JEE Main - 2023

30th JAN 2023 (Morning Shift)

General Instructions

1. The test is of **3 hours** duration and the maximum marks is **300.**
2. The question paper consists of **3 Parts** (Part I: **Physics**, Part II: **Chemistry**, Part III: **Mathematics**). Each Part has **two** sections (Section 1 & Section 2).
3. **Section 1** contains **20 Multiple Choice Questions**. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE CHOICE** is correct.
4. **Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. You will NOT be allowed to attempt the sixth question. If you wish to attempt any other question apart from the five already attempted, then you will have to delete any one response from the five previously answered and then proceed to answer the new one.**
   The answer to each question should be **rounded off to the nearest integer**.
5. No candidate is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.

Marking Scheme

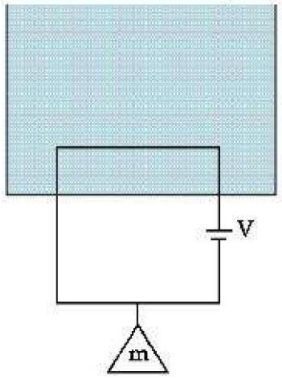
1. **Section – 1:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. **Section – 2:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.

SUBJECT I: PHYSICS	MARKS: 100

SECTION-1

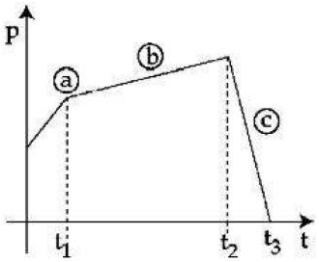
This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE CHOICE is correct.

1. A massless square loop, of wire of resistance 10Ω, surrounding a mass of 1*g*, hangs vertically with one of its sides in a uniform magnetic field of $10^3 G$, directed outwards in the shaded region. A *dc* voltage *V* is applied to the loop. For what value of *V*, the magnetic force will exactly balance the weight of the supporting mass of 1g? (If sides of the loop $= 10cm,\ g = 10ms^{-2}$)



(1) $10V$ **(2)** $100V$ **(3)** $\frac{1}{10}V$ **(4)** $1V$

2. The figure represents the momentum time $(p\text{-}t)$ curve for a particle moving along an axis under the influence of the force. Identify the regions on the graph where the magnitude of the force is maximum and minimum respectively? (If $(t_3 - t_2) < t_1$)



(1) *c* and *a* **(2)** *b* and *c* **(3)** *c* and *b* **(4)** *a* and *b*

3. Electric field in a certain region is given by $\vec{E} = \left(\frac{A}{x^2}\hat{i} + \frac{B}{y^3}\hat{j}\right)$. The SI unit of *A* and *B* are:

(1) $Nm^3C^{-1};\ Nm^2C^{-1}$ **(2)** $Nm^3C;\ Nm^2C$

(3) $Nm^2C;\ Nm^3C$ **(4)** $Nm^2C^{-1};\ Nm^3C^{-1}$

4. In a series LR circuit with $X_L = R$, power factor is P_1. If a capacitance *C* with $X_C = X_L$ is added to the circuit the power factor becomes P_2. The ratio of P_1 to P_2 will be:

(1) $1:\sqrt{2}$ **(2)** 1 : 2 **(3)** 1 : 1 **(4)** 1 : 3

5. Speed of an electron in Bohr's 7th orbit for hydrogen atom is $3.6\times10^6\ m/s$. The corresponding speed of the electron in 3rd orbit, in *m*/*s* is:

(1) (1.8×10^6) **(2)** (8.4×10^6) **(3)** (7.5×10^6) **(4)** (3.6×10^6)

6. Choose the correct relationship between Poisson ratio (σ), bulk modulus (K) and modulus of rigidity (η) of a given solid object.

(1) $\sigma = \frac{3K-2\eta}{6K+2\eta}$ **(2)** $\sigma = \frac{6K-2\eta}{3K-2\eta}$ **(3)** $\sigma = \frac{3K+2\eta}{6K+2\eta}$ **(4)** $\sigma = \frac{6K+2\eta}{3K-2\eta}$

7. A person has been using spectacles of power –1.0 dioptre for distant vision and a separate reading glass of power 2.0 dioptres. What is the least distance of distinct vision for this person?

(1) 40 *cm* **(2)** 10 *cm* **(3)** 30 *cm* **(4)** 50 *cm*

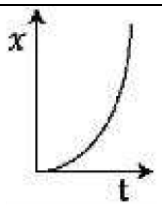
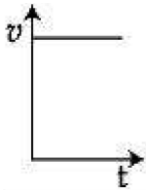
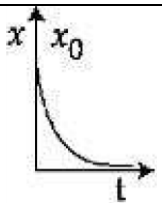
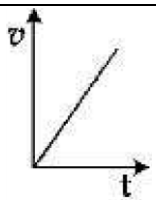
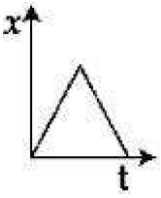
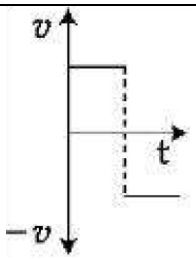
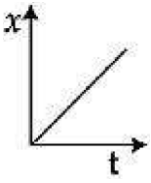
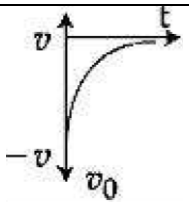
8. Two isolated metallic solid spheres of radii *R* and 2*R* are charged such that both have same charge density σ. The spheres are then connected by a thin conducting wire. If the new charge density if the bigger sphere is $'\sigma'$. The ratio $\frac{\sigma'}{\sigma}$ is:

(1) $\frac{5}{6}$ **(2)** $\frac{9}{4}$ **(3)** $\frac{5}{3}$ **(4)** $\frac{4}{3}$

9. A sinusoidal carrier voltage is amplitude modulated. The resultant amplitude modulated wave has maximum and minimum amplitude of 120*V* and 80*V* respectively. The amplitude of each sideband is:

(1) 5*V* **(2)** 10*V* **(3)** 20*V* **(4)** 15*V*

10. Match Column-I with Column-II.

Column-I		Column-II	
A.		**I.**	
B.		**II.**	
C.		**III.**	
D.		**IV.**	

Choose the correct answer from the options given below:

(1) A-II, B-IV, C-III, D-I **(2)** A-I, B-II, C-III, D-IV

(3) A-II, B-III, C-IV, D-I **(4)** A-I, B-III, C-IV, D-II

11. A small object rest, absorbs a light pulse of power 20 *mW* and duration 30 *ns*. Assuming speed of light as $3\times10^{8} m/s,$ the momentum of the object becomes equal to:

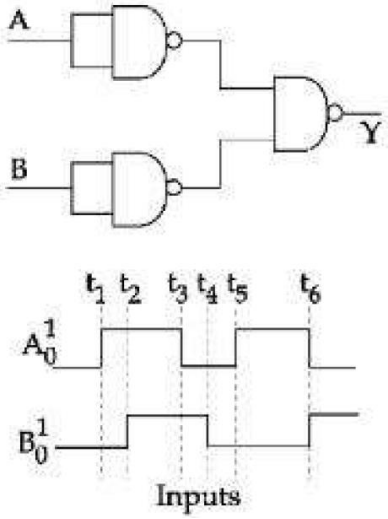
(1) $2\times10^{-17} kg\,m/s$ **(2)** $0.5\times10^{-17} kg\,m/s$

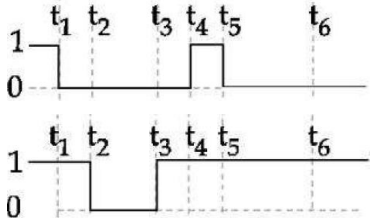
(3) $1\times10^{-17} kg\,m/s$ **(4)** $3\times10^{-17} kg\,m/s$

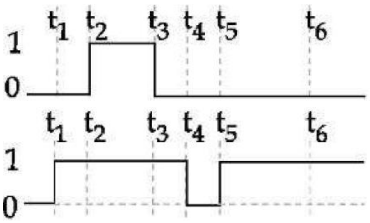
12. If the gravitation field in the space is given as $\left(-\frac{K}{r^2}\right)$. Taking the reference point to be at $r = 2cm$ with gravitational potential $V = 10\,J/kg.$ Find the gravitational potential at $r = 3cm$ in SI unit. (Given, that $K = 6\,Jm/kg$)

(1) 10 **(2)** 11 **(3)** 9 **(4)** 12

13. The output waveform of the given logical circuit for the following inputs *A* and *B* as shown below, is:



(1) 

(2) 

(3)

(4)

14. The height of liquid column raised in a capillary two of certain radius when dipped in liquid *A* vertically is, 5 *cm*. If the tube is dipped in a similar manner in another liquid *B* of surface tension and density double the values of liquid *A*, the height of liquid column raised in liquid *B* would be _____ *m*.

(1) 0.20 **(2)** 0.5 **(3)** 0.10 **(4)** 0.05

15. The charge flowing in a conductor changes with time as $Q(t) = \alpha t - \beta t^2 + \gamma t^3$. Where α, β and γ are constants. Minimum value of current is:

(1) $\alpha - \frac{\beta^2}{3\gamma}$ **(2)** $\beta - \frac{\alpha^2}{3\gamma}$ **(3)** $\alpha - \frac{\gamma^2}{3\beta}$ **(4)** $\alpha - \frac{3\beta^2}{\gamma}$

16. The pressure (*P*) and temperature (*T*) relationship of an ideal gas obeys the equation $PT^2 = \text{constant}$. The volume expansion coefficient of the gas will be:

(1) $3T^2$ **(2)** $\frac{3}{T}$ **(3)** $\frac{3}{T^3}$ **(4)** $\frac{3}{T^2}$

17. The magnetic moments associated with two closely wound circular coils *A* and *B* of radius $r_A = 10\,cm$ and $r_B = 20\,cm$ respectively are equal if:

(Where N_A, I_A and N_B, I_B are number of turn and current of *A* and *B* respectively)

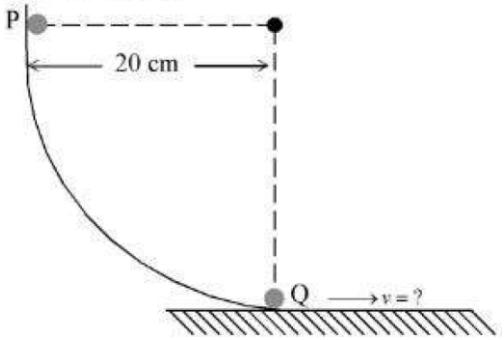
(1) $2N_A I_A = N_B I_B$ **(2)** $4N_A I_A = N_B I_B$

(3) $N_A I_A = 4N_B I_B$ **(4)** $N_A = 2N_B$

18. A ball of mass 200 *g* rests on a vertical post of height 20*m*. A bullet of mass 10*g*. travelling in horizontal direction, hits the centre of the ball. After collision both travels independently. The ball hits the ground at a distance 30*m* and the bullet at a distance of 120*m* from the foot of the post. The value of initial velocity of the bullet will be (if $g = 10\,m/s^2$).

(1) 360 *m/s* **(2)** 400 *m/s* **(3)** 120 *m/s* **(4)** 60 *m/s*

19. As per the given figure, a small ball *P* slides sown the quadrant of a circle and hits the other ball *Q* of equal mass which is initially at rest. Neglecting the effect of friction and assume the collision to be elastic, the velocity of ball *Q* after collision will be: $(g = 10\,m/s^2)$



(1) 0 **(2)** 2 *m/s* **(3)** 4 *m/s* **(4)** 0.25 *m/s*

20. Heat is given to an ideal gas in an isothermal process.

A. Internal energy of the gas will decrease.

B. Internal energy of the gas will increase.

C. Internal energy of the gas will not change.

D. The gas will do positive work.

D. The gas will do negative work.

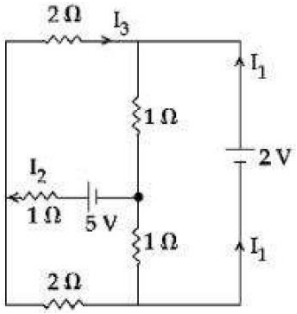
Choose the **correct** answer from the options given below:

(1) *C* and *E* only **(2)** *A* and *E* only **(3)** *B* and *D* only **(4)** *C* and *D* only

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

21. In the following circuit, the magnitude of current I_1, is _____ *A*.



22. In a screw gauge, there are 100 divisions on the circular scale and the main scale moves by 0.5 *mm* on a complete rotation of the circular scale. The zero of circular scale lies 6 divisions below the line of graduation when two studs are brought in contact with each other. When a wire is placed between the studs, 4 linear scale divisions are clearly visible while 46th division the circular scale coincide with the reference line. The diameter of the wire is _____ $\times 10^{-2}$ *mm.*

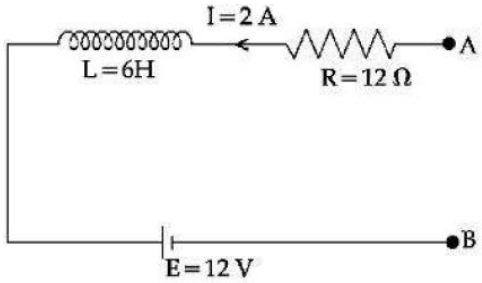
23. In an experiment for estimating the value of focal length of converging mirror, image of an object placed at 40*cm* from the pole of the mirror is formed at distance 120*cm* from the pole of the mirror. These distances are measured with a modified scale in which there are 20 small divisions in 1*cm*. The value of error in measurement of focal length of the mirror is $\frac{1}{K}cm.$ The value of *K* is _____.

24. A horse rider covers half the distance with 5 *m*/*s* speed. The remaining part of the distance was travelled with speed 10 *m*/*s* for half the time and with 15 *m*/*s* for other half of the time. The mean speed of the rider averaged over the whole time of motion is $\frac{x}{7}m/s.$ The value of *x* is _____.

25. A point source of light is placed at the centre of curvature of a hemispherical surface. The source emits a power of 24*W*. The radius of curvature of hemisphere is 10*cm* and the inner surface is completely reflecting. The force on the hemisphere due to the light falling on it is _____ $\times 10^{-8} N.$

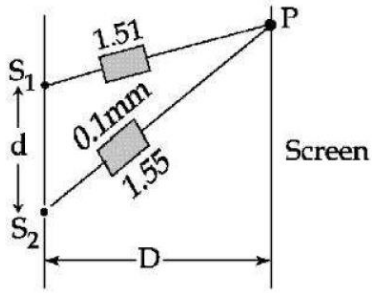
26. A thin uniform rod of length 2*m*, cross sectional area '*A*' and density '*d*' is rotated about an axis passing through the centre and perpendicular to its length with angular velocity ω. If value of ω in terms of its rotational kinetic energy *E* is $\sqrt{\frac{\alpha E}{Ad}}$ then value of α is _____.

27.



As per the given figure, if $\frac{dI}{dt} = -1A/s$ then the value of V_{AB} at this instant will be _____ *V*.

28. In Young's souble slit experiment, two slits S_1 and S_2 are '*d*' distance apart and the separation from slits screen is *D*. (as shown in figure). Now if two transparent slobs of equal thickness 0.1 *mm* but index 1.51 and 1.55 are introduction in the path of beam $(\lambda = 400\,\mathring{A})$ from S_1 and S_2 respectively. The central bright fringe spot will shift by _____ number of fringes.



29. The general displacement of a simple harmonic oscillator is $x = A\sin\omega t$. Let T be its time period. The slope of its potential energy (*U*) - time (*t*) curve will be maximum when $t = \frac{T}{\beta}$. The value of β is_____.

30. A capacitor of capacitance $90\,\mu F$ charged by a 100*V* battery. The capacitor is disconnected from the battery and connected to another plate uncharged identical capacitor such that one plate of uncharged capacitor connected to positive plate and another plate of uncharged connected to negative plate of the charged capacitor. The loss of energy in this process is measured as $x \times 10^{-2} J$. The value of *x* is_____.

SUBJECT II: CHEMISTRY	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE CHOICE is correct.

1. In the extraction of copper, its sulphide ore is heated in a reverberatory furance after mixing with silica to:

(1) decrease the temperature needed for roasting of Cu_2S

(2) remove calcium as $CaSiO_3$

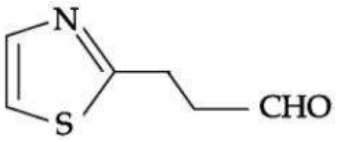
(3) separate CuO as $CuSiO_3$

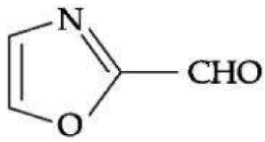
(4) remove FeO as $FeSiO_3$

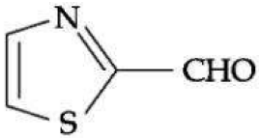
2. Which of the following compounds would give the following set of qualitative analysis?

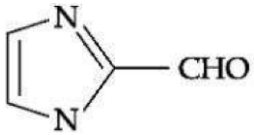
(i) Fehling's Test : Positive

(ii) Na Fusion extract upon treatment with sodium nitroprusside gives a blood red colour but not Prussian blue.

(1) 

(2) 

(3) 

(4) 

3. Caprolactam when heated at high temperature in pressure of water, gives:

(1) Nylon 6 **(2)** Teflon **(3)** Nylon 6, 6 **(4)** Dacron

4. Amongst the following compounds, which one is an antacid?

(1) Brompheniramine **(2)** Terfenadine

(3) Ranitidine **(4)** Meprobamate

5. Given below are two statements : one is labelled as **Assertion (A)** and the other labelled as **Reason (R)**.

Assertion (A) : Ketoses gives Seliwanoff's test faster than Alsoses.

Reason (R) : Ketoses undergoes β-elimination followed by formation of furfural.

In the light of the above statements, choose the correct from the options given below:

(1) **(A)** is true but **(R)** is false

(2) Both **(A)** and **(R)** are true **(R)** is the explanation of **(A)**

(3) **(A)** is false but **(R)** is true

(4) Both **(A)** and **(R)** are true but **(R)** is **not** the explanation of **(A)**

6. The alkaline earth metal sulphate(s) which are readily soluble in water is/are:

A. $BeSO_4$ **B.** $MgSO_4$ **C.** $CaSO_4$

D. $SrSO_4$ **E.** $BaSO_4$

Choose the **correct** answer from the options given below:

(1) B and C **(2)** B only **(3)** A only **(4)** A and B

7. Match **List-I** with **List-II**.

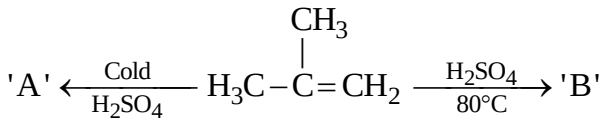
List-I (Atomic number)		List-II (Block of periodic table)	
A.	37	**I.**	p-Block
B.	78	**II.**	d-Block
C.	52	**III.**	f-Bock
D.	65	**IV.**	s-Block

Choose the **correct** answer from the options given below:

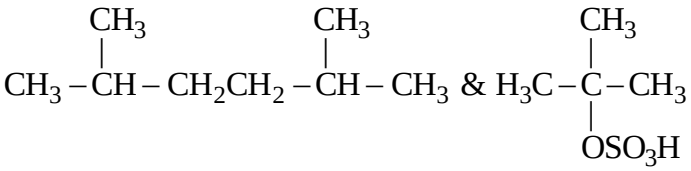
(1) A-IV, B-III, C-II, D-I **(2)** A-IV, B-II, C-I, D-III

(3) A-II, B-IV, C-I, D-III **(4)** A-I, B-III, C-IV, D-II

8. The major products 'A' and 'B', respectively, are:



(1)



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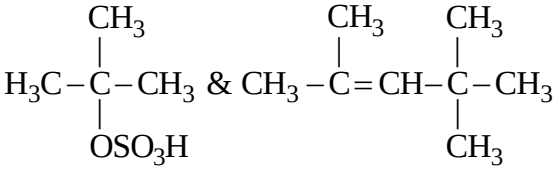
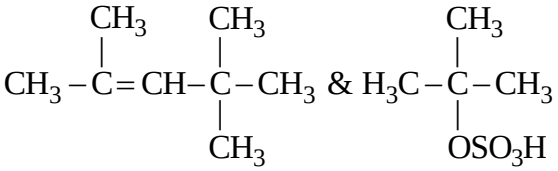
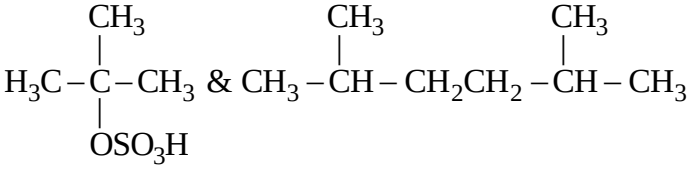


(3)



(4)



9. Which of the following is correct order of ligand field strength?

(1) $S^{2-} < NH_3 < en < CO < C_2O_4^{2-}$ **(2)** $NH_3 < en < CO < S^{2-} < C_2O_4^{2-}$

(3) $CO < en < NH_3 < C_2O_4^{2-} < S^{2-}$ **(4)** $S^{2-} < C_2O_4^{2-} < NH_3 < en < CO$

10. Match **List-I** with **List-II**.

List-I (molecules/ions)		List-II (No. of lone pairs of e^- on central atom)	
A.	IF_7	**I.**	Three
B.	ICl_4^-	**II.**	One
C.	XeF_6	**III.**	Two
D.	XeF_2	**IV.**	Zero

Choose the **correct** answer from the options given below:

(1) A-IV, B-III, C-II, D-I **(2)** A-II, B-III, C-IV, D-I

(3) A-IV, B-I, C-II, D-III **(4)** A-II, B-I, C-IV, D-III

11. Formation of photochemical smog involves the following reaction in which A, B and C are respectively.

(i) $NO_2 \xrightarrow{h\nu} A + B$ **(ii)** $B + O_2 \longrightarrow C$ **(iii)** $A + C \longrightarrow NO_2 + O_2$

Choose the **correct** answer from the options given below:

(1) O, N_2O & NO **(2)** N, O_2 and O_3

(3) NO, O & O_3 **(4)** O, NO & NO_3^-

12. Given below are two statements : one is labelled as **Assertion (A)** and the other labelled as **Reason (R)**.

Assertion (A) : In expensive scientific instruments, silica gel is kept in watch-galsses or in semipermeable membrane begs.

Reason (R) : Silica gel adsorbs moisture from air via adsorption, thus protects the instrument from water corrosion (rusting) and / or prevents malfunctioning

In the light of the above statements, choose the **correct** from the options given below:

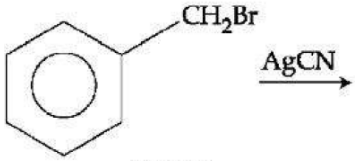
(1) Both **(A)** and **(R)** are true **(R)** is the explanation of **(A)**

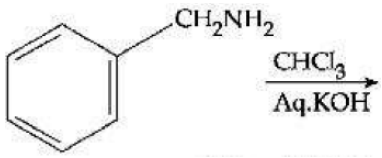
(2) **(A)** is false but **(R)** is true

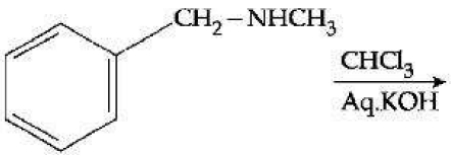
(3) Both **(A)** and **(R)** are true but **(R)** is **not** the explanation of **(A)**

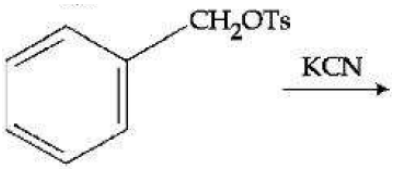
(4) **(A)** is true but **(R)** is false

13. Benzyl isocyanide can be obtained by:

A. 

B. 

C. 

D. 

Choose the **correct** answer from the options given below:

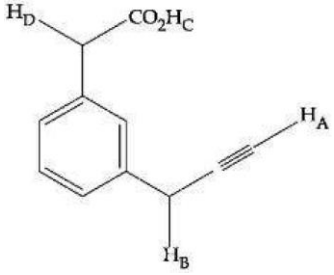
(1) A and B **(2)** A and D **(3)** Only C **(4)** B and C

14. Lithium aluminium hydride cab be prepared from the reaction of:

(1) LiH and Al_2Cl_6 **(2)** LiH and $Al(OH)_3$

(3) LiCl and Al_2H_6 **(4)** LiCl, Al and H_2

15. What is the correct order of acidity of the protons marked A – D in the given compounds?



(1) $H_C > H_D > H_B < H_A$ **(2)** $H_C > H_D > H_A > H_B$

(3) $H_D > H_C > H_B > H_A$ **(4)** $H_C > H_A > H_D > H_B$

16. During the qualitative analysis of SO_3^{2-} using dilute H_2SO_4, SO_2 gas is evolved which turns $K_2Cr_2O_7$ solution (acidified with dilute H_2SO_4).

(1) red **(2)** green **(3)** blue **(4)** black

17. For OF_2 molecule consider the following:

A. Number of lone pairs on oxygen is 2.
B. FOF angle is less than 104.5°.
C. Oxidation state of O is –2.
D. Molecule is bent 'V' shaped.
E. Molecular geometry is linear.

Correct option are:

(1) C, D, E only **(2)** A, B, C only **(3)** B, E, A only **(4)** A, C, D only

18. In the wet tests for identification of various cations by precipitate, which transition element cation doesn't belong to group IV in qualitative inorganic analysis?

(1) Co^{2+} **(2)** Zn^{2+} **(3)** Ni^{2+} **(4)** Fe^{3+}

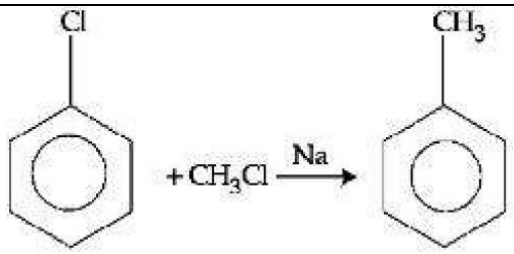
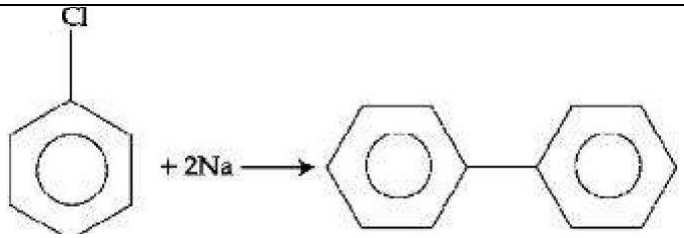
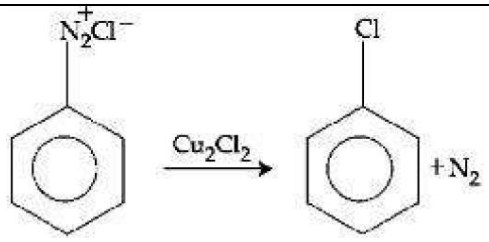
19. To inhibit the growth of tumours, identify the compounds used from the following:

A. EDTA **B.** Coordination compounds of Pt
C. D-Penicillamine **D.** Cis-Platin

Choose the **correct** answer from the options given below:

(1) C and D only **(2)** A and C only **(3)** B and D only **(4)** A and B only

20. Match **List-I** with **List-II**.

List-I		**List-II**	
A.		**I.**	Fitting reaction
B.		**II.**	Wurtz fitting reaction
C.		**III.**	Finkelstein reaction
D.	$C_2H_5Cl + NaI \longrightarrow C_2H_5I + NaCl$	**IV.**	Sandmeyer reacrtion

Choose the **correct** answer from the options given below:

(1) A-II, B-I, C-III, D-IV **(2)** A-IV, B-II, C-III, D-I
(3) A-III, B-II, C-IV, D-I **(4)** A-II, B-I, C-IV, D-III

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

21. 600 mL of 0.01 M HCl is mixing with 400 mL of $0.01\ M\ H_2SO_4$. The pH of the mixture is _____ $\times 10^{-2}$. (Nearest integer)
[Given : $\log 2 = 0.30, \log 3 = 0.48, \log 5 = 0.69, \log 7 = 0.84, \log 11 = 1.04$]

22. The number of electrons involved in the reduction permanganate to manganese dioxide in acidic medium is _____.

23. If compound A reacts with B following first order kinetics with rate constant $2.011\times10^{-3}s^{-1}$. The time taken by A (in seconds) to reduce from 7 g to 2 g will be _____. (Nearest integer)
$[\log 5 = 0.698, \log 7 = 0.845, \log 2 = 0.301]$

24. When 2 litre of ideal gas expands isothermally into vacuum to a total volume of 6 litre, the change in internal energy is _____ J. (Nearest integer)

25. A 300 mL bottle of soft drink has $0.2\ M\ CO_2$ dissolved in it. Assuming CO_2 behaves as an ideal gas, the volume of the dissolved CO_2 at STP is _____ mL. (Nearest integer)
[Given : At STP, molar volume of an ideal gas is $22.7\,L\ mol^{-1}$]

26. A solution containing 2 g of a non-volatile solute in 20 g of water boils at 373.52 K. The molecular mass of the solute is _____ $g\,mol^{-1}$. (Neatest integer)
[Given, water boils at 373 K, K_b for water $= 0.52\,K\,kg\,mol^{-1}$]

27. Some amount of dichloromethane (CH_2Cl_2) is added to 671.141 mL of chloroform $(CHCl_3)$ to prepare $2.6\times10^{-3}\ M$ solution of $CH_2Cl_2(DCM)$. The concentration of DCM is _____ ppm (by mass). [Given : Atomic mass : C = 12, H = 1, Cl = 35.5 density of $CHCl_3 = 1.49\,g\,cm^{-3}$]

28. The energy of mole of photons of radiation of frequency $2\times10^{12}\,Hz$ in $J\,mol^{-1}$ is _____.
(Nearest integer) [Given : $h = 6.626\times10^{-34}\,Js,\ N_A = 6.022\times10^{23}$]

29. A trisubstituted compound 'A', $C_{10}H_{12}O_2$ gives neutral $FeCl_3$ test positive. Treatment of compound 'A' with NaOH and CH_3Br gives $C_{11}H_{14}O_2$, with hydroiodic acid gives methyl iodide and with hot conc. NaOH gives a compound B, $C_{10}H_{12}O_2$. Compound 'A' also decolorizes alkaline $KMnO_4$. The number of π bond/s present in the compound 'A' is _____.

30. Consider the cell $Pt(s)\,|\,H_2(g, 1atm)\,|\,H^+(aq.1M)\,||\,Fe^{3+}(aq), Fe^{2+}(aq)\,|\,Pt(s).$
When the potential of the cell is 0.712 V at 298 K, the ratio $[Fe^{2+}]/[Fe^{3+}]$ is _____.
(Nearest integer) [Given : $Fe^{3+} + e^- \rightleftharpoons Fe^{2+},\ E^{\theta}Fe^{3+}, Fe^{2+}\,|\,Pt = 0.771;\ \frac{2.303RT}{F} = 0.06\,V$]

SUBJECT III: MATHEMATICS	MARKS: 100

SECTION-1

This section contains 20 Multiple Choice Questions. Each question has 4 choices (1), (2), (3) and (4), out of which ONLY ONE CHOICE is correct.

1. If $\tan 15^\circ + \frac{1}{\tan 75^\circ} + \frac{1}{\tan 105^\circ} + \tan 195^\circ = 2a$, Then the value of $\left(a + \frac{1}{a}\right)$ is:

(1) $5 - \frac{3}{2}\sqrt{3}$ **(2)** $4 - 2\sqrt{3}$ **(3)** 2 **(4)** 4

2. If an unbiased die, marked with –2, –1, 0, 1, 2, 3 on its faces, is thrown five times, then the probability that the product of the outcomes is positive, is:

(1) $\frac{27}{288}$ **(2)** $\frac{440}{2592}$ **(3)** $\frac{881}{2592}$ **(4)** $\frac{521}{2592}$

3. If the solution of the equation $\log_{\cos x} \cot x + 4\log_{\sin x} \tan x = 1,\ x \in \left(0, \frac{\pi}{2}\right)$, is $\sin^{-1}\left(\frac{\alpha + \sqrt{\beta}}{2}\right)$, where α, β are integers, then $\alpha + \beta$ is equal to:

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

4. Suppose $f : R \to (0, \infty)$ be a differentiable function such that

$5f(x+y) = f(x) \cdot f(y),\ \forall\ x, y \in R.$ If $f(3) = 320,$ then $\sum_{n=0}^{5} f(n)$ is equal to:

(1) 6825 **(2)** 6525 **(3)** 6575 **(4)** 6875

5. If [t] denotes the greatest integer $\le t,$ then the value of $\frac{3(e-1)}{e}\int_2^2 x^2 e^{[x]+[x^3]}dx$ is:

(1) $e^8 - e$ **(2)** $e^7 - 1$ **(3)** $e^9 - e$ **(4)** $e^8 - 1$

6. The number of points on the curve $y = 54x^5 - 135x^4 - 70x^3 + 180x^2 + 210x$ at which the normal lines are parallel to $x + 90y + 2 = 0$ is:

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

7. Let $A = \begin{pmatrix} m & n \\ p & q \end{pmatrix},\ d = |A| \neq 0$ and $|A - d(Adj\ A)| = 0.$ Then:

(1) $(1+d)^2 = m^2 + q^2$ **(2)** $(1+d)^2 = (m+q)^2$

(3) $1 + d^2 = m^2 + q^2$ **(4)** $1 + d^2 = (m+q)^2$

8. Let the system of linear equations $x + y + kz = 2,\ 2x + 3y - z = 1,\ 3x + 4y + 2z = k$ have infinitely many solutions.

Then the system

$(k+1)x + (2k-1)y = 7$

$(2k+1)x + (k+5)y = 10$

has:

(1) unique solution satisfying $x - y = 1$ **(2)** no solution

(3) unique solution satisfying $x + y = 1$ **(4)** infinitely many solutions

9. Among the statements:

$(S1)\ ((p \vee q) \Rightarrow r) \Leftrightarrow (p \Rightarrow r)$

$(S2)\ ((p \vee q) \Rightarrow r) \Leftrightarrow ((p \Rightarrow r) \vee (q \Rightarrow r))$

(1) both (S1) and (S2) are tautologies **(2)** only (S2) is a tautology

(3) only (S1) is a tautology **(4)** neither (S1) nor (S2) is a tautology

10. Let $y = x+2,\ 4y = 3x+6$ and $3y = 4x+1$ be three tangent lines to the circle $(x-h)^2 + (y-k)^2 = r^2$. Then $h+k$ is equal to:

(1) $5(1+\sqrt{2})$ **(2)** 5 **(3)** $5\sqrt{2}$ **(4)** 6

11. Let the solution curve $y = y(x)$ of the differential equation $\frac{dy}{dx} - \frac{3x^5 \tan^{-1}(x^3)}{(1+x^6)^{3/2}} y = 2x \exp\left\{\frac{x^3 - \tan^{-1} x^3}{\sqrt{(1+x^6)}}\right\}$ pass through origin. Then $y(1)$ is equal to:

(1) $\exp\left(\frac{\pi-4}{4\sqrt{2}}\right)$ **(2)** $\exp\left(\frac{4-\pi}{4\sqrt{2}}\right)$ **(3)** $\exp\left(\frac{1-\pi}{4\sqrt{2}}\right)$ **(4)** $\exp\left(\frac{4+\pi}{4\sqrt{2}}\right)$

12. Let a unit vector OP make angles α, β, γ with the positive directions of the co-ordinate axes OX, OY, OZ respectively, when $\beta \in \left(0, \frac{\pi}{2}\right)$. If OP is perpendicular to the plane through points (1, 2, 3), (2, 3, 4) and (1, 5, 7), then which one of the following is true?

(1) $\alpha \in \left(\frac{\pi}{2}, \pi\right)$ and $\gamma \in \left(\frac{\pi}{2}, \pi\right)$ **(2)** $\alpha \in \left(\frac{\pi}{2}, \pi\right)$ and $\gamma \in \left(0, \frac{\pi}{2}\right)$

(3) $\alpha \in \left(0, \frac{\pi}{2}\right)$ and $\gamma \in \left(\frac{\pi}{2}, \pi\right)$ **(4)** $\alpha \in \left(0, \frac{\pi}{2}\right)$ and $\gamma \in \left(0, \frac{\pi}{2}\right)$

13. If $a_n = \frac{-2}{4n^2 - 16n + 15}$, then $a_1 + a_2 + ... + a_{25}$ is equal to:

(1) $\frac{52}{147}$ **(2)** $\frac{49}{138}$ **(3)** $\frac{50}{141}$ **(4)** $\frac{51}{144}$

14. If $P(h, k)$ be a point on the parabola $x = 4y^2$, which is nearest to the point $Q(0, 33)$, then the distance of P from the directrix of the parabola $y^2 = 4(x+y)$ is equal to:

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

15. The line l_1 passes through the point (2, 6, 2) and is perpendicular to the plane $2x + y - 2z = 10$. Then the shortest distance between the line l_1 and the line $\frac{x+1}{2} = \frac{y+4}{-3} = \frac{z}{2}$ is:

(1) 9 **(2)** $\frac{13}{3}$ **(3)** $\frac{19}{3}$ **(4)** 7

16. A straight line cuts off the intercepts $OA = a$ and $OB = b$ on the positive directions of x-axis and y-axis respectively. If the perpendicular from origin O to this makes an angle of $\frac{\pi}{6}$ with positive direction of y-axis and the area of ΔOAB is $\frac{98}{3}\sqrt{3}$, then $a^2 - b^2$ is equal to:

(1) $\frac{392}{3}$ **(2)** $\frac{196}{3}$ **(3)** 196 **(4)** 98

17. If the coefficient of x^{15} in the expansion of $\left(ax^3+\frac{1}{bx^{1/3}}\right)^{15}$ is equal to the coefficient of x^{-15} in the expansion of $\left(ax^{1/3}-\frac{1}{bx^3}\right)^{15}$, where a and b are positive real numbers, then for each such ordered pair (a, b).

(1) $a = 3b$ **(2)** $a = b$ **(3)** $ab = 3$ **(4)** $ab = 1$

18. The coefficient of x^{301} in $(1+x)^{500}+x(1+x)^{499}+x^2(1+x)^{498}+.....+x^{500}$ is:

(1) ${}^{500}C_{301}$ **(2)** ${}^{501}C_{302}$ **(3)** ${}^{500}C_{300}$ **(4)** ${}^{501}C_{200}$

19. The minimum number of elements that must be added to the relation $R=\{(a, b), (b, c)\}$ on the set $\{a, b, c\}$ so that it becomes symmetric and transitive is:

(1) 7 **(2)** 3 **(3)** 4 **(4)** 5

20. If $\vec{a}, \vec{b}, \vec{c}$ are three non-zero vectors and $\hat{n}$ is a unit vector perpendicular to $\vec{c}$ such that $\vec{a}=\alpha\vec{b}-\hat{n}, (\alpha\neq 0)$ and $\vec{b}\cdot\vec{c}=12,$ then $|\vec{c}\times(\vec{a}\times\vec{b})|$ is equal to:

(1) 15 **(2)** 9 **(3)** 6 **(4)** 12

SECTION-2

Section 2 contains 10 Numerical Value Type Questions Out of which ONLY 5 (any) questions have to be attempted. The answer to each question should be **rounded off to the nearest integer**.

21. The mean and variance of 7 observations are 8 and 16 respectively. If one observation 14 is omitted and *a* and *b* are respectively mean and variance of remaining 6 observation, then $a+3b-5$ is equal to_____.

22. If $\lambda_1 < \lambda_2$ are two values of λ such that the angle between the planes $P_1 : \vec{r}(3\hat{i}-5\hat{j}+\hat{k}) = 7$ and $P_2 : \vec{r}\cdot(\lambda\hat{i}+\hat{j}-3\hat{k}) = 9$ is $\sin^{-1}\left(\frac{2\sqrt{6}}{5}\right)$, then the square of the length of perpendicular from the point $(38\lambda_1, 10\lambda_2, 2)$ to the plane P_1 is _____.

23. $\lim\limits_{x\to 0}\frac{48}{x^4}\int\limits_0^x \frac{t^3}{t^6+1}dt$ is equal to _____.

24. Let $z = 1+i$ and $z_1 = \frac{1+i\bar{z}}{\bar{z}(1-z)+\frac{1}{z}}$. Then $\frac{12}{\pi}\arg(z_1)$ is equal to _____.

25. Let $S = \{1, 2, 3, 4, 5, 6\}$. Then the number of one-one functions $f : S \to P(S)$, where *P*(*S*) denotes the power set of *S*, such that $f(n) \subset f(m)$ where $n < m$ is _____.

26. Number of 4-digit numbers (the repeation of digits is allowed) which are made using the digits 1,2, 3 and 5, and are divisible by 15, is equal to _____.

27. Let $\sum\limits_{n=0}^{\infty}\frac{n^3((2n)!)+(2n-1)(n!)}{(n!)((2n)!)} = ae+\frac{b}{e}+c$, where $a, b, c \in Z$ and $e = \sum\limits_{n=0}^{\infty}\frac{1}{n!}$. Then a^2-b+c is equal to _____.

28. Let α be the area of the larger region bounded by the curve $y^2 = 8x$ and the $y = x$ and $x = 2$, which lies in the first quadrant. Then the value of 3α is equal to _____.

29. If the equation of the plane passing through the point (1, 1, 2) and perpendicular to the line $x-3y+2z = 0 = 4x-y+z$ is $Ax+By+Cz = 1$, then $140(C-B+A)$ is equal to _____.

30. Let $f^1(x) = \frac{3x+2}{2x+3}$, $x \in R-\left\{\frac{-3}{2}\right\}$.

For $n \geq 2$, define $f^n(x) = f^1(x) = f^1 O f^{n-1}(x)$.

If $f^5(x) = \frac{ax+b}{bx+a}$, $\gcd(a, b) = 1$, then $a+b$ is equal to _____.