JEE Main – 2020

8th January 2020 (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 **5 Numerical Value Type Questions**. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places.

Marking Scheme

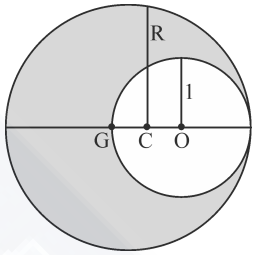
1. **Section – 1:** +4 for correct answer, –1 (negative marking) for incorrect answer, 0 for all other cases.
2. **Section – 2:** +4 for correct answer, 0 for all other cases. There is no negative marking.

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. As shown in figure when a spherical cavity (centred at O) of radius 1 is cut out of a uniform sphere of radius R (centred at C), the centre of mass of remaining (shaded) part of sphere is at G, i.e. on the surface of the cavity. R can be determined by the equation:



(1) $(R^2 - R + 1)(2 - R) = 1$ **(2)** $(R^2 + R - 1)(2 - R) = 1$

(3) $(R^2 - R - 1)(2 - R) = 1$ **(4)** $(R^2 + R + 1)(2 - R) = 1$

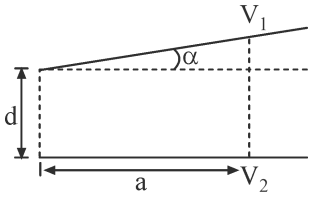
2. An electron (mass m) with initial velocity $\vec{v} = v_0\hat{i} + v_0\hat{j}$ is in an electric field $\vec{E} = -E_0\hat{k}$. If λ_0 is initial de-Broglie wavelength of electron, its de-Broglie wave length at time *t* is given by:

(1) $\dfrac{\lambda_0}{\sqrt{2 + \dfrac{e^2E^2t^2}{m^2v_0^2}}}$ **(2)** $\dfrac{\lambda_0}{\sqrt{1 + \dfrac{e^2E^2t^2}{2m^2v_0^2}}}$ **(3)** $\dfrac{\lambda_0}{\sqrt{1 + \dfrac{e^2E_0^2t^2}{m^2v_0^2}}}$ **(4)** $\dfrac{\lambda_0\sqrt{2}}{\sqrt{1 + \dfrac{e^2E^2t^2}{m^2v_0^2}}}$

3. A galvanometer having a coil resistance 100Ω gives a full scale deflection when a current of 1mA is passed through it. What is the value of the resistance which can convert this galvanometer into a voltmeter giving full scale deflection for a potential difference of 10 V?

(1) $9.9k\Omega$ **(2)** $10k\Omega$ **(3)** $8.9\ k\Omega$ **(4)** $7.9\ k\Omega$

4. A capacitor is made of two square plates each of side 'a' making a very small angle α between them, as shown in figure. The capacitance will be close to:



(1) $\dfrac{\epsilon_0 a^2}{d}\left(1 - \dfrac{\alpha a}{2d}\right)$ **(2)** $\dfrac{\epsilon_0 a^2}{d}\left(1 - \dfrac{\alpha a}{4d}\right)$

(3) $\dfrac{\epsilon_0 a^2}{d}\left(1 + \dfrac{\alpha a}{d}\right)$ **(4)** $\dfrac{\epsilon_0 a^2}{d}\left(1 - \dfrac{3\alpha a}{2d}\right)$

5. A particle moves such that its position vector $\vec{r}(t) = \cos\omega t\,\hat{i} + \sin\omega t\,\hat{j}$ where ω is a constant and *t* is time. Then which of the following statements is true for the velocity $\vec{v}(t)$ and acceleration $\vec{a}(t)$ of the particle:

(1) $\vec{v}$ and $\vec{a}$ both are parallel to $\vec{r}$

(2) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed towards the origin

(3) $\vec{v}$ is perpendicular to $\vec{r}$ and $\vec{a}$ is directed away from the origin

(4) $\vec{v}$ and $\vec{a}$ both are perpendicular to $\vec{r}$

6. In a double-slit experiment, at a certain point on the screen the path difference between the two interfering waves is $\frac{1}{8}$ th of a wavelength. The ratio of the intensity of light at that point to that at the centre of a bright fringe is:

(1) 0.672 **(2)** 0.760 **(3)** 0.568 **(4)** 0.853

7. A transverse wave travels on a taut steel wire with a velocity of v when tension in it is $2.06\times10^4\,N$. When the tension is changed to T, the velocity changed to $v/2$. The value of T is close to :

(1) $2.50\times10^4\,N$ **(2)** $10.2\times10^2\,N$ **(3)** $5.15\times10^3\,N$ **(4)** $30.5\times10^4\,N$

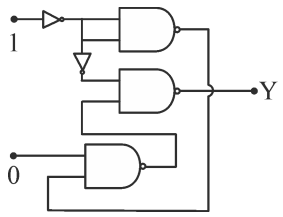
8. In the given circuit, value of Y is:

(1) Will not execute

(2) 1

(3) 0

(4) toggles between 0 and 1



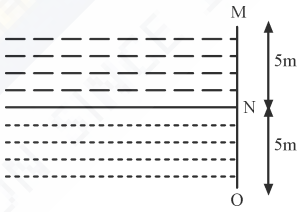
9. A simple pendulum is being used to determine the value of gravitational acceleration g at a certain place. The length of the pendulum is 25.0 cm and a stop watch with 1s resolution measures the time taken for 40 oscillations to be 50 s. The accuracy in g is:

(1) 3.40% **(2)** 2.40% **(3)** 5.40% **(4)** 4.40%

10. A uniform sphere of mass 500 g rolls without slipping on a plane horizontal surface with its centre moving at speed of 5.00 cm/s. Its kinetic energy is:

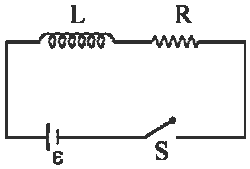
(1) $1.13\times10^{-3}\,J$ **(2)** $6.25\times10^{-4}\,J$ **(3)** $8.75\times10^{-3}\,J$ **(4)** $8.75\times10^{-4}\,J$

11. Two liquids of densities ρ_1 and $\rho_2(\rho_2=2\rho_1)$ are filled up behind a square wall of side $10m$ as shown in figure. Each liquid has a height of $5m$. The ratio of the forces due to these liquids exerted on upper part MN to that at the lower part NO is (Assume that the liquids are not mixing):



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

12. As sown in the figure, a battery of emf $\in$ is connected to an inductor L and resistance R in series. The switch is closed at t = 0. The total charge that flows from the battery, between t = 0 and $t=t_c$ (t_c is the time constant of the circuit) is :



(1) $\dfrac{\in R}{eL^2}$ **(2)** $\dfrac{\in L}{R^2}\left(1-\dfrac{1}{e}\right)$ **(3)** $\dfrac{\in L}{R^2}$ **(4)** $\dfrac{\in L}{eR^2}$

13. A plane electromagnetic wave of frequency 25 GHz is propagating in vacuum along the z-direction. At a particular point in space and time, the magnetic field is given by $\vec{B}=5\times10^{-8}\,\hat{j}T$. The corresponding electric field $\vec{E}$ is (speed of light $c=3\times10^8\,ms^{-1}$)

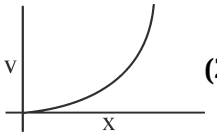
(1) $15\hat{i}\,V/m$ **(2)** $-15\hat{i}\,V/m$

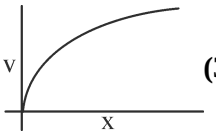
(3) $1.66\times10^{-16}\hat{i}\,V/m$ **(4)** $-1.66\times10^{-16}\hat{i}\,V/m$

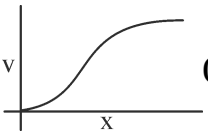
14. Consider two charged metallic spheres S_1 and S_2 of radii R_1 and R_2, respectively. The electric field $E_1(\text{on}\,S_1)$ and $E_2(\text{on}\,S_2)$ on their surfaces are such that $E_1/E_2=R_1/R_2$. Then the ratio $V_1(\text{on}\,S_1)/V_2(\text{on}\,S_2)$ of the electrostatic potentials on each sphere is :

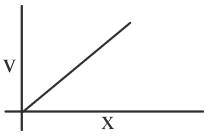
(1) $\left(\dfrac{R_1}{R_2}\right)^3$ **(2)** $\left(\dfrac{R_2}{R_1}\right)$ **(3)** $\dfrac{R_1}{R_2}$ **(4)** $\left(\dfrac{R_1}{R_2}\right)^2$

15. A particle of mass m and charge q is released from rest in a uniform electric field. If there is no other force on the particle, the dependence of its speed v on the distance x travelled by it is correctly given by (graphs are schematic and not drawn to scale)

(1) 

(2) 

(3) 

(4) 

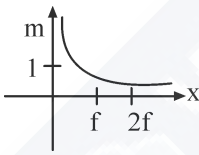
16. A particle of mass m is dropped from a height h above the ground. At the same time another particle of the same mass is thrown vertically upwards from the ground with a speed of $\sqrt{2gh}$. If they collide head-on completely inelastically, the time taken for the combined mass to reach the ground, in units of $\sqrt{\frac{h}{g}}$ is:

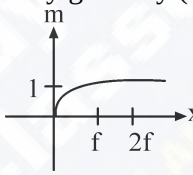
(1) $\sqrt{\frac{1}{2}}$ **(2)** $\sqrt{\frac{3}{2}}$ **(3)** $\frac{1}{2}$ **(4)** $\sqrt{\frac{3}{4}}$

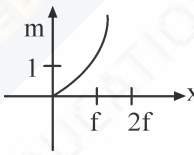
17. Consider a mixture of n moles of helium gas and $2n$ moles of oxygen gas (molecules taken to be rigid) as an ideal gas. Its C_P / C_V value will be:

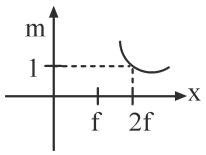
(1) $\frac{67}{45}$ **(2)** $\frac{40}{27}$ **(3)** $\frac{23}{15}$ **(4)** $\frac{19}{13}$

18. An object is gradually moving away from the focal point of a concave mirror along the axis of the mirror. The graphical representation of the magnitude of linear magnification (m) versus distance of the object from the mirror (x) is correctly given by (Graphs are drawn schematically and are not to scale)

(1) 

(2) 

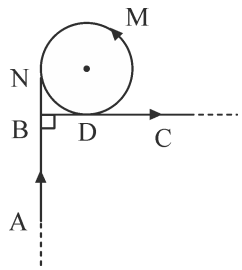
(3) 

(4) 

19. A Carnot engine having an efficiency of $\frac{1}{10}$ is being used as a refrigerator if the work done on the refrigerator is 10J, the amount of heat absorbed from the reservoir at lower temperature is :

(1) 1 J **(2)** 90 J **(3)** 100 J **(4)** 99 J

20. A very long wire ABDMNDC is shown in figure carrying current I AB and BC parts are straight, long and at right angle. At D wire forms a circular turn DMND of radius R. AB, BC parts are tangential to circular turn at N and D. Magnetic field at the centre of circle is:



(1) $\frac{\mu_0 I}{2\pi R}(\pi+1)$ **(2)** $\frac{\mu_0 I}{2R}$

(3) $\frac{\mu_0 I}{2\pi R}\left(\pi-\frac{1}{\sqrt{2}}\right)$ **(4)** $\frac{\mu_0 I}{2\pi R}\left(\pi+\frac{1}{\sqrt{2}}\right)$

SECTION 2

This section has FIVE (05) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places.

21. A ball is dropped from the top of a 100 m high tower on a planet. In the last $\frac{1}{2}s$ before hitting the ground, it covers a distance of 19m. Acceleration due to gravity ($in\, ms^{-2}$) near the surface on that planet is _____.

22. The first member of the Balmer series of hydrogen atom has a wavelength of 6561Å. The wavelength of the second member of the Balmer series (in nm) is _____.

23. Three containers C_1, C_2 and C_3 have water at different temperatures. The table below shows that final temperature T when different amounts of water (given in liters) are taken from each container and mixed (assume no loss of heat during the process)

C_1	C_2	C_3	T
$1l$	$2l$	--	$60°C$
--	$1l$	$2l$	$30°C$
$2l$	--	$1l$	$60°C$
$1l$	$1l$	$1l$	θ

The value of θ (in °C to the nearest integer) is_____)

24. An asteroid is moving directly towards the centre of the earth. When at a distance of 10R (R is the radius of the earth) from the earths centre, it has a speed of 12 km/s. Neglecting the effect of earths atmosphere, what will be the speed of the asteroid when it hits the surface of the earth (escape velocity from the earth is 11.2 km/s)? Give your answer to the nearest integer in kilometre / s_____.

25. The series combination of two batteries, both of the same emf 10V, but different internal resistance of 20Ω and 5Ω, is connected to the parallel combination of two resistors 30Ω and $R\Omega$. The voltage difference across the battery of internal resistance 20Ω is zero, the value of R (in Ω) 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. A metal (A) on heating in nitrogen gas given compound B. B on treatment with H_2O gives a colourless gas which when passed through $CuSO_4$ solution gives a dark blue-violet coloured solution. A and B respectively, are:

(1) Na and Na_3N **(2)** Mg and $Mg(NO_3)_2$

(3) Na and $NaNO_3$ **(4)** Mg and Mg_3N_2

2. Which of the following compounds is likely to shown both Frenkel and Schottky defects in its crystalling form ?

(1) CsCl **(2)** AgBr **(3)** ZnS **(4)** KBr

3. Among the reactions (a) – (d), the reaction(s) that does/do not occur in the blast furnance during the extraction of iron is/are:

(a) $CaO + SiO_2 \longrightarrow CaSiO_3$ (b) $3Fe_2O_3 + CO \longrightarrow 2Fe_3O_4 + CO_2$

(c) $FeO + SiO_2 \longrightarrow FeSiO_3$ (d) $FeO \longrightarrow Fe + \frac{1}{2}O_2$

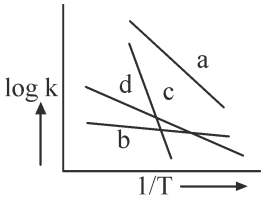
(1) (c) and (d) **(2)** (d) **(3)** (a) **(4)** (a) and (d)

4. Kjeldahi's method cannot be used to estimate nitrogen for which of the following compounds?

(1) $NH_2 - \overset{\overset{O}{\|}}{C} - NH_2$ **(2)** $CH_3CH_2 - C \equiv N$

(3) $C_6H_5NH_2$ **(3)** $C_6H_5NO_2$

5. Consider the following plots of rate constant versus $\frac{1}{T}$ for four different reactions. Which of the following orders is correct for the activation energies of these reactions?



(1) $E_b > E_d > E_c > E_a$

(2) $E_a > E_c > E_d > E_b$

(3) $E_b > E_a > E_d > E_c$

(4) $E_c > E_a > E_d > E_b$

6. Hydrogen has three isotopes (A), (B) and (C). If the number of neutron(s) in (A), (B) and (C) respectively, are (x), (y) and (z), the sum of (x), (y) and (z) is:

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

7. For the following **Assertion and Reason** the correct option is:

Assertion : For hydrogenation reactions, the catalytic activity increases from Group 5 to Group 11 metals with maximum activity shown by Group 7-9 elements.

Reason : The reactants are most strongly adsorbed on group 7-9 element

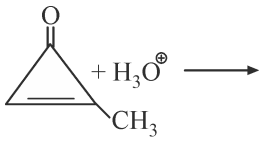
(1) Both assertion and reason are true and the reason is the correct explanation for the assertion.

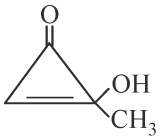
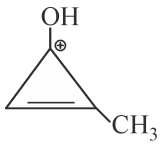
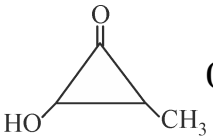
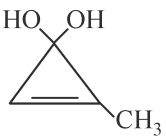
(2) Both assertion and reason are false. Both assertion and reason are true but

(3) Both assertion and reason are true but the reason is not the correct explanation for the assertion

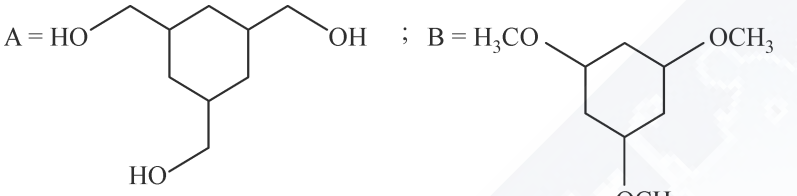
(4) The assertion is true, but the reason is false

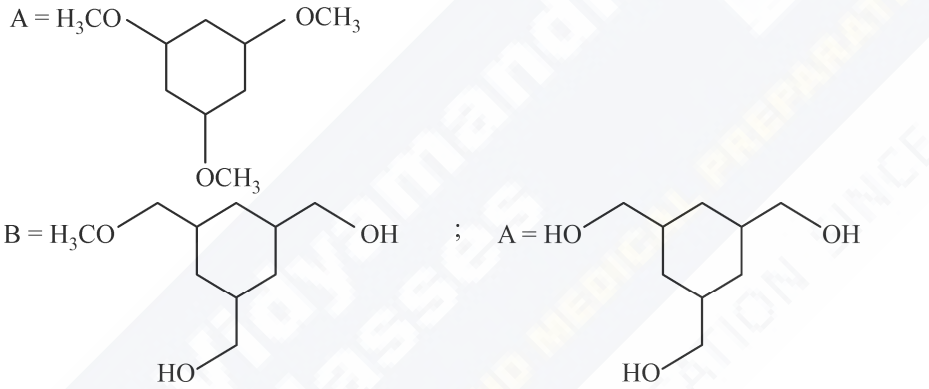
8. The major product in the following reaction is:

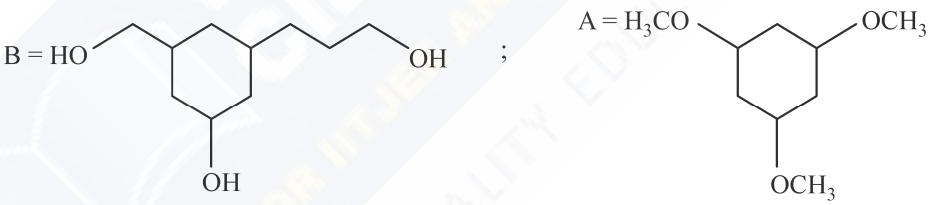


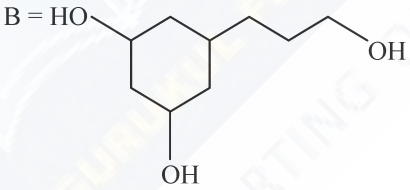
(1)  **(2)**  **(3)**  **(4)** 

9. Among the compounds A and B with molecular formula $C_9H_{18}O_3$. A is having higher boiling point the B. The possible structures of A and B are :

(1) 

(2) 

(3) 

(4) 

10. Arrange the following bonds according to their average bond energies in descending order :

$C-Cl, C-Br, C-F, C-I$

(1) $C-I > C-Br > C-Cl > C-F$ **(2)** $C-Br > C-I > C-Cl > C-F$

(3) $C-F > C-Cl > C-Br > C-I$ **(4)** $C-Cl > C-Br > C-I > C-F$

11. The increasing order of the atomic radii of the following elements is:

(a) C (b) O (C) F (d) Cl (e) Br

(1) (c) < (b) < (a) < (d) < (e) **(2)** (a) < (b) < (c) < (d) < (e)

(3) (b) < (c) < (d) < (a) < (e) **(4)** (d) < (c) < (b) < (a) < (e)

12. Among (a) – (d) , the complexes that can display geometrical isomerism are :

(a) $[Pt(NH_3)_3Cl]^+$ (b) $[Pt(NH_3)_3Cl_5]^-$

(c) $[Pt(NH_3)_2Cl(NO_2)]$ (d) $[Pt(NH_3)_4ClBr]^{2+}$

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

13. The radius of the second Bohr orbit, in terms of the Bohr radius, a_0, in Li^{2+} is:

(1) $\frac{4a_0}{9}$ **(2)** $\frac{2a_0}{3}$ **(3)** $\frac{4a_0}{3}$ **(4)** $\frac{2a_0}{9}$

14. The correct order of the calculated spin – only magnetic moments of complexes (A) to (D) is:

(A) $Ni(CO)_4$ (B) $[Ni(H_2O)_6]Cl_2$ (C) $Na_2[Ni(CN)_4]$ (D) $PdCl_2(PPh_3)_2$

(1) (C) ≈ (D) < (B) <(A) **(2)** (A) ≈ (C) < (B) ≈ (D)

(3) (C) < (D) < (B) < (A) **(4)** (A) ≈ (C) ≈ (D) < (B)

15. Preparation of Bakelite proceeds via reactions:

(1) Electrophilic substitution and dehydration

(2) Condensation and elimination

(3) Electrophilic addition and dehydration

(4) Nucleophilic addition and dehydration

16. The major product [B] in the following sequence of reactions is:

$$CH_3-\underset{\underset{CH(CH_3)_2}{|}}{C}=CH-CH_2CH_3 \xrightarrow[(ii)\ H_2O_2, OH^{\ominus}]{(i)\ B_2H_6} [A] \xrightarrow[\Delta]{dil.\ H_2SO_4} [B]$$

(1) $CH_3-\underset{\underset{CH(CH_3)_2}{|}}{C}=CH-CH_2CH_3$ **(2)** $CH_2=\underset{\underset{CH(CH_3)_2}{|}}{C}-CH_2-CH_2CH_3$

(3) $CH_3-\underset{\underset{CH(CH_3)_2}{|}}{CH}-CH=CH-CH_3$ **(4)** $CH_3-\underset{\underset{H_3C}{\diagup}\ \ \underset{CH_3}{\diagdown}}{\overset{\overset{\|}{C}}{}}-CH_2CH_2CH_3$

17. For the following **Assertion and Reason** the correct option is:

Assertion : The pH of water increases with increase in temperature

Reason : The dissociation of water into H^+ and OH^- is an exothermic reaction

(1) Assertion is not true, but reason is true

(2) Both assertion and reason are true, but the reason is not the correct explanation for the assertion

(3) Both assertion and reason are false

(4) Both assertion and reason are true, and the reason the correct explanation for the assertion

18. White phosphorus on reaction with concentrated NaOH solution in an inert atmosphere of CO_2 gives phosphine and compound (X). X on acidification with HCl gives compound (Y). The basicity of compound (Y) is:

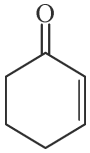
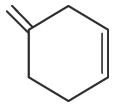
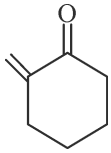
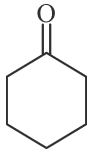
(1) 2 **(2)** 4 **(3)** 1 **(4)** 3

19. Two monomers in maltose are:

(1) α -D-glucose and β -D-glucose **(2)** α -D-glucose and α -D-glucose

(3) α -D-glucose and α -D-Fructose **(4)** α -D-glucose and α -D-galactose

20. An unsaturated hydrocarbon X absorbs two hydrogen molecules on catalytic hydrogenation, and also gives following reaction $X \xrightarrow[Zn/H_2O]{O_3} A \xrightarrow{[Ag(NH_3)_2]^+1} B$(3-oxo-hezanedicarboxylic acid) X will be:

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

SECTION 2

This section has FIVE (05) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places.

21. Complexes (ML_5) of metal Ni and Fe have ideal square pyramidal and trigonal bipyramidal geometries, respectively. The sum of the 90°, 120° and 180° L-M-L angles in the two complexes is_____.

22. In the following sequence of reactions the maximum number of atoms present in molecule 'C' in one plane is _____ .

$A \xrightarrow[Cu\ true]{Red\ hod} B \xrightarrow[Anhydrous\ AlCl_3]{CH_3Cl(1.\ eq.)} C$ (A is a lowest molecular weight alkyne)

23. $NaClO_3$ is used, even in spacecrafts, to product O_2. The daily consumption of pure O_2 by a person is 492L at 1 atm, 300 K. How much amount of $NaClO_3$, in grams, is required to produce O_2 for the daily consumption of a person at 1 atm, 300 K?

$NaClO_3(s) + Fe(s) \longrightarrow O_2(g) + NaCl(s) + FeO(s)$ R = 0.082 L atm $mol^{-1}K^{-1}$

24. For an electrochemical cell $Sn(s)Sn^{2+}(aq, 1M) \,||\, Pb^{2+}(aq, 1M)\,|Pb(s)$ the ratio $\frac{[Sn^{2+}]}{[Pb^{2+}]}$ when this cell attains equilibrium is _____

$\left(\text{Given}: E^0_{Sn^{2+}|Sn} = -\ 0.14\ V,\ E^0_{pb^{2+}\,|\,Pb} = -\ 0.13V,\ \frac{2.303RT}{F} = 0.06\right)$

25. At constant volume, 4 mol of an ideal gas when heated from 300 K to 500 K changes its internal energy by 5000 J. The molar heat capacity at constant volume is_____ .

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. Let $F:(1,3)\to R$ be a function defined by $f(x)=\frac{x[x]}{1+x^2}$, where $[x]$ denotes the greatest integer $\le x$.

Then the range of f is:

(1) $\left(\frac{3}{5},\frac{4}{5}\right)$ **(2)** $\left(\frac{2}{5},\frac{4}{5}\right]$

(3) $\left(\frac{2}{3},\frac{3}{5}\right]\cup\left(\frac{3}{4},\frac{4}{5}\right)$ **(4)** $\left(\frac{2}{5},\frac{1}{2}\right)\cup\left(\frac{3}{5},\frac{4}{5}\right]$

2. The mean and variance of 20 observations are found to be 10 and 4, respectively. On rechecking, it was found that an observation 9 was incorrect and the correct observation was 11. Then the correct variance is:

(1) 4.01 **(2)** 4.02 **(3)** 3.98 **(4)** 3.99

3. $\lim\limits_{x\to 0}\frac{\int_0^x t\sin(10t)dt}{x}$ is equal to:

(1) $\frac{1}{10}$ **(2)** 0 **(3)** $-\frac{1}{5}$ **(4)** $-\frac{1}{10}$

4. Let $\vec{a}=\hat{i}-2\hat{j}+\hat{k}$ and $\vec{b}=\hat{i}-\hat{j}+\hat{k}$ be two vectors. If $\vec{c}$ is a vector such that $\vec{b}\times\vec{c}=\vec{b}\times\vec{a}$ and $\vec{c}\cdot\vec{a}=0$, then $\vec{c}\cdot\vec{b}$ is equal to :

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

5. The length of the perpendicular form the origin, on the normal to the curve, $x^2+2xy-3y^2=0$ at the point (2, 2) is;

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

6. If $I=\int_1^2\frac{dx}{\sqrt{2x^3-9x^2+12x+4}}$, then:

(1) $\frac{1}{16}<I^2<\frac{1}{9}$ **(2)** $\frac{1}{9}<I^2<\frac{1}{8}$ **(3)** $\frac{1}{6}<I^2<\frac{1}{2}$ **(4)** $\frac{1}{8}<I^2<\frac{1}{4}$

7. If $A=\begin{pmatrix}2&2\\9&4\end{pmatrix}$ and $I=\begin{pmatrix}1&0\\0&1\end{pmatrix}$, then $10A^{-1}$ is equal to :

(1) $6I-A$ **(2)** $A-4I$ **(3)** $4I-A$ **(4)** `$A-6I$

8. Let $\alpha=\frac{1+i\sqrt{3}}{2}$. If $a=(1+\alpha)\sum_{k=0}^{100}\alpha^{2k}$ and $b=\sum_{k=0}^{100}\alpha^{3k}$, then a and b are the roots of the quadratic equation:

(1) $x^2-102x+101=0$ **(2)** $x^2+102x+101=0$

(3) $x^2-101x+100=0$ **(4)** $x^2+101x+100=0$

9. Let *S* be the set of all functions $f:[0,1]\to R$, which are continuous on $[0,1]$ and differentiable on (0, 1). Then for every *f* in *S*, there exists $a\ c\in(0,1)$, depending on *f*, such that:

(1) $\frac{f(1)-f(c)}{1-c}=f'(c)$ **(2)** $|f(c)-f(1)|<(1-c)|f'(c)|$

(3) $|f(c)-f(1)|<|f'(c)|$ **(4)** $|f(c)-f(1)|<(1+c)f'(c)|$

10. Let *S* be the set of all real roots of the equation, $3^x(3^x-1)+2=|3^x-1|+|3^x-2|$, then S:

(1) Is a singleton **(2)** Contains exactly two elements

(3) Is an empty set **(4)** Contains at least four elements

11. The area (in sq. units) of the region $\{(x,y)\in R^2:x^2\le y\le 3-2x\}$, is:

(1) $\frac{29}{3}$ **(2)** $\frac{31}{3}$ **(3)** $\frac{32}{3}$ **(4)** $\frac{34}{3}$

12. The system of linear equations

$\lambda x+2y+2z=5$

$2\lambda x+3y+5z=8$

$4x+\lambda y+6z=10$ has:

(1) No solution when $\lambda=2$ **(2)** Infinitely many solutions when $\lambda=2$

(3) No solution when $\lambda=8$ **(4)** A unique solution when $\lambda=-8$

13. The differential equation of the family of curves, $x^2=4b(y+b),\ b\in R$, is:

(1) $xy''=y'$ **(2)** $x(y')^2=x+2yy'$ **(3)** $x(y')^2=x-2yy'$ **(4)** $x(y')^2=2yy'-x$

14. The mirror image of the point (1, 2, 3) in a plane is $\left(-\frac{7}{3},-\frac{4}{3},-\frac{1}{3}\right)$. Which of the following points lies on this plane?

(1) (1, 1, 1) **(2)** (1, –1, 1) **(3)** (–1, –1, 1) **(4)** (–1,–1, –1)

15. Let A and B two events such that the probability that exactly one of them occurs is $\frac{2}{5}$ and the probability that A or B occurs is $\frac{1}{2}$, then the probability of both of them occur together is:

(1) 0.02 **(2)** 0.01 **(3)** 0.10 **(4)** 0.20

16. Which of the following statements is a tautology?

(1) $\sim(p\vee\sim q)\to p\vee q$ **(2)** $p\vee(\sim q)\to p\wedge q$

(3) $\sim(p\vee\sim q)\to p\vee q$ **(4)** $\sim(p\vee\sim q)\to p\wedge q$

17. If a hyperbola passes through the point $P(10,16)$ and it has vertices at $(\pm 6,0)$, then the equation of the normal to it at *P* is:

(1) $3x+4y=94$ **(2)** $x+2y=42$ **(3)** $x+3y=58$ **(4)** $2x+5y=100$

18. If the 10^{th} tern an A.P. is $\frac{1}{20}$ and its 20^{th} term is $\frac{1}{10}$, then the sum of its first 200 terms is:

(1) 100 **(2)** $100\frac{1}{2}$ **(3)** 50 **(4)** $50\frac{1}{4}$

19. If a line, $y = mx + c$ is a tangent to the circle, $(x-3)^2 + y^2 = 1$ and it is perpendicular to a line L_1 where L_1 is the tangent to the circle, $x^2 + y^2 = 1$ at the point $\left(\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right)$; then :

(1) $c^2 - 7c + 6 = 0$ **(2)** $c^2 - 6c + 7 = 0$ **(3)** $c^2 + 6c + 7 = 0$ **(4)** $c^2 + 7c + 6 = 0$

20. If α and β be the coefficients of x^4 and x^2 respectively in the expansion of $\left(x + \sqrt{x^2-1}\right)^6 + \left(x - \sqrt{x^2-1}\right)^6$, then :

(1) $\alpha + \beta = 60$ **(2)** $\alpha - \beta = 60$ **(3)** $\alpha + \beta = -30$ **(4)** $\alpha - \beta = -132$

SECTION 2

This section has FIVE (05) Questions. The answer to each question is a NUMERICAL VALUE. For each question, enter the correct numerical value of the answer. If the answer is a decimal numerical value, then round-off the value to TWO decimal places.

21. The number of 4 letter words (with or without meaning) that can be formed from the eleven letters of the word 'EXAMINATION' is_____.

22. Let $f(x)$ be a polynomial of degree 3 such that $f(-1) = 10, f(1) = -6$, $f(x)$ has a critical point at $x = -1$ and $f'(x)$ has a critical point at x = 1. Then $f(x)$ has a local minima at $x =$ _____ .

23. If $\frac{\sqrt{2}\sin\alpha}{\sqrt{1+\cos 2\alpha}} = \frac{1}{7}$ and $\sqrt{\frac{1-\cos 2\beta}{2}} = \frac{1}{\sqrt{10}}$, $\alpha, \beta \in \left(0, \frac{\pi}{2}\right)$ then $\tan(\alpha + 2\beta)$ is equal to _____.

24. The sum, $\sum_{n=1}^{7} \frac{n(n+1)(2n+1)}{4}$ is equal to _____.

25. Let a line $y = mx (m > 0)$ intersect the parabola, $y^2 = x$ at a point P, other than the origin. Let the tangent to it at P meet x – axis at the point Q. If area $(\Delta OPQ) = 4$ sq. units, then *m* is equal to _____.