + 3 \cos P = 1$, then the angle R is equal to :

- (1) $\frac{5\pi}{6}$
 (2) $\frac{\pi}{6}$
 (3) $\frac{\pi}{4}$
 (4) $\frac{3\pi}{4}$

12. An equation of a plane parallel to the plane $x - 2y + 2z - 5 = 0$ and at a unit distance from the origin is :

- (1) $x - 2y + 2z - 3 = 0$
 (2) $x - 2y + 2z + 1 = 0$
 (3) $x - 2y + 2z - 1 = 0$
 (4) $x - 2y + 2z + 5 = 0$

13. If the line $2x + y = k$ passes through the point which divides the line segment joining the points (1, 1) and (2, 4) in the ratio 3 : 2, then k equals :

- (1) $\frac{29}{5}$
 (2) 5
 (3) 6
 (4) $\frac{11}{5}$

14. Let x_1, x_2, \dots, x_n be n observations, and \bar{x} be their arithmetic mean and σ^2 be the variance.

Statement 1 : Variance of $2x_1, 2x_2, \dots, 2x_n$ is $4\sigma^2$.

Statement 2 : Arithmetic mean of $2x_1, 2x_2, \dots, 2x_n$ is $4\bar{x}$.

- (1) Statement 1 is false, Statement 2 true.
 (2) Statement 1 is true, Statement 2 true, Statement 2 is a correct explanation for Statement 1.
 (3) Statement 1 is true, Statement 2 true, Statement 2 is not a correct explanation for Statement 1.
 (4) Statement 1 is true, Statement 2 false.

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SPACE FOR ROUGH WORK

$$x - 2y + 2z = 5$$

$$\frac{1}{\sqrt{1+4+4}} (x - 2y + 2z - 5) = \frac{5}{\sqrt{9}}$$

$$\frac{1}{3} (x - 2y + 2z - 5) = \frac{5}{3}$$

$$x - 2y + 2z - 5 = 5$$

$$x - 2y + 2z - 1 = 0$$

$$\frac{2}{\sqrt{1+4+4}} (a + 99d) = \frac{56}{3} (a + 49d)$$

$$2(a + 99d) = 56(a + 49d)$$

$$2a + 198d = 56a + 2744d$$

$$a = -149d$$

$2\left(\frac{850}{5}\right) + \frac{14}{5} = k$
 $\frac{16}{4} = \frac{30}{5} = 6$

15. The population $p(t)$ at time t of a certain mouse species satisfies the differential equation $\frac{dp(t)}{dt} = 0.5 p(t) - 450$. If $p(0) = 850$, then the time at which the population becomes zero is :

- (1) $2 \ln 18$
 - (2) $\ln 9$
 - (3) $\frac{1}{2} \ln 18$
 - (4) $\ln 18$
- Handwritten solution for Q15:*
 $\int \frac{p(t) dp(t)}{0.5 p(t) - 450} = dt$
 $\log(0.5 p(t) - 450) = -t$

16. Let $a, b \in \mathbb{R}$ be such that the function f given by $f(x) = \ln|x| + bx^2 + ax$, $x \neq 0$ has extreme values at $x = -1$ and $x = 2$.

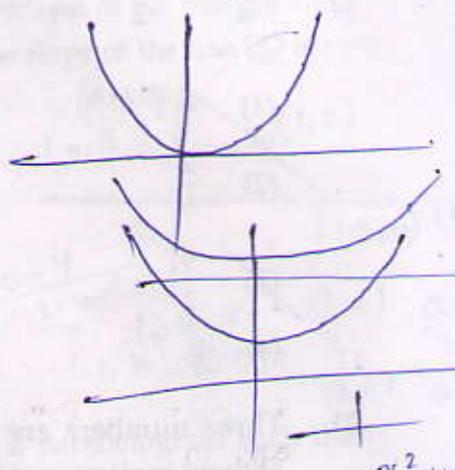
Statement 1 : f has local maximum at $x = -1$ and at $x = 2$.

Statement 2 : $a = \frac{1}{2}$ and $b = \frac{-1}{4}$.

- (1) Statement 1 is false, Statement 2 is true.
- (2) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1.
- (3) Statement 1 is true, Statement 2 is true; Statement 2 is **not** a correct explanation for Statement 1.
- (4) Statement 1 is true, Statement 2 is false.

17. The area bounded between the parabolas $x^2 = \frac{y}{4}$ and $x^2 = 9y$, and the straight line $y = 2$ is :

- (1) $20\sqrt{2}$
- (2) $\frac{10\sqrt{2}}{3}$
- (3) $\frac{20\sqrt{2}}{3}$
- (4) $10\sqrt{2}$



18. Assuming the balls to be identical except for difference in colours, the number of ways in which one or more balls can be selected from 10 white, 9 green and 7 black balls is :

- (1) 880
- (2) 629
- (3) 630
- (4) 879

Handwritten solution for Q18:
 ${}^{26}C_0 + {}^{26}C_1 + \dots + {}^{26}C_{26} = 2^{26} = 67108864$
 ${}^{26}C_0 = 1$
 ${}^{26}C_1 = 26$
 ${}^{26}C_2 = 273$
 ${}^{26}C_3 = 1327$
 ${}^{26}C_4 = 6503$
 ${}^{26}C_5 = 23034$
 ${}^{26}C_6 = 65780$
 ${}^{26}C_7 = 156227$
 ${}^{26}C_8 = 312454$
 ${}^{26}C_9 = 520071$
 ${}^{26}C_{10} = 772915$
 ${}^{26}C_{11} = 1041913$
 ${}^{26}C_{12} = 1302428$
 ${}^{26}C_{13} = 1562277$
 ${}^{26}C_{14} = 1819397$
 ${}^{26}C_{15} = 2073570$
 ${}^{26}C_{16} = 2323797$
 ${}^{26}C_{17} = 2569077$
 ${}^{26}C_{18} = 2809397$
 ${}^{26}C_{19} = 3044670$
 ${}^{26}C_{20} = 3274997$
 ${}^{26}C_{21} = 3500277$
 ${}^{26}C_{22} = 3720597$
 ${}^{26}C_{23} = 3935870$
 ${}^{26}C_{24} = 4146097$
 ${}^{26}C_{25} = 4351277$
 ${}^{26}C_{26} = 4551497$

19. If $f : \mathbb{R} \rightarrow \mathbb{R}$ is a function defined by $f(x) = [x] \cos\left(\frac{2x-1}{2}\right)\pi$, where $[x]$ denotes the greatest integer function, then f is :

- (1) continuous for every real x .
- (2) discontinuous only at $x = 0$.
- (3) discontinuous only at non-zero integral values of x .
- (4) continuous only at $x = 0$.

148
 48
 $\frac{148}{48} = a + 149d$
 $\frac{148}{48} = 149d$

$1 + \frac{1}{2} = 1.5$

$- [x] \sin\left(\frac{2x-1}{2}\right)\pi$

20. If the lines $\frac{x-1}{2} = \frac{y+1}{3} = \frac{z-1}{4}$ and

$\frac{x-3}{1} = \frac{y-k}{2} = \frac{z}{1}$ intersect, then k is equal

to :

(1) -1

(2) $\frac{2}{9}$

(3) $\frac{9}{2}$

(4) 0

21. Three numbers are chosen at random without replacement from $\{1, 2, 3, \dots, 8\}$. The probability that their minimum is 3, given that their maximum is 6, is :

(1) $\frac{3}{8}$

(2) $\frac{1}{5}$

(3) $\frac{1}{4}$

(4) $\frac{2}{5}$

22. If $z \neq 1$ and $\frac{z^2}{z-1}$ is real, then the point represented by the complex number z lies :

(1) either on the real axis or on a circle passing through the origin.

(2) on a circle with centre at the origin.

(3) either on the real axis or on a circle not passing through the origin.

(4) on the imaginary axis.

23. Let P and Q be 3×3 matrices with $P \neq Q$. If $P^3 = Q^3$ and $P^2Q = Q^2P$, the determinant of $(P^2 + Q^2)$ is equal to :

(1) -2

(2) 1

(3) 0

(4) -1

24. If $g(x) = \int_0^x \cos 4t \, dt$, then $g(x)$ equals :

(1) $\frac{g(x)}{g(\pi)}$

(2) $g(x) + g(\pi)$

(3) $g(x) - g(\pi)$

(4) $g(x) \cdot g(\pi)$

25. The length of the diameter of the circle which touches the x-axis at the point (1, 0) and passes through the point (4, 3) is :

(1) 10/3

(2) 3/5

(3) 6/5

(4) 5/3

26. Let $X = \{1, 2, 3, 4, 5\}$. The number of different ordered pairs (Y, Z) that can be formed such that $Y \subseteq X, Z \subseteq X$ and $Y \cap Z$ is empty, is :

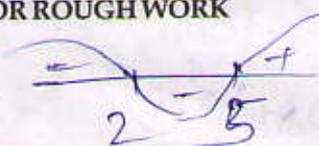
(1) 5^2

(2) 3^5

(3) 2^5

(4) 5^3

$-x+2 = -x+5$
 $-4+2 = -4+5$
 $-8+7$



$-2x+7 = 0$
 $x = 3.5$
 (A circle is drawn around the number 2 on the x-axis.)

27. An ellipse is drawn by taking a diameter of the circle $(x-1)^2 + y^2 = 1$ as its semi-minor axis and a diameter of the circle $x^2 + (y-2)^2 = 4$ as its semi-major axis. If the centre of the ellipse is at the origin and its axes are the coordinate axes, then the equation of the ellipse is :

- (1) $4x^2 + y^2 = 4$
- (2) $x^2 + 4y^2 = 8$
- (3) $4x^2 + y^2 = 8$
- (4) $x^2 + 4y^2 = 16$

28. Consider the function, $f(x) = |x-2| + |x-5|, x \in \mathbb{R}$.

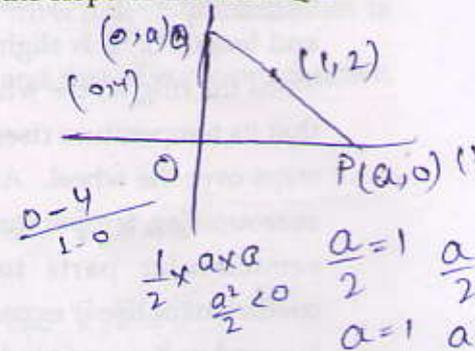
Statement 1 : $f'(4) = 0$

Statement 2 : f is continuous in $[2, 5]$, differentiable in $(2, 5)$ and $f(2) = f(5)$.

- (1) Statement 1 is false, Statement 2 is true.
- (2) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1.
- (3) Statement 1 is true, Statement 2 is true; Statement 2 is **not** a correct explanation for Statement 1.
- (4) Statement 1 is true, Statement 2 is false.

29. A line is drawn through the point $(1, 2)$ to meet the coordinate axes at P and Q such that it forms a triangle OPQ , where O is the origin. If the area of the triangle OPQ is least, then the slope of the line PQ is :

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

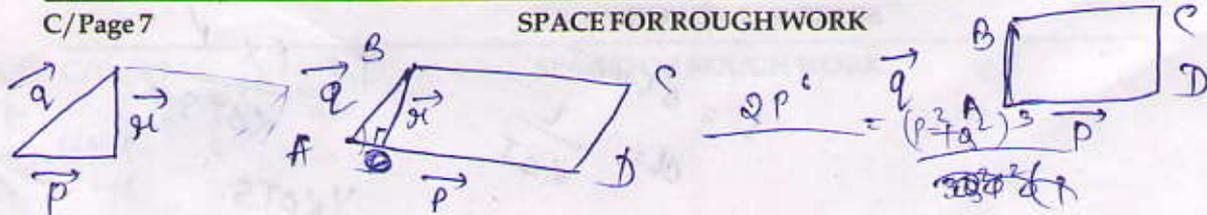


30. Let $ABCD$ be a parallelogram such that $\vec{AB} = \vec{q}$, $\vec{AD} = \vec{p}$ and $\angle BAD$ be an acute angle. If \vec{r} is the vector that coincides with the altitude directed from the vertex B to the side AD , then \vec{r} is given by :

- (1) $\vec{r} = 3\vec{q} - \frac{3(\vec{p} \cdot \vec{q})}{(\vec{p} \cdot \vec{p})} \vec{p}$
- (2) $\vec{r} = -\vec{q} + \frac{(\vec{p} \cdot \vec{q})}{(\vec{p} \cdot \vec{p})} \vec{p}$
- (3) $\vec{r} = \vec{q} - \frac{(\vec{p} \cdot \vec{q})}{(\vec{p} \cdot \vec{p})} \vec{p}$
- (4) $\vec{r} = -3\vec{q} + \frac{3(\vec{p} \cdot \vec{q})}{(\vec{p} \cdot \vec{p})} \vec{p}$

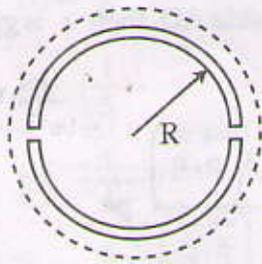
C/Page 7

SPACE FOR ROUGHWORK



PART B – PHYSICS

31. A wooden wheel of radius R is made of two semicircular parts (see figure). The two parts are held together by a ring made of a metal strip of cross sectional area S and length L . L is slightly less than $2\pi R$. To fit the ring on the wheel, it is heated so that its temperature rises by ΔT and it just steps over the wheel. As it cools down to surrounding temperature, it presses the semicircular parts together. If the coefficient of linear expansion of the metal is α , and its Young's modulus is Y , the force that one part of the wheel applies on the other part is :



(1) $2\pi SY\alpha\Delta T$

(2) $SY\alpha\Delta T$

(3) $\pi SY\alpha\Delta T$

(4) $2SY\alpha\Delta T$

$$Y = \frac{F}{\pi R^2} \cdot \frac{L}{\Delta L}$$

$$Y = \frac{F \times \Delta L}{\pi R^2 L}$$

$$Y = \frac{F \times \Delta L}{S L}$$

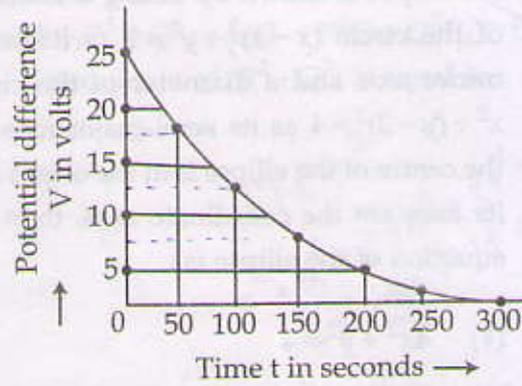
$$L = \Delta L \times \alpha \Delta T$$

$$\Delta L = \frac{L}{\alpha \Delta T}$$

$$Y = \frac{F \times L}{\alpha \Delta T S L}$$

$$Y \times \alpha \Delta T S$$

32.



The figure shows an experimental plot discharging of a capacitor in an RC circuit. The time constant τ of this circuit lies between :

(1) 150 sec and 200 sec

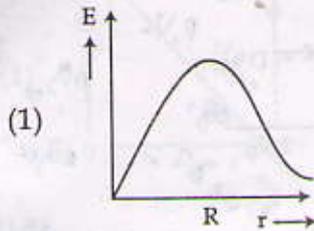
(2) 0 and 50 sec

(3) 50 sec and 100 sec

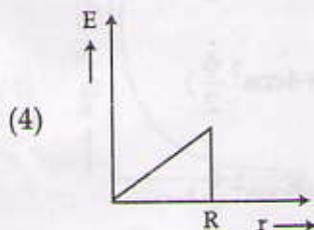
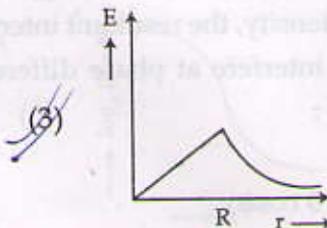
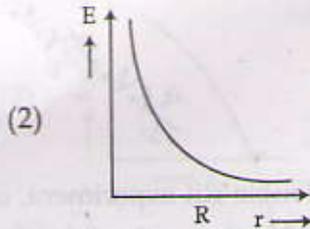
(4) 100 sec and 150 sec

SEAL

33. In a uniformly charged sphere of total charge Q and radius R , the electric field E is plotted as a function of distance from the centre. The graph which would correspond to the above will be :



$\frac{kQ}{r^2}$
 $\frac{kQr}{R^3}$



34. An electromagnetic wave in vacuum has the electric and magnetic fields \vec{E} and \vec{B} , which are always perpendicular to each other. The direction of polarization is given by \vec{X} and that of wave propagation by \vec{k} . Then :

- (1) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$
- (2) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$
- (3) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$
- (4) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

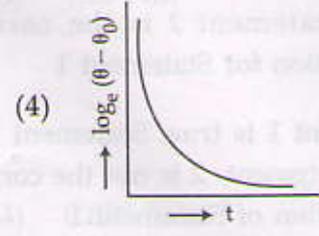
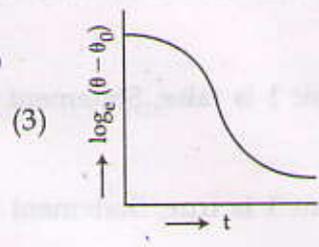
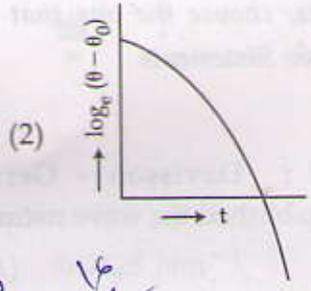
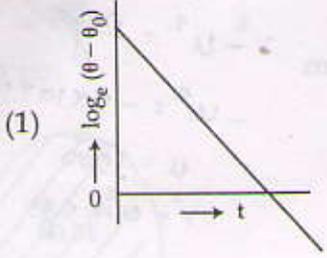
35. If a simple pendulum has significant amplitude (up to a factor of $1/e$ of original) only in the period between $t=0s$ to $t=\tau s$, then τ may be called the average life of the pendulum. When the spherical bob of the pendulum suffers a retardation (due to viscous drag) proportional to its velocity, with 'b' as the constant of proportionality, the average life time of the pendulum is (assuming damping is small) in seconds :

- (1) $\frac{0.693}{b}$
- (2) b
- (3) $\frac{1}{b}$
- (4) $\frac{2}{b}$

$\frac{L}{R}$
 $\frac{C}{R}$
 $\frac{L}{R}$
50x96
45

SPACE FOR ROUGH WORK

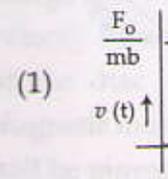
41. A liquid in a beaker has temperature $\theta(t)$ at time t and θ_0 is temperature of surroundings, then according to Newton's law of cooling the correct graph between $\log_e(\theta - \theta_0)$ and t is :



42. A particle of mass m is at rest at the origin at time $t=0$. It is subjected to a force $F(t) = F_0 e^{-bt}$ in the x direction. Its speed $v(t)$ is depicted by which of the following curves ?

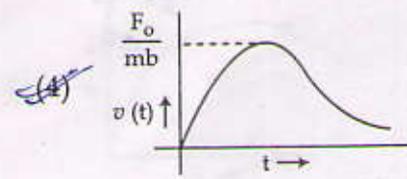
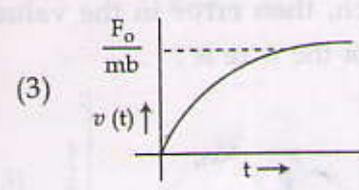
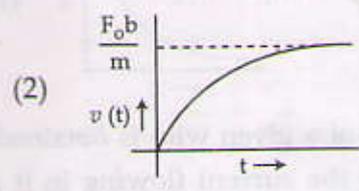
$-b F_0 e^{-bt} = F = \frac{-dV}{dt}$

$F = ma$
 $F = m \frac{dv}{dt}$



$F_0 e^{-bt} dt = m dv$
 $\frac{F_0 e^{-bt}}{-b} = mv$

$\frac{F_0 e^{-bt}}{-b m} = v$



$\int p dy$
 $\int nRT dy$

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SPACE FOR ROUGH WORK

$(21 \cdot 2) \times \frac{1}{2} \times 1000$

H₂ He₂ N₂

Handwritten rough work including calculations and diagrams. Includes terms like $\Delta n (2n-1)$, $\frac{5}{2} R$, $\frac{1}{2} R$, $\frac{3}{2} R$, $\frac{24}{2}$, and $\frac{24}{2}$. There are also some scribbles and a large 'X' mark.

43. Two electric bulbs marked 25W-220V and 100W-220V are connected in series to a 440V supply. Which of the bulbs will fuse ?

- (1) both
- (2) 100W
- (3) 25W
- (4) neither

$$R_1 = \frac{220 \times 220}{25} = 1936$$

$$R_2 = \frac{220 \times 220}{100} = 484$$

45. A boy can throw a stone up to a maximum height of 10 m. The maximum horizontal distance that the boy can throw the stone up to will be :

- (1) $20\sqrt{2}$ m
- (2) 10 m
- (3) $10\sqrt{2}$ m
- (4) 20 m

$s = 10$

$$v^2 - u^2 = 2gs$$

$$-u^2 = -2 \times 10 \times 10$$

$$u = \sqrt{200}$$

$$v^2 = u^2 + 2gs$$

$\theta = \frac{1}{2} \times \pi$
 $t = \sqrt{2}$

46. This question has Statement 1 Statement 2. Of the four choices given the Statements, choose the one that describes the two Statements.

Statement 1 : Davisson - Germer experiment established the wave nature of electrons.

Statement 2 : If electrons have wave nature, they can interfere and show diffraction.

- (1) Statement 1 is false, Statement 2 is true.
- (2) Statement 1 is true, Statement 2 is false
- (3) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation for Statement 1
- (4) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1

44. Resistance of a given wire is obtained by measuring the current flowing in it and the voltage difference applied across it. If the percentage errors in the measurement of the current and the voltage difference are 3% each, then error in the value of resistance of the wire is :

- (1) 6%
- (2) zero
- (3) 1%
- (4) 3%

$$I_0 R = V_0$$

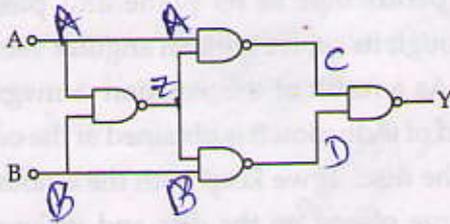
$$\frac{V_0 - \frac{3}{100} V_0}{I_0 - \frac{3}{100} I_0} = R$$

$$\frac{44}{1936} = \frac{44}{1936}$$

$$\frac{22}{22} = \frac{22}{22}$$

$P = 1 \text{ kW}$
 $f = 10 \text{ GHz}$
 $h = 500 \text{ m}$
 $P = \frac{d}{t}$
 $\lambda = \frac{c}{f}$

49. Truth table for system of four NAND gates as shown in figure is :



| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 1 |
| 1 | 0 | 1 |
| 1 | 1 | 0 |

(2)

| A | B | Y |
|---|---|---|
| 0 | 0 | 0 |
| 0 | 1 | 0 |
| 1 | 0 | 1 |
| 1 | 1 | 1 |

(3)

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 1 |
| 1 | 0 | 0 |
| 1 | 1 | 0 |

(4)

| A | B | Y |
|---|---|---|
| 0 | 0 | 1 |
| 0 | 1 | 0 |
| 1 | 0 | 0 |
| 1 | 1 | 1 |

50.

A radar has a power of 1 kW and is operating at a frequency of 10 GHz. It is located on a mountain top of height 500 m. The maximum distance upto which it can detect object located on the surface of the earth (Radius of earth = $6.4 \times 10^6 \text{ m}$) is :

- (1) 80 km
- (2) 16 km
- (3) 40 km
- (4) 64 km

51.

Assume that a neutron breaks into a proton and an electron. The energy released during this process is :

(Mass of neutron = $1.6725 \times 10^{-27} \text{ kg}$)

Mass of proton = $1.6725 \times 10^{-27} \text{ kg}$

Mass of electron = $9 \times 10^{-31} \text{ kg}$)

- (1) 0.73 MeV
- (2) 7.10 MeV
- (3) 6.30 MeV
- (4) 5.4 MeV

0 m e^2
 231.5

$\eta = \frac{48}{100} = \frac{1}{5}$ $M = 1 - \frac{T_2}{T_1}$
 $3 \sqrt{500 \times 2}$ $3 \sqrt{1000}$

$\frac{m_1}{m_2} = \frac{T_1}{T_2}$ $\frac{4\phi X}{6\phi X} = \frac{500}{T}$ $\frac{2}{3} = \frac{500}{T}$ $T = \frac{500 \times 3}{2}$ $T = 750$

52. A Carnot engine, whose efficiency is 40%, takes in heat from a source maintained at a temperature of 500 K. It is desired to have an engine of efficiency 60%. Then, the intake temperature for the same exhaust (sink) temperature must be :

- (1) efficiency of Carnot engine cannot be made larger than 50%
- (2) 1200 K
- (3) 750 K
- (4) 600 K

54. Two cars of masses m_1 and m_2 are moving in circles of radii r_1 and r_2 , respectively. Their speeds are such that they make complete circles in the same time t . The ratio of their centripetal acceleration is :

- (1) $m_1 r_1 : m_2 r_2$
- (2) $m_1 : m_2$
- (3) $r_1 : r_2$
- (4) 1 : 1

$t = \frac{2\pi r_1}{v_1}$
 $t = \frac{2\pi r_2}{v_2}$
 $v_1 = \frac{2\pi r_1}{t}$
 $v_2 = \frac{2\pi r_2}{t}$

53. This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

If two springs S_1 and S_2 of force constants k_1 and k_2 , respectively, are stretched by the same force, it is found that more work is done on spring S_1 than on spring S_2 .

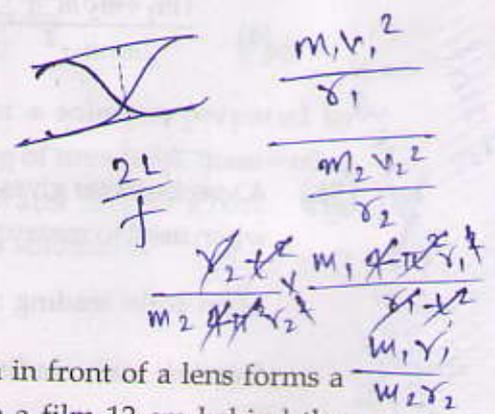
Statement 1 : If stretched by the same amount, work done on S_1 , will be more than that on S_2

Statement 2 : $k_1 < k_2$

- (1) Statement 1 is false, Statement 2 is true.
- (2) Statement 1 is true, Statement 2 is false.
- (3) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1.
- (4) Statement 1 is true, Statement 2 is true, Statement 2 is not the correct explanation of Statement 1.

55. A cylindrical tube, open at both ends, has a fundamental frequency, f , in air. The tube is dipped vertically in water so that half of it is in water. The fundamental frequency of the air-column is now :

- (1) f
- (2) $f/2$
- (3) $3f/4$
- (4) $2f$



56. An object 2.4 m in front of a lens forms a sharp image on a film 12 cm behind the lens. A glass plate 1 cm thick, of refractive index 1.50 is interposed between lens and film with its plane faces parallel to film. At what distance (from lens) should object be shifted to be in sharp focus on film?

- (1) 7.2 m
- (2) 2.4 m
- (3) 3.2 m
- (4) 5.6 m

$f = \frac{2L}{\lambda}$
 $f' = \frac{2L}{\lambda/4}$
 $k_1 > k_2$
 $\omega S_1 > \omega S_2$
 $\frac{1}{2} k_1 x_1^2 > \frac{1}{2} k_2 x_2^2$

214
 Q31.5 MeV

SPACE FOR ROUGH WORK

Q 08 3.4

1.6725×10^{-27} 1.672×10^{-27} 9×10^{-31} $1 - \frac{T_2}{T_1}$
 $2T_1 - 2T = 3T_1 - 1500T$ $\frac{2}{3} = \frac{T_1 - 500}{T_1 - T} = \frac{T_1 - T_2}{T_1 - T}$

$$\eta = \frac{4\phi}{10\phi} = \frac{2}{5}$$

$$M = 1 - \frac{12}{T_1}$$

$$3 \sqrt{500 \times 2} \quad 3 \sqrt{1000}$$

$$\frac{M_1}{\eta_2} = \frac{T_1}{T_2}$$

$$\frac{4\phi \times 1}{6\phi \times 1} = \frac{500}{T}$$

$$\frac{2}{3} = \frac{500}{T} \quad T = \frac{500 \times 3}{2} = 750$$

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- (1) efficiency of Carnot engine cannot be made larger than 50%
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- (1) $m_1 r_1 : m_2 r_2$
- (2) $m_1 : m_2$
- (3) $r_1 : r_2$
- (4) 1 : 1

$$t = \frac{2\pi r_1}{v_1}$$

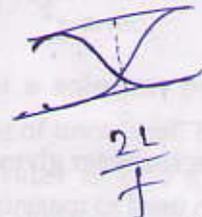
$$t = \frac{2\pi r_2}{v_2}$$

$$v_1 = \frac{2\pi r_1}{t}$$

$$v_2 = \frac{2\pi r_2}{t}$$

55. A cylindrical tube, open at both ends, has a fundamental frequency, f , in air. The tube is dipped vertically in water so that half of it is in water. The fundamental frequency of the air-column is now :

- (1) f
- (2) $f/2$
- (3) $3f/4$
- (4) $2f$



$$\frac{m_1 v_1^2}{\delta_1}$$

$$\frac{m_2 v_2^2}{\delta_2}$$

$$\frac{v_2^2 \times m_1}{m_2 v_1^2} = \frac{v_2^2}{v_1^2} \times \frac{m_1}{m_2}$$

56. An object 2.4 m in front of a lens forms a sharp image on a film 12 cm behind the lens. A glass plate 1 cm thick, of refractive index 1.50 is interposed between lens and film with its plane faces parallel to film.

At what distance (from lens) should object be shifted to be in sharp focus on film?

- (1) 7.2 m
- (2) 2.4 m
- (3) 3.2 m
- (4) 5.6 m

$$f = \frac{2L}{\mu}$$

$$f' = \frac{2L}{\mu/4}$$

$$K_1 > K_2$$

$$\omega S_1 > \omega S_2$$

$$\frac{1}{2} K_1 x_1^2 > \frac{1}{2} K_2 x_2^2$$



57. A diatomic molecule is made of two masses m_1 and m_2 which are separated by a distance r . If we calculate its rotational energy by applying Bohr's rule of angular momentum quantization, its energy will be given by :

- (n is an integer)
- (1) $\frac{(m_1+m_2)^2 n^2 h^2}{2m_1^2 m_2^2 r^2}$
 - (2) $\frac{n^2 h^2}{2(m_1+m_2)r^2}$
 - (3) $\frac{2n^2 h^2}{(m_1+m_2)r^2}$
 - (4) $\frac{(m_1+m_2)n^2 h^2}{2m_1 m_2 r^2}$

$\frac{m_1 h}{2\pi} = m_1 v r$
 $\frac{m_2 h}{2\pi} = m_2 v r$
 $\frac{1}{2} I \omega^2$
 $\frac{m_1 r^2 \omega}{2} + \frac{m_2 r^2 \omega}{2} = \frac{m_1 m_2 r^2 \omega}{5}$

58. A spectrometer gives the following reading when used to measure the angle of a prism.

Main scale reading : 58.5 degree
 Vernier scale reading : 09 divisions

Given that 1 division on main scale corresponds to 0.5 degree. Total divisions on the vernier scale is 30 and match with 29 divisions of the main scale. The angle of the prism from the above data :

- (1) 58.59 degree
- (2) 58.77 degree
- (3) 58.65 degree
- (4) 59 degree

59. This question has Statement 1 and Statement 2. Of the four choices given after the Statements, choose the one that best describes the two Statements.

An insulating solid sphere of radius R has a uniformly positive charge density ρ . As a result of this uniform charge distribution there is a finite value of electric potential at the centre of the sphere, at the surface of the sphere and also at a point outside the sphere. The electric potential at infinity is zero.

Statement 1 : When a charge 'q' is taken from the centre to the surface of the sphere its potential energy changes by $\frac{q\rho}{3\epsilon_0}$

Statement 2 : The electric field at a distance r ($r < R$) from the centre of the sphere is $\frac{\rho r}{3}$

- (1) Statement 1 is true, Statement 2 is true; Statement 2 is not the correct explanation of Statement 1.
- (2) Statement 1 is true Statement 2 is false.
- (3) Statement 1 is false Statement 2 is true.
- (4) Statement 1 is true, Statement 2 is true, Statement 2 is the correct explanation of Statement 1.

60. Proton, Deuteron and alpha particle of same kinetic energy are moving in circular trajectories in a constant magnetic field. The radii of proton, deuteron and alpha particle are respectively r_p , r_d and r_α . Which one of the following relations is correct ?

- (1) $r_\alpha = r_p = r_d$
- (2) $r_\alpha = r_p < r_d$
- (3) $r_\alpha > r_d > r_p$
- (4) $r_\alpha = r_d > r_p$

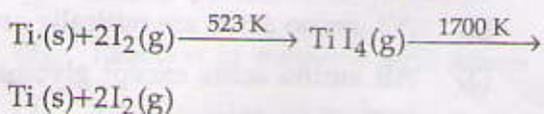
$r_d = m_d v$
 $r_p = \frac{m_p v}{qB}$
 $\frac{58.5}{10} = 5.85$
 $\frac{20}{10.0} = 2.0$
 $r = \frac{m \times v}{qB}$
 ${}^4_2\text{He}$
 ${}^1_1\text{H}$

PART C – CHEMISTRY

61. Which among the following will be named as dibromidobis(ethylene diamine) chromium (III) bromide ?

- (1) $[\text{Cr}(\text{en})_3] \text{Br}_3$
- (2) $[\text{Cr}(\text{en})_2 \text{Br}_2] \text{Br}$
- (3) $[\text{Cr}(\text{en}) \text{Br}_4]^-$
- (4) $[\text{Cr}(\text{en}) \text{Br}_2] \text{Br}$

62. Which method of purification is represented by the following equation :



- (1) Zone refining
- (2) Cupellation
- (3) Poling
- (4) Van Arkel

63. Lithium forms body centred cubic structure. The length of the side of its unit cell is 351 pm. Atomic radius of the lithium will be :

- (1) 75 pm
- (2) 300 pm
- (3) 240 pm
- (4) 152 pm

64. The molecule having smallest bond angle is :

- (1) NCl_3
- (2) AsCl_3
- (3) SbCl_3
- (4) PCl_3

65. Which of the following compounds can be detected by Molisch's test ?

- (1) Nitro compounds
- (2) Sugars
- (3) Amines
- (4) Primary alcohols

66. The incorrect expression among the following is :

- (1) $\frac{\Delta G_{\text{system}}}{\Delta S_{\text{total}}} = -T$
- (2) In isothermal process,
 $w_{\text{reversible}} = -nRT \ln \frac{V_f}{V_i}$
- (3) $\ln K = \frac{\Delta H^\circ - T\Delta S^\circ}{RT}$
- (4) $K = e^{-\Delta G^\circ/RT}$

67. The density of a solution prepared by dissolving 120 g of urea (mol. mass = 60 u) in 1000 g of water is 1.15 g/mL. The molarity of this solution is :

- (1) 0.50 M
- (2) 1.78 M
- (3) 1.02 M
- (4) 2.05 M

68. The species which can best serve as an initiator for the cationic polymerization is :

- (1) LiAlH_4
- (2) HNO_3
- (3) AlCl_3
- (4) BuLi

$$\begin{array}{r} 433 \\ \times 351 \\ \hline 11433 \\ 21653 \\ 12993 \\ \hline 151983 \end{array}$$

$$\begin{array}{r} 29 \\ 0.5 \\ \hline 14.5 \end{array}$$

$$\begin{array}{r} 433 \\ \times 4 \\ \hline 1732 \\ 16 \\ \hline 1732 \end{array}$$

$$R = \frac{M_1}{M_2}$$

$$\sqrt{3}a = 4r$$

$$\frac{\sqrt{3} \times 351}{4} = r$$

$$\begin{array}{r} 56 \overline{) 115} 2.0 \\ \underline{112} \\ 300 \\ \underline{280} \end{array}$$

$$\begin{array}{r} 3 \\ 56 \\ \hline 280 \end{array}$$

69. Which of the following on thermal-decomposition yields a basic as well as an acidic oxide ?

- (1) NaNO_3
- (2) KClO_3
- (3) CaCO_3
- (4) NH_4NO_3

70. The standard reduction potentials for Zn^{2+}/Zn , Ni^{2+}/Ni , and Fe^{2+}/Fe are -0.76 , -0.23 and -0.44 V respectively. The reaction $\text{X} + \text{Y}^{2+} \rightarrow \text{X}^{2+} + \text{Y}$ will be spontaneous when :

- (1) $\text{X} = \text{Ni}$, $\text{Y} = \text{Fe}$
- (2) $\text{X} = \text{Ni}$, $\text{Y} = \text{Zn}$
- (3) $\text{X} = \text{Fe}$, $\text{Y} = \text{Zn}$
- (4) $\text{X} = \text{Zn}$, $\text{Y} = \text{Ni}$

71. According to Freundlich adsorption isotherm, which of the following is correct ?

- (1) $\frac{x}{m} \propto p^0$
- (2) $\frac{x}{m} \propto p^1$
- (3) $\frac{x}{m} \propto p^{1/n}$
- (4) All the above are correct for different ranges of pressure.

72. The equilibrium constant (K_c) for the reaction $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{NO}(\text{g})$ at temperature T is 4×10^{-4} . The value of K_c for the reaction, $\text{NO}(\text{g}) \rightarrow \frac{1}{2}\text{N}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$ at the same temperature is :

- (1) 0.02
- (2) 2.5×10^2
- (3) 4×10^{-4}
- (4) 50.0

73.

The compressibility factor for a real gas at high pressure is :

- (1) $1 + RT/pb$
- (2) 1
- (3) $1 + pb/RT$
- (4) $1 - pb/RT$

74.

Which one of the following statements is correct ?

- (1) All amino acids except lysine are optically active.
- (2) All amino acids are optically active.
- (3) All amino acids except glycine are optically active.
- (4) All amino acids except glutamic acid are optically active.

75.

Aspirin is known as :

- (1) Acetyl salicylic acid
- (2) Phenyl salicylate
- (3) Acetyl salicylate
- (4) Methyl salicylic acid

76.

Ortho-Nitrophenol is less soluble in water than p- and m-Nitrophenols because

- (1) o-Nitrophenol is more volatile steam than those of m- and p-isomers.
- (2) o-Nitrophenol shows Intramolecular H-bonding
- (3) o-Nitrophenol shows Intermolecular H-bonding
- (4) Melting point of o-Nitrophenol lower than those of m- and p-isomers.

77. How many chiral compounds are possible on monochlorination of 2-methyl butane ?

- (1) 8
(2) 2
(3) 4
(4) 6

78. Very pure hydrogen (99.9%) can be made by which of the following processes ?

- (1) Reaction of methane with steam
(2) Mixing natural hydrocarbons of high molecular weight
(3) Electrolysis of water
(4) Reaction of salt like hydrides with water

79. The electrons identified by quantum numbers n and l :

- (a) $n=4, l=1$ P 5
(b) $n=4, l=0$ S 4
(c) $n=3, l=2$ d 5
(d) $n=3, l=1$ P 4

can be placed in order of increasing energy as :

- (1) (c) < (d) < (b) < (a)
(2) (d) < (b) < (c) < (a)
(3) (b) < (d) < (a) < (c)
(4) (a) < (c) < (b) < (d)

80. For a first order reaction, $(A) \rightarrow \text{products}$, the concentration of A changes from 0.1 M to 0.025 M in 40 minutes. The rate of reaction when the concentration of A is 0.01M, is :

- (1) 1.73×10^{-5} M/min
(2) 3.47×10^{-4} M/min
(3) 3.47×10^{-5} M/min
(4) 1.73×10^{-4} M/min

81. Iron exhibits +2 and +3 oxidation states. Which of the following statements about iron is **incorrect** ?

- (1) Ferrous oxide is more basic in nature than the ferric oxide. Fe^{+2} Fe^{+3}
(2) Ferrous compounds are relatively more ionic than the corresponding ferric compounds.
(3) Ferrous compounds are less volatile than the corresponding ferric compounds.
(4) Ferrous compounds are more easily hydrolysed than the corresponding ferric compounds.

82. The pH of a 0.1 molar solution of the acid HQ is 3. The value of the ionization constant, K_a of this acid is :

- (1) 3×10^{-1}
(2) 1×10^{-3}
(3) 1×10^{-5}
(4) 1×10^{-7}

0 1 2 3
s p d f

90×70
147

(63)

83. Which branched chain isomer of the hydrocarbon with molecular mass 72u gives only one isomer of mono substituted alkyl halide ?

- (1) Tertiary butyl chloride
- (2) Neopentane
- (3) Isohexane
- (4) Neohexane

84. K_f for water is $1.86 \text{ K kg mol}^{-1}$. If your automobile radiator holds 1.0 kg of water, how many grams of ethylene glycol ($\text{C}_2\text{H}_6\text{O}_2$) must you add to get the freezing point of the solution lowered to -2.8°C ?

- (1) 72 g
- (2) 93 g
- (3) 39 g
- (4) 27 g

85. What is DDT among the following :

- (1) Greenhouse gas
- (2) A fertilizer
- (3) Biodegradable pollutant
- (4) Non - biodegradable pollutant

86. The increasing order of the ionic radii of the given isoelectronic species is :

- (1) Cl^- , Ca^{2+} , K^+ , S^{2-}
- (2) S^{2-} , Cl^- , Ca^{2+} , K^+
- (3) Ca^{2+} , K^+ , Cl^- , S^{2-}
- (4) K^+ , S^{2-} , Ca^{2+} , Cl^-

87. 2 - Hexyne gives trans - 2 - Hexene on treatment with :

- (1) Pt/H_2
- (2) Li/NH_3
- (3) Pd/BaSO_4
- (4) LiAlH_4

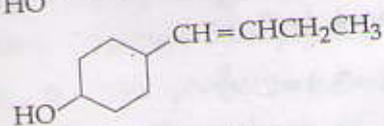
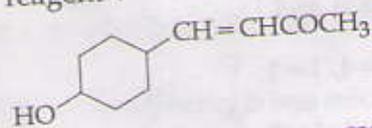
88. Iodoform can be prepared from all except :

- (1) Ethyl methyl ketone
- (2) Isopropyl alcohol
- (3) 3 - Methyl - 2 - butanone
- (4) Isobutyl alcohol

89. In which of the following pairs the two species are not isostructural ?

- (1) CO_3^{2-} and NO_3^-
- (2) PCl_4^+ and SiCl_4
- (3) PF_5 and BrF_5
- (4) AlF_6^{3-} and SF_6

90. In the given transformation, which the following is the most appropriate reagent ?



- (1) $\text{NH}_2\text{NH}_2, \text{OH}^-$
- (2) $\text{Zn} - \text{Hg}/\text{HCl}$
- (3) $\text{Na}, \text{Liq. NH}_3$
- (4) NaBH_4

SPACE FOR ROUGHWORK

C/ Page 20

