This booklet contains **24** printed pages.

RBS

No.: 170658127

PAPER - 1 : CHEMISTRY, MATHEMATICS & PHYSICS

Test Booklet Code

C

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 **Chemistry**, **Mathematics** and **Physics** 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 **C**. 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 – CHEMISTRY

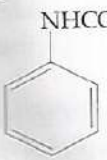
1. The freezing point of benzene decreases by 0.45°C when 0.2 g of acetic acid is added to 20 g of benzene. If acetic acid associates to form a dimer in benzene, percentage association of acetic acid in benzene will be :
(K_f for benzene = 5.12 K kg mol^{-1})

(1) 94.6%
(2) 64.6%
(3) 80.4%
(4) 74.6%

2. On treatment of 100 mL of 0.1 M solution of $CoCl_3.6H_2O$ with excess $AgNO_3$; 1.2×10^{22} ions are precipitated. The complex is :

(1) $[Co(H_2O)_5Cl]Cl_2.H_2O$
(2) $[Co(H_2O)_4Cl_2]Cl.2H_2O$
(3) $[Co(H_2O)_3Cl_3].3H_2O$
(4) $[Co(H_2O)_6]Cl_3$

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

(1) 

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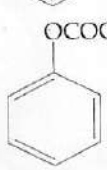
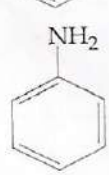
(3) 

(4) 

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

(1) Cl^- and ClO_2^-
(2) ClO^- and ClO_3^-
(3) ClO_2^- and ClO_3^-
(4) Cl^- and ClO^-

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

(1) nitrates of both Li and Mg yield NO_2 and O_2 on heating
(2) both form basic carbonates
(3) both form soluble bicarbonates
(4) both form nitrides

6. 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) only SO_4^{2-}
(2) only NO_3^-
(3) both SO_4^{2-} and NO_3^-
(4) only F^-

SPACE FOR ROUGH WORK

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

(1) Terylene

(2) Nylon 6

(3) Bakelite

(4) Nylon 6, 6

8. 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 (c)

(2) (a) and (d)

(3) (b) and (d)

(4) (a) and (c)

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

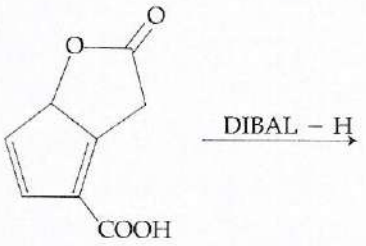
(1) 1.0

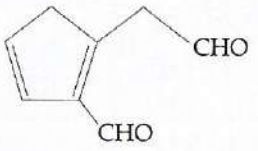
(2) 7.2

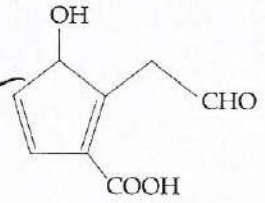
(3) 6.9

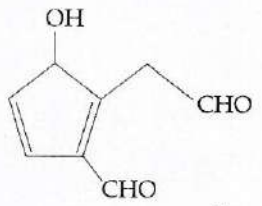
(4) 7.0

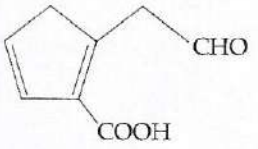
10. The major product obtained in the following reaction is :



(1) 

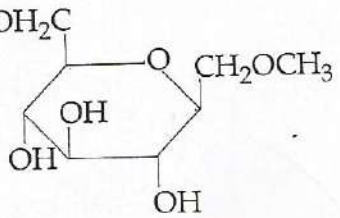
(2) 

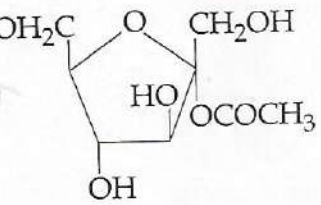
(3) 

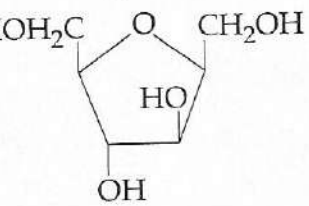
(4) 

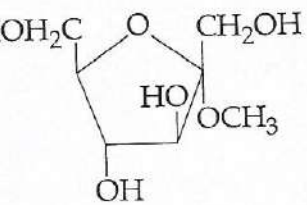
SPACE FOR ROUGH WORK

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

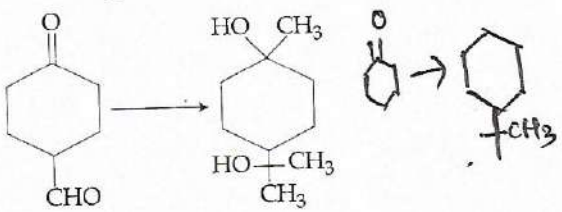
(1) 

(2) 

(3) 

(4) 

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



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

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

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

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

13. Which of the following species is **not** paramagnetic ?

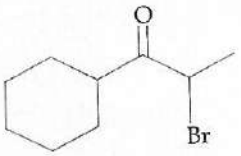
(1) B_2

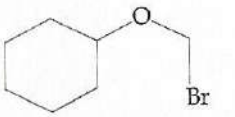
(2) NO

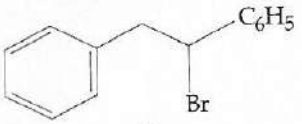
(3) CO

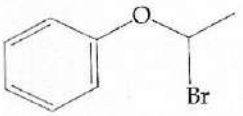
(4) O_2

14. 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) 

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

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

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

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

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

16. ΔU is equal to :

(1) Isothermal work

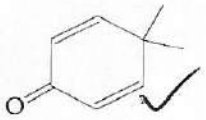
(2) Isochoric work

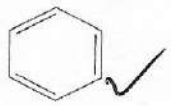
(3) Isobaric work

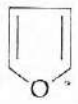
(4) Adiabatic work

SPACE FOR ROUGH WORK

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

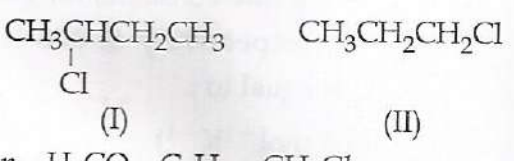
(1) 

(2) 

(3) 

(4) 

18. The increasing order of the reactivity of the following halides for the S_N1 reaction is :



(I) (II) (III)

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

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

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

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

19. 1 gram of a carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. The molar mass of M_2CO_3 in g mol^{-1} is :

(1) 11.86

(2) 1186

(3) 84.3

(4) 118.6

20. 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) $Na_2C_2O_4$

(2) C_6H_5COONa

(3) HCOONa

(4) CH_3COONa

21. 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 :

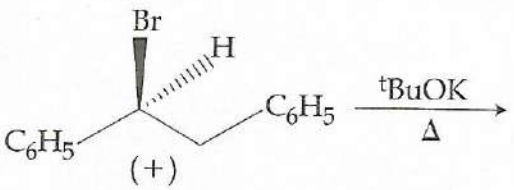
(1) 10 kg

(2) 15 kg

(3) 37.5 kg

(4) 7.5 kg

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



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

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

(3) $C_6H_5CH=CHC_6H_5$

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

SPACE FOR ROUGH WORK

23. Given

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

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

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

Based on the above thermochemical equations, the value of $\Delta_r H^\circ$ at 298 K for the reaction
$C_{(graphite)} + 2H_2(g) \rightarrow CH_4(g)$ will be :

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

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

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

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

24. 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) acid and base

(2) base and acid

(3) base and base

(4) acid and acid

25. 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
$\epsilon_0 = 8.854185 \times 10^{-12} \text{ kg}^{-1}\text{m}^{-3}\text{A}^2$)

(1) 2.12 Å

(2) 1.65 Å

(3) 4.76 Å

(4) 0.529 Å

26. 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 :
($R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$)

(1) 4

(2) 8

(3) 12

(4) 6

27. 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) $\frac{a}{\sqrt{2}}$

(2) 2a

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

(4) $\sqrt{2}$ a

SPACE FOR ROUGH WORK

28. The group having isoelectronic species is :

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

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

(3) O^-, F^-, Na, Mg^+

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

29. 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) Cl^-

(2) Cr

(3) Mn^{2+}

(4) Cr^{3+}

30. 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) Four

(2) Six

(3) Zero

(4) Two

PART B – MATHEMATICS

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

(1) 4

(2) -1

(3) -2

(4) 2

32. Let $I_n = \int \tan^n x\, dx, (n > 1)$. If $I_4 + I_6 = a \tan^5 x + bx^5 + C$, where C is a constant of integration, then the ordered 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) $\left(\frac{1}{5}, 0\right)$

33. 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) $\frac{7}{3}$

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

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

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

SPACE FOR ROUGH WORK

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

(1) 4

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

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

(4) 6

35. 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) $\frac{4}{3}$

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

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

36. Let ω 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) -1

(2) 1

(3) $-z$

(4) z

37. 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) 5

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

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

(4) 2

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

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

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

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

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

SPACE FOR ROUGH WORK

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

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

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

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

40. 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) $\frac{14}{45}$

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

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

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

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

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

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

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

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

42. 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) $2^{20} - 2^9$

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

(3) $2^{21} - 2^{11}$

(4) $2^{21} - 2^{10}$

43. 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) $\frac{7}{64}$

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

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

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

SPACE FOR ROUGH WORK

44. 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) $\frac{2}{9}$

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

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

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

45. 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) $4x + 2y = 7$

(2) $x + 2y = 4$

(3) $2y - x = 2$

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

46. 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) 10

(2) 11

(3) 12

(4) 9

47. The following statement

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

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

(2) a fallacy

(3) a tautology

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

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

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

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

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

49. For any three positive real numbers a, b and c,

$9(25a^2 + b^2) + 25(c^2 - 3ac) = 15b(3a + c)$.

Then :

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

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

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

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

SPACE FOR ROUGH WORK

50. 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) $\sqrt{42}$

(2) $6\sqrt{5}$

(3) $3\sqrt{5}$

(4) $2\sqrt{42}$

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

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

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

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

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

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

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

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

(1) 190

(2) 255

(3) 330

(4) 165

53. The distance of the point (1, 3, −7) from the plane passing through the point (1, −1, −1), having normal perpendicular to both the lines $\frac{x-1}{1}=\frac{y+2}{-2}=\frac{z-4}{3}$ and $\frac{x-2}{2}=\frac{y+1}{-1}=\frac{z+7}{-1}$, is :

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

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

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

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

54. 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) a finite set containing two or more elements

(2) a singleton

(3) an empty set

(4) an infinite set

SPACE FOR ROUGH WORK

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

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

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

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

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

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

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

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

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

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

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

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

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

58. 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) 25

(2) 30

(3) 12.5

(4) 10

59. 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) surjective but not injective.

(2) neither injective nor surjective.

(3) invertible.

(4) injective but not surjective.

60. 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) 469

(2) 484

(3) 485

(4) 468

SPACE FOR ROUGH WORK

PART C – PHYSICS

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

61. 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) 12.1 GHz

(2) 17.3 GHz

(3) 15.3 GHz

(4) 10.1 GHz

62. 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 :

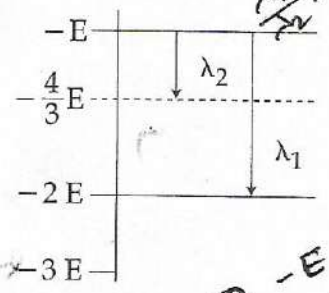
(1) 1.5%

(2) 2.4%

(3) 10%

(4) 0.15%

63. 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) $r = \frac{2}{3}$

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

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

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

64. 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^{-3} kg s^{-1}

(2) 10^{-4} kg m^{-1}

(3) 10^{-1} kg m^{-1} s^{-1}

(4) 10^{-3} kg m^{-1}

SPACE FOR ROUGH WORK

65. 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

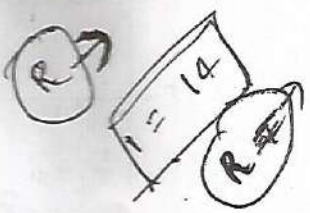
The correct relation between a and b is :

(1) $a = b$

(2) $a = 14\ b$

(3) $a = 28\ b$

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



66. The moment of inertia of a uniform cylinder of length l and radius R about its perpendicular bisector is I. What is the ratio l/R such that the moment of inertia is minimum ?

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

(2) 1

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

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

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

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

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

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

68. Which of the following statements is false ?

(1) In a balanced wheatstone bridge if the cell and the galvanometer are exchanged, the null point is disturbed.

(2) A rheostat can be used as a potential divider.

(3) Kirchhoff's second law represents energy conservation.

(4) Wheatstone bridge is the most sensitive when all the four resistances are of the same order of magnitude.

69. 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) 16

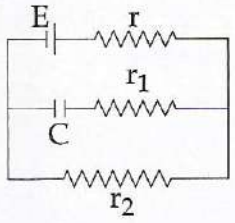
(2) 24

(3) 32

(4) 2

SPACE FOR ROUGH WORK

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

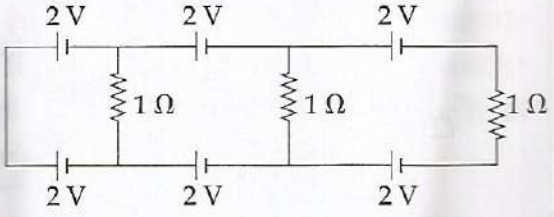


(1) $CE\frac{r_1}{(r_2+r)}$

(2) $CE\frac{r_2}{(r+r_2)}$

(3) $CE\frac{r_1}{(r_1+r)}$

(4) CE

71. 

In the above circuit the current in each resistance is :

(1) 0.25 A

(2) 0.5 A

(3) 0 A

(4) 1 A

72. In amplitude modulation, sinusoidal carrier frequency used is denoted by ω_c and the signal frequency is denoted by ω_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) ω_c

(2) $\omega_m + \omega_c$

(3) $\omega_c - \omega_m$

(4) ω_m

73. 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) 90°

(2) 135°

(3) 180°

(4) 45°

74. 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) 885°C

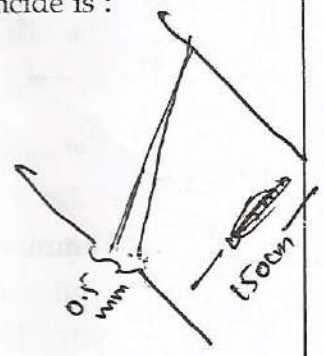
(2) 1250°C

(3) 825°C

(4) 800°C

SPACE FOR ROUGH WORK

75. 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) 7.8 mm

(2) 9.75 mm

(3) 15.6 mm

(4) 1.56 mm

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

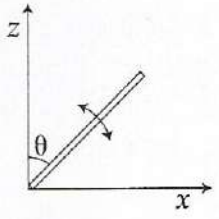
(1) 45°

(2) 60°

(3) 90°

(4) 30°

77. A slender uniform rod of mass M and length l is pivoted at one end so that it can rotate in a vertical plane (see figure). There is negligible friction at the pivot. The free end is held vertically above the pivot and then released. The angular acceleration of the rod when it makes an angle θ with the vertical is :



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

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

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

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

SPACE FOR ROUGH WORK

78. 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) $\sqrt{\frac{P}{\alpha K}}$

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

(3) $3PK\alpha$

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

79. 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 :

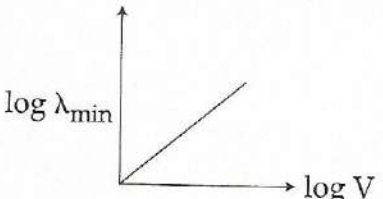
(1) virtual and at a distance of 40 cm from convergent lens.

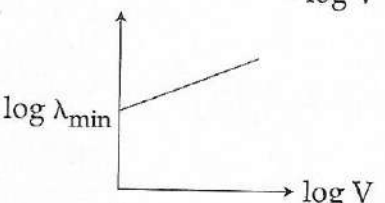
(2) real and at a distance of 40 cm from the divergent lens.

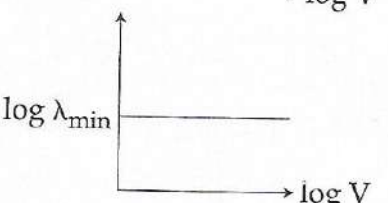
(3) real and at a distance of 6 cm from the convergent lens.

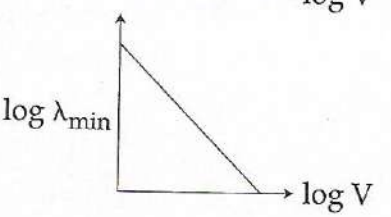
(4) real and at a distance of 40 cm from convergent lens.

80. 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 λ_{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) 

81. 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 1×10^5 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) 1.38×10^{23}

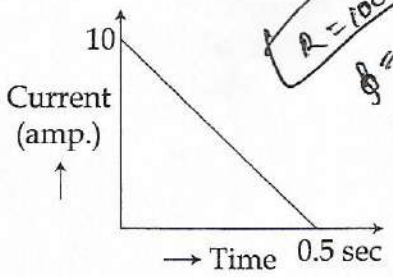
(2) 2.5×10^{25}

(3) -2.5×10^{25}

(4) -1.61×10^{23}

SPACE FOR ROUGH WORK

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



(1) 225 Wb

(2) 250 Wb

(3) 275 Wb

(4) 200 Wb

83. 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) 2.045×10^3 Ω

(2) 2.535×10^3 Ω

(3) 4.005×10^3 Ω

(4) 1.985×10^3 Ω

84. 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) 22 J

(2) 9 J

(3) 18 J

(4) 4.5 J

85. A magnetic needle of magnetic moment 6.7×10^{-2} Am^2 and moment of inertia 7.5×10^{-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) 8.89 s

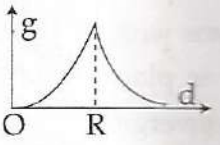
(2) 6.98 s

(3) 8.76 s

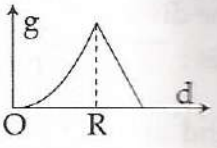
(4) 6.65 s

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

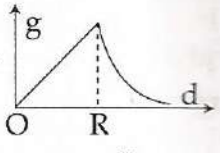
(1)



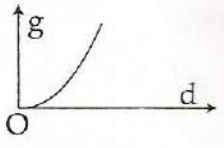
(2)



(3)

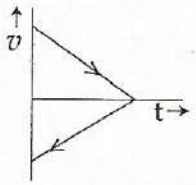


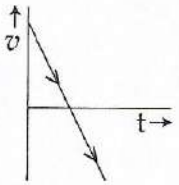
(4)

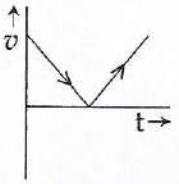


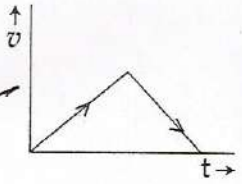
SPACE FOR ROUGH WORK

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

(1) 

(2) 

(3) 

(4) 

88. 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 λ_A to λ_B after the collision is :

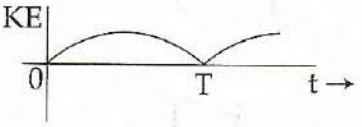
(1) $\frac{\lambda_A}{\lambda_B} = 2$

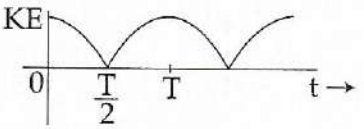
(2) $\frac{\lambda_A}{\lambda_B} = \frac{2}{3}$

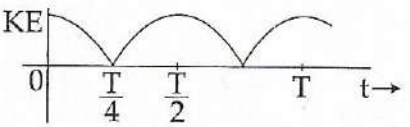
(3) $\frac{\lambda_A}{\lambda_B} = \frac{1}{2}$

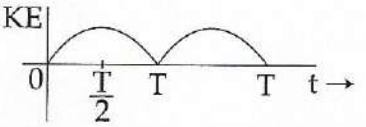
(4) $\frac{\lambda_A}{\lambda_B} = \frac{1}{3}$

89. 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) 

(3) 

(4) 

90. 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) $\frac{1}{9}$

(2) 81

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

(4) 9

-o0o-

SPACE FOR ROUGH WORK

Read the following instructions carefully :

1. The candidates should fill in the required particulars on the Test Booklet and Answer Sheet (***Side-1***) with ***Black Ball Point Pen.***
2. For writing/marking particulars on ***Side-2*** of the Answer Sheet, use ***Black Ball Point Pen only.***
3. The candidates should not write their Roll Numbers anywhere else (except in the specified space) on the Test Booklet/Answer Sheet.
4. Out of the four options given for each question, only one option is the correct answer.
5. For each ***incorrect response, ¼ (one-fourth)*** marks of the total marks allotted to the question (i.e. 1 mark) will be deducted from the total score. ***No deduction*** from the total score, however, will be made ***if no response*** is indicated for an item in the Answer Sheet.
6. Handle the Test Booklet and Answer Sheet with care, *as under no circumstances (except for discrepancy in Test Booklet Code and Answer Sheet Code), another set will be provided.*
7. The candidates are not allowed to do any rough work or writing work on the Answer Sheet. All calculations/writing work are to be done in the space provided for this purpose in the Test Booklet itself, marked 'Space for Rough Work'. This space is given at the bottom of each page and in four pages (Page 20-23) at the end of the booklet.
8. On completion of the test, the candidates 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.**
9. Each candidate must show on demand his/her Admit Card to the Invigilator.
10. No candidate, without special permission of the Superintendent or Invigilator, should leave his/her seat.
11. The candidates should not leave the Examination Hall without handing over their Answer Sheet to the Invigilator on duty and sign the Attendance Sheet again. Cases where a candidate has not signed the Attendance Sheet second time will be deemed not to have handed over the Answer Sheet and dealt with as an unfair means case. **The candidates are also required to put their left hand THUMB impression in the space provided in the Attendance Sheet.**
12. Use of Electronic/Manual Calculator and any Electronic device like mobile phone, pager etc. is prohibited.
13. The candidates are governed by all Rules and Regulations of the Examination body with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of the Examination body.
14. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.
15. **Candidates are not allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, electronic device or any other material except the Admit Card inside the examination room/hall.**