All The Best...!!!

Part - A Physics

Section - I: Single Correct

This section contains a total of 20 questions.
All questions in this section are mandatory.
For every correct response you shall be awarded 4 marks.
For every incorrect response -1 marks shall be deducted.
For more details refer the first page of this booklet.

1. Three point masses each of mass m are joined together using strings to form an equilateral triangle of side a. The system is placed on a smooth horizontal surface and rotated with a constant angular velocity ω about a vertical axis passing through the centroid. Then the tension in each string is

(a) $ma\omega^2$

(b) $3\,ma\omega^2$

(c) $\dfrac{ma\omega^2}{3}$
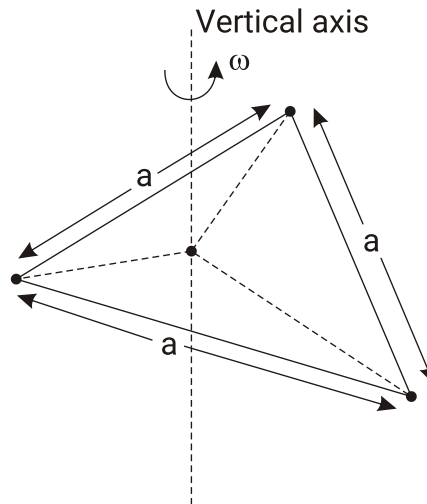
(d) $\dfrac{ma\omega^2}{\sqrt{3}}$

2. A block of wood floats in water with $\dfrac{4}{5}^{\text{th}}$ of its volume submerged, but it just floats in another liquid. The density of the liquid is (in kg/m^3)

(a) 750

(b) 800

(c) 1000

(d) 1250

3. If speed V, area A and force F are chosen as fundamental units, then the dimension of Young's modulus will be:

(a) $FA^{-1}V^0$

(b) FA^2V^{-1}

(c) FA^2V^{-3}

(d) FA^2V^{-2}

4. In a historical experiment to determine Planck's constant, a metal surface was irradiated with light of different wavelengths. The emitted photoelectron energies were measured by applying a stopping potential. The relevant data for the wavelength (λ) of incident light and the corresponding stopping potential (V_0) are given below:

$\lambda(\mu m)$	V_0 (volt)
0.3	2.0
0.4	1.0
0.5	0.4

Given that $c = 3 \times 10^8$ m/s and $e = 1.6 \times 10^{-19}$ C, Planck's constant (in units of Js) found from such an experiment is :

(a) 6.0×10^{-34}

(b) 6.4×10^{-34}

(c) 6.6×10^{-34}

(d) 6.8×10^{-34}

5. The coefficients of thermal conductivity of copper, manganese and glass are respectively K_c, K_m and K_g such that $K_c > K_m > K_g$. If the same quantity of heat is to flow per second per unit area of each rod (in steady-state) and the corresponding temperature gradients are X_c, X_m and X_g then

(a) $X_c = X_m = X_g$

(b) $X_c > X_m > X_g$

(c) $X_c < X_m < X_g$

(d) $X_m < X_c < X_g$

6. A rocket of mass 5700 kg ejects mass at a constant rate of 15 kg/s with a constant speed of 12 km/s relative to itself. The acceleration of the rocket 1 minute after the blast is ($g = 10$ m/s^2). Assume that the rocket moves vertically upwards and that the mass is ejected vertically downwards with respect to the rocket.

(a) 34.9 m/s^2

(b) 27.5 m/s^2

(c) 3.50 m/s^2

(d) 13.5 m/s^2

7. Two cars started from a place one moving due East and the other due North with equal speed V. Then the rate at which they are being separated from each other is
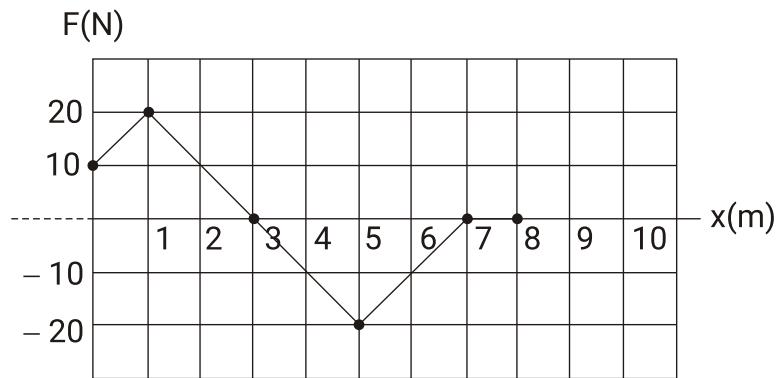
(a) $\dfrac{\sqrt{2}}{V}$

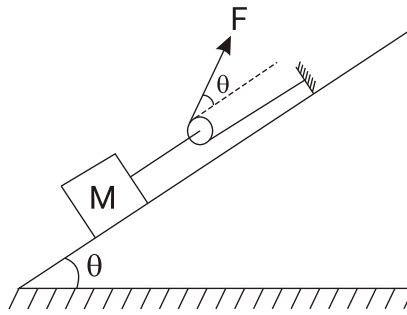(b) $\dfrac{V}{\sqrt{2}}$

(c) $\dfrac{1}{\sqrt{2}V}$

(d) $\sqrt{2}V$

8. The figure shows the variation of a force F acting on a particle along the x-axis. If the particle begins at rest at x = 0, what is the particle's coordinate when it again has zero speed?

(a) x = 3

(b) x = 6

(c) x = 5

(d) x = 7

9. A long solenoid of radius R carries a time dependent current, $I(t) = I_0 t(1-t)$. A ring of radius $2R$ is placed coaxially near its middle. During the time interval $0 \leq t \leq 1$, the induced current (I_R) and the induced EMF (V_R) in the ring change as :

(a) Direction of I_R remains unchanged and V_R is zero at t = 0.25

(b) At t = 0.5 direction of I_R reverses and V_R is zero

(c) At t = 0.25 direction of I_R reverses and V_R is maximum

(d) Direction of I_R remains unchanged and V_R is maximum at t = 0.5

10. What is the minimum value of F needed so that block begins to move upward on a frictionless incline plane as shown? Assume that there is some force holding the pulley so that it is not able to move perpendicular to the incline.

(a) $\mathrm{Mg}\tan\left(\dfrac{\theta}{2}\right)$

(b) $\mathrm{Mg}\cot\left(\dfrac{\theta}{2}\right)$

(c) $\dfrac{\mathrm{Mg}\sin\theta}{(1+\sin\theta)}$

(d) $\mathrm{Mg}\sin\left(\dfrac{\theta}{2}\right)$

11. At 50.0 °C, the average translational kinetic energy of a gas molecule is K. If the temperature is now increased to 100.0 °C, the average translational kinetic energy of a molecule will be closest to

(a) 1.07 K

(b) 1.15 K

(c) 1.41 K

(d) 2.00 K

12. An object of mass m is projected on a rough horizontal surface of coefficient of friction μ with some initial kinetic energy (fixed). The time t taken before stopping is

(i) $t \propto \mu$　(ii) $t \propto \dfrac{1}{\sqrt{m}}$　(iii) $t \propto \sqrt{m}$　(iv) $t \propto \dfrac{1}{\mu}$

(a) both (i) and (ii) are correct

(b) both (i) and (iii) are correct

(c) both (ii) and (iv) are correct

(d) both (ii) and (iii) are correct

13. A galvanometer of 50 ohm resistance has 25 divisions. A current of 4×10^{-4} ampere gives a deflection of one division. To convert this galvanometer into a voltmeter having a range of 25 volt, it should be connected with a resistance of ____

(a) 2500 Ω in parallel

(b) 2450 Ω in parallel

(c) 2550 Ω in series

(d) 2450 Ω in series

14. A body is executing SHM. At a displacement x from the mean position, its potential energy is E_1 and at a displacement y, its potential energy is E_2. Find the potential energy at a displacement $(x + y)$. (Assume zero potential energy at the mean position.)

(a) $(\sqrt{E_1} - \sqrt{E_2})^2$

(b) $(\sqrt{E_1} + \sqrt{E_2})^2$

(c) $E_1 + E_2$

(d) $E_1 - E_2$

15. In an isothermal process if heat is released from an ideal gas then

    (a) the internal energy of the gas will increase

    (b) the gas will do positive work

    (c) the gas will do negative work

    (d) the given process is not possible

16. Two batteries, two resistors and two condensers are connected as shown in the figure. Find out charge on 2 µF capacitor?

(a) 30 µC

(b) 20 µC

(c) 25 µC
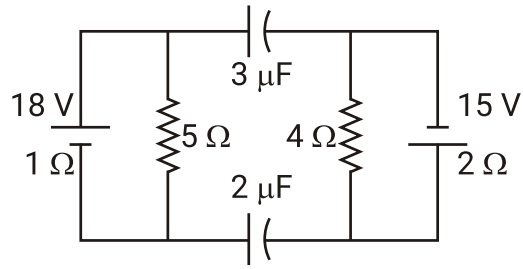
(d) 48 µC

17. A wire elongates by l units, when a load w is suspended from it. If the wire gets over a pulley (equally on both the sides) and two weights w each are hung at the two ends, the elongation of the wire (in units) will be

(a) zero

(b) $\dfrac{l}{2}$

(c) l

(d) $2l$

18. The ratio of the initial lengths of an iron rod and an Aluminum rod for which the difference in the lengths is independent of temperature is (The coefficients of linear expansion of iron and Aluminum are 12×10^{-6} /°C and 24×10^{-6} /°C respectively)

(a) $2 : 1$

(b) $3 : 1$

(c) $1 : 2$

(d) $4 : 1$

19. The driver of a car travelling with speed 30 m/s towards a hill sounds a horn of frequency 600 Hz. If the velocity of sound in air is 330 m/s, the frequency of reflected sound as heard by driver is

(a) 500 Hz

(b) 550 Hz

(c) 555.5 Hz

(d) 720 Hz

20. A proton, a deuteron and an α-particle are moving with same momentum in a uniform magnetic field. The ratio of magnetic forces acting on them is ____ and their speed is ____ in the ratio.

(a) 1 : 2 : 4 and 2 : 1 : 1

(b) 2 : 1 : 1 and 4 : 2 : 1

(c) 4 : 2 : 1 and 2 : 1 : 1

(d) 1 : 2 : 4 and 1 : 1 : 2

Section - II: Numerical

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21. A cube of wood of mass 0.5 kg and density 800 kgm^{-3} is fastened to the free end of a vertical spring of spring constant $\mathrm{k} = 50$ Nm^{-1}, fixed at the bottom. Now, the entire system is completely submerged in water. The elongation or compression of the spring in equilibrium is $\dfrac{\beta}{2}$ cm. Find the value of β. (Given, $\mathrm{g} = 10$ m/s^2)
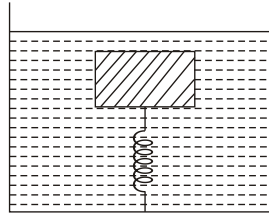
22. The number of significant digits in 0.001001 is

23. A solenoid has 10^3 turns per unit length. On passing a current of 2 A, the magnetic induction is measured to be 4π Wb/m^2. Calculate the magnetic susceptibility of the core.

24. One mole of a monatomic ideal gas undergoes an adiabatic expansion in which its volume becomes eight times its initial value. If the initial temperature of the gas is 100 K and the universal gas constant R = 8.0 J mol^{-1}K^{-1}, the decrease in its internal energy, in Joule, is_____.

25. Two wires of same length and thickness having specific resistances 6 Ω-cm and 3 Ω-cm respectively are connected in parallel. The effective resistivity is ρ Ω-cm. The value of ρ to the nearest integer is_____.

26. Consider two vectors, $\vec{L} = \hat{i} + 2\hat{j} + 3\hat{k}$ and $\vec{I} = 4\hat{i} + 5\hat{j} + 6\hat{k}$. The value of the scalar α such that the vector $\vec{L} - \alpha \vec{I}$ is perpendicular to $\vec{L}$ is $\dfrac{n}{16}$. Find n.

27. A solid copper sphere (density ρ and specific heat s of radius r at an initial temperature 200 K is suspended inside a chamber whose walls are at almost 0 K. The time required for the temperature of the sphere to drop to 100 K is $\dfrac{x\rho sr}{72e\sigma} \times 10^{-6}$. Then x is equal to _____.

28. An inverted tube lying at the bottom of a lake 47.6 m deep has 50 cc of air trapped in it. The tube is brought to the surface of the lake. The volume of the air trapped in it now is $100x$ cc if the temperature remains constant. Find x. (Treat air as an ideal gas and take atmospheric pressure $= 70$ cm of Hg and the density of $\text{Hg} = 13.6$ g/cc).

29. The circuit shown below is working as a 8V dc regulated voltage source. When 12 V is used as input, considering both zener diodes are identical, find out the power dissipated (in mW) in each diode?

200Ω

200Ω

$V_{in} = 12\ V$

V_0
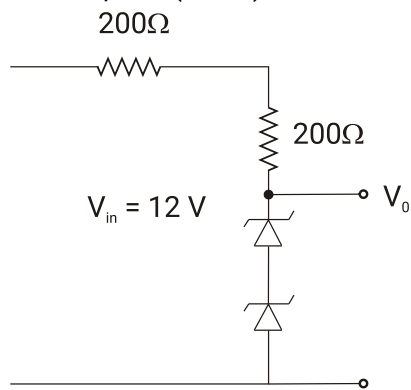
30. The K_α X-Ray of Molybdenum has wavelength 0.071 nm. If the energy of a Molybdenum atom with a K-electron knocked out is 27.5 keV, the energy of this atom when an L electron is knocked out will be _____ keV. (Round off to the nearest integer) [$h = 4.14 \times 10^{-15}$ eV-s, $c = 3 \times 10^8$ ms^{-1}]

Part - B Chemistry

Section - I: Single Correct

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31. In Clark's process for removing the hardness of water, the reagent used is
    (a) Acidic
    (b) Basic
    (c) Neutral
    (d) Both (A) & (B)

32. Which of the following is not a redox reaction?

(a) $H_2 + Cl_2 \longrightarrow 2\,HCl$

(b) $NaOH + HCl \longrightarrow NaCl + H_2O$
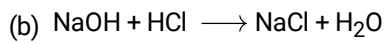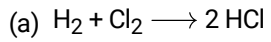
(c) Photosynthesis

(d) Cell respiration

33. In a crystal of NaCl, if all the ions along one of the body diagonal are removed then the simplest formula of the crystalline solid will be

(a) NaCl

(b) Na_4Cl_5

(c) Na_2Cl_3

(d) Na_3Cl_5

34. The phenomenon of optical activity can be shown by –

(a)

(b)

(c)

(d)
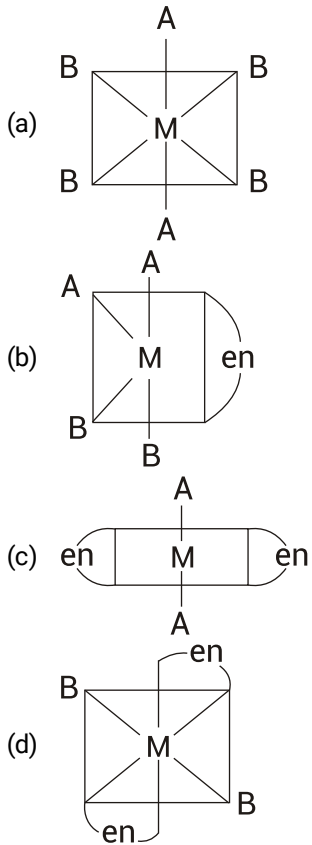
35. On heating sodium hydrogen carbonate, the product formed is

(a) $Na_2O + CO_2 + H_2O$

(b) $Na_2CO_3 + CO_2$

(c) $Na_2CO_3 + H_2O + CO_2$

(d) $Na_2CO_3 + H_2O$

36. If 0.2 g of an organic compound on complete combustion produces 0.18 g of water then % of hydrogen in it is
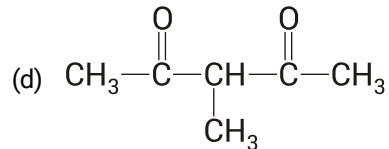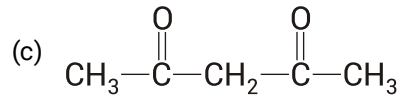
   (a) 5

   (b) 10

   (c) 1

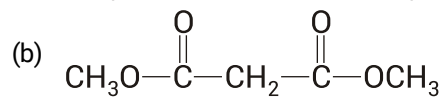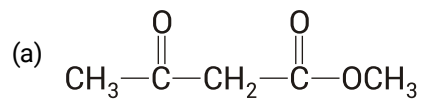   (d) 20

37. Saturated solution of KNO$_3$ is used to make salt bridge because

(a) Velocity of K$^+$ is greater than that of NO_3^-

(b) Velocity of NO_3^- is greater than that of K$^+$

(c) Velocity of K$^+$ and NO_3^- are nearly same

(d) KNO$_3$ is highly soluble in water

38. If any solute 'A' dimerizes in water at 1 atm pressure and the boiling point of this solution is $100.52\,^0$C. If 2 moles of A are added to 1 kg of water and k_b for water is $0.52\,^0$C/molal, calculate the percentage association of A
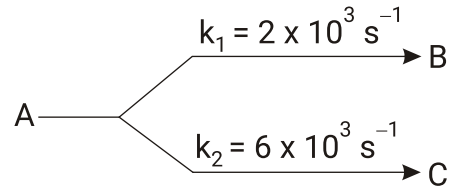
(a) 50%

(b) 30%

(c) 25%

(d) 100%

39. Which tautomer in following is Diad system:

(a) CH_3COCH_3

(b) $CH_3CH_2NO_2$

(c)

(d) HCN
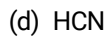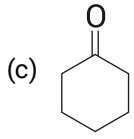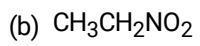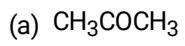
40. The most acidic compound among the following is

(a)
$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-OCH_3$$

(b)
$$CH_3O-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-OCH_3$$

(c)
$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$$

(d)
$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-\underset{\underset{\displaystyle CH_3}{|}}{CH}-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$$
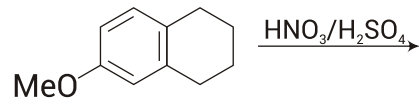
41. Consider the following parallel reaction in which reactant A can form two products B & C

$$A \xrightarrow{\quad k_1 = 2 \times 10^3 \text{ s}^{-1} \quad} B$$
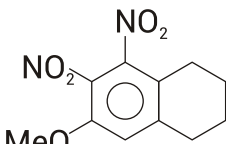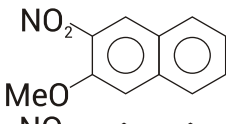$$A \xrightarrow{\quad k_2 = 6 \times 10^3 \text{ s}^{-1} \quad} C$$
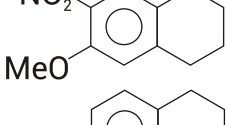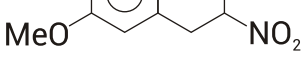
find B%

(a) 25%

(b) 50%

(c) 75%

(d) 80%

42.

What is the major product in the given reaction?

(a)

(b)

(c)

(d)

43. In the given reaction:

$$C_6H_5 - \overset{\overset{\displaystyle O}{\|}}{C} - H \xrightarrow{\ NH_2OH/H^{\oplus}\ } [X]$$
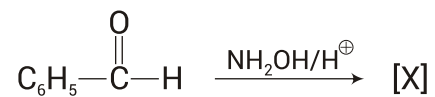
[X] will be:
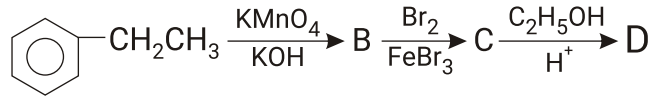
(a) Only syn oxime

(b) Only anti oxime

(c) Mixture of syn and anti oxime

(d) Secondary amide

44. What is formed on treating chloroform with aniline and alcoholic KOH?

(a) Phenyl cyanide

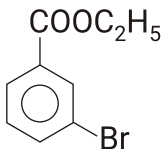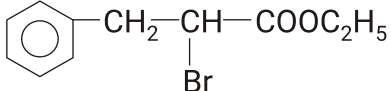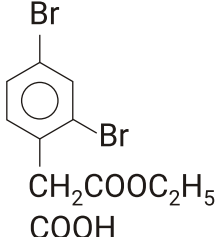(b) Phenyl isocyanide

(c) Phenyl cyanate

(d) Phenyl isocyanate
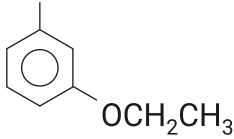
45. If the density of a certain gas at 30°C and 720 torr is 1.35 kg/m^3 its density at STP would be

(a) 1.25 kg/m^3

(b) 1.58 kg/m^3

(c) 1.35 kg/m^3

(d) 1.45 kg/m^3

46. An aqueous blue coloured solution of a transition metal sulphate reacts with H_2S to give a black precipitate. The black precipitate dissolves in 50% nitric acid forming a blue coloured solution. The blue solution on treatment with KI in weakly acidic medium turns yellow / brown and produces a white precipitate.

(a) Co^{2+}

(b) Cu^{2+}

(c) Hg^{2+}

(d) Pb^{2+}

47. In a set of reactions, ethylbenzene yielded a product D.

$$\text{C}_6\text{H}_5-\text{CH}_2\text{CH}_3 \xrightarrow[\text{KOH}]{\text{KMnO}_4} B \xrightarrow[\text{FeBr}_3]{\text{Br}_2} C \xrightarrow[\text{H}^+]{\text{C}_2\text{H}_5\text{OH}} D$$

'D' would be

(a)

COOC$_2$H$_5$

Br

(b)

CH$_2$—CH—COOC$_2$H$_5$
|
Br

(c)

Br

Br

(d)

CH$_2$COOC$_2$H$_5$
COOH

OCH$_2$CH$_3$

48.

$$H_3BO_3 \xrightarrow{375\ K} A \xrightarrow{Red\ Heat} B_2O_3$$

$$H_3BO_3 \xrightarrow{435\ K} B \xrightarrow{Red\ Heat} B_2O_3$$
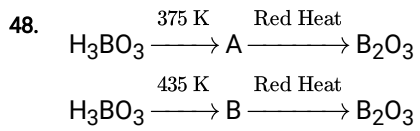
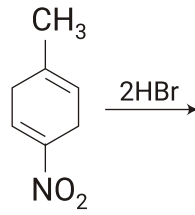The compounds A & B are:

(a) Orthoboric acid, metaboric acid

(b) Metaboric acid, Tetra boric acid

(c) Tetra boric acid, Metaboric acid

(d) Tetra boric acid, orthoboric acid

49. Enzymes in the living systems

(a) Provide energy

(b) Provide immunity

(c) Transport oxygen

(d) Catalyze biological reactions

50. The major product of the following reaction is

(a)

(b)

(c)

(d)

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51. Consider the titration of NaOH solution versus 1.25M oxalic acid solution. At the endpoint following burette readings were obtained.
(i) 4.5 mL
(ii) 4.5 mL
(iii) 4.4 mL
(iv) 4.4 mL
(v) 4.4 mL
If the volume of oxalic acid taken was 10.0 mL then the molarity of the NaOH solution is _____M. (Rounded-off to the nearest integer)

52. The face diagonal length of f.c.c. cubic cell is $660\sqrt{2}$ pm. If the radius of the cation is 110 pm, the radius of the anion in (pm) is

53. The temperature (in Kelvin) at which the molarity of pure water is equal to its molality is

54. An aqueous solution of contains Hg^{2+}, Hg_2^{2+}, Pb^{2+} and Cd^{2+}. Out of these, how many ions will produce white precipitate with dilute HCl?

55. How many of the following metallurgies involve leaching?
    $Al_2O_3 \rightarrow Al$;
    $Ag_2S \rightarrow Ag$;
    $Au \rightarrow Au$;
    $CuFeS_2 \rightarrow Cu$;
    $PbS \rightarrow Pb$
    $MgCl_2 \rightarrow Mg$;
    $FeCO_3 \rightarrow Fe$;
    Low-grade copper ore $\rightarrow$ Cu;
    $HgS \rightarrow Hg$
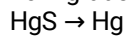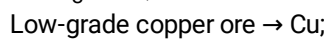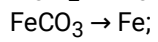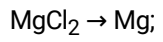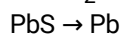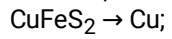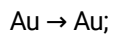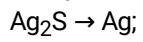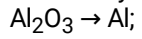
56. During the nuclear explosion, one of the products is ^{90}Sr with half life of 6.93 years. If 1 μg of ^{90}Sr was absorbed in the bones of a newly born baby in place of Ca, how much time, in years, is required to reduce it by 90% if it is not lost metabolically.

57. The mass percentage of nitrogen in histamine is _____

58. How many of the following compounds are found to exist?

BiF_5, TlI_3, PbO_2, $SnCl_2$, Tl_2O_3, PbI_4, As_2O_3

59. How many of the following will give a positive iodoform test?

$$Ph-\overset{\overset{\displaystyle O}{\|}}{C}-Me$$

$$Ph-\overset{\overset{\displaystyle O}{\|}}{C}-Ph$$

$$Me-\underset{\underset{\displaystyle OH}{|}}{CH}-COOH$$

$$MeCH_2OH$$
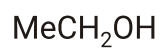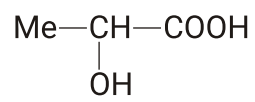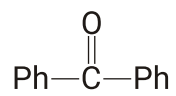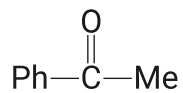
60. Among the following the number of compounds which react with Fehling's solution is:

$$C_6H_5-\overset{\overset{\displaystyle O}{\|}}{C}-H, \quad H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-H, \quad H_3C-CH_2-\overset{\overset{\displaystyle O}{\|}}{C}-H,$$

$$C_6H_5-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3, \quad C_6H_5-\overset{\overset{\displaystyle O}{\|}}{C}-C_6H_5,$$

HCHO, HCOOH, CH$_3$COCH$_3$
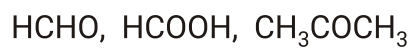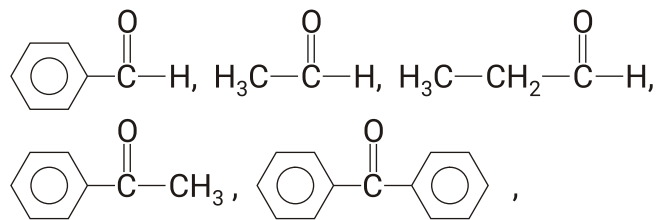
Part - C Mathematics

Section - I: Single Correct

This section contains a total of 20 questions.
All questions in this section are mandatory.
For every correct response you shall be awarded 4 marks.
For every incorrect response -1 marks shall be deducted.
For more details refer the first page of this booklet.

61. If $f(x) = \begin{cases} \dfrac{x}{e^{\frac{1}{x}} + 1}, \text{when } x \neq 0 \\ 0, \text{when } x = 0 \end{cases}$, then

(a) $\lim\limits_{x \to 0+} f(x) = 1$

(b) $\lim\limits_{x \to 0-} f(x) = 1$

(c) $f(x)$ is continuous at $x = 0$

(d) None of these

62. The value of $\sin(\cot^{-1}(\tan(\cos^{-1}x)))$ is equal to

(a) x

(b) $\dfrac{\pi}{2}$

(c) 1

(d) None of these

63. A tower is situated on a horizontal plane. From two points, the line joining three points passes through the base and which are a and b distance from the base. The angle of elevation of the top are α and $90° - \alpha$ and the line joining the two points subtends an angle θ at the top of the tower, then height of the tower will be

(a) $\dfrac{a+b}{a-b}$

(b) $\dfrac{a-b}{a+b}$

(c) $\sqrt{ab}$

(d) $(ab)^{\frac{1}{3}}$

64. If the sum of the series $20 + 19\dfrac{3}{5} + 19\dfrac{1}{5} + 18\dfrac{4}{5} + \ldots$ upto n^{th} term is 488 and the nth term is negative, then :

(a) n^{th} term is $-4\dfrac{2}{5}$

(b) $n = 41$

(c) n^{th} term is -4

(d) $n = 60$

65.

The line $lx + my + n = 0$ will be a tangent to hyperbola $\dfrac{x^2}{a^2} - \dfrac{y^2}{b^2} = 1$, if -

(a) $a^2l^2 + b^2m^2 = n^2$

(b) $a^2l^2 - b^2m^2 = n^2$

(c) $am^2 - b^2n^2 = a^2l^2$

(d) None of these

66. Solution of the equation $(e^x + 1)y\,dy = (y + 1)e^x dx$ is

(a) $c(y + 1)(e^x + 1) + e^y = 0$

(b) $c(y + 1)(e^x - 1) + e^y = 0$

(c) $c(y + 1)(e^x - 1) - e^y = 0$

(d) $c(y + 1)(e^x + 1) = e^y$

67. If $\text{Median} = (\text{Mode} + 2\,\text{Mean})\text{M}$, then M is equal to -

(a) 3

(b) $\dfrac{1}{3}$

(c) 2

(d) None

68. If $2^{(\log_2 3)^x} = 3^{(\log_2 2)^x}$ then the value of x equal to

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

(b) $\dfrac{1}{4}$

(c) $\dfrac{1}{3}$

(d) $\dfrac{1}{6}$

69. What will be the unit digit of $1^{781} + 2^{781} + 3^{781} + \ldots + 9^{781}$?

(a) 1

(b) 3

(c) 5

(d) 7

70.

If $\begin{vmatrix} a+x & a-x & a-x \\ a-x & a+x & a-x \\ a-x & a-x & a+x \end{vmatrix} = 0$, then value of x are -

(a) $0, a$

(b) $0, -a$

(c) $a, -a$

(d) $0, 3a$

71. Area bounded by the curve $y = xe^{x^2}$, $x-$axis and the ordinates $x = 0$, $x = \alpha$ is

(a) $\dfrac{e^{\alpha^2} + 1}{2} sq.\, units$

(b) $\dfrac{e^{\alpha^2} - 1}{2} sq.\, units$

(c) $e^{\alpha^2} + 1\, sq.\, units$

(d) $e^{\alpha^2} - 1\, sq.\, units$

72. If A is invertible matrix, then $\det(A^{-1})$ equals:

(a) $\det(A)$

(b) $\dfrac{1}{\det(A)}$

(c) 1

(d) None of these

73. $\int \left(\dfrac{x+2}{x+4} \right)^2 e^x dx$ is equal to

(a) $e^x \left(\dfrac{x}{x+4} \right) + c$

(b) $e^x \left(\dfrac{x+2}{x+4} \right) + c$

(c) $e^x \left(\dfrac{x-2}{x+4} \right) + c$

(d) $\left(\dfrac{2xe^x}{x+4} \right) + c$

74. $\tan \dfrac{A}{2}$ is equal to

(a) $\pm\sqrt{\dfrac{1 - \sin A}{1 + \sin A}}$

(b) $\pm\sqrt{\dfrac{1 + \sin A}{1 - \sin A}}$

(c) $\pm\sqrt{\dfrac{1 - \cos A}{1 + \cos A}}$

(d) $\pm\sqrt{\dfrac{1 + \cos A}{1 - \cos A}}$

75. Let ABC be a triangle such that $\angle A = 45^\circ, B = 75^\circ$ then $a + c\sqrt{2}$ is equal to -

(a) 0

(b) b

(c) $2b$

(d) $-b$

76. $\displaystyle\int_{-1}^{1} x\tan^{-1} x\,dx$ equals

(a) $\left(\dfrac{\pi}{2} - 1\right)$

(b) $\left(\dfrac{\pi}{2} + 1\right)$

(c) $(\pi - 1)$

(d) 0

77. The general solution of $\tan\left(\dfrac{2}{3}\theta\right) = \sqrt{3}$ is -

(a) $\dfrac{3n\pi}{2} + \dfrac{\pi}{2}; n \in I$

(b) $\dfrac{n\pi}{2}; \pm\dfrac{\pi}{2}; n \in I$

(c) $n\pi \pm \dfrac{\pi}{2}; n \in I$

(d) None of these

78. If $y = \dfrac{\sqrt{a+x} - \sqrt{a-x}}{\sqrt{a+x} + \sqrt{a-x}}$, then $\dfrac{dy}{dx} =$

(a) $\dfrac{ay}{x\sqrt{a^2 - x^2}}$

(b) $\dfrac{ay}{\sqrt{a^2 - x^2}}$

(c) $\dfrac{ay}{x\sqrt{x^2 - a^2}}$

(d) None of these

79. The statement $(p \rightarrow \sim q) \Leftrightarrow (p \wedge q)$ is a -

(a) Tautology

(b) contradiction

(c) Neither tautology nor contradiction

(d) None

80.
Two perpendicular tangents drawn to the ellipse $\dfrac{x^2}{9} + \dfrac{y^2}{16} = 1$ intersect on the curve -

(a) $a = \dfrac{a}{e}$

(b) $x^2 + y^2 = 25$

(c) $x^2 + y^2 = 9$

(d) $x^2 - y^2 = 41$

Section - II: Numerical

This section contains a total of 10 questions.
Out of the 10 questions, 5 questions are mandatory.
For every correct response you shall be awarded 4 marks.
For every incorrect response -1 marks shall be deducted.
For more details refer the first page of this booklet.

81. If $\int \dfrac{x^5 dx}{x^3 + 1} = \dfrac{x^3}{l} + \dfrac{1}{m}\ln|x^3 + n| + C$ (Where C is integration constant, & $l, m, n \in N$), then $(l - m - n)$ is equal to

82.

If $\dfrac{\sin \alpha}{\sin \beta} = \dfrac{\cos \gamma}{\cos \delta}$, then $\dfrac{\sin\left(\dfrac{\alpha - \beta}{2}\right) \cdot \cos\left(\dfrac{\alpha + \beta}{2}\right) \cdot \cos \delta}{\sin\left(\dfrac{\delta - \gamma}{2}\right) \cdot \sin\left(\dfrac{\delta - \gamma}{2}\right) \cdot \sin \beta}$ is equal to

83. Find a rational number which is 50 times its own logarithm to the base 10.

84.
The area of the triangle formed by any tangent to the hyperbola $\dfrac{x^2}{16} - \dfrac{y^2}{9} = 1$ with its asymptotes is

85. If $\cos^{-1} x + \cos^{-1} y + \cos^{-1} z = \pi$, where $-1 \leq x, y, z, \leq 1$, then find the value of $x^2 + y^2 + z^2 + 2\,xyz$

86. The locus of a point, which moves such that the sum of squares of its distances from the points $(0, 0), (1, 0), (0, 1)(1, 1)$ is 18 unit, is a circle of diameter d. Then d^2 is equal to ....

87. A mixture of wine and water is made in the ratio of wine: total = $k : m$. Adding x units of water or removing x units of wine $(x \neq 0)$, each produces the same new ratio of wine : total. The numerical value of the new ratio is _____.

88. Let T_n denote the nth term of a G.P. with a common ratio 2 and $\left(\log_2(\log_3(\log_{512} T_{100}))\right) = 1.$ If three sides of a triangle ABC have the lengths of $(T_1 + T_2), T_2$ and T_3 then the area of the triangle is $\dfrac{\sqrt{2160}}{N},$ where N is a positive integer. Find the remainder when N is divided by $2^{10}.$

89.

A tangent to the ellipse $\dfrac{x^2}{18} + \dfrac{y^2}{32} = 1$, having a slope of $-\dfrac{4}{3}$, intersects the major and minor axes at points A and B respectively. If C is the centre of the ellipse, then the area of the $\triangle ABC$ is equal to

90. If $x + y = k$ is a normal to the parabola $y^2 = 12x$, then k is equal to