JEE Main – 2023

31st JAN 2023 (Evening 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. Considering a group of positive charges, which of the following statements is correct?

(1) Both the net potential and the net electric field cannot be zero at a point

(2) Net potential of the system cannot be zero at a point but net electric field can't be zero at that point

(3) Net potential of the system at a point can be zero but net electric field can't be zero at that point

(4) Both the net potential and the net field can be zero at a point

2. The number of turns of the coil of a moving coil galvanometer is increased in order to increase current sensitivity by 50%. The percentage change in voltage sensitivity of the galvanometer will be:

(1) 100% **(2)** 75% **(3)** 0% **(4)** 50%

3. Heat energy of 735J is given to a diatomic gas allowing the gas to expand at constant pressure. Each gas molecule rotates around an internal axis but do not oscillate. The increase in the internal energy of the gas will be:

(1) 735 J **(2)** 525 J **(3)** 572 J **(4)** 441 J

4. The H amount of thermal energy is developed by a resistor in 10s when a current of 4A is passed through it. If the current is increased to 16A, the thermal energy developed by the resistor in 10s will be:

(1) 4H **(2)** H **(3)** $\frac{H}{4}$ **(4)** 16H

5. Under the same load, wire A having length 5.0 m and cross section $2.5\times10^{-5}m^2$ stretches uniformly by the same amount as another wire B of length 6.0 m and a cross section of $3.0\times10^{-5}\ m^2$ stretches. The ratio of the Young's modulus of wire A to that of wire B will be:

(1) 1 : 2 **(2)** 1 : 1 **(3)** 1 : 10 **(4)** 1 : 4

6. A stone of mass 1 kg is tied to end of a massless string of length 1m. If the breaking tension of the string is 400 N, then maximum linear velocity, the stone can have without breaking the string, while rotating in horizontal plane, is:

(1) $40ms^{-1}$ **(2)** $10ms^{-1}$ **(3)** $20ms^{-1}$ **(4)** $400ms^{-1}$

7. A long conducting wire having a current I flowing through it, is bent into a circular coil of N turns. Then it is bent into a circular coil of n turns. The magnetic field is calculated at the centre of coils in both the cases. The ratio of the magnetic field in first case to that of second case is:

(1) $N^2:N^2$ **(2)** $N^2:n^2$ **(3)** $N:n$ **(4)** $n:N$

8. Given below are two statements:

Statement I: For transmitting a signal, size of antenna (l) should be comparable to wavelength of signal (at least $l=\frac{\lambda}{4}$ in dimension)

Statement II: In amplitude modulation, amplitude of carrier wave remains constant (unchanged).

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are correct

(2) Both Statement I and Statement II are incorrect

(3) Statement I is correct but Statement II is incorrect

(4) Statement I is incorrect but Statement II is correct

9. A hypothetical gas expands adiabatically such that its volume changes from 08 litres to 27 litres. If the ratio of final pressure of the gas to initial pressure of the gas is $\frac{16}{81}$. Then the ratio of $\frac{Cp}{Cv}$ will be:

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

10. The radius of electron's second stationary orbit in Bohr's atom is R. The radius of 3rd orbit will be:

(1) 3R **(2)** 2.25R **(3)** $\frac{R}{3}$ **(4)** 9R

11. A body is moving with constant speed, in a circle of radius 10m. The body completes one revolution in 4s. At the end of 3rd second, the displacement of body (in m) from its starting point is:

(1) 30 **(2)** 15π **(3)** $10\sqrt{2}$ **(4)** 5π

12. If the metals A and B are exposed to radiation of wavelength 350 nm. The work functions of metals A and B are 4.8 eV and 2.2 eV. The choose the correct option:

(1) Metal B will not emit photo-electrons
(2) Metal A will not emit photo-electrons
(3) Both metals A and B will not emit photo-electrons
(4) Both metals A and B will emit photo-electrons

13. Match List I with List II:

	List-I		List-II
A	Microwaves	**I**	Physiotherapy
B	UV rays	**II**	Treatment of cancer
C	Infra-red light	**III**	Lasik eye surgery
D	X-ray	**IV**	Aircraft navigation

Choose the correct answer from the options given below:

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

14. A microscope is focused on an object at the bottom of a bucket. If liquid with refractive index $\frac{5}{3}$ is poured inside the bucket, the microscope have to be raised by 30 cm to focus the object again. The height of the liquid in the bucket is:

(1) 50 cm **(2)** 12 cm **(3)** 75 cm **(4)** 18 cm

15. A body weight W, is projected vertically upwards from earth's surface to reach a height above the earth which is equal to nine times the radius of earth. The weight of the body at that height will be:

(1) $\frac{W}{3}$ **(2)** $\frac{W}{100}$ **(3)** $\frac{W}{91}$ **(4)** $\frac{W}{9}$

16. An alternating voltage source V = 260 sin (628t) is connected across a pure inductor of 5 mH. Inductive reactance in the circuit is:

(1) 0.318Ω **(2)** 3.14Ω **(3)** 0.5Ω **(4)** 6.28Ω

17. For a solid rot, the Young's modulus of elasticity is $3.2\times10^{11}Nm^{-2}$ and density is $8\times10^{3}kg\ m^{-3}$. The velocity of longitudinal wave in the rod will be:

(1) $145.75\times10^{3}ms^{-1}$ **(2)** $18.93\times10^{3}ms^{-1}$
(3) $6.32\times10^{3}ms^{-1}$ **(4)** $3.65\times10^{3}ms^{-1}$

18. Given below are two statements:

Statement I: In a typical transistor, all three regions emitter, base and collector have same doping level.

Statement II: In a transistor, collector is the thickest and base is the thinnest segment.

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) Both Statement I and Statement II are correct

(2) Statement I is incorrect but Statement II is correct

(3) Both Statement I and Statement II are incorrect

(4) Statement I is correct but Statement II is incorrect

19. A body of mass 10 kg is moving with an initial speed of 20 m/s. The body stops after 5s due to friction between body and the floor. The value of the coefficient of friction is: (Take acceleration due to gravity $g = 10ms^{-2}$)

(1) 0.2 **(2)** 0.4 **(3)** 0.5 **(4)** 0.3

20. Match List I with List II:

	List-I		List-II
A	Angular momentum	**I**	$\left[ML^2T^{-2}\right]$
B	Torque	**II**	$\left[ML^{-2}T^{-2}\right]$
C	Stress	**III**	$\left[ML^2T^{-1}\right]$
D	Pressure gradient	**IV**	$\left[ML^{-1}T^{-2}\right]$

Choose the correct answer from the options given below:

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

(3) A-I, B-IV, C-III, D-II **(4)** A-IV, B-II, C-I, 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. The displacement equations of two interfering waves are given by: $y_1 = 10\sin\left(\omega t + \frac{\pi}{3}\right) cm,\ y_2 = 5\left[\sin\omega t + \sqrt{3}\cos\omega t\right] cm$ respectively. The amplitude of the resultant wave is _____ cm.

22. Two discs of same mass and different radii are made of different materials such that their thicknesses are 1 cm and 0.5 cm respectively. The densities of materials are in the ratio 3 : 5. The moment of inertia of these discs respectively about their diameters will be in the ratio of $\frac{x}{6}$. The value of *x* is _____ .

23. A series LCR circuit consists of $R = 80\Omega,\ X_L = 100\Omega,$ and $X_C = 40\Omega.$ The input voltage is 2500 $\cos(100\pi t)V.$ The amplitude of current, in the circuit, is _____ A.

24. If the binding energy of ground state electron in a hydrogen atom is 13.6eV, then the energy required to remove the electron from the second excited state of Li^{2+} will be: $x \times 10^{-1} eV.$ The value of *x* is _____.

25. Two bodies are projected from ground with same speeds $40 ms^{-1}$ at two different angles with respect to horizontal. The bodies were found to have same range. If one of the body was projected at an angle of 60°, with horizontal then sum of the maximum heights, attained by the two projectiles, is _____m. (Given $g = 10\ ms^{-2}$)

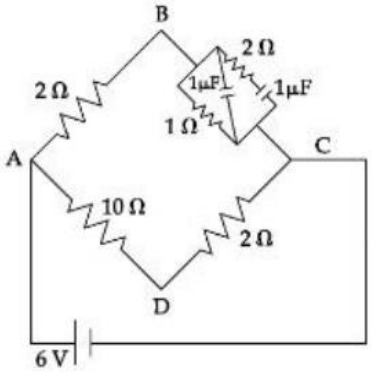
26. Two light waves of wavelengths 800 and 600 nm are used in Young's double slit experiment to obtain interference fringes on a screen placed 7 m away from plane of slits. If the two slits are separated by 0.35 mm, then shortest distance from the central bright maximum to the point where the bright fringes of the two wavelength coincide will be _____ mm.

27. Two parallel plate capacitors C_1 *and* C_2 each having capacitance of 10 μF are individually charged by a 100 VD.C. source Capacitor C_1 is kept connected to the source and a dielectric slab is inserted between it plates. Capacitor C_2 is disconnected from the source and then a dielectric slab is inserted in it. Afterwards the capacitor C_1 is also disconnected from the source and the two capacitors are finally connected in parallel combination. The common potential of the combination will be _____ V.

28. A ball is dropped from a height of 20m. If the coefficient of restitution for the collision between ball and floor is 0.5, after hitting the floor, the ball rebounds to a height of _____ m.

29. A water heater of power 2000 W is used to heat water. The specific heat capacity of water 4200 J $kg^{-1}K^{-1}.$ The efficiency of heater is 70%. Time required to heat 2kg of water from 10°C to 60°C is _____ s. (Assume that the specific heat capacity of water remains constant over the temperature range of the water)

30. For the given circuit, in the steady state, $|V_B - V_D| =$ _____ V.



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. Which of the following elements have half-filled f-orbitals in their ground state?

(Given: atomic number Sm = 62; Eu = 63; Tb = 65; Gd = 64, Pm = 61)

A. Sm B. Eu C. Tb D. Gd E. Pm

(1) A and B only **(2)** B and D only

(3) A and E only **(4)** C and D only

2. Incorrect statement for the use of indicators in acid-base titration is:

(1) Phenolphthalein may be used for a strong acid vs strong base titration

(2) Methyl orange may be used for a weak acid vs weak base titration

(3) Phenolphthalein is a suitable indicator for a weak acid vs strong base titration

(4) Methyl orange is a suitable indicator for a strong acid vs weak base titration

3. In the following halogenated organic compounds the one with maximum number of chlorine atoms in its structure is:

(1) Chloral **(2)** Chloropicrin **(3)** Freon-12 **(4)** Gammaxene

4. Given below are two statements:

Statement I: H_2O_2 is used in the synthesis of Cephalosporin

Statement II: H_2O_2 is used for the restoration of aerobic conditions wo sewage wastes. In the light of the above statement, choose the most appropriate answer from the options given below.

(1) Statement I is incorrect but Statement II is correct

(2) Both Statement I and Statement II are incorrect

(3) Both Statement I and Statement II are correct

(4) Statement I is correct but statement II is incorrect

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

Assertion (A): The first ionization enthalpy of 3d series elements is more than that of group 2 metals

Reason (R): In 3d series of elements successive filling of d-orbitals takes place.

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

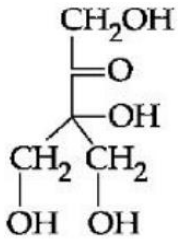
(1) (A) is true but (R) is false

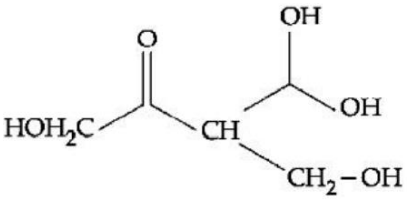
(2) (A) is false but (R) is true

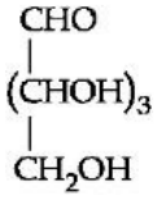
(3) Both (A) and (R) are true and (R) is the correct explanation of (A)

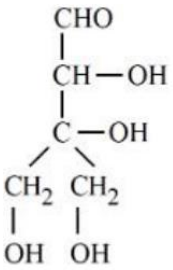
(4) Both (A) and (R) are true but (R) is not the correct explanation of (A)

6. Compound A, $C_5H_{10}O_5$, given a tetraacetate with AC_2O and oxidation of A with Br_2-H_2O given an acid, $C_5H_{10}O_6$. Reduction of A with HI gives isopentane. The possible structure of A is:

(1) 

(2) 

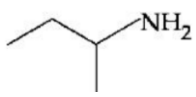
(3) 

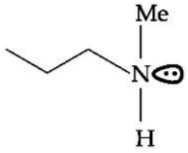
(4) 

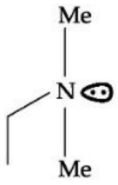
7. When a hydrocarbon A undergoes complete combustion it requires 11 equivalents of oxygen and produces 4 equivalents of water. What is the molecular formula of A?

(1) C_9H_8 **(2)** C_5H_8 **(3)** $C_{11}H_4$ **(4)** $C_{11}H_8$

8. An organic compound $[A](C_4H_{11}N)$, shows optical activity and gives N_2 gas on treatment with HNO_2. The compound [A] reacts with $PhSO_2Cl$ producing a compound which is soluble in KOH.

(1) 

(2) 

(3) 

(4) 

9. Match List I with List II:

List-I		List-II	
A	Physisorption	**I**	Single Layer Adsorption
B	Chemisorption	**II**	$20-40\ kJ\ mol^{-1}$
C	$N_2(g)+3H_2(g)\xrightarrow{Fe(s)}2NH_3(g)$	**III**	Chromatography
D	Analytical Application of Adsorption	**IV**	Heterogeneous catalysis

Choose the correct answer from the options given below:

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

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

10. The normal rain water is slightly acidic and its pH value is 5.6 because of which one of the following?

(1) $4NO_2+O_2+2H_2O\rightarrow 4HNO_3$ **(2)** $2SO_2+O_2+2H_2O\rightarrow 2H_2SO_4$

(3) $N_2O_5+H_2O\rightarrow 2HNO_3$ **(4)** $CO_2+H_2O\rightarrow H_2CO_3$

11. In Dumas method for the estimation of N_2, the sample is heated with copper oxide and the gas evolved is passed over:

(1) NI **(2)** Copper gauze **(3)** Pd **(4)** Copper oxide

12. Which of the following compounds are not used as disinfectants?

A. Chloroxylenol **B.** Bithional **C.** Veronal
D. Prontosil **E.** Terpineol

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

13. Given below are two statements:

Statement I: Upon heating a borax bead dipped in cupric sulphate in a luminous flame, the colour of the becomes green

Statement II: The green colour observed is due to the formation of copper(I) metaborate

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is false but Statement II is true
(2) Both Statement I and Statement II are false
(3) Statement I is true but Statement II is false
(4) Both Statement I and Statement II are true

14. Arrange the following orbitals in decreasing order of energy:

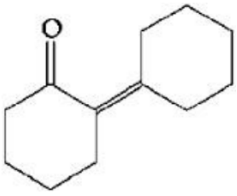
A. $n=3, l=0, m=0$ **B.** $n=4, l=0, m=0$
C. $n=3, l=1, m=0$ **D.** $n=3, l=2, m=1$

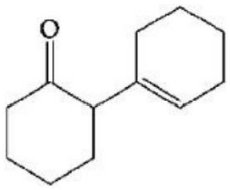
(1) D > B > C > A **(2)** D > B > A > C **(3)** A > C > B > D **(4)** B > D > C > A

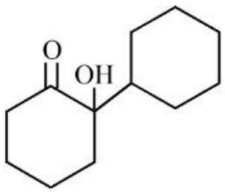
15. A hydrocarbon 'X' with formula C_6H_8 uses two moles of H_2 on catalytic hydrogenation of its one mole. On ozonolysis, 'X' yields two moles of methane dicarbaldehyde. The hydrocarbon 'X' is:

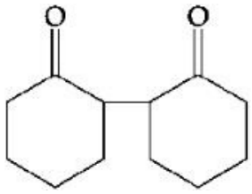
(1) Hexa-1, 3, 5-triene **(2)** Cyclohexa-1, 4-diene
(3) Cycolhexa-1, 3-diene **(4)** 1-methylcyclopenta-1, 4-diene

16. Cyclohexylamine when treated with nitrous acid yields (P). On treating (P) with PCC results in (Q). When (Q) is heated with dil. NaOH we get (R) The final product (R) is:

(1) 

(2) 

(3) 

(4) 

17. Evaluate the following statements for their correctness.

(A) The elevation in boiling point temperature of water will be same for 0.1M NaCl and 0.1 M urea.
(B) Azeotropic mixtures boil without change in their composition.
(C) Osmosis always takes place from hypertonic to hypotonic solution.
(D) The density of 32% H_2SO_4 solution having molarity 4.09 M is approximately $1.26 g\ mL^{-1}$.
(E) A negatively charged sol is obtained when KI solution is added to silver nitrate solution.

Choose the correct answer from the options given below:

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

18. The element playing significant role in neuromuscular function and interneuronal transmission is:

(1) Be **(2)** Ca **(3)** Li **(4)** Mg

19. The Lewis acid character of boron tri halides follows the order:

(1) $BF_3 > BCl_3 > BBr_3 > BI_3$ **(2)** $BF_3 > BBr_3 > BCl_3 > BF_3$

(3) $BBr_3 > BI_3 > BCl_3 > BF_3$ **(4)** $BCl_3 > BF_3 > BBr_3 > BI_3$

20. Which one of the following statements is incorrect?

(1) The malleable iron is prepared from cast iron by oxidising in a reverberatory furnace

(2) Van Arkel method is used to purify tungsten

(3) Boron and Indium can be purified by zone refining method

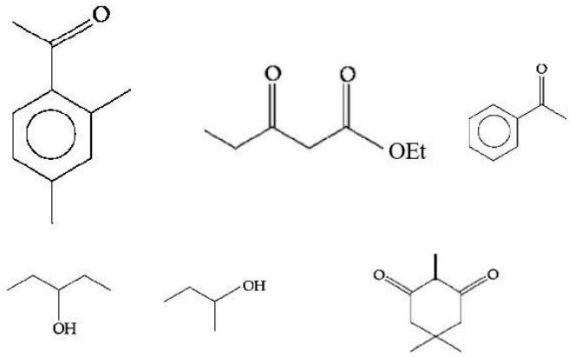
(4) Cast iron is obtained by melting pig iron with scrap iron and coke using hot air blast

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 resistivity of a $0.8M$ solution of an electrolyte is $5\times10^{-3}\Omega cm.$ Its conductivity is _____ $\times10^{4}\Omega^{-1}cm^{2}mol^{-1}.$ (Nearest integer)

22. The number of molecules which gives haloform test among the following molecules is _____.



23. The number of alkali metal(s), from Li, K, Cs, Rb having ionization enthalpy greater than 400 kJ mol^{-1} and forming stable super oxide is _____.

24. If the CFSE of $\left[Ti(H_2O)_6\right]^{3+}$ is $-96.0kJ/mol,$ this complex will absorb maximum at wavelength _____ nm. (Nearest integer)

Assume Planck's constant $(h)=6.4\times10^{-34}Js,$ Speed of light $(c)=3.0\times10^{8}m/s$ and Avogadro's Constant $(N_A)=6\times10^{23}/mol.$

25. Enthalpies of formation of $CCl_4(g), H_2O(g), CO_2(g)$ and $HCl(g)$ are $-105, -242, -394$ and $-92\ kJ\ mol^{-1}$ respectively. The magnitude of enthalpy of the reaction given below is _____ kJ mol^{-1}. (Nearest integer)

$$CCl_4(g)+2H_2O(g)\rightarrow CO_2(g)+4HCl(g)$$

26. At 298K, the solubility of silver chloride in water is $1.434\times10^{-3}gL^{-1}.$ The value of $-\log K_{sp}$ for silver chloride is _____.

(Given mass of Ag is $107.9g\ mol^{-1}$ and mass of Cl is 35.5g mol^{-1})

27. Assume carbon buns according to following equation:

$$2C_{(s)}+O_{2(g)}\rightarrow 2CO(g)$$

[Given: Assume CO as ideal gas Mass of C is 12g $mol^{-1},$ Mass of O is mol^{-1} and molar volume of an ideal gas at STP is $22.7L\ mol^{-1}$]

28. The rate constant for a first order reaction is $20\,\text{min}^{-1}$. The time required for the initial concentration of the reactant to reduce to its $\frac{1}{32}$ level is _____ $\times 10^{-2}\,\text{min}$. (Nearest integer)

(Given: $\ln 10 = 2.303 \quad \log 2 = 0.3010$)

29. A sample of metal oxide has formula $M_{0.83}O_{1.00}$. The metal M can exist in two oxidation states $+2 \text{ and } +3$. In the sample of $M_{0.83}O_{1.00}$, the percentage of metal ions existing in +2 oxidation state is _____ %. (Nearest integer)

30. Amongst the following, the number of species having the linear shape is _____.

$XeF_2, I_3^+, C_2O_2, I_3^-, CO_2, SO_2, BeCl_2 \text{ and } BCl_2^{\oplus}$

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. The equation $e^{4x}+8e^{3x}+13e^{2x}-8e^{x}+1=0,\ x\in\mathbb{R}$ has:

(1) Two solutions and both are negative

(2) Two solutions and only of them is negative

(3) No solution

(4) Four solutions two of which are negative

2. Let $y=y(x)$ be the solution of the differential equation $\left(3y^2-5x^2\right)y\,dx+2x\left(x^2-y^2\right)dy=0$ such that $y(1)=1.$ Then $\left|y(2)^3-12y(2)\right|$ is equal to:

(1) 64 **(2)** $32\sqrt{2}$ **(3)** 32 **(4)** $16\sqrt{2}$

3. $\lim\limits_{x\to\infty}\dfrac{\left(\sqrt{3x+1}+\sqrt{3x-1}\right)^6+\left(\sqrt{3x+1}-\sqrt{3x-1}\right)^6}{\left(x+\sqrt{x^2-1}\right)^6+\left(x-\sqrt{x^2-1}\right)^6}x^3$

(1) is equal to 27 **(2)** is equal to 9

(3) is equal to $\dfrac{27}{2}$ **(4)** does not exist

4. Let $\alpha>0.$ If $\int\limits_0^{\alpha}\dfrac{x}{\sqrt{x+\alpha-\sqrt{x}}}dx=\dfrac{16+20\sqrt{2}}{15}$, then α is equal to:

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

5. Let $(a,b)\subset(0,2\pi)$ be the largest interval for which $\sin^{-1}(\sin\theta)-\cos^{-1}(\sin\theta)>0,\ \theta\in(0,2\pi),$ holds. If $\alpha x^2+\beta x+\sin^{-1}\left(x^2-6x+10\right)+\cos^{-1}\left(x^2-6x+10\right)=0$ *and* $\alpha-\beta=b-a,$ then α is equal to:

(1) $\dfrac{\pi}{12}$ **(2)** $\dfrac{\pi}{48}$ **(3)** $\dfrac{\pi}{16}$ **(4)** $\dfrac{\pi}{8}$

6. If $\phi(x)=\dfrac{1}{\sqrt{x}}\int\limits_{\pi/4}^{x}\left(4\sqrt{2}\sin t-3\phi'(t)\right)dt,\ x>0,$ then $\phi'\left(\dfrac{\pi}{4}\right)$ is equal to:

(1) $\dfrac{4}{6+\sqrt{\pi}}$ **(2)** $\dfrac{8}{6+\sqrt{\pi}}$ **(3)** $\dfrac{4}{6-\sqrt{\pi}}$ **(4)** $\dfrac{8}{\sqrt{\pi}}$

7. The set of all values of a^2 for which the line $x+y=0$ bisects two distinct chords drawn from a point $P\left(\dfrac{1+a}{2},\dfrac{1-a}{2}\right)$ on the circle $2x^2+2y^2-(1-a)x-(1-a)y=0,$ is equal to:

(1) $(8,\infty)$ **(2)** $(4,\infty)$ **(3)** $(2,12]$ **(4)** $(0,4]$

8. Let $f:\mathbb{R}-\{2,6\}\to\mathbb{R}$ be real valued function defined as $f(x)=\dfrac{x^2+2x+1}{x^2-8x+12}$. Ten range of *f* is

(1) $\left(-\infty,-\dfrac{21}{4}\right]\cup[0,\infty)$ **(2)** $\left(-\infty,-\dfrac{21}{4}\right]\cup\left[\dfrac{21}{4},\infty\right)$

(3) $\left(-\infty,-\dfrac{21}{4}\right]\cup[1,\infty)$ **(4)** $\left(-\infty,-\dfrac{21}{4}\right]\cup[0,\infty)$

9. Let : $\vec{a}=\hat{i}+2\hat{j}+3\hat{k},\vec{b}=\hat{i}-\hat{j}+2\hat{k}$ *and* $\vec{c}=5\hat{i}-3\hat{j}+3\hat{k}$ be vectors. If $\vec{r}$ is a vector such that, $\vec{r}\times\vec{b}=\vec{c}\times\vec{b}$ and $\vec{r}.\vec{a}=0,$ then $25|\vec{r}|^2$ is equal to

(1) 560 **(2)** 336 **(3)** 449 **(4)** 339

10. The complex number $z=\dfrac{i-1}{\cos\frac{\pi}{3}+i\sin\frac{\pi}{3}}$ is equal to:

(1) $\cos\dfrac{\pi}{12}-i\sin\dfrac{\pi}{12}$ **(2)** $\sqrt{2}\left(\cos\dfrac{5\pi}{12}+i\sin\dfrac{5\pi}{12}\right)$

(3) $\sqrt{2}i\left(\cos\dfrac{5\pi}{12}-i\sin\dfrac{5\pi}{12}\right)$ **(4)** $\sqrt{2}\left(\cos\dfrac{\pi}{12}+i\sin\dfrac{\pi}{12}\right)$

11. Let $a_1,a_2,a_3,....$ be an A.P. If $a_7=3,$ the product a_1a_4 is minimum and the sum of its first n terms is zero, then $n!-4a_{n(n+2)}$ is equal to:

(1) $\dfrac{33}{4}$ **(2)** 24 **(3)** $\dfrac{381}{4}$ **(4)** 9

12. If a point $P(\alpha,\beta,\gamma)$ satisfying $(\alpha\ \beta\ \gamma)\begin{pmatrix}2&10&8\\9&3&8\\8&4&8\end{pmatrix}=(0,0,0)$ lies on the plane $2x+4y+3z=5,$ then $6\alpha+9\beta+7\gamma$ is equal to:

(1) $\dfrac{11}{5}$ **(2)** -1 **(3)** $\dfrac{5}{4}$ **(4)** 11

13. Among the relations:

$S=\left\{(a,b):a,b\in R-\{0\},2+\dfrac{a}{b}>0\right\}$ *and* $T=\{(a,b):a,b\in R,a^2-b^2\in Z\},$

(1) Neither S nor T is transitive **(2)** T is symmetric but S is not

(3) S is transitive but T is not **(4)** both S and T are symmetric

14. The number of values of $r\in\{p,q,\sim p,\}$ for which $((p\wedge q)\Rightarrow(r\vee q))\wedge((p\wedge r)\Rightarrow q)$ is a tautology, is:

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

15. Let the plane $P:8x+\alpha_1y+\alpha_2z+12=0$ be parallel to the line $L:\dfrac{x+2}{2}=\dfrac{y-3}{3}=\dfrac{z+4}{5}$. If the intercept of P on the y-axis is 1, then the distance between P and L is:

(1) $\dfrac{6}{\sqrt{14}}$ **(2)** $\sqrt{\dfrac{7}{2}}$ **(3)** $\sqrt{14}$ **(4)** $\sqrt{\dfrac{2}{7}}$

16. Let H be the hyperbola, whose foci are $\left(1\pm\sqrt{2},0\right)$ and accentricity is $\sqrt{2}$. Then the length of its latus rectum is _____.

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

17. Let the mean and standard deviation of marks of class A of 100 students be respectively 40 and $\alpha(>0)$, and the mean and standard deviation of marks of class B of n students be respectively 55 and 30 $-\alpha$. If the mean and variance of the marks of the combined class of 100 + n students are respectively 50 and 350, then the sum of variances of classes A and B is:

(1) 450 **(2)** 500 **(3)** 650 **(4)** 900

18. The absolute minimum value, of the function $f(x)=\left|x^2-x+1\right|+\left[x^2-x+1\right]$, where $[t]$ denotes the greatest integer function, in the interval $[-1,2]$, is:

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

19. The foot of perpendicular from the origin O to a plane P which meets the co-ordinate axes at the points A, B, C is $(2,a,4), a\in N$. If the volume of the tetrahedron OABC is 144 $unit^3$, then which of the following points is NOT on P?

(1) $(0,6,3)$ **(2)** $(3,0,4)$ **(3)** $(2,2,4)$ **(4)** $(0,4,4)$

20. Let P be the plane, passing through the point $(1,-1,-5)$ and perpendicular to the line joining the points $(4,1,-3)$ and $(2,4,3)$. Then the distance of P from the point $(3,-2,2)$ is

(1) 4 **(2)** 7 **(3)** 6 **(4)** 5

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. If ${}^{2n+1}P_{n-1} : {}^{2n-1}P_n = 11:21$, then n^2+n+15 is equal to:

22. Let $\vec{a},\vec{b},\vec{c}$ be three vectors such that $|\vec{a}| = \sqrt{31}, 4|\vec{b}| = |\vec{c}| = 2$ and $2\left(\vec{a}\times\vec{b}\right) = 3\left(\vec{c}\times\vec{a}\right)$. If the angle between $\vec{b}$ and $\vec{c}$ is $\frac{2\pi}{3}$, then $\left(\frac{\vec{a}\times\vec{c}}{\vec{a}\,.\,\vec{b}}\right)^2$ is equal to _____.

23. Let A be a $n\times n$ matrix such that $|A| = 2$. If the determinant of the matrix $Adj\left(2\cdot Adj\left(2A^{-1}\right)\right)$. is 2^{84}, then n is equal to_____.

24. Let the area of the region $\left\{(x,y): 2|2x-1| \le y \le |x^2-x|, 0 \le x \le 1\right\}$ be A. Then $(6A+11)^2$ is equal to _____.

25. If the constant term in the binomial expansion of $\left(\frac{x^{\frac{5}{2}}}{2} - \frac{4}{x^l}\right)^9$ is -84 and coefficient of x^{-3l} is $2^{\alpha}\beta$, where $\beta < 0$ is an odd number, then $|al-\beta|$ is equal to_____.

26. Let $A = \left[a_{ij}\right], a_{ij} \in Z \cap [0,4], 1 \le i, j \le 2$. The number of matrices A such that sum of all entries is a prime numbers $p \in (2,13)$ is _____.

27. The sum $1^2 - 2.3^2 + 3.5^2 - 4.7^2 + 5.9^2 - .... + 15.29^2$ is _____.

28. Let A be the event that the absolute difference between two randomly chosen real numbers in the sample space $[0,60]$ is less than or equal to a. If $P(A) = \frac{11}{36}$, then a is equal to _____.

29. Let S be the set of all $a \in N$ such that the area of the triangle formed by the tangent at the point $P(b,c), b, c \in N$, on the parabola $y^2 = 2ax$ and the lines $x = b, y = 0$ is $16\,unit^2$, then $\sum_{a\in S} a$ is equal to _____.

30. The coefficient of x^{-6}, in the expansion of $\left(\frac{4x}{5} + \frac{5}{2x^2}\right)^9$, is _____.