NUCLEUS EDUCATION
Centre of excellence

JEE MAIN PATTERN

FST # 02 | 02-01-2019

Time: 3 Hours | SCORE-1 | **Maximum Marks : 360**

PAPER & SOLUTIONS

Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

1. **This booklet contains 36 printed pages.**
   (i) Page No. 1 to 16 Question paper
   (ii) Page No. 17 to 36 Answer key and Solutions
2. The Test Booklet consists of **90** questions. The maximum marks are 360.
3. There are three parts in the question paper A, B, C consisting of Physics, Mathematics and Chemistry having 30 questions in each part of equal weightage. Each question is allotted **4** (four) marks for correct response.
4. Candidates will be awarded marks as stated above in instruction No. 3 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.
5. 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 4 above.
6. 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.
7. 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.
8. 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.
9. Do not fold or make any stray mark on the Answer Sheet

Name of the Candidate

I have read all the instructions and shall abide by them.

Signature of the Candidate

Form Number

I have verified all the information filled in by the Candidate.

Signature of the invigilator

PART-A : PHYSICS

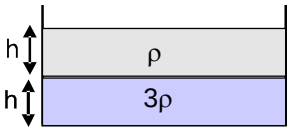
1. The distance between an object and the screen is 100 cm. A lens produces an image on the when the lens is placed at either of the positions 40 cm apart. The power of the lens is nearly:

(1) 3 diopters (2) 5 diopters (3) 2 diopters (4) 9 diopters

2. The wavelength of a certain line in the x-ray spectrum for tungsten (Z = 74) is 200 Å. What would be the wavelength of the same line for platinum (Z = 78)? The screening constant a is unity.

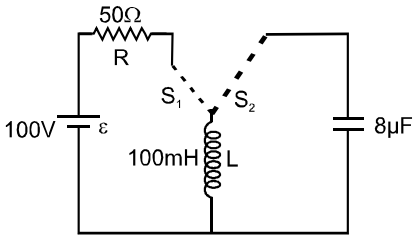
(1) 179.76 Å (2) 189.76 Å (3) 289.76 Å (4) 379.76 Å

3. Equal volumes of two immiscible liquids of densities ρ and 3ρ are filled in a big vessel. Two small holes are punched at depth h/3 and 4h/3 from upper surface of lighter liquid. If v_1 and v_2 are velocities of efflux at these two holes, then v_1/v_2 is :



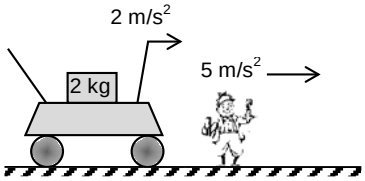
(1) $\frac{1}{2}$ (2) $\frac{1}{\sqrt{2}}$ (3) $\frac{1}{2\sqrt{2}}$ (4) $\frac{1}{4}$

4. In the circuit shown, after sufficiently long time in position 1 of the switch, so that current is steady in the circuit, the switch is changed over to position 2. the maximum voltage that can be develop across 'L'



(1) 100 V (2) $100\sqrt{2}$V (3) $100\sqrt{5}$V (4) 200 V

5. An observer and a vehicle, both start moving together from rest (towards right) with acceleration 5m/s^2 and 2m/s^2, respectively. There is a 2 kg block on the floor of the vehicle and co-efficient of friction is μ = 0.3 between their surface. Then the work done by frictional force on the 2 kg block observed by the running observer, during first 2 seconds of the motion is :



(1) 24 J (2) –24 J (3) 16 J (4) 36 J

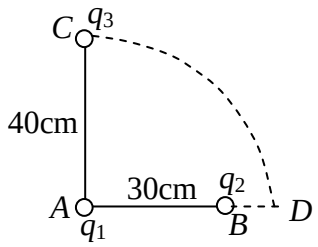
6. A particle is projected with speed u at an angle θ with horizontal particle explodes at highest point of its path into two equal fragments one of fragment moving up straight with a speed u. The difference in time in which the particles fall on ground. (Assume it explodes at height H)

(1) u/g (2) $\frac{u}{g}\sqrt{u^2-2gH}$ (3) $\frac{1}{2g}\sqrt{u^2+2gH}$ (4) 2u/g

7. A copper sphere is suspended in a evacuated chamber maintained at 300 K. The sphere is maintained at constant temperature of 900 K by heating electrically. A total of 300 W electric power is needed to do this. When half of the surface of the copper sphere is completely blackened, 600 W is needed to maintain the same temperature of sphere. The emissivity of copper is

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

8. Two charges q_1 and q_2 are placed 30 cm apart as shown. A third charge q_3 is moved along the arc of a circle of radius 40 cm from *C* to *D*. The change in the potential energy of the system is $\frac{q_3}{4\pi\varepsilon_0}k$, where *k* is



(1) $8q_2$ (2) $8q_1$ (3) $6q_2$ (4) $6q_1$

9. A cubical vessel of edge 1 m and total thermal resistance (of its walls) $\frac{1}{R}$ (where, R is universal gas constant) has a small hole in one of its walls. It is kept in a very big closed chamber whose temperature T_0 remains constant. In the chamber and vessel, a mono-atomic gas is filled at a same constant pressure P_0. At time $t = 0$, temperature of the gas in the vessel is T_1 ($< 2T_0/3$). When temperature of the gas in the vessel becomes $0.8\ T_0$, rate of change of moles in it will be

(1) $\frac{1}{10}$ (2) $\frac{1}{6}$ (3) $-\frac{1}{10}$ (4) $-\frac{1}{6}$

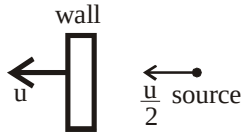
10. A satellite is launched into a circular orbit of radius R around the earth. A second satellite is launched into an orbit of radius (1.01)R. The period of the second satellite is larger than the first one by approximately

(1) 0.7 % (2) 1 % (3) 1.5 % (4) 3 %

11. The pitch of a screw gauge is 1 mm and there are 100 division on its circular scale. When nothing is put in between its jaws, the zero of the circular scale lies 4 divisions below the reference line. When a steel wire is placed between the jaws, two main scale divisions are clearly visible and 67 divisions on the circular scale are observed. The diameter of the wire is

(1) 2.71 mm (2) 2.67 mm (3) 2.63 mm (4) 2.65 mm

12. A wall is moving with velocity u and a source of sound moves with velocity $\frac{u}{2}$ in the same direction as shown in the figure. Assuming that the sound travels with velocity 10u. Find the ratio of incident sound wavelength on the wall to the reflected sound wavelength by the wall.

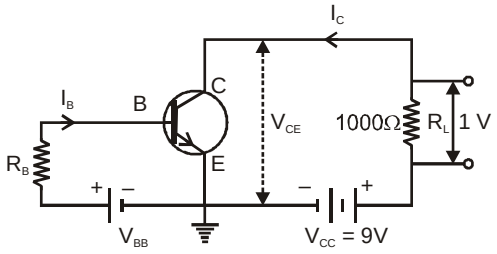


(1) $\frac{19}{18}$ (2) $\frac{9}{11}$ (3) $\frac{2}{18}$ (4) $\frac{19}{11}$

13. Let the wavelength at which the spectral emissive power of a black body (at a temperature T) is maximum, be denoted by λ_{max} .As the temperature of the body is increased by 4 K , λ_{max} decreases by 1 percent. The temperature T of the black body is

(1) 100K (2) 25K (3) 400K (4) None of these

14. An N-P-N transistor is connected in common emitter configuration in which collector supply is 9V and the voltage drop across the load resistance of 1000Ω connected in the collector circuit is 1 V. If current amplification factor is (250/26), If the internal resistance of the transistor is 200Ω, then which of the following options is **incorrect**:



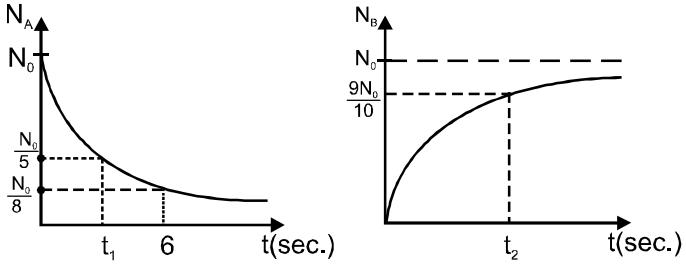
(1) V_{CE} = 8 V

(2) collector current is 1.0 mA

(3) voltage gain $\frac{50}{23}$, and power gain is 4.6

(4) emitter current is 1.104 mA

15. In a decay process A decays to B, Two graphs of number of nuclei of A and B versus time is given then, which of the following options is **incorrect** :

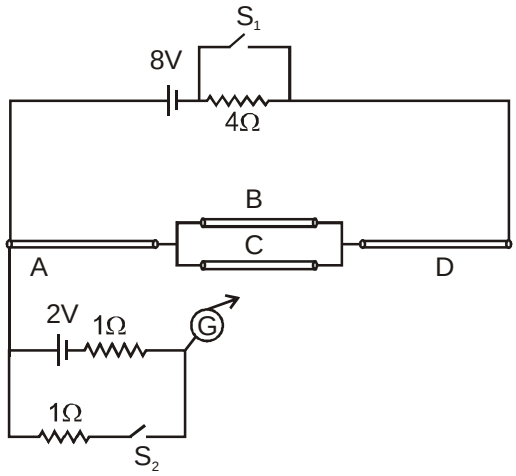


(1) $t_2 - t_1 = 4$ (2) $t_2 - t_1 = 2$ (3) $t_1 = 2\log_2 5$ (4) $t_2 = \log_2 100$

16. All electrons ejected from a surface by incident light of wavelength 200 nm can be stopped before travelling 1 m in the direction of uniform electric field of 4 N/C. The work function of the surface is:

(1) 4 eV (2) 6.2 eV (3) 2 eV (4) 2.2 eV

17. Four wire A, B, C and D each of length ℓ = 10cm and each of area of cross section is 0.1 m^2 are connected in the given circuit. Then, the position of null point is (Given that resistivity $\rho_A = 1\ \Omega - m$, $\rho_B = 3\ \Omega - m$, $\rho_C = 6\ \Omega - m$, $\rho_D = 1\ \Omega - m$)



(1) mid point of wire B or wire C when both the switches S_1 and S_2 open.

(2) mid point of wire B when both the switches S_1 and S_2 are closed.

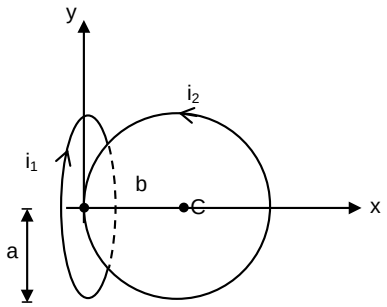
(3) mid point of wire D when both the switches S_1 and S_2 are open.

(4) None of these

18. Angular magnification produced by astronomical telescope for normal adjustment is 10 and length of telescope is 1.1 m. The angular magnification when the image is formed at least distance of distinct vision (D = 25 cm) is -

(1) 14 (2) 6 (3) 16 (4) 18

19. Two perpendicular circular loops of radius 'a' and 'b' carry currents i_1 and i_2 respectively. The loop of radius 'b' is in xy plane and centered at (b, 0, 0). The loop of radius 'a' is in yz plane centered at (0, 0, 0). The magnetic field at centre (b,0,0) is



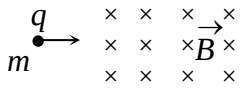
(1) $\frac{\mu_0}{2}\left[\frac{-i_1a^2}{(a^2+b^2)^{3/2}}\hat{i}+\frac{i_2}{b}\hat{k}\right]$

(2) $\frac{\mu_0}{2}\left[\frac{i_1b^2}{(a^2+b^2)^{3/2}}\hat{i}+\frac{i_2}{b}\hat{k}\right]$

(3) $\frac{\mu_0}{2}\left[\frac{i_1a^2}{(a^2+b^2)^{3/2}}\hat{i}-\frac{i_2}{b}\hat{k}\right]$

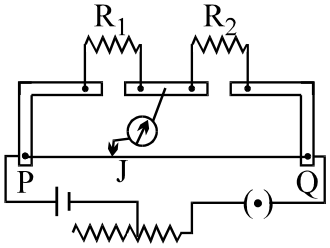
(4) None of these

20. A charged particle of mass *m* and charge *q* is projected into a uniform magnetic field of induction *B* with speed *v* which is perpendicular to *B*. The width of the magnetic field is *d*. the impulse imparted to the particle by the field is ($d << mv/qB$)



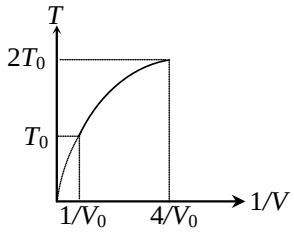
(1) qBv (2) mv/qB (3) qBd (4) $2mv^2/qB$

21. The circuit diagram given in the figure shows the experimental setup for the measurement of unknown resistance by using a meter bridge. The wire connected between the points P & Q has non-uniform resistance such that resistance per unit length varies directly as the distance from the point P. Null point is obtained with the jockey J with R_1 and R_2 in the given position. On interchanging the positions R_1 and R_2 in the gaps the jockey has to be displaced through a distance Δ from the previous position along the wire to establish the null point. If the ratio of $\frac{R_1}{R_2}=3$, find the value of Δ (in cm).Ignore any end corrections. [Take $\sqrt{3}=1.7$]



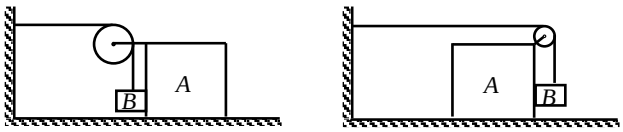
(1)50 (2)45 (3)30 (4)35

22. Figure shows a parabolic graph between T and $\frac{1}{V}$ (T = temperature, V = volume) for a mixture of a gases undergoing an adiabatic process. The ratio of rms velocity of molecules and speed of sound in the mixture of gases at the same temperature is



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

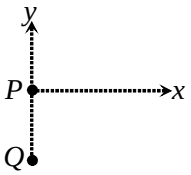
23. In the given figure, the mass of block A is 40 kg and of block B is 20 kg. There is no friction at any of the contact surface. Both the systems are held at rest initially. The ratio of acceleration of block B in condition (i) to condition (ii) just at the moment system is released, is



(i) (ii)

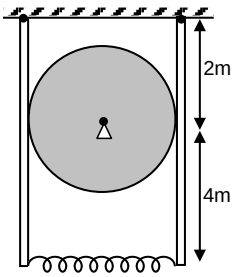
(1) $\frac{3}{2\sqrt{2}}$ (2) $\frac{2\sqrt{2}}{3}$ (3) 1 (4) $\frac{3}{2}$

24. Two identical sources P and Q emit waves in same phase and of same wavelength. Spacing between P and Q is 3λ. The maximum distance from P along the x–axis at which a minimum intensity occurs is given by



(1) 6.58λ (2) 2.25λ (3) 8.75λ (4) 0.55λ

25. A drum and its braking system are shown in figure. The drum of radius 1.5m has a moment of inertia of 80 kg.m^2 about its fixed axis of rotation and the spring has a spring constant (k) of 50 N/m. The coefficient of friction μ between bars and drum is 0.4. When the brake is in action, the spring has a 2m elongation. The drum rotates at 200 rpm. Time required for it to stop is :



(1) 2.84 sec (2) 3.76 sec (3) 5 sec (4) 4.65 sec

26. Unpolarized light of intensity $32 Wm^{-2}$ passes through three polarizers such that transmission axes of the first and second polarizer makes and angle 30° with each other and the transmission axis of the last polarizer is crossed with that of the first. The intensity of final emerging light will be

(1) 32 Wm^{-2} (2) 3 Wm^{-2} (3) 8 Wm^{-2} (4) 4 Wm^{-2}

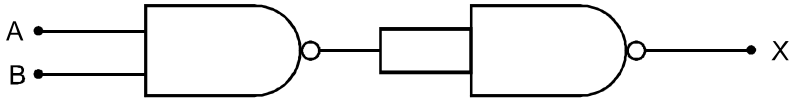
27. The equation of a particle executing SHM is given by $x = 3\cos\left(\frac{\pi}{2}\right)t$ cm, where t is in second. The distance travelled by the particle in the first 8.5 s is

(1) $\left(24+\frac{3}{\sqrt{2}}\right)$ cm (2) $\left(27-\frac{3}{\sqrt{2}}\right)$ cm (3) $\left(24-\frac{3}{\sqrt{2}}\right)$ cm (4) $\left(27+\frac{3}{\sqrt{2}}\right)$ cm

28. The mass, specific heat capacity and initial temperature of the sphere was 1000 gm, 1/2 cal/gm°C and 80°C respectively. The mass of the liquid and the calorimeter are 900 gm and 200 gm, and initially both were at room temperature 20°C. Both calorimeter and the sphere are made of same material. If the steady-state temperature after mixing is found to be 40°C, then the specific heat capacity of unknown liquid, is

(1) 0.25 cal/gmºC (2) 0.5 cal/gmºC. (3) 1 cal/gmºC (4) 1.5 cal/gmºC

29. The output(X) of the logic circuit shown in figure will be :



(1) $X = \overline{A \cdot B}$ (2) $X = A \cdot B$ (3) $X = \overline{A + B}$ (4) $2X = \overline{A \cdot B}$

30. Six stars of equal mass m are moving about the centre of mass of the system such that they are always on the vertices of a regular hexagon of side length a. Their common time period of revolution will be

(1) $4\pi\sqrt{\frac{a^3}{Gm}}$ (2) $2\pi\sqrt{\frac{4\sqrt{3}\,a^3}{Gm(5\sqrt{3}+4)}}$ (3) $4\pi\sqrt{\frac{3a^3}{Gm}}$ (4) $2\pi\sqrt{\frac{a^3}{Gm(1+\sqrt{3})}}$

PART-B : MATHEMATICS

31. If α is the nth root of unity, then $1 + 2\alpha + 3\alpha^2$+...to n terms is equal to

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

32. If $\left|\int_a^b f(x)\,dx\right| = \int_a^b |f(x)|\,dx$ (a $\neq$ b) also f(x) $\neq$ 0 for any x $\in$ (a, b) and $g(x) = \int_0^x f(x)\,dx$, then $\int_a^b f(x)\,g(x)\,dx$ when a and b are positive

(1) cannot be positive (2) cannot be negative
(3) can be less than –1 (4) nothing can be said

33. If $xf(x) = 3(f(x))^2 + 2$, then $\int \frac{2x^2 - 12xf(x) + f(x)}{(6f(x) - x)(x^2 - f(x))^2}dx$ equals to

(1) $\frac{1}{x^2 - f(x)} + c$ (2) $\frac{1}{x^2 + f(x)} + c$ (3) $\frac{1}{x - f(x)} + c$ (4) $\frac{1}{x + f(x)} + c$

34. The differential equation of a curve, passing through $\left(0, -\frac{\pi}{4}\right)$ and (t, 0) is

$\cos y\left(\frac{dy}{dx} + e^{-x}\right) + \sin y\left(e^{-x} - \frac{dy}{dx}\right) = e^{e^{-x}}$, the value of $t.e^{e^{-t}}$ is

(1) –1 (2) 1 (3) 2 (4) –2

35. If (1, 2, p), (2, 2p, – 6) and (α^2 – 2α, 1, 1) are the ordered triplets of form (x, y, z) which satisfies all the equations. $\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1, \frac{x}{b} + \frac{y}{c} + \frac{z}{a} = 1$ and $\frac{x}{c} + \frac{y}{a} + \frac{z}{b} = 1$ then α can be

(1) 2 (2) – 2 (3) – 4 (4) 6

36. The number of 5 digit numbers that can be made using the digits 1 and 2 and in which atleast one digit is different, is

(1) 30 (2) 31 (3) 32 (4) 35

37. A variable plane passes through a fixed point (1, 2, 3). The locus of the foot of the perpendicular drawn from origin to this plane is:

(1) $x^2 + y^2 + z^2 - x - 2y - 3z = 0$ (2) $x^2 + 2y^2 + 3z^2 - x - 2y - 3z = 0$
(3) $x^2 + 4y^2 + 9z^2 + x + 2y + 3 = 0$ (4) $x^2 + y^2 + z^2 + x + 2y + 3z = 0$

38. If the ellipse $\frac{x^2}{4} + y^2 = 1$ meets the ellipse $x^2 + \frac{y^2}{a} = 1$ in four distinct points and $a = b^2 - 5b + 7$, then b does not lies in the interval

(1) [4, 5] (2) $(-\infty, 2) \cup (3, \infty)$ (3) $(-\infty, 0)$ (4) [2, 3]

39. If a curve is represented parametrically by the equations $x = 4t^3 + 3$ and $y = 4 + 3t^4$ and $\frac{\left(\frac{d^2x}{dy^2}\right)}{\left(\frac{dx}{dy}\right)^n}$ is a constant then the value of n, is

(1) 3 (2) 4 (3) 5 (4) 6

40. The smaller area enclosed by y = f(x), where f(x) is a polynomial of least degree satisfying $\lim_{x\to 0}\left(1+\frac{f(x)}{x^3}\right)^{1/x} = e$ and the circle $x^2 + y^2 = 2$ above the x-axis is

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

41. Let f: $R \to \left[\frac{\pi}{6},\frac{\pi}{2}\right)$ is defined by $f(x) = \sin^{-1}\left(\frac{x^2-k}{1+x^2}\right)$.

Then the possible values of 'k' for which f is surjective function, is

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

42. For what values of a, m and b, Lagrange's mean value theorem is applicable to the function f(x)

for $x \in [0, 2]$ $f(x) = \begin{cases} 3 & x = 0 \\ -x^2 + a & 0 < x < 1 \\ mx + b & 1 \le x \le 2 \end{cases}$

(1) a = 3, m = – 2, b = 0 (2) a = 3, m = – 2, b = 4

(3) a = 3, m = 2, b = 0 (4) No such a, m, b exist

43. Negation of statement of $\sim p \wedge (p \Leftrightarrow q)$ is equivalent to

(1) $p \vee q$ (2) $q \wedge p$ (3) t (tautology) (4) f (fallacy)

44. A line intersects the ellipse $\frac{x^2}{4a^2}+\frac{y^2}{a^2}=1$ at A and B and the parabola $y^2 = 4a(x + 2a)$ at C and D. The line segment AB subtends a right angle at the ellipse. Then, the locus of the point of intersection of tangents to the parabola of C and D is

(1) $y^2 - a^2 = \frac{5}{4}(x-4a)^2$ (2) $y^2 - 2a^2 = 10(x - 4a)^2$

(3) $y^2 + a^2 = \frac{5}{2}(x-4a)^2$ (4) $y^2 + 4a^2 = 5(x + 4a)^2$

45. If a variable takes the values 0, 1, 2,....., n with frequencies 1, ${}^nC_1$, ${}^nC_2$,....,${}^nC_n$ then the A.M. is

(1) n (2) $\frac{2^n}{n}$ (3) n + 1 (4) $\frac{n}{2}$

46. A and B throw a pair of dice alternately till one of them wins. If A wins by throwing 7 while B wins by throwing 5 as a sum respectively, then the probability that one of the dice shows 3 on the last throw if A starts the game is

(1) $\frac{11}{36}$ (2) $\frac{11}{28}$ (3) $\frac{7}{22}$ (4) None of these

47. Two persons who are 500 m apart, observe the direction and the angle of elevation of a balloon at the same instant. One finds the elevation to be $\frac{\pi}{3}$ and direction being South-West, while the other finds the elevation to be $\frac{\pi}{4}$ and direction being west. Height of the balloon is

(1) $500\sqrt{\frac{3}{4-\sqrt{6}}}$m (2) $250\sqrt{\frac{3}{4+\sqrt{6}}}$m (3) $250\sqrt{\frac{3}{4-\sqrt{6}}}$m (4) $500\sqrt{\frac{3}{4+\sqrt{6}}}$m

48. If $\sin\theta$ and $-\cos\theta$ are the roots of the equation $ax^2 - bx - c = 0$, where a, b, c are the sides of a triangle ABC, then cos B is equal to

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

49. If a singular matrix $A=[a_{ij}]_{2\times2}$ always commute with $B=\begin{bmatrix}1 & 1\\ 2 & 1\end{bmatrix}$ such that $\frac{a_{11}}{a_{12}}=\sqrt{k}$, then k is

(1) 0 (2) 1 (3) 2 (4) 3

50. Let R_1, R_2 are relations defined on Z (set of all integers) such that $aR_1b \Leftrightarrow (a - b)$ is divisible by 3 and $aR_2b \Leftrightarrow (a - b)$ is divisible by 4 is. Then which of the two relations $(R_1 \cup R_2)$, $(R_1 \cap R_2)$ is/are an equivalence relation/s

(1) $R_1 \cup R_2$ only (2) $R_1 \cap R_2$ only

(3) Both $(R_1 \cap R_2)$, $(R_1 \cup R_2)$ (4) Neither $(R_1 \cup R_2)$ nor $(R_1 \cap R_2)$

51. If $\vec{x}$ and $\vec{y}$ are two non-collinear vectors and a triangle ABC with side lengths a, b, c satisfying $(20a-15b)\vec{x}+(15b-12c)\vec{y}+(12c-20a)(\vec{x}\times\vec{y})=\vec{0}$. Then triangle ABC is

(1) an acute angle triangle (2) an obtuse angle triangle

(3) a right angle triangle (4) an isosceles triangle

52. If m is a natural number, then $m(m + 1)(m + 2) + (7^m - 1)$ is always divisible by

(1) 5 (2) 9 (3) 6 (4) 12

53. Number of solutions of the equation $\cos 9x \cos 3x = \cos 18x \cos 12x$, $x \in [0, \pi]$ is

(1) 12 (2) 30 (3) 28 (4) 32

54. $\lim_{x\to 0}\frac{\tan x\cos(\sin x)-\sin(\sin x)}{\cos(\tan x)\tan x-\sin(\tan x)}$ is

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

55. If $f(x) = (a^2 - 3a + 2)\left(\cos^2\frac{x}{4}-\sin^2\frac{x}{4}\right)+ (a - 1)x + \sin 1$ possesses critical points, then the exhaustive set of value of 'a' are

(1) $(-\infty, 0] \cup [4, \infty)$ (2) $(-\infty, 0] \cup [4, \infty) \cup \{1\}$

(3) $(-\infty, 0] \cup (4, \infty) \cup \{1\}$ (4) None of these

56. On the line segment joining (1, 0) and (3, 0) an equilateral triangle is drawn having its vertex in the fourth quadrant, then radical centre of the circles described on its sides as diameter is

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

57. Let A(5, 12), B($-13\cos\theta$, $13\sin\theta$) and C($13\sin\theta$, $-13\cos\theta$) are vertices of ΔABC where $\theta \in R$. The locus of the orthocentre of ΔABC is

(1) $x - y + 7 = 0$ (2) $x - y - 7 = 0$ (3) $x + y - 7 = 0$ (4) $x + y + 7 = 0$

58. The greatest value of the function $y = \frac{x}{ax^2 + b}$ $(a, b > 0)$

(1) $\frac{1}{\sqrt{ab}}$ (2) $\frac{1}{2\sqrt{ab}}$ (3) $\sqrt{ab}$ (4) $2\sqrt{ab}$

59. Let a function $f:[0, 256] \to R$ be a differentiable in the entire domain. If $\alpha \in [2, 3]$ & $\beta \in [3, 4]$, then value of $\int_{16}^{256} f(t)\,dt$ is

(1) $3[\alpha^3.f(\alpha^3)+\beta^3.f(\beta^3)]$ (2) $4[\alpha^4.f(\alpha^4)+\beta^4.f(\beta^4)]$

(3) $3[\alpha^3.f(\alpha^4)+\beta^3.f(\beta^4)]$ (4) $4[\alpha^3.f(\alpha^4)+\beta^3.f(\beta^4)]$

60. Let $f(x)=\begin{cases}\sin\pi x, & x<\frac{1}{2}\\ |4x-1|[2x], & x\ge\frac{1}{2}\end{cases}$

where $[\cdot]$ denotes the greatest integer function. Then the function is

(1) discontinuous at $x=\frac{1}{2}$ (2) continuous but not differentiable at $x=\frac{1}{2}$

(3) differentiable at $x=\frac{1}{2}$ (4) continuous but not differentiable at x = 0

PART-C : CHEMISTRY

61. If 40 mL of 0.2 M CH_3COOH is titrated with 0.2 M NaOH. How many ml of base must be added to form a buffer solution with greatest buffering capacity :

(1) 10 mL (2) 20 mL (3) 30 mL (4) 40 mL

62. During the extraction of gold the following reactions takes place :

$Au + CN^- + H_2O \xrightarrow{O_2} X$, $X + Zn \longrightarrow Y + Au$

Here, X and Y respectively are :

(1) $[Au(CN)_2]^-$ and $[Zn(CN)_4]^{2-}$ (2) $[Au(CN)_2]^-$ and $[Zn(CN)_6]^{4-}$

(3) $[Au(CN)_4]^{4-}$ and $[Zn(CN)_4]^{2-}$ (4) $[Au(CN)_4]^{3-}$ and $[Zn(CN)_4]^{2-}$

63. Which of the following does not given the same osazone:

(1) D-Glucose and D-mannose (2) D-fructose and D-mannose

(3) D-Erythrose and D-Threose (4) D-Glucose and L-fructose

64. Determine the amount of $CaCl_2$ dissolve in 2.5 L of water such that its osmotic pressure is 0.75 atm. at 27ºC. If degree of dissociation of $CaCl_2$ is 75%.

(1) 3.38gm (2) 5.27gm (3) 4.25 gm (4) 52.7gm

65. What is true about N_2O_4?

(1) It is a mixture N_2O_3 and N_2O_5

(2) All atoms are sp^2 hybridised

(3) It is reddish brown gas

(4) It reacts with water to give mixture of two oxoacids of nitrogen

66. Which of the following cannot exhibit conformational isomerism:

(1) H_2O_2 (2) $H_2N–OH$ (3) C_2H_6 (4) $CH_3–Cl$

67. One mole each of benzene (P^0 = 600 torr), toluene (P^0 = 400 torr) and mercury (P^0 = 100 torr) are mixed in a well-stirred container and allowed to reach equilibrium with their vapors.The vapors are formed in very little amount. Vapor pressure of this mixture is (Benzene and toluene are miscible with each other while Hg dissolves in neither) :

(1) 400 torr (2) 500 torr (3) 600 torr (4) 760 torr

68. Concentrated nitric acid oxidises phosphorus into :

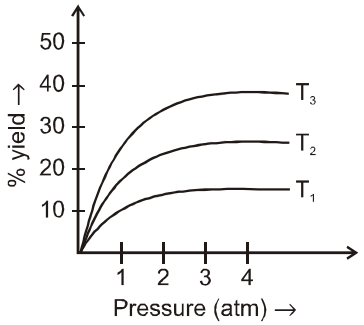
(1) PH_3 (2) H_3PO_2 (3) H_3PO_4 (4) H_3PO_3

69. Which of the following statement is incorrect?
(1) Brompheniramine (Dimetane) is an antihistaminic drug.
(2) The C–H bond of propane is shorter than in cyclopropane.
(3) Sign of rotation of a chiral compound (+) and (–) is unrelated to the it's configuration R/S.
(4) Mixture of CO + H_2 is called water gas.

70. The preparation of $SO_3(g)$ by reaction

$$SO_2(g) + \frac{1}{2} O_2(g) \rightleftharpoons SO_3(g)$$

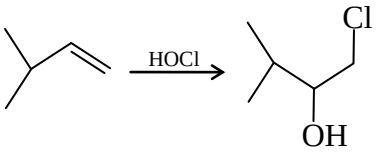
is an exothermic reaction. If the preparation follows the following temperature-pressure relationship for its % yield, K_1 , K_2 and K_3 are the equilibrium constant for the given reaction at temperature T_1, T_2 and T_3 respectively. The correct option is :

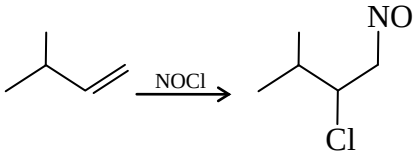


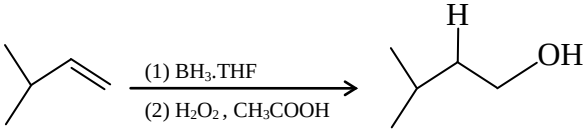
(1) $T_3 > T_2 > T_1$
(2) $T_3 < T_2 < T_1$
(3) $K_1 = K_2 = K_3$
(4) Nothing could be predicted about temperature through given information.

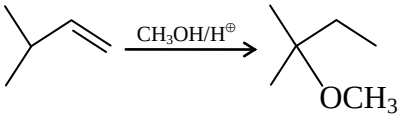
71. Arrange the following in increasing order of their magnetic moment.
(I) $[Fe(CN)_6]^{-3}$ (II) $[Ni(CO)_4]$ (III) $[Cr(NH_3)_6]^{+3}$
(1) I = II < III (2) I < II < III (3) II < I < III (4) III < I < II

72. Which of the following reaction leads to incorrect product?

(1) 

(2) 

(3) 

(4) 

73. Select the incorrect statement :

(1) Gases 'X' and 'Y' having similar intermolecular forces, have their critical volume related as $\frac{(V_C)_Y}{(V_C)_X} > 1$. Therefore, gas 'Y' is more compressible than gas 'X' under similar conditions.

(2) Under normal conditions, helium gas shows positive deviation from ideal behaviour.

(3) Value of second virial coefficient of Z vs V_m equation for a gas is zero at Boyle's temperature.

(4) At very high molar volume, behaviour of gas becomes ideal.

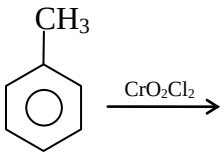
74. Which of the following is amphoteric oxide among :

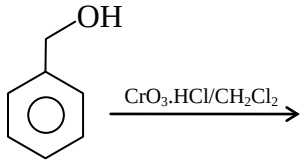
Mn_2O_7 , CrO_3 , Cr_2O_3 , CrO , V_2O_5, V_2O_4?

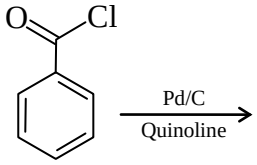
(1) V_2O_5 and CrO_3 (2) Cr_2O_3 and V_2O_5

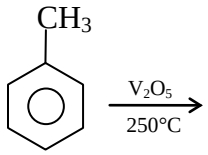
(3) Mn_2O_7 and Cr_2O_3 (4) CrO and V_2O_4

75. Which of the following reactions will not form benzaldehyde as major product?

(1) 

(2) 

(3) 

(4) 

76. The minimum voltage required to electrolyse alumina in the Hall-Heroult process is :

(Given, ΔG_f^0 $(Al_2O_3) = -1520$ kJmol^{-1} ; ΔG_f^0 $(CO_2) = -394$ kJmol^{-1})

{In Hall-Heroult process, the following reactions occur $3C + 2Al_2O_3 \rightarrow 4Al + 3CO_2$}

(1) 1.575 V (2) 1.60 V (3) 1.312 V (4) – 2.62 V

77. $MnO_4^- + I^- \longrightarrow MnO_2 + X$

If reaction is taken out in faintly alkaline medium then hybridization of central atom of X will be :

(1) sp^3d^2 (2) sp^3d (3) sp^3 (4) sp^2

78. Which of the following reactions does not yield an alkyl amine?

(1) $R - X + NH_3 \longrightarrow$

(2) $R - CH = N - OH + [H] \xrightarrow[C_2H_5OH]{Na}$

(3) $R - C \equiv N + H_2O \xrightarrow{H^\oplus}$

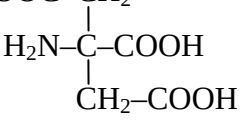
(4) $R-\overset{\overset{O}{\|}}{C}-OH \xrightarrow[(ii)\ \Delta \\ (ii)LiAlH_4]{(i)\ NH_3}$

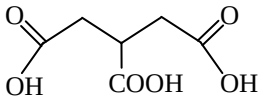
79. The non-stoichiometric compound $Fe_{0.94}O$ is formed when x% of Fe^{2+} ions are replaced by Fe^{3+} ions, then x is:

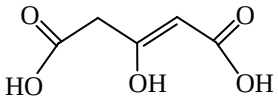
(1) 18 (2) 15 (3) 12 (4) 6

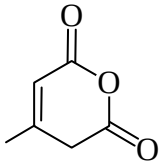
80. Select the specie(s) among the following which contain maximum number of atoms in one plane?

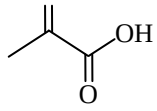
(1) BrF_5 (2) $C_2(CN)_4$ (3) IF_7 (4) C_2Cl_4

81.  $\xrightarrow[\Delta]{NaNO_2,\ HCl}$ Product is:

(1) 

(2) 

(3) 

(4) 

82. A gas ($C_{v,m} = \frac{5}{2}$ R) behaving ideally was allowed to expand reversibly and adiabatically from 1 L to 32 L. It's initial temperature was 527°C

Molar Enthalpy Change (ΔH_m) for the process is

(1) –1500 R Joule (2) –2100 R Joule (3) 2100 Joule (4) 1800 R Joule

83. Select the correct order among the following :

(1) S < Cl < P : Ionization energy (2) O < S > Se : Electron affinity

(3) B < Al < Ga : Electronegativity (4) F < Cl > Br : Atomic radius

84. Which of the following can distinguish 1°, 2° and 3° amines the best?

(1) Mustard oil test (2) Exhaustive methylation

(3) Carbylamine test (4) Using diethyl oxalate

85. At a certain temperature the following data were collected for the reaction

$$2ICl + H_2 \longrightarrow I_2 + 2HCl$$

Initial Concentrations (in M)		Initial Rate of formation of I_2 (Ms^{-1})
[ICl]	[H_2]	
0.10	0.10	0.0015
0.20	0.10	0.0030
0.10	0.05	0.00075

Determine overall order of reaction

(1) 0 (2) 1 (3) 2 (4) 3

86. Which of the following molecule is planar as well as polar?

(1) PH_3 (2) $SOCl_2$ (3) $\dot{C}H_3$ (4) $\dot{N}O_2$

87. $CH_3\underset{*}{\overset{\overset{OH}{|}}{C}}H–COOH + CH_3OH \xrightarrow{HCl} CH_3\underset{*}{\overset{\overset{OH}{|}}{C}}H–\overset{\overset{O}{||}}{C}–O–CH_3 + H_2O$

R, (–) lactic acid

Which of the following statement is correct about following conversion?

(1) Product is necessarily levorotary. (2) Product is necessarily dextrorotary.

(3) The product is S-methyl lactate (4) The product is R-methyl lactate

88. According to the Bohr theory for the hydrogen atom, the number of revolutions of the electron per second in the orbit of quantum number, n is proportional to

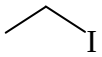
(1) n^{-2} (2) $\sqrt{n}$ (3) n^{-3} (4) n^{-1}

89. Select the oxyacids which have basicity ≥ 2.

(I) $H_4P_2O_5$ (II) $H_3P_3O_9$ (III) H_3BO_3 (IV) H_3PO_5

(1) I, II only (2) II and IV only (3) I, II and IV (4) Only II

90. $CH_2 = CH_2 \xrightarrow[(iii)\,PI_3\,(2\,eq),\Delta]{(i)\,PhCO_3H \;(ii)\,H_3O^{\oplus}}$ product is:

(1)  (2) $CH_2 = CH_2$ (3)  (4)