This booklet contains **24** printed pages.

**RBS**

No.: 170741464

**PAPER - 1 : MATHEMATICS, PHYSICS & CHEMISTRY**

Test Booklet Code

**D**

**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.**

*Important Instructions :*

1. Immediately fill in the particulars on this page of the Test Booklet with ***only Black Ball Point Pen*** provided in the examination hall.
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 correct response.
6. *Candidates will be awarded marks as stated above in instruction No. 5 for correct response of each question. ¼ (one-fourth) marks of the total marks allotted to the question (i.e. 1 mark) 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 any question will be treated as wrong response and marks for wrong response will be deducted accordingly as per instruction 6 above.
8. For writing particulars/marking responses on ***Side-1*** and ***Side-2*** of the Answer Sheet use ***only Black Ball Point Pen*** provided in the examination hall.
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 room/hall.
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 **four** pages (Page **20-23**) 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 **D**. Make sure that the CODE printed on **Side-2** of the Answer Sheet and also tally the serial number of the Test Booklet and Answer Sheet are 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 mark on the Answer Sheet.**

## PART A – MATHEMATICS

1. If S is the set of distinct values of 'b' for which the following system of linear equations

$$x+y+z=1$$
$$x+ay+z=1$$
$$ax+by+z=0$$

has no solution, then S is :

(1) an empty set

(2) an infinite set

(3) a finite set containing two or more elements

(4) a singleton

2. The following statement

$(p\rightarrow q)\rightarrow[(\sim p\rightarrow q)\rightarrow q]$ is :

(1) a tautology

(2) equivalent to $\sim p\rightarrow q$

(3) equivalent to $p\rightarrow\sim q$

(4) a fallacy

3. If $5(\tan^2 x-\cos^2 x)=2\cos 2x+9$, then the value of $\cos 4x$ is :

(1) $-\frac{3}{5}$

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

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

(4) $-\frac{7}{9}$

4. For three events A, B and C,

P(Exactly one of A or B occurs)

= P(Exactly one of B or C occurs)

= P(Exactly one of C or A occurs) = $\frac{1}{4}$ and

P(All the three events occur simultaneously) = $\frac{1}{16}$.

Then the probability that at least one of the events occurs, is :

(1) $\frac{7}{32}$

(2) $\frac{7}{16}$

(3) $\frac{7}{64}$

(4) $\frac{3}{16}$

5. Let $\omega$ be a complex number such that $2\omega+1=z$ where $z=\sqrt{-3}$. If

$$\begin{vmatrix} 1 & 1 & 1 \\ 1 & -\omega^2-1 & \omega^2 \\ 1 & \omega^2 & \omega^7 \end{vmatrix} = 3k,$$

then k is equal to :

(1) $-z$

(2) $z$

(3) $-1$

(4) $1$



SPACE FOR ROUGH WORK

6. Let k be an integer such that the triangle with vertices (k, $-3k$), (5, k) and ($-k$, 2) has area 28 sq. units. Then the orthocentre of this triangle is at the point :

(1) $\left(2, -\frac{1}{2}\right)$

(2) $\left(1, \frac{3}{4}\right)$

(3) $\left(1, -\frac{3}{4}\right)$

(4) $\left(2, \frac{1}{2}\right)$

7. Twenty meters of wire is available for fencing off a flower-bed in the form of a circular sector. Then the maximum area (in sq. m) of the flower-bed, is :

(1) 12.5

(2) 10

(3) 25

(4) 30

8. The area (in sq. units) of the region $\{(x, y) : x \geq 0, x+y \leq 3, x^2 \leq 4y$ and $y \leq 1+\sqrt{x}\}$ is :

(1) $\frac{59}{12}$

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

(3) $\frac{7}{3}$

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

9. If the image of the point P(1, $-2$, 3) in the plane, $2x+3y-4z+22=0$ measured parallel to the line, $\frac{x}{1}=\frac{y}{4}=\frac{z}{5}$ is Q, then PQ is equal to :

(1) $3\sqrt{5}$

(2) $2\sqrt{42}$

(3) $\sqrt{42}$

(4) $6\sqrt{5}$

10. If, for $x \in \left(0, \frac{1}{4}\right)$, the derivative of $\tan^{-1}\left(\frac{6x\sqrt{x}}{1-9x^3}\right)$ is $\sqrt{x} \cdot g(x)$, then $g(x)$ equals :

(1) $\frac{9}{1+9x^3}$

(2) $\frac{3x\sqrt{x}}{1-9x^3}$

(3) $\frac{3x}{1-9x^3}$

(4) $\frac{3}{1+9x^3}$

11. If $(2+\sin x)\frac{dy}{dx}+(y+1)\cos x = 0$ and $y(0)=1$, then $y\left(\frac{\pi}{2}\right)$ is equal to :

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

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

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

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



SPACE FOR ROUGH WORK

12. Let a vertical tower AB have its end A on the level ground. Let C be the mid-point of AB and P be a point on the ground such that AP = 2AB. If $\angle BPC = \beta$, then $\tan\beta$ is equal to :

(1) $\frac{6}{7}$

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

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

(4) $\frac{4}{9}$

13. If $A = \begin{bmatrix} 2 & -3 \\ -4 & 1 \end{bmatrix}$, then adj $(3A^2 + 12A)$ is equal to :

(1) $\begin{bmatrix} 72 & -84 \\ -63 & 51 \end{bmatrix}$

(2) $\begin{bmatrix} 51 & 63 \\ 84 & 72 \end{bmatrix}$

(3) $\begin{bmatrix} 51 & 84 \\ 63 & 72 \end{bmatrix}$

(4) $\begin{bmatrix} 72 & -63 \\ -84 & 51 \end{bmatrix}$

14. For any three positive real numbers a, b and c,
$9(25a^2 + b^2) + 25(c^2 - 3ac) = 15b(3a + c)$.
Then :

(1) b, c and a are in G.P.

(2) b, c and a are in A.P.

(3) a, b and c are in A.P.

(4) a, b and c are in G.P.

15. The distance of the point (1, 3, −7 the plane passing through the (1, −1, −1), having normal perpenc to both the lines $\frac{x-1}{1} = \frac{y+2}{-2} =$ and $\frac{x-2}{2} = \frac{y+1}{-1} = \frac{z+7}{-1}$, is :

(1) $\frac{20}{\sqrt{74}}$

(2) $\frac{10}{\sqrt{83}}$

(3) $\frac{5}{\sqrt{83}}$

(4) $\frac{10}{\sqrt{74}}$

16. Let $I_n = \int \tan^n x \, dx, (n > 1)$.
$I_4 + I_6 = a \tan^5 x + bx^5 + C$, where C constant of integration, then the orc pair (a, b) is equal to :

(1) $\left(-\frac{1}{5}, 1\right)$

(2) $\left(\frac{1}{5}, 0\right)$

(3) $\left(\frac{1}{5}, -1\right)$

(4) $\left(-\frac{1}{5}, 0\right)$



SPACE FOR ROUGH WORK

17. The eccentricity of an ellipse whose centre is at the origin is $\frac{1}{2}$. If one of its directrices is $x = -4$, then the equation of the normal to it at $\left(1, \frac{3}{2}\right)$ is :

(1) $2y - x = 2$

(2) $4x - 2y = 1$

(3) $4x + 2y = 7$

(4) $x + 2y = 4$

18. A hyperbola passes through the point $P(\sqrt{2}, \sqrt{3})$ and has foci at $(\pm 2, 0)$. Then the tangent to this hyperbola at P also passes through the point :

(1) $(3\sqrt{2}, 2\sqrt{3})$

(2) $(2\sqrt{2}, 3\sqrt{3})$

(3) $(\sqrt{3}, \sqrt{2})$

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

19. The function $f : \mathbf{R} \to \left[-\frac{1}{2}, \frac{1}{2}\right]$ defined as $f(x) = \frac{x}{1 + x^2}$, is :

(1) invertible.

(2) injective but not surjective.

(3) surjective but not injective.

(4) neither injective nor surjective.

20. $\lim\limits_{x \to \frac{\pi}{2}} \frac{\cot x - \cos x}{(\pi - 2x)^3}$ equals :

(1) $\frac{1}{24}$

(2) $\frac{1}{16}$

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

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

21. Let $\vec{a} = 2\hat{i} + \hat{j} - 2\hat{k}$ and $\vec{b} = \hat{i} + \hat{j}$. Let $\vec{c}$ be a vector such that $|\vec{c} - \vec{a}| = 3$, $\left|(\vec{a} \times \vec{b}) \times \vec{c}\right| = 3$ and the angle between $\vec{c}$ and $\vec{a} \times \vec{b}$ be 30°. Then $\vec{a} \cdot \vec{c}$ is equal to :

(1) $\frac{25}{8}$

(2) 2

(3) 5

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



SPACE FOR ROUGH WORK

22. The normal to the curve $y(x-2)(x-3)=x+6$ at the point where the curve intersects the $y$-axis passes through the point :

(1) $\left(-\frac{1}{2}, -\frac{1}{2}\right)$

(2) $\left(\frac{1}{2}, \frac{1}{2}\right)$

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

(4) $\left(\frac{1}{2}, \frac{1}{3}\right)$

23. If two different numbers are taken from the set {0, 1, 2, 3, ....., 10}; then the probability that their sum as well as absolute difference are both multiple of 4, is :

(1) $\frac{6}{55}$

(2) $\frac{12}{55}$

(3) $\frac{14}{45}$

(4) $\frac{7}{55}$

24. A man X has 7 friends, 4 of them are ladies and 3 are men. His wife Y also has 7 friends, 3 of them are ladies and 4 are men. Assume X and Y have no common friends. Then the total number of ways in which X and Y together can throw a party inviting 3 ladies and 3 men, so that 3 friends of each of X and Y are in this party, is :

(1) 485

(2) 468

(3) 469

(4) 484

25. The value of

$\left({}^{21}C_1 - {}^{10}C_1\right) + \left({}^{21}C_2 - {}^{10}C_2\right) +$

$\left({}^{21}C_3 - {}^{10}C_3\right) + \left({}^{21}C_4 - {}^{10}C_4\right) +$

$\left({}^{21}C_{10} - {}^{10}C_{10}\right)$ is :

(1) $2^{21} - 2^{11}$

(2) $2^{21} - 2^{10}$

(3) $2^{20} - 2^9$

(4) $2^{20} - 2^{10}$

26. A box contains 15 green and 10 ye balls. If 10 balls are randomly dr one-by-one, with replacement, the variance of the number of green drawn is :

(1) $\frac{12}{5}$

(2) 6

(3) 4

(4) $\frac{6}{25}$

27. Let a, b, c $\in$ **R**. If $f(x)=ax^2+bx+c$ is s that $a+b+c=3$ and

$f(x+y)=f(x)+f(y)+xy, \forall\ x, y \in \mathbf{R}$,

then $\sum_{n=1}^{10} f(n)$ is equal to :

(1) 330

(2) 165

(3) 190

(4) 255



SPACE FOR ROUGH WORK

28. The radius of a circle, having minimum area, which touches the curve $y = 4 - x^2$ and the lines, $y = |x|$ is :

(1) $2(\sqrt{2} + 1)$

(2) $2(\sqrt{2} - 1)$

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

(4) $4(\sqrt{2} + 1)$

29. If, for a positive integer n, the quadratic equation,

$x(x+1) + (x+1)(x+2) + \ldots$
$+ (x + \overline{n-1})\ (x+n) = 10n$

has two consecutive integral solutions, then n is equal to :

(1) 12

(2) 9

(3) 10

(4) 11

30. The integral $\int_{\frac{\pi}{4}}^{\frac{3\pi}{4}} \frac{dx}{1 + \cos x}$ is equal to :

(1) $-2$

(2) 2

(3) 4

(4) $-1$

## PART B – PHYSICS

*ALL THE GRAPHS/DIAGRAMS GIVEN ARE SCHEMATIC AND NOT DRAWN TO SCALE.*

31. A radioactive nucleus A with a half life T, decays into a nucleus B. At $t = 0$, there is no nucleus B. At sometime t, the ratio of the number of B to that of A is 0.3. Then, t is given by :

(1) $t = \frac{T}{\log(1.3)}$

(2) $t = \frac{T}{2} \frac{\log 2}{\log 1.3}$

(3) $t = T \frac{\log 1.3}{\log 2}$

(4) $t = T \log(1.3)$

32. The following observations were taken for determining surface tension T of water by capillary method :

diameter of capillary, $D = 1.25 \times 10^{-2}$ m

rise of water, $h = 1.45 \times 10^{-2}$ m.

Using $g = 9.80$ m/s$^2$ and the simplified relation $T = \frac{rhg}{2} \times 10^3$ N/m, the possible error in surface tension is closest to :

(1) 10%

(2) 0.15%

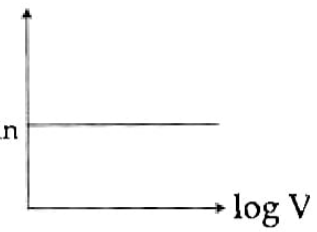
(3) 1.5%

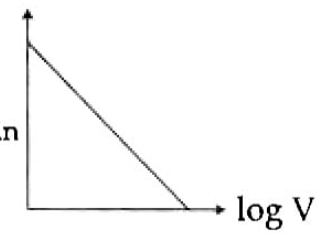
(4) 2.4%

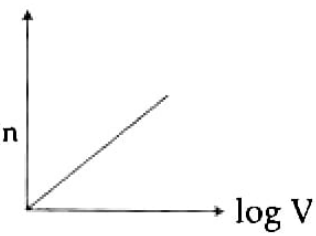


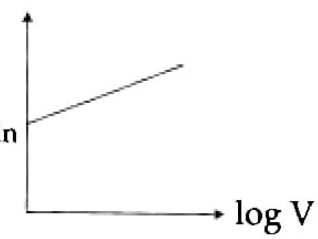
SPACE FOR ROUGH WORK

33. An electron beam is accelerated by a potential difference V to hit a metallic target to produce X-rays. It produces continuous as well as characteristic X-rays. If $\lambda_{min}$ is the smallest possible wavelength of X-ray in the spectrum, the variation of $\log \lambda_{min}$ with $\log V$ is correctly represented in :

(1) 


(2) 


(3) 


(4) 


34. The moment of inertia of a unifo cylinder of length $l$ and radius $R$ about perpendicular bisector is I. What is ratio $l/R$ such that the moment of ine is minimum ?

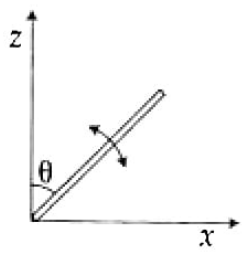
(1) $\frac{3}{\sqrt{2}}$

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

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

(4) 1

35. A slender uniform rod of mass M a length $l$ is pivoted at one end so that it rotate in a vertical plane (see figure). Th is negligible friction at the pivot. The f end is held vertically above the pivot a then released. The angular accelerat of the rod when it makes an angle θ w the vertical is :




(1) $\frac{2g}{3l}\cos\theta$

(2) $\frac{3g}{2l}\sin\theta$

(3) $\frac{2g}{3l}\sin\theta$

(4) $\frac{3g}{2l}\cos\theta$



SPACE FOR ROUGH WORK

36. $C_p$ and $C_v$ are specific heats at constant pressure and constant volume respectively. It is observed that

$C_p - C_v = a$ for hydrogen gas

$C_p - C_v = b$ for nitrogen gas

The correct relation between a and b is :

(1) $a = 28\ b$

(2) $a = \frac{1}{14} b$

(3) $a = b$

(4) $a = 14\ b$

37. A copper ball of mass 100 gm is at a temperature T. It is dropped in a copper calorimeter of mass 100 gm, filled with 170 gm of water at room temperature. Subsequently, the temperature of the system is found to be 75°C. T is given by :

(Given : room temperature = 30°C, specific heat of copper = 0.1 cal/gm°C)

(1) 825°C

(2) 800°C

(3) 885°C

(4) 1250°C

38. In amplitude modulation, sinusoidal carrier frequency used is denoted by $\omega_c$ and the signal frequency is denoted by $\omega_m$. The bandwidth ($\Delta\omega_m$) of the signal is such that $\Delta\omega_m << \omega_c$. Which of the following frequencies is **not** contained in the modulated wave ?

(1) $\omega_c - \omega_m$

(2) $\omega_m$

(3) $\omega_c$

(4) $\omega_m + \omega_c$

39. The temperature of an open room of volume 30 $m^3$ increases from 17°C to 27°C due to the sunshine. The atmospheric pressure in the room remains $1 \times 10^5$ Pa. If $n_i$ and $n_f$ are the number of molecules in the room before and after heating, then $n_f - n_i$ will be :

(1) $-2.5 \times 10^{25}$

(2) $-1.61 \times 10^{23}$

(3) $1.38 \times 10^{23}$

(4) $2.5 \times 10^{25}$

40. In a Young's double slit experiment, slits are separated by 0.5 mm, and the screen is placed 150 cm away. A beam of light consisting of two wavelengths, 650 nm and 520 nm, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is :

(1) 15.6 mm

(2) 1.56 mm

(3) 7.8 mm

(4) 9.75 mm

SPACE FOR ROUGH WORK

41. A particle A of mass m and initial velocity $v$ collides with a particle B of mass $\frac{m}{2}$ which is at rest. The collision is head on, and elastic. The ratio of the de-Broglie wavelengths $\lambda_A$ to $\lambda_B$ after the collision is :

(1) $\frac{\lambda_A}{\lambda_B} = \frac{1}{2}$

(2) $\frac{\lambda_A}{\lambda_B} = \frac{1}{3}$

(3) $\frac{\lambda_A}{\lambda_B} = 2$

(4) $\frac{\lambda_A}{\lambda_B} = \frac{2}{3}$

42. A magnetic needle of magnetic moment $6.7 \times 10^{-2}$ Am$^2$ and moment of inertia $7.5 \times 10^{-6}$ kg m$^2$ is performing simple harmonic oscillations in a magnetic field of 0.01 T. Time taken for 10 complete oscillations is :

(1) 8.76 s

(2) 6.65 s

(3) 8.89 s

(4) 6.98 s

43. An electric dipole has a fixed c moment $\vec{p}$, which makes angle $\theta$ respect to $x$-axis. When subjected electric field $\vec{E}_1 = E\hat{i}$, it experienc torque $\vec{T}_1 = \tau\hat{k}$. When subjecte another electric field $\vec{E}_2 = \sqrt{3}\,E_1$, experiences a torque $\vec{T}_2 = -\vec{T}_1$. The a $\theta$ is :

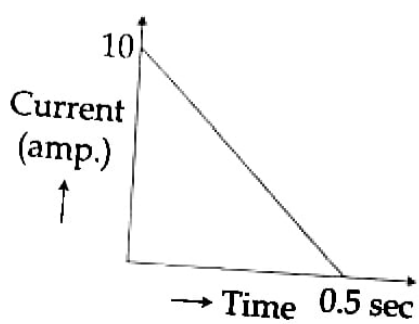
(1) 90°

(2) 30°

(3) 45°

(4) 60°

44. In a coil of resistance 100 Ω, a current induced by changing the magnetic flu through it as shown in the figure. Th magnitude of change in flux through th coil is :




(1) 275 Wb

(2) 200 Wb

(3) 225 Wb

(4) 250 Wb



SPACE FOR ROUGH WORK

45. A time dependent force $F = 6t$ acts on a particle of mass 1 kg. If the particle starts from rest, the work done by the force during the first 1 sec. will be :

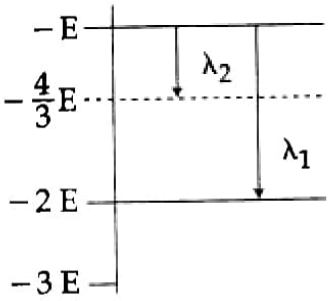
(1) 18 J

(2) 4.5 J

(3) 22 J

(4) 9 J

46. Some energy levels of a molecule are shown in the figure. The ratio of the wavelengths $r = \lambda_1/\lambda_2$, is given by :



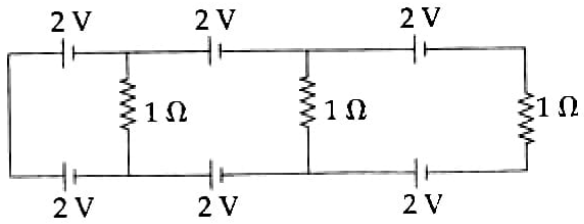

(1) $r = \frac{1}{3}$

(2) $r = \frac{4}{3}$

(3) $r = \frac{2}{3}$

(4) $r = \frac{3}{4}$

47.




In the above circuit the current in each resistance is :

(1) 0 A

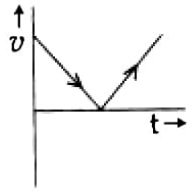
(2) 1 A

(3) 0.25 A

(4) 0.5 A

48. A body is thrown vertically upwards. Which one of the following graphs correctly represent the velocity vs time ?

(1)

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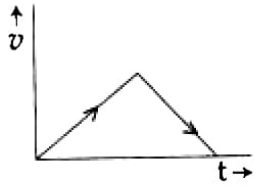


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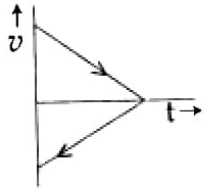
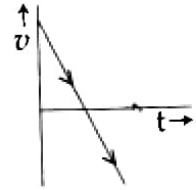



(4)

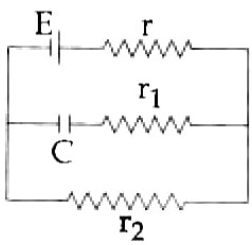





SPACE FOR ROUGH WORK

49. A capacitance of 2 μF is required in an electrical circuit across a potential difference of 1.0 kV. A large number of 1 μF capacitors are available which can withstand a potential difference of not more than 300 V.
The minimum number of capacitors required to achieve this is :
(1) 32
(2) 2
(3) 16
(4) 24

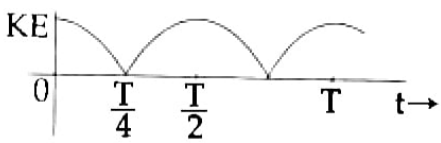
50. In the given circuit diagram when the current reaches steady state in the circuit, the charge on the capacitor of capacitance C will be :

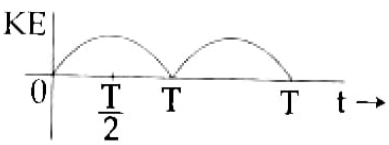



(1) $CE\frac{r_1}{(r_1+r)}$
(2) CE
(3) $CE\frac{r_1}{(r_2+r)}$
(4) $CE\frac{r_2}{(r+r_2)}$

51. In a common emitter amplifier circuit using an n-p-n transistor, the phase difference between the input and the output voltages will be :
(1) 180°
(2) 45°
(3) 90°
(4) 135°

52. Which of the following statements false ?
(1) Kirchhoff's second law represent energy conservation.
(2) Wheatstone bridge is the mos sensitive when all the fou resistances are of the same order o magnitude.
(3) In a balanced wheatstone bridge il the cell and the galvanometer are exchanged, the null point is disturbed.
(4) A rheostat can be used as a potential divider.

53. A particle is executing simple harmonic motion with a time period T. At time t = 0, it is at its position of equilibrium. The kinetic energy - time graph of the particle will look like :
(1)


(2)


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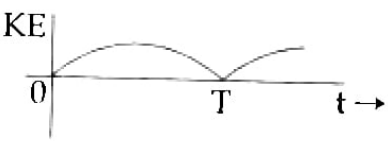

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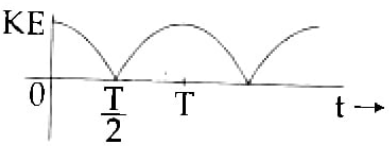




SPACE FOR ROUGH WORK

54. An observer is moving with half the speed of light towards a stationary microwave source emitting waves at frequency 10 GHz. What is the frequency of the microwave measured by the observer ? (speed of light $= 3 \times 10^8$ ms$^{-1}$)

(1) 15.3 GHz

(2) 10.1 GHz

(3) 12.1 GHz

(4) 17.3 GHz

55. A man grows into a giant such that his linear dimensions increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of :

(1) $\frac{1}{81}$

(2) 9

(3) $\frac{1}{9}$

(4) 81

56. When a current of 5 mA is passed through a galvanometer having a coil of resistance 15 Ω, it shows full scale deflection. The value of the resistance to be put in series with the galvanometer to convert it into a voltmeter of range 0 – 10 V is :

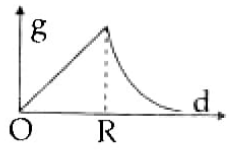
(1) $4.005 \times 10^3$ Ω

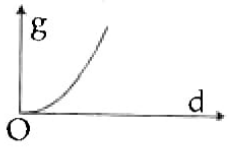
(2) $1.985 \times 10^3$ Ω

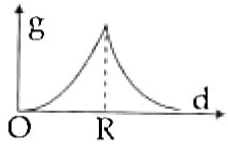
(3) $2.045 \times 10^3$ Ω

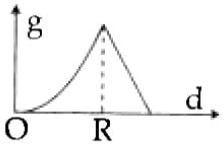
(4) $2.535 \times 10^3$ Ω

57. The variation of acceleration due to gravity g with distance d from centre of the earth is best represented by (R = Earth's radius) :

(1) 


(2) 


(3) 


(4) 


58. An external pressure P is applied on a cube at 0°C so that it is equally compressed from all sides. K is the bulk modulus of the material of the cube and α is its coefficient of linear expansion. Suppose we want to bring the cube to its original size by heating. The temperature should be raised by :

(1) $3PK\alpha$

(2) $\frac{P}{3\alpha K}$

(3) $\frac{P}{\alpha K}$

(4) $\frac{3\alpha}{PK}$



SPACE FOR ROUGH WORK

59. A diverging lens with magnitude of focal length 25 cm is placed at a distance of 15 cm from a converging lens of magnitude of focal length 20 cm. A beam of parallel light falls on the diverging lens. The final image formed is :

(1) real and at a distance of 6 cm from the convergent lens.

(2) real and at a distance of 40 cm from convergent lens.

(3) virtual and at a distance of 40 cm from convergent lens.

(4) real and at a distance of 40 cm from the divergent lens.

60. A body of mass $m = 10^{-2}$ kg is moving in a medium and experiences a frictional force $F = -kv^2$. Its initial speed is $v_0 = 10\ ms^{-1}$. If, after 10 s, its energy is $\frac{1}{8} mv_0^2$, the value of k will be :

(1) $10^{-1}\ kg\ m^{-1}\ s^{-1}$

(2) $10^{-3}\ kg\ m^{-1}$

(3) $10^{-3}\ kg\ s^{-1}$

(4) $10^{-4}\ kg\ m^{-1}$

## PART C – CHEMISTRY

61. 1 gram of a carbonate ($M_2CO_3$) c treatment with excess HCl produc 0.01186 mole of $CO_2$. The molar mass $M_2CO_3$ in g $mol^{-1}$ is :

(1) 84.3

(2) 118.6

(3) 11.86

(4) 1186

62. Given

$C_{(graphite)} + O_2(g) \rightarrow CO_2(g)$ ;
$\Delta_r H^\circ = -393.5\ kJ\ mol^{-1}$

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ ;
$\Delta_r H^\circ = -285.8\ kJ\ mol^{-1}$

$CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g)$ ;
$\Delta_r H^\circ = +890.3\ kJ\ mol^{-1}$

Based on the above thermochemica equations, the value of $\Delta_r H^\circ$ at 298 K fc the reaction

$C_{(graphite)} + 2H_2(g) \rightarrow CH_4(g)$ will be :

(1) $+144.0\ kJ\ mol^{-1}$

(2) $-74.8\ kJ\ mol^{-1}$

(3) $-144.0\ kJ\ mol^{-1}$

(4) $+74.8\ kJ\ mol^{-1}$

63. The freezing point of benzene decrease by 0.45°C when 0.2 g of acetic acid added to 20 g of benzene. If acetic aci associates to form a dimer in benzen percentage association of acetic acid i benzene will be :

($K_f$ for benzene = 5.12 K kg $mol^{-1}$)

(1) 80.4%

(2) 74.6%

(3) 94.6%

(4) 64.6%



SPACE FOR ROUGH WORK

64. The most abundant elements by mass in the body of a healthy human adult are : Oxygen (61.4%); Carbon (22.9%), Hydrogen (10.0%); and Nitrogen (2.6%). The weight which a 75 kg person would gain if all $^1H$ atoms are replaced by $^2H$ atoms is :

(1) 37.5 kg

(2) 7.5 kg

(3) 10 kg

(4) 15 kg

65. $\Delta U$ is equal to :

(1) Isobaric work

(2) Adiabatic work

(3) Isothermal work

(4) Isochoric work

66. The formation of which of the following polymers involves hydrolysis reaction ?

(1) Bakelite

(2) Nylon 6, 6

(3) Terylene

(4) Nylon 6

67. Given

$E^{\circ}_{Cl_2/Cl^-} = 1.36$ V, $E^{\circ}_{Cr^{3+}/Cr} = -0.74$ V

$E^{\circ}_{Cr_2O_7^{2-}/Cr^{3+}} = 1.33$ V, $E^{\circ}_{MnO_4^-/Mn^{2+}} = 1.51$ V.

Among the following, the strongest reducing agent is :

(1) $Mn^{2+}$

(2) $Cr^{3+}$

(3) $Cl^-$

(4) Cr

68. The Tyndall effect is observed only when following conditions are satisfied :

(a) The diameter of the dispersed particles is much smaller than the wavelength of the light used.

(b) The diameter of the dispersed particle is not much smaller than the wavelength of the light used.

(c) The refractive indices of the dispersed phase and dispersion medium are almost similar in magnitude.

(d) The refractive indices of the dispersed phase and dispersion medium differ greatly in magnitude.

(1) (b) and (d)

(2) (a) and (c)

(3) (b) and (c)

(4) (a) and (d)

69. In the following reactions, ZnO is respectively acting as a/an :

(a) $ZnO + Na_2O \rightarrow Na_2ZnO_2$

(b) $ZnO + CO_2 \rightarrow ZnCO_3$

(1) base and base

(2) acid and acid

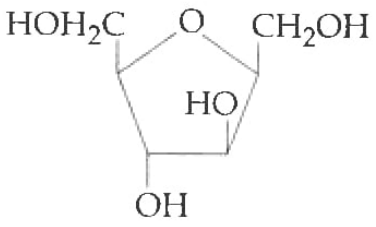
(3) acid and base

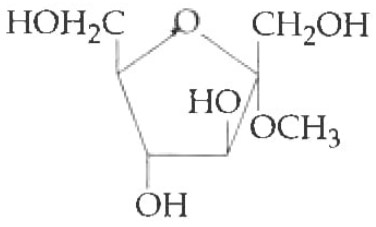
(4) base and acid

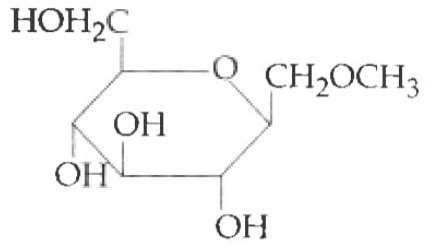


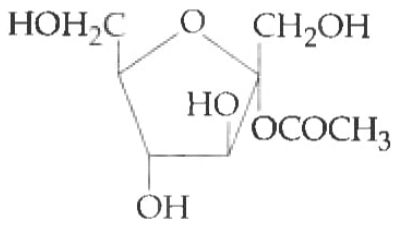
SPACE FOR ROUGH WORK

70. Which of the following compounds will behave as a reducing sugar in an aqueous KOH solution ?

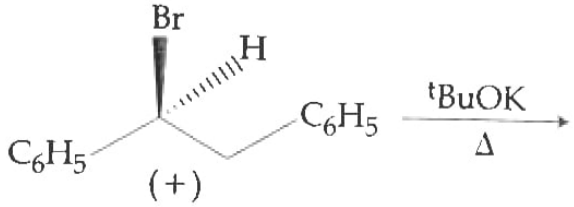
(1) 

(2) 

(3) 

(4) 

71. The major product obtained in the following reaction is :



(1) $C_6H_5CH=CHC_6H_5$

(2) $(+)C_6H_5CH(O^tBu)CH_2C_6H_5$

(3) $(-)C_6H_5CH(O^tBu)CH_2C_6H_5$

(4) $(\pm)C_6H_5CH(O^tBu)CH_2C_6H_5$

72. Which of the following species is paramagnetic ?

(1) CO

(2) $O_2$

(3) $B_2$

(4) NO

73. On treatment of 100 mL of 0.1 M soluti of $CoCl_3.6H_2O$ with excess AgNC $1.2\times10^{22}$ ions are precipitated. T complex is :

(1) $[Co(H_2O)_3Cl_3].3H_2O$

(2) $[Co(H_2O)_6]Cl_3$

(3) $[Co(H_2O)_5Cl]Cl_2.H_2O$

(4) $[Co(H_2O)_4Cl_2]Cl.2H_2O$

74. $pK_a$ of a weak acid (HA) and $pK_b$ of a we base (BOH) are 3.2 and 3.4, respective The pH of their salt (AB) solution is :

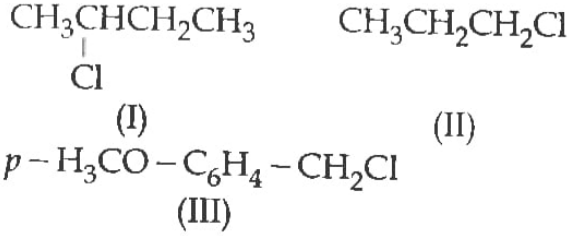
(1) 6.9

(2) 7.0

(3) 1.0

(4) 7.2

75. The increasing order of the reactivity the following halides for the $S_N1$ reacti is :



(1) (II) < (I) < (III)

(2) (I) < (III) < (II)

(3) (II) < (III) < (I)

(4) (III) < (II) < (I)



SPACE FOR ROUGH WORK

76. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect, is :

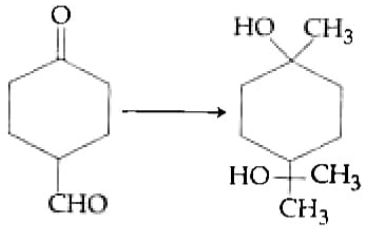
(1) both form soluble bicarbonates

(2) both form nitrides

(3) nitrates of both Li and Mg yield $NO_2$ and $O_2$ on heating

(4) both form basic carbonates

77. The correct sequence of reagents for the following conversion will be :




(1) $CH_3MgBr$, $H^+/CH_3OH$, $[Ag(NH_3)_2]^+OH^-$

(2) $CH_3MgBr$, $[Ag(NH_3)_2]^+OH^-$, $H^+/CH_3OH$

(3) $[Ag(NH_3)_2]^+OH^-$, $CH_3MgBr$, $H^+/CH_3OH$

(4) $[Ag(NH_3)_2]^+OH^-$, $H^+/CH_3OH$, $CH_3MgBr$

78. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are :

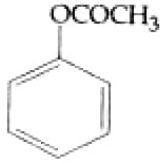
(1) $ClO_2^-$ and $ClO_3^-$

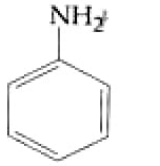
(2) $Cl^-$ and $ClO^-$

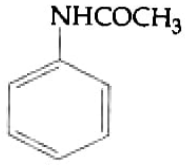
(3) $Cl^-$ and $ClO_2^-$

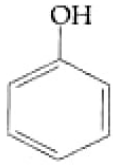
(4) $ClO^-$ and $ClO_3^-$

79. Which of the following compounds will form significant amount of *meta* product during mono-nitration reaction ?

(1) 


(2) 


(3) 


(4) 


80. 3-Methyl-pent-2-ene on reaction with HBr in presence of peroxide forms an addition product. The number of possible stereoisomers for the product is :

(1) Zero

(2) Two

(3) Four

(4) Six

81. Two reactions $R_1$ and $R_2$ have identical pre-exponential factors. Activation energy of $R_1$ exceeds that of $R_2$ by 10 kJ $mol^{-1}$. If $k_1$ and $k_2$ are rate constants for reactions $R_1$ and $R_2$ respectively at 300 K, then $\ln(k_2/k_1)$ is equal to :
($R = 8.314$ J $mol^{-1}K^{-1}$)

(1) 12

(2) 6

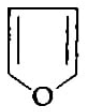
(3) 4

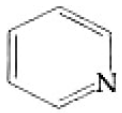
(4) 8

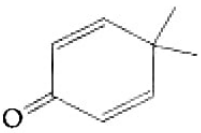


SPACE FOR ROUGH WORK

82. Which of the following molecules is least resonance stabilized ?

(1) 

(2) 

(3) 

(4) 

83. The group having isoelectronic species is :

(1) $O^-$, $F^-$, Na, $Mg^+$

(2) $O^{2-}$, $F^-$, Na, $Mg^{2+}$

(3) $O^-$, $F^-$, $Na^+$, $Mg^{2+}$

(4) $O^{2-}$, $F^-$, $Na^+$, $Mg^{2+}$

84. The radius of the second Bohr orbit for hydrogen atom is :
(Planck's Const. $h = 6.6262 \times 10^{-34}$ Js;
mass of electron $= 9.1091 \times 10^{-31}$ kg;
charge of electron $e = 1.60210 \times 10^{-19}$ C;
permittivity of vacuum
$\epsilon_0 = 8.854185 \times 10^{-12}\ kg^{-1}m^{-3}A^2$)

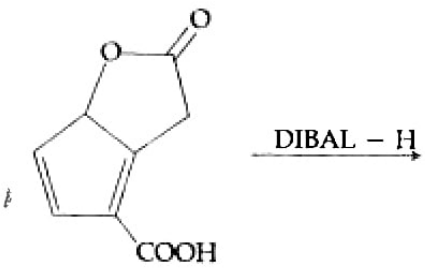
(1) 4.76 Å

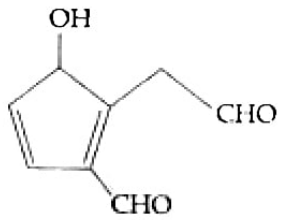
(2) 0.529 Å

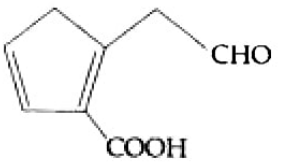
(3) 2.12 Å

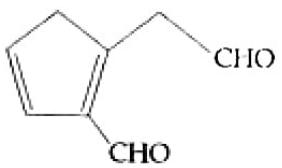
(4) 1.65 Å

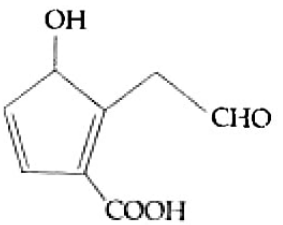
85. The major product obtained in following reaction is :




(1) 


(2) 


(3) 


(4) 


86. Which of the following reactions is example of a redox reaction ?

(1) $XeF_2 + PF_5 \rightarrow [XeF]^+ PF_6^-$

(2) $XeF_6 + H_2O \rightarrow XeOF_4 + 2HF$

(3) $XeF_6 + 2H_2O \rightarrow XeO_2F_2 + 4HF$

(4) $XeF_4 + O_2F_2 \rightarrow XeF_6 + O_2$



SPACE FOR ROUGH WORK

87. A metal crystallises in a face centred cubic structure. If the edge length of its unit cell is 'a', the closest approach between two atoms in metallic crystal will be :

(1) $2\sqrt{2}$ a

(2) $\sqrt{2}$ a

(3) $\frac{a}{\sqrt{2}}$

(4) 2a

88. Sodium salt of an organic acid 'X' produces effervescence with conc. $H_2SO_4$. 'X' reacts with the acidified aqueous $CaCl_2$ solution to give a white precipitate which decolourises acidic solution of $KMnO_4$. 'X' is :

(1) HCOONa

(2) $CH_3COONa$

(3) $Na_2C_2O_4$

(4) $C_6H_5COONa$

89. A water sample has ppm level concentration of following anions

$F^- = 10$; $SO_4^{2-} = 100$; $NO_3^- = 50$

The anion/anions that make/makes the water sample unsuitable for drinking is/are :

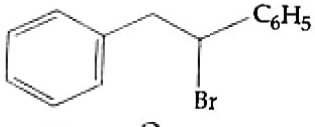
(1) both $SO_4^{2-}$ and $NO_3^-$

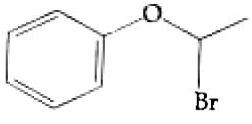
(2) only $F^-$

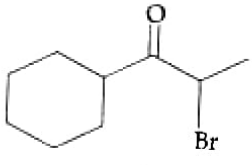
(3) only $SO_4^{2-}$

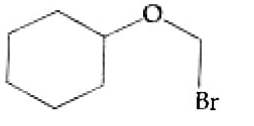
(4) only $NO_3^-$

90. Which of the following, upon treatment with *tert*-BuONa followed by addition of bromine water, fails to decolourize the colour of bromine ?

(1) 


(2) 


(3) 


(4) 


SPACE FOR ROUGH WORK