Sri Chaitanya Educational Institutions | Infinity Learn

38 Years of Excellence 1986-2023

The BEST Results in India!
Dominant! Unparalleled!

ALL INDIA RANKS IN JEE-ADVANCED 2022

D JOHN JOSEPH | H.T.NO: 6036441*

JEE MAIN (JAN) 2023 (01-02-2023-Session-1)

MATHEMATICS, PHYSICS & CHEMISTRY

Sri Chaitanya IIT Academy.,India.

✪ A.P ✪ T.S ✪ KARNATAKA ✪ TAMILNADU ✪ MAHARASTRA ✪ DELHI ✪ RANCHI

A right Choice for the Real Aspirant

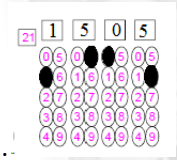
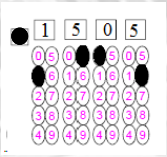
ICON Central Office - Madhapur - Hyderabad

Jee-Main_01-Feb-2023_Shift-01

IMPORTANT INSTRUCTION:

1. Immediately fill in the Admission number on this page of the Test Booklet with **Blue/Black** Ball Point **Pen** only.
2. The candidates should not write their Admission Number anywhere (except in the specified space) on the Test Booklet/ Answer Sheet.
3. The test is of **3 hours** duration.
4. The Test Booklet consists of 90 questions. The maximum marks are **300.**
5. There are **three** parts in the question paper 1, 2, 3 consisting of **Physics, Chemistry** and **Mathematics** having **30 questions** in each subject and subject having **two sections.**
   (I) Section –I contains 20 **multiple choice** questions with only one correct option.
   Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases.
   (II) Section-II contains 10 **Numerical Value Type** questions. Attempt any 5 questions only, if more than 5 questions attempted, First 5 attempted questions will be considered.

■ The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **nearest Integer** value (Example i, e. If answer is above **10** and less than **10.5** round off is **10** and If answer is from **10.5** and less than **11** round off is **11).**
To cancel any attempted question bubble on the question number box.
For example: To cancel attempted question 21. Bubble on 21 as shown below

Question Answered for Marking **Question Cancelled for Marking**
Marking scheme: +4 for correct answer, 0 if **not attempt** and **-1** in all other cases.

6. Use **Blue / Black Point Pen only** for writing particulars / marking responses on the Answer Sheet. **Use of pencil is strictly prohibited.**
7. No candidate is allowed to carry any textual material, printed or written, bits of papers, mobile phone any electron device etc, except the Identity Card inside the examination hall.
8. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
9. On completion of the test, the candidate must hand over the Answer Sheet to the invigilator on duty in the Hall. **However, the candidate are allowed to take away this Test Booklet with them.**
10. **Do not fold of make any stray marks on the Answer Sheet**

PHYSICS **Max Marks: 100**

(SINGLE CORRECT ANSWER TYPE)

This section contains 20 multiple choice questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

1. A steel wire with mass per unit length $7.0\times10^{-3} kg\ m^{-1}$ is under tension of 70 N. The speed of transverse waves in the wire will be:

1) 10 m/s 2) 100 m/s 3) 200π m/s 4) 50 m/s

Key: 2

Sol: $V=\sqrt{\frac{T}{\mu}}$

$=\sqrt{\frac{70}{7\times10^{-3}}}=100\ m/s$

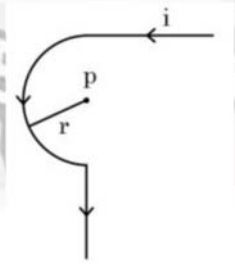
2. $\left(P+\frac{a}{V^2}\right)(V-b)=RT$ represents the equation of state of some gases. Where P is the pressure, V is the volume, T is the temperature and a,b,R are the constants. The physical quantity, which has dimensional formula as that of $\frac{b^2}{a}$, will be:

1) Bulk modulus 2) Compressibility 3) Modulus of rigidity 4) Energy density

Key: 2

Sol: $\frac{a}{V^2}\to P$, $b\to V$, $\frac{b^2}{a}=\frac{V^2}{V^2P}=\frac{1}{P}\to$ compressibility

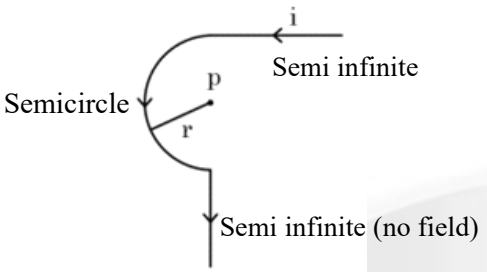
3. Find the magnetic field at the point P in figure. The curved portion is a semicircle connected to two long straight wires.



1) $\frac{\mu_0 i}{2r}\left(1+\frac{1}{\pi}\right)$ 2) $\frac{\mu_0 i}{2r}\left(1+\frac{2}{\pi}\right)$ 3) $\frac{\mu_0 i}{2r}\left(\frac{1}{2}+\frac{1}{\pi}\right)$ 4) $\frac{\mu_0 i}{2r}\left(\frac{1}{2}+\frac{1}{2\pi}\right)$

Key: 4

Sol:



$$, \vec{B}=\left(\frac{\mu_0}{4\pi}\right)\frac{i}{r}+\left(\frac{\mu_0}{4\pi}\right)\frac{\pi i}{r} , =\frac{\mu_0 i}{4\pi r}+\frac{\mu_0 i}{4r} , =\frac{\mu_0 i}{2r}\left(\frac{1}{2\pi}+\frac{1}{2}\right)$$

4. The mass of proton, neutron and helium nucleus are respectively 1.0073 u, 1.0087 u and 4.0015 u. The binding energy of helium nucleus is:

1) 14.2 MeV 2)7.1 MeV 3)56.8 MeV 4)28.4 MeV

Key: 4

Sol: $2He^4 \rightarrow 2\text{Proton}+2\text{Neutron}$

$B.E=2\left[1.0073+1.0087\right]-4.0015$

$=0.03054$

$B.E \Rightarrow \left(0.0305\times 931.5\right)Mev$

$=28.41\ Mev$

5. Match List I with List II:

List I	List II
A. AC gemerator	I. Presence of both L and C
B. Transformer	II. Electromagnetic Induction
C. Resonance phenomenon to occur	III. Quality factor
D. Sharpness of resonance	IV. Mutual Induction

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

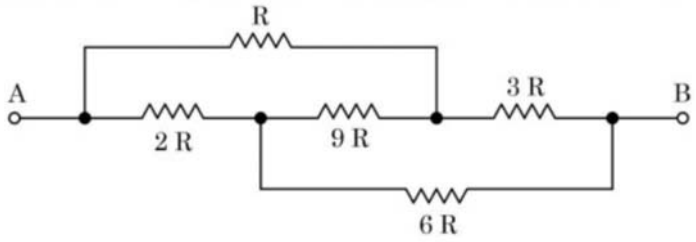
1) A-IV, B-III, C-I, D-II 2) A-II, B-IV, C-I, D-III

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

Key: 2

Sol: Conceptual

6. The equivalent resistance between A and B of the network shown in figure:



1) $11\frac{2}{3}R$ 2) $14\ R$ 3) $\frac{8}{3}R$ 4) $21\ R$

Key:3

Sol: $\frac{R}{2R}=\frac{3R}{6R}\ \rightarrow$ Wheatstone Bridge.

$\Rightarrow \text{Req}=\frac{4R\times 8R}{4R+8R}=\frac{8R}{3}$

7. The average kinetic energy of a molecule of the gas is

1) Proportional to absolute temperature 2) Proportional to volume

3) dependent on the nature of the gas 4) proportional to pressure

Key: 1

Sol: Translational $\left(K.E\right)_q=\frac{3}{2}nRT$

8. An object moves with speed υ_1,υ_2 and υ_3 along a line segment AB, BC and CD respectively as shown in figure. Where $AB=BC$ and $AD=3AB$, then average speed of the object will be:

1) $\frac{\left(\upsilon_1+\upsilon_2+\upsilon_3\right)}{3}$ 2) $\frac{3\upsilon_1\upsilon_2\upsilon_3}{\left(\upsilon_1\upsilon_2+\upsilon_2\upsilon_3+\upsilon_3\upsilon_1\right)}$

3) $\frac{\left(\upsilon_1+\upsilon_2+\upsilon_3\right)}{3\upsilon_1\upsilon_2\upsilon_3}$ 4) $\frac{\upsilon_1\upsilon_2\upsilon_3}{3\left(\upsilon_1\upsilon_2+\upsilon_2\upsilon_3+\upsilon_3\upsilon_1\right)}$

Key: 2

Sol: $V_{av}=\dfrac{\text{Total Distance}}{\text{Total Time}}=\dfrac{3s}{\frac{s}{V_1}+\frac{s}{V_2}+\frac{s}{V_3}}=\dfrac{3V_1V_2V_3}{V_1V_2+V_2V_3+V_1V_3}$

9. Match List I with List II:

List I	List II
A. Microwaves	I. Radio active decay of the nucleus
B. Gamma rays	II. Rapid acceleration and deceleration of electron in aerials
C. Radio waves	III. Inner shell electrons
D. X-rays	IV. Klystron valve

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

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

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

Key: 3

Sol: Memory Based

10. 'n' polarizing sheets are arranged such that each makes an angle $45°$ with the preceeding sheet. An unpolarized light of intensity I is incident into this arrangement. The output intensity is found to be $I/64$. The value of n will be:

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

Key: 1

Sol: $I'=\dfrac{I}{2}\left(\cos^2 45\right)^{n-1}$

$I'=\dfrac{I}{64}$

$\dfrac{I}{64}=\dfrac{I}{2}\left(\dfrac{1}{2}\right)^{n-1}$

$\dfrac{1}{2^{n-1}}=\dfrac{1}{32}$

$n=6$

11. A mercury drop of radius $10^{-3}m$ is broken into 125 equal size droplets. Surface tension of mercury is $0.45\ Nm^{-1}$. The gain in surface energy is:

1) $5\times10^{-5}J$ 2) $17.5\times10^{-5}J$ 3) $2.26\times10^{-5}J$ 4) $28\times10^{-5}J$

Key: 3

Sol: From vol conservation

$$\left(\frac{4}{3}\pi r^3\right)\times125=\frac{4}{3}\pi R^3$$

$$R^3=125r^3$$

$$R=5r\Rightarrow r=\frac{R}{5}$$

$$surface\ energy=\left[4\pi r^2\times125-4\pi R^2\right]\times S.T$$

$$=4\pi r^2\times100\times0.45=2.26\times10^{-5}J$$

12. A proton moving with one tenth of velocity of light has a certain de Broglie wavelength of λ. An alpha particle having certain kinetic energy has the same de-Brogle wavelength λ. The ratio of kinetic energy of proton and that of alpha particle is:

1) 2 : 1 2) 4 : 1 3) 1 : 4 4) 1 : 2

Key: 2

Sol: $$\frac{P^2}{2m}=K.E=\frac{h^2}{2m\lambda^2}$$

$$K.E\ \alpha\ \frac{1}{m\lambda^2}$$

$$\text{Ratio}=\frac{\frac{1}{m_p}}{\frac{1}{m_\alpha}}=4$$

13. Match List I with List II:

List I	List II
A. Intrinsic semiconductor	I. Fermi-level near the valence band
B. n-type semiconductor	II. Fermi-level in the middle of valence and conduction band
C. p-type semiconductor	III. Fermi-level near the conduction band
D. Metals	IV. Fermi-level inside the conduction band

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

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

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

Key: 4

Sol: Conceptual

14. A sample of gas at temperature T is adiabatically expanded to double its volume. The work done by the gas in the process is $\left(\text{given, } \gamma = \frac{3}{2}\right)$:

1) $W = TR\left[\sqrt{2}-2\right]$ 2) $W = \frac{R}{T}\left[2-\sqrt{2}\right]$ 3) $W = RT\left[2-\sqrt{2}\right]$

4) $W = \frac{T}{R}\left[\sqrt{2}-2\right]$

Key: 3

Sol: $TV^{\gamma-1} = T_2(2V)^{\gamma-1}$, $T_2 = T/2^{\gamma-1}$, $= \frac{T}{\sqrt{2}}$, $W = \frac{nR(T_2 - T_1)}{1-\gamma}$

$= \frac{nR}{1-\frac{3}{2}}\left(\frac{T}{\sqrt{2}} - T\right) = nRT\left(\sqrt{2}-1\right)\sqrt{2}$,

$= nRT\left(2-\sqrt{2}\right)$, We have taken $n = 1$ otherwise can't be solved

15. Which of the following frequencies does not belong to FM broadcast.

1) 64 MHz 2) 106 MHz 3) 99 MHz 4) 89 MHz

Key: 1

Sol: F.M Range is 88 to 108 MHz

16. Given below are two statements:

Statement I: Acceleration due to gravity is different at different places on the surface of earth.

Statement II: Acceleration due to gravity increases as we go down below the earth's surface.

In the light of the above statements, choose the **correct** answer from the options given belwo

1) Both Statement I and Statement II are false

2) Statement I is false but Statement II is true

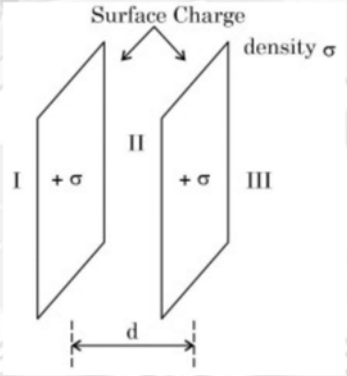
3) Statement I is true but Statement II is false

4) Both Statement I and Statement II are true

Key: 3

Sol: Due to Rotation g varies ay different places. On earth's surface.

17. Let σ be the uniform surface charge density of two infinite thin plane sheets shown in figure. Then the electric fields in three different region E_I, E_{II} and E_{III} are:



1) $\vec{E}_I = 0, \vec{E}_{II} = \frac{\sigma}{\in_0}\hat{n}, E_{III} = 0$

2) $\vec{E}_I = \frac{2\sigma}{\in_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{2\sigma}{\in_0}\hat{n}$

3) $\vec{E}_I = -\frac{\sigma}{\in_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{\sigma}{\in_0}\hat{n}$

4) $\vec{E}_I = \frac{\sigma}{2\in_0}\hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{\sigma}{2\in_0}\hat{n}$

Key: 3

Sol: $E_I = \frac{\sigma}{2\in_0} + \frac{\sigma}{2\in_0} = E_{III}$

E_I & E_{II} are in opposite direction

18. If earth has a mass nine times and radius twice to that of a planet P. Then $\frac{\upsilon_e}{3}\sqrt{x}\ ms^{-1}$ will be the minimum velocity required by a rocket to pull out of gravitational force of P, where υ_e is escape velocity on earth. The value of x is.

1) 1 2) 18 3) 3 4) 2

Key:4

Sol: $V_e=\sqrt{\frac{2GM}{R}}$

$V_e \alpha \sqrt{\frac{M}{R}}$

$\frac{V_p}{V_e}=\sqrt{\frac{M}{R}}\ \ \frac{1}{\sqrt{\frac{9M}{2R}}}=\frac{\sqrt{2}}{3}=x=2$

19. A child stands on the edge of the cliff 10 m above the ground and throws a stone horizontally with an initial speed of 5 ms^{-1}. Neglecting the air resistance, the speed with which the stone hits the ground will be _____ ms^{-1} $\left(\text{given, } g=10\ ms^{-2}\right)$.

1) 15 2) 20 3) 30 4) 25

Key:1

Sol:

$V_y=\sqrt{2\times10\times10}=10\sqrt{2}\text{m/s}$

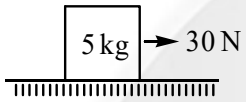
Total speed $=\sqrt{5^2+\left(10\sqrt{2}\right)^2}=15\,\text{m/s}$

20. A block of mass 5 kg is placed at rest on a table of rough surface. Now, if a force of 30N is the direction parallel to surface of the table, the block slides through a distance of 50 m in an interval of time 10s. Coefficient of kinetic friction is $\left(\text{given, } g = 10\ ms^{-2}\right)$:

1) 0.50 2) 0.60 3) 0.75 4) 0.25

Key:1

Sol:



$$, \frac{1}{2}at^2 = 50$$

$$a = \frac{50\times 2}{10^2} = 1\,m/s^2 \quad , \quad \frac{30-\mu mg}{m} = 1$$

$$6 - 10m = 1$$

$$\mu = 0.5$$

(NUMERICAL VALUE TYPE)

Section-II contains 10 **Numerical Value Type** questions. Attempt any 5 questions only. If more than 5 questions attempted, First 5 Attempted questions will be considered. The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **nearest Integer** value (Example i,e. If answer is above 10 and less than 10.5 round off is 10 and if answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if **not attempt** and **-1** in all other cases.

21. A light of energy $12.75\ eV$ is incident on a hydrogen atom in its ground state. The atom absorbs the radiation and reaches to one of its excited states. The angular momentum of the atom in the excited state is $\frac{x}{\pi}\times 10^{-17}\ eVs$. The value of x is _____

$\left(\text{use } h = 4.14\times 10^{-15}\ eVs,\ c = 3\times 10^8\ ms^{-1}\right)$.

Key: No Key

Sol: $12.75 = 13.6\left(1-\frac{1}{n^2}\right)$

solving we get $n = 4$

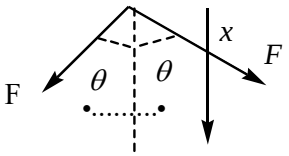
$$Angular\ M_{6meter} = \frac{nh}{2\pi} = \frac{4\times 4.14\times 10^{-15}}{2\pi} = \frac{828}{\pi}\times 10^{-17}$$

$$x = 828$$

22. Two equal positive point charges are separated by a distance $2a$. The distance of a point from the line joining two charges on the equatorial line (perpendicular bisector) at which force experienced by a test charge q_0 becomes maximum is $\frac{a}{\sqrt{x}}$. The value of x is _____.

Key: 2

Sol:



$$F_{net} = 2F\cos\theta$$

$$= \frac{2KNQx}{\left(a^2+x^2\right)^{3/2}}$$

$$For\ \text{maxima}\ \frac{d}{dx}\left(\frac{2KNQx}{\left(a^2+x^2\right)^{3/2}}\right)=0$$

$$We\ get\ x=\frac{a}{\sqrt{2}}$$

23. In an experiment to find emf of a cell using potentiometer, the length of null point for a cell of emf $1.5\,V$ is found to be 60 cm. If this cell is replaced by another cell of emf E, the length of null point increases by 40 cm. The value of E is $\frac{x}{10}V$. The value of x is _____.

Key: No Key

Sol: $$\frac{E}{1.6}=\frac{60+40}{60}$$

$$E = 2.5\,volt$$

24. A certain pressure 'P' is applied to 1 litre of water and 2 litre of a liquid separately. Water gets compressed to 0.01% whereas the liquid gets compressed to 0.03%. The ratio of Bulk modulus of water to that of the liquid is $\frac{3}{x}$. The value of x is _____.

Key: 1

Sol: $$B=-\frac{P}{\frac{\Delta v}{v}}$$

$$B\ \alpha\ \frac{1}{\Delta v}$$

$$\therefore Ratio=\frac{0.03}{0.01}=3$$

25. The amplitude of a particle executing SHM is 3 cm. The displacement at which its kinetic energy will be 25% more that the potential energy is _____cm.

Key: 2

Sol: $PE = P$

$K.E = P + \frac{P}{4} = 125\,P$

$2.25\,P = \left(\frac{1}{2} m w^2 A^2\right) / 2.25\,P$

$Now\ \ P = \frac{1}{2} m w^2 x^2$

$x^2 = \frac{A^2}{2.25} \rightarrow x = \frac{A}{1.5} = 2\ cm.$

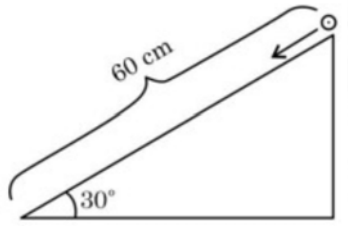
26. A charge particle of $2\ \mu C$ accelerated by a potential difference of 100V enters a region of uniform magnetic field of magnitude 4 mT at right angle to the direction of field. The charge completes semicircle of radius 3 cm inside magnetic field. The mass of the charge particle is _____ $\times 10^{-18} kg$.

Key: 144

Sol: $r = \frac{mV}{Ba} = \frac{\sqrt{2aVm}}{Ba}$, $m = \frac{B^2 A^2 r^2}{2aV} = 48 \times 10^{-18kg}$ $48 \times 10^{-18}\ kg.$,

$\frac{\left(4 \times 10^{-3}\right)^2 \times \left(2 \times 10^{-6}\right) \times \left(3 \times 10^{-2}\right)^2}{2 \times 100}$ 144×10^{-18} ,

27. A solid cylinder is released from rest from the top of an inclined plane of inclination 30° and length 60 cm. If the cylinder rolls without slipping, its speed upon reaching the bottom of the inclined plane is _____ ms^{-1}. $\left(\text{Given } g = 10\ ms^{-2}\right)$



Key: 2

Sol: $mgh = \frac{1}{2} mV^2 + \frac{1}{2} Iw^2 \left(Energy\ conservation\right)$

$V = wr \left(\ for\ Pure\ Rolling\right)$

$V = \sqrt{\frac{4gh}{3}} = \sqrt{\frac{4 \times 10 \times 0.3}{3}} = 2m/s.$

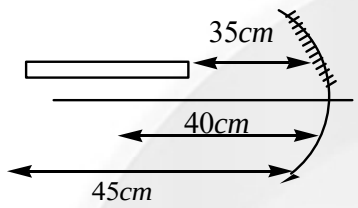
28. A thin cylindrical rod of length 10 cm is placed horizontally on the principle axis of a concave mirror of focal length 20 cm. The rod is placed in a such a way that mid point of the rod is at 40 cm from the pole of mirror. The length of the image formed by the mirror will be $\frac{x}{3} cm$. The value of x is _____.

Key: 32

Sol: $\frac{1}{v_1}-\frac{1}{35}=-\frac{1}{20}$

$v_1=-\frac{700}{15}cm=-\frac{140}{3}cm$

$\frac{1}{v_2}-\frac{1}{45}=-\frac{1}{20}\quad v_2=\frac{900}{25}cm=-36cm$



$Length=\frac{140}{3}-36=\frac{32}{3}cm$

29. A series LCR circuit is connected to an ac source of 220V, 50Hz. The circuit contain a resistance $R=100\Omega$ and an inductor of inductive reactance $X_L=79.6\Omega$. The capacitance of the capacitor needed to maximize the average rate at which energy is supplied will be _____ μF.

Key: 40

Sol: $X_L=X_c=\frac{1}{wc}$

$c=\frac{1}{79.6\times 2\pi\times 50}F$

$=\frac{10^6}{79.6\times 100\pi}\mu F=40\mu F$

$X_L=X_c=\frac{1}{wc}$

$c=\frac{1}{79.6\times 2\pi\times 50}F$

$=\frac{10^6}{79.6\times 100\pi}\mu F=40\mu F$

30. A small particle moves to position $5\hat{i}-2\hat{j}+\hat{k}$ from its initial position $2\hat{i}+3\hat{j}-4\hat{k}$ under the action of force $5\hat{i}+2\hat{j}+7\hat{k}\ N$. The value of work done will be_____J.

Key: 40

Sol: Displacement

$=\left(5\hat{i}-2\hat{j}+\hat{k}\right)-\left(2\hat{i}+3\hat{j}-4\hat{k}\right)$

$=3\hat{i}-5\hat{j}+5\hat{k}$

$W.D = \hat{F}.\hat{r} = 40\,unit$

CHEMISTRY **Max Marks: 100**

(SINGLE CORRECT ANSWER TYPE)

This section contains 20 multiple choice questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

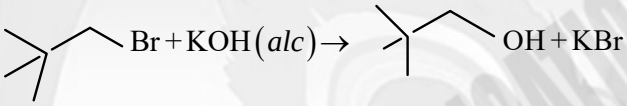
31. Which of the following complex will show largest splitting of d-orbitals?

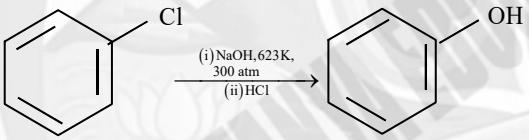
1) $\left[F_e(C_2O_4)_3\right]^{3-}$ 2) $\left[F_e(CN)_6\right]^{3-}$ 3) $\left[F_e(NH_3)_6\right]^{3+}$ 4) $\left[F_eF_6\right]^{3-}$

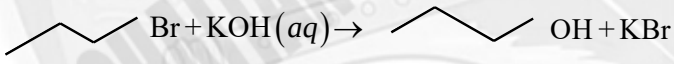
Key:- 2

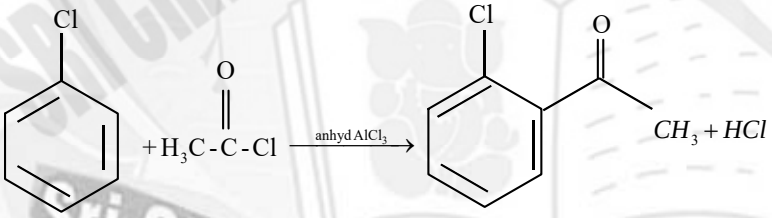
Sol:- Largest splitting is observed for strong field ligand $CN^- > NH_3 > C_2O_4^{-2} > F^-$

32. Identify the incorrect option from the following:

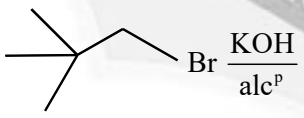
1) 

2) 

3) 

4) 

Key:- 1

Sol:- 

No reaction due to lack of alpha Hugroge

33. Match List I with List II

List I	List II
Test	Functional group/Class of Compound
(A) Molisch's Test	(I) Peptide
(B) Biuret Test	(II) Carbohydrate
(C) Carbylamine Test	(III) Primary amine
(D) Shiffs Test	(IV) Aldehyde

Choose the correct answer from the options given below:

1) (A) – III, (B) – IV, (C) –II, (D) –I

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

3) (A) – III, (B) – IV, (C) – I, (D) – II

4) (A) – I, (B) – II, (C) – III, (D) – IV

Key:- 2

Sol:- Molisch test $\longrightarrow$ Carbohydrates, Biuret test $\longrightarrow$ Peptide

Carbylamine test $\longrightarrow$ Primaryamines

Schiffi test $\longrightarrow$ Aldehydes

34. A solution of $FeCl_3$ when treated with $K_4\left[Fe(CN)_6\right]$ gives a prussiun blue precipitation due to the formation of

1) $Fe\left[Fe(CN)_6\right]$ 2) $K\left[Fe_2(CN)_6\right]$ 3) $Fe_4\left[Fe(CN)_6\right]_3$ 4) $Fe_3\left[Fe(CN)_6\right]_2$

Key:- 3

Sol:- $K_4\left[Fe(CN)_6\right]+Fecl_3 \rightarrow Fe_4\left[Fe(CN)_6\right]_3$ Prussian blue

35. Which of the following are the example of double salt?

A) $FeSO_4.(NH_4)_2SO_4.6H_2O$ B) $CuSO_4.4NH_3.H_2O$

C) $K_2SO_4.Al_2(SO_4)_3.24H_2O$ D) $Fe(CN_2).4KCN$

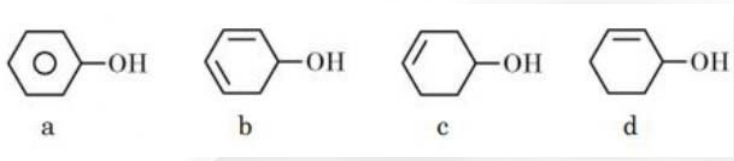
Choose the correct answer

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

Key:-3

Sol:- $\left.\begin{matrix} FeSo_4(NH_4)So_4 6H_2o\text{-Mohr salt} \\ K_2So_4\,Al_2(So_4)_3\text{-Potassivmalum} \end{matrix}\right\}$ Double Salts.

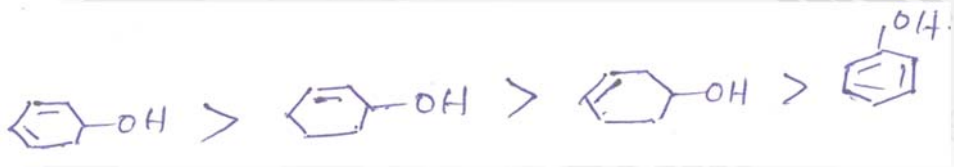
36. Decreasing order of dehydration of the following alcohols is



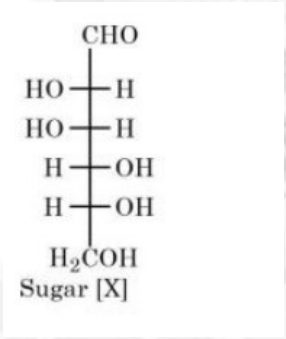
1) a > d > b > c 2) d > b > c > a 3) b > a > d > c 4) b > d > c > a

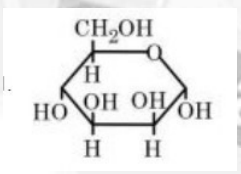
Key:- 4

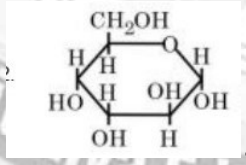
Sol:- Rate of dehydration

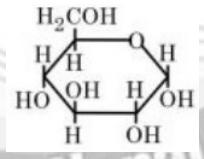


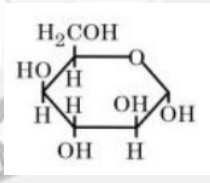
37. The correct representation in six membered pyranose from for the following sugar [X] is



1) 

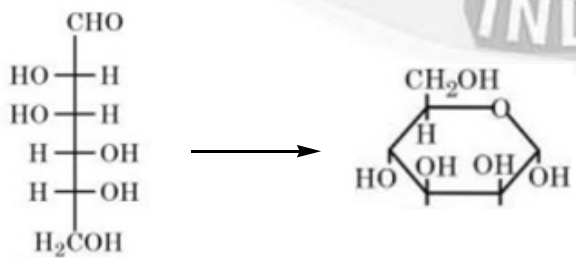
2) 

3) 

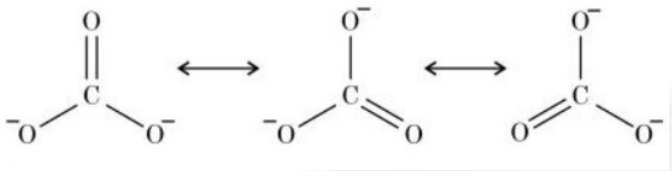
4) 

Key: 1

Sol:-



38. Resonance in carbonate ion $\left(CO_3^{2-}\right)$ is



Which of the following is true?

1) All these structures are in dynamic equilibrium with each other.

2) Each structure exists for equal amount of time.

3) $\left(CO_3^{2-}\right)$ has a single structure i.e., resonance hybrid of the above three structures.

4) It is possible to identify each structure individually by some physical or chemical method.

Key:- 3

Sol:- CO_3^{-2} has single structure i.e., resonance hybrid of the above three structures.

39. Given below are two statements: one is labeled as **Assertion A** and the other is labeled as **Reason R**

Assertion A: Hydrogen is an environment friendly fuel.

Reason R: Atomic number of hydrogen is 1 and it is a very light element.

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

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

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

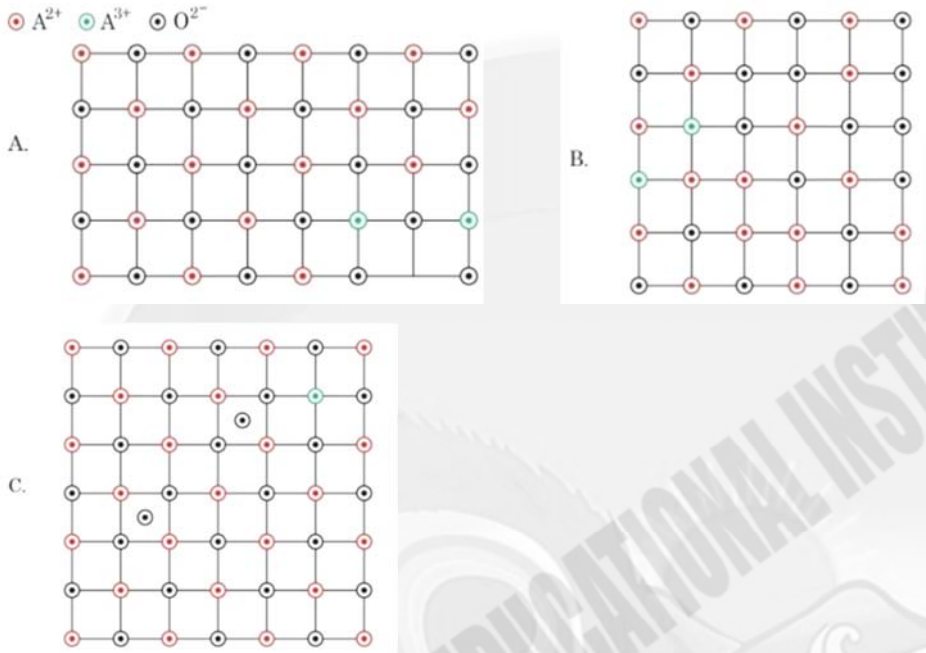
3) **A** is false but **R** is true.

4) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

Key:- 4

Sol:- Both the statements are correct but **Reason** is not correct explanation to **Assertion**

40. Which of the following represents the lattice structure of $A_{0.95}O$ containing A^{2+}, A^{3+} and O^{2-} ions?



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

Key:- 3

Sol:- $A_0.95^o$ is Non stoichiometric crystal with metal deficiency defeet.

41. How can photochemical smog be controlled?

1) By using catalytic convertors in the automobiles/industry.

2) By complete combustion of fuel.

3) By using catalyst.

4) By using tall chineys.

Key:- 1

Sol:- Photochemical smog can be controlles by using catalytic converters in the automobile industry.

42. Match List I with List II

List I	List II
(A) Slaked lime	(I) NaOH
(B) Dead burnt plaster	(II) $Ca(OH)_2$
(C) Caustic soda	(III) $Na_2CO_3,10H_2O$
(D) Washing soda	(IV) $CaSO_4$

Choose the correct answer from the options given below:

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

3) (A) – I, (B) –IV. (C) – II, (D) – III 4) (A) – II, (B) –IV, (C) – I, (D) – III

Key:- 4

Sol:- Slaked lime _____ $Ca(OH)_4$

Dead burnt plaster _____ $CaSo_4$

Caustic soda _____ NaoH

Washing septic _____ $Na_2Co_310H_2o$

43. Match List I with List II

List I	List II
(A) Tranquilizers	(I) Anti blood clotting
(B) Aspirine	(II) Salvarsan
(C) Antibiotic	(III) Antidepressant drugs
(D) Antiseptic	(IV) soframicine

Choose the correct answer from the options given below:

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

3) (A) – III, (B) –I. (C) – II, (D) – IV 4) (A) – II, (B) –I, (C) – III, (D) – IV

Key:- 3

Sol:- Tranquilizers _____ Antidepressant drugs

Aspirine _____ Anti blood clotting

Antibiotic _____ Salvarsan

Antibiotic _____ soframicine

44. Highest oxidation state Mn is exhibited in Mn_2O_7. The correct statements about Mn_2O_7 are

(A) Mn is tetrahedrally surrounded by oxygen atoms.

(B) Mn is octahedrally surrounded by oxygen atoms.

(C) Contans Mn-O-Mn bride.

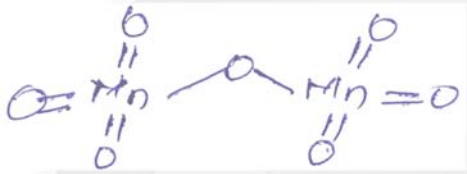
(D) Contans Mn-Mn bond.

Choose the correct answer from the option given below:

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

Key:- 2

Sol:-



45. Given below are two statements:

Statement I: Chlorine can easily combine with oxygen to from oxides;

And the product has a tendency to explode.

Statement II: Chemical reactivity of an element can be determined by

Its reaction with oxygen and halogens.

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

1) Both the Statements I and II are false

2) Both the Statements I and II are true

3) Statement I is false but Statement II is true

4) Statement I is true but Statement II is false

Key:- 2

Sol:- Both the statements are correct

46. Given below are two statements: one is labeled as **Assertion A** and the other is labeled as **Reason R**

Assertion A: In an Ellingham diagram, the oxidation of carbon to carbon monoxide shows a negative slope with respect to temperature.

Reason R: CO tends to get decomposed at higher temperature.

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

1) **A** is correct but **R** is not correct

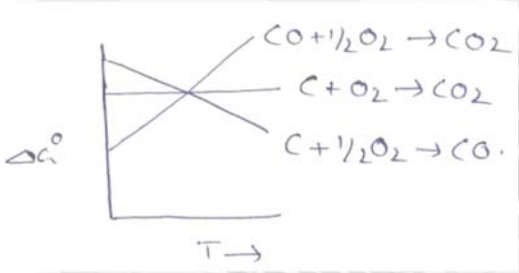
2) **A** is not correct but **R** is correct

3) Both **A** and **R** are correct and **R** is **NOT** correct explanation of **A**

4) Both **A** and **R** are correct but **R** is **NOT** the correct explanation of **A**

Key:- 1

Sol:-



47. Given below are two statements: one is labeled as **Assertion A** and the other is labeled as **Reason R**

Assertion A: Amongst He, Ne, Ar and Kr;

1g of activated charcoal adsorbs more of Kr.

Reason R: The critical volume $V_e\left(cm^3\ mol^{-1}\right)$ and critical pressure P_e (atm) is highest for Krypton but the compressibility factor at critical point Z_e is lowest for Krypton.

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

1) Both **A** and **R** are true but **R** is **NOT** the correct explanation of **A**

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

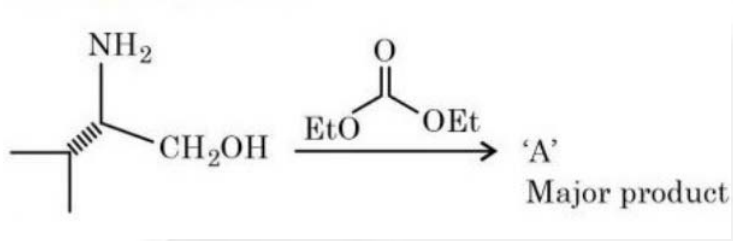
3**)** **A** is false but **R** is true

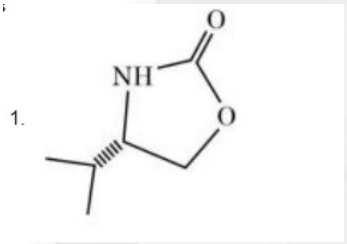
4**)** **A** is true but **R** is false

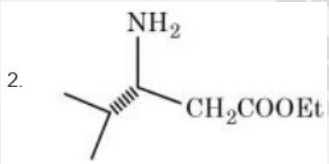
Key: - 4

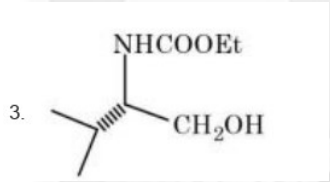
Sol:- $Z = \frac{PV}{RT}$

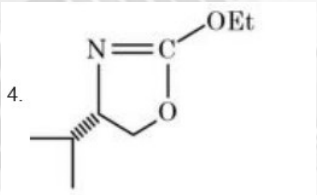
48. In the following reaction, 'A' is



1. 

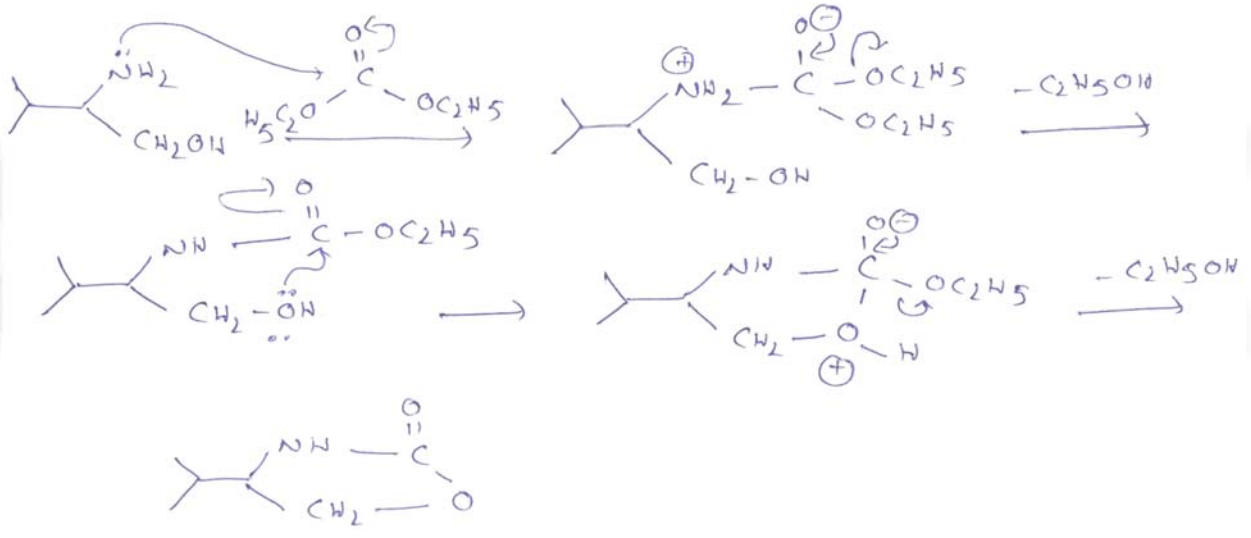
2. 

3. 

4. 

Key:- 1

Sol:-



49. Choose the correct statement(s):

A) Beryllium oxide is purely acidic in nature.

B) Beryllium carbonate is kept in the atmosphere of CO_2.

C) Beryllium sulphate is readily soluble in water.

D) Beryllium shows anomalous behavior.

Choose the correct answer from the options given below:

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

Key:- 2

Sol:- BeO is amphoteric in nature.

50. But-2-yne is reacted separately with one mole of Hydrogen as shown below:

$$\underline{B} \xleftarrow[liq\,NH_3]{Na} CH_3\text{-}C^{o}C\text{-}CH_3 \xrightarrow[\Delta]{Pd/C} A$$

A) A is more soluble than B.

B) The boiling point & melting point of A are higher and lower than B respectively.

C) A is more polar than B because dipole moment of A is Zero.

D) Br_2 adds easily to B than A.

Identify the incorrect statement from the option given below:

1) A, C & D only 2) A and B only 3) B, C & D only 4) B and C only

Key: - 3

Sol:- A is cis – but – 2 ene and B is trans – but – 2-ene.

A is more soluble due to its polarity.

(NUMERICAL VALUE TYPE)

Section-II contains 10 **Numerical Value Type** questions. Attempt any 5 questions only. If more than 5 questions attempted, First 5 Attempted questions will be considered. The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **nearest Integer** value (Example i,e. If answer is above 10 and less than 10.5 round off is 10 and if answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if **not attempt** and **-1** in all other cases.

51. The density of 3 M solution of NaCl is 1.0 g mL^{-1}. Molality of the solution is _____ $\times 10^{-2}$m. (Nearest integer).

Given: Mole mass of Na and Cl is 23 and 35.5 g mol^{-1} respectively.

Key :- 364

Sol:- n = 3 moles

Weight of solute = $3 \times 58.5 = 175.5\,g$

Weight of solvent $= 1000 - 175.5 = 824.5\,g$ $m = \dfrac{n}{W_{(kg)}}$

$$= \frac{3}{824.5} \times 1000 = 3.64.$$

52. Sum of oxidation states of bromine in bromic acid and perbromic acid is _____.

Key : 12

Sol:- Bromic Acid $HBrO_3$ and perbromic acid is $HBrO_4$

53. 25 mL of an aqueous solution of KCl was found to require 20 mL of 1 M $AgNO_3$ solution when titrated using K_2CrO_4 as an indicator. What is the depression in freezing point of KCl solution of the concentration? _____(Nearest integer).

(Given: $(K_f = 2.0\,K\,kg\,mol^{-1})$

Assume 1) 100% ionization and

2) density of the aqeous solution as 1 g mL^{-1}

Key: 3

Solution :- $25\times M = 20\times 1$

$M = 0.8(KCl)$

$KCl \rightarrow K^+ + Cl^-$

$0.8 \quad 0 \quad 0$

$0 \quad 0.8 \quad 0.8$

$\Delta T_f = i\times K_f \times m = 1.6\times 2 = 3.2.$

54. A and B are two substances undergoing radioactive decay in a container. The half life of A is 15 min and that of B is 5 min. If the initial concentration of B is 4 times that of A and they both start decaying at the same time, how much time will it take for the concentration of both of them to be same?_____min.

Key : 15 min

$\frac{n_1}{n_2} = \frac{15}{5}$

$n_1 = 3n_2$

Solution :- $\frac{[A_o]}{2^{n_1}} = \frac{[B_o]}{2^{n_2}} \Rightarrow [A_o] = 4[B_o]$

$4 = \frac{2^{n_i}}{2^{n_2}}$

55. (i) $X(g) \rightleftharpoons Y(g) + z(g)$ $K_{pt} = 3$

(ii) $A(g) \rightleftharpoons 2B(g)$ $K_{p2} = 1$

If the degree of dissociation and initial concentration of both the reactants X(g) and A(g) are equal, then the ratio of the total pressure at equilibrium $\left(\frac{p_1}{p_2}\right)$ is equal to x : 1. The value of x is _____(Nearest integer)

Key: 12

Sol:-

$(i)\ X_{(g)} \rightleftharpoons Y_{(g)} + Z_{(g)}$ $K_{P_1} = 3$

1 0 0

$1-x$ x x

Total moles at equilibrium $= 1+x$

$$K_{P_1} = \frac{\frac{x}{1+x}.P_1 \times \frac{x}{1+x}.P_1}{\frac{1-x}{1+x}.P_1}$$

$$K_{P_1} = \frac{P_1.x^2}{1-x^2}$$

$(ii)\ A_{(g)} \rightleftharpoons 2B_{(g)}$ $K_{P_2} = 1$

1 0

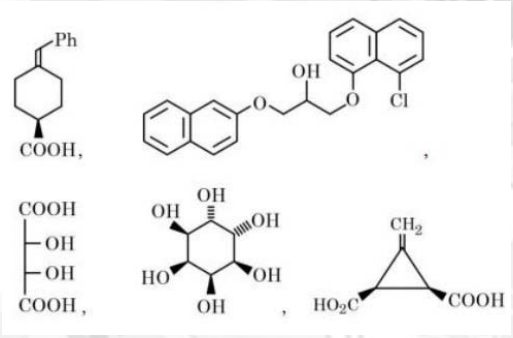
$1-x$ $2x$

$$K_{P_2} = \frac{\frac{2x}{1+x}.P_2 \times \frac{2x}{1+x}.P_2}{\frac{1-x}{1+x}.P_2}$$

$$K_{P_2} = P_2.\frac{4x^2}{1-x^2}$$

$$\frac{K_{P_1}}{K_{P_2}} = \frac{3}{1} = \frac{P_1.x^2/1-x^2}{P_2.4x^2/1-x^2} \Rightarrow \frac{P_1}{P_2} = 12$$

56. The total number of chiral compound/s from the following is _____.



Key : 2

Sol : Only 1and 2

57. At what pH, given half cell $MO_4^-(0.1M)|Mn^{2+}(0.001M)$ will have electrode potential of 1.282 V? _____(Nearest Integer)

Given $E^\circ_{MnO_4^-|Mn^{2+}} = 1.54\,V, \frac{2.303RT}{F} = 0.059V$

Key : 3

Answer:- $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$, $1.282 = 1.54 - \frac{0.059}{5}\log\frac{10^{-3}}{10^{-1}\left[H^+\right]^8}$, PH=3

58. Electrons in a cathode ray tube have been emitted with a velocity of $1000 m\ s^{-1}$. The number of following statements which is/are true about the emitted radiation is _____.
Given : $h = 6\times10^{-34}\ Js,\ m_e = 9\times10^{-31} kg.$

A) The deBroglie wavelength of the electron emitted is 666.67 nm.
B) The characteristic of electrons emitted depend upon the material of the electrodes of the cathode ray tube.
C) The cathode rays start from cathode and move toward anode.
D) The nature of the emitted electrons depends on the nature of the gas present in cathode ray tube.

Key : 2

Solution :- A and C are correct

59. At 25^oC, the enthalpy of the following processes are given:

$$H_2(g) + O_2(g) \rightarrow 2OH(g) \quad \Delta H^o = 78\ kJ\ mol^{-1}$$
$$H_2(g) + {}^{1/2}O_2(g) \rightarrow H_2O(g) \quad \Delta H^o = -2.42\ kJ\ mol^{1}$$
$$H_2(g) \rightarrow 2H(g) \quad \Delta H^o = 436\ kJ\ mol^{-1}$$
$${}^{1/2}O(g) \rightarrow O(g) \quad \Delta H^o = 249\ kJ\ mol^{-1}$$

What would be the value of X for the following reaction? _____
(Nearest integer)

$$H_2O(g) \rightarrow H(g) + OH(g) \quad \Delta H^o = X\ kJ\ mol^{-1}$$

Key : 499

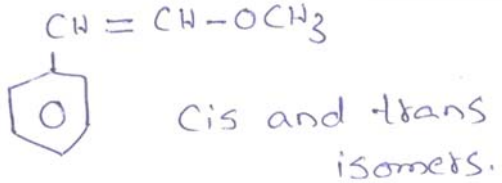
Solution :

$$H_2O \rightarrow H_2 + \frac{1}{2}O_2 \quad \Delta H^o = 242$$
$$\frac{1}{2}H_2 + \frac{1}{2}O_2 \rightarrow OH \quad \Delta H^o = 39$$
$$\frac{1}{2}H_2 \rightarrow H \quad \Delta H^o = 218$$
$$H_2O \rightarrow H + OH \quad \Delta H^o = 499$$

60. Number of isomeric compounds with molecular formula $C_9H_{10}O$ which (i) do not dissolve in NaOH (ii) do not dissolve in Hcl (iii) do not give orange precipitate with 2, 4 – DNP (iv) on hydrogenation give identical compound with molecular formula $C_9H_{12}O$ is _____.

Key : 2

Solution :



MATHEMATICS **Max Marks: 100**

(SINGLE CORRECT ANSWER TYPE)

This section contains 20 multiple choice questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

61. Let $f(x)=2x+\tan^{-1}x$ and $g(x)=\log_e\left(\sqrt{1+x^2}+x\right), x\in[0,3]$. Then

1) $\min f'(x)=1+\max g'(x)$

2) there exist $0<x_1<x_2<3$ such that $f(x)<g(x), \forall x\in(x_1,x_2)$

3) $\max f(x)>\max g(x)$

4) there exists $\hat{x}\in[0,3]$ such that $f'(\hat{x})<g'(\hat{x})$

Key: 3

SOL: $f'(x)=2+\frac{1}{1+x^2}$, $g'(x)=\frac{1}{\sqrt{1+x^2}}$

Both does not have critical values

$f(0)=0,\ f(3)=6+\tan^{-1}(3)$

$g(0)=0,\ g(3)=\log\left(3+\sqrt{10}\right)$

Let $h(x)=f(x)-g(x)$

$h'(x)>0\ \forall\ x\in(0,3)$

$\therefore h(x)$ is increasing function

62. Let R be a relation $\mathbb{R}$, given by

$R=\left\{(a,b):3a-3b+\sqrt{7}\ \text{ is an irrational number}\right\}$

Then R is

1) reflexive and symmetric but not transitive

2) reflexive and transitive but not symmetric

3) reflexive but neither symmetric nor transitive

4) an equivalence relation

Key: 3

SOL: Reflexive $3a-3a+\sqrt{7}=\sqrt{7}$ *is irrational*

$\therefore (a,a)\in R$

Not symmetric if $(a,b)\in R$ but $(b,a)\notin R$

$a=\frac{\sqrt{7}}{3}, b=7$

Not transitive

63. The shortest distance between the lines $\frac{x-5}{1}=\frac{y-2}{2}=\frac{z-4}{-3}$ & $\frac{x+3}{1}=\frac{y+5}{4}=\frac{z-1}{-5}$ is

1) $7\sqrt{3}$ 2) $6\sqrt{3}$ 3) $4\sqrt{3}$ 4) $5\sqrt{3}$

Key: 2

SOL: $\bar{a}=(5,2,4), \bar{b}=(1,2,-3), \bar{c}=(-3,-5,1), \bar{d}=(1,4,-5)$

Shortest distance $=\frac{\left|\left[\bar{c}-\bar{a}\ \bar{b}\ \bar{d}\right]\right|}{\left|\bar{b}\times\bar{d}\right|}=\frac{|-36|}{2\sqrt{3}}=6\sqrt{3}$

64. The sum to 10 terms of the series $\frac{1}{1+1^2+1^4}+\frac{2}{1+2^2+2^4}+\frac{3}{1+3^2+3^4}+\ldots\ldots$ is

1) $\frac{56}{111}$ 2) $\frac{58}{111}$ 3) $\frac{55}{111}$ 4) $\frac{59}{111}$

Key: 3

SOL: $\sum_{r=1}^{10}\frac{r}{1+r^2+r^4}=\frac{1}{2}\sum_{r=1}^{10}\left[\frac{1}{r^2-r+1}-\frac{1}{r^2+r+1}\right]=\frac{1}{2}\left(\frac{1}{1}-\frac{1}{111}\right)=\frac{55}{111}$

65. Let $S=\left\{x: x\in\mathbb{R}\ \text{and}\ \left(\sqrt{3}+\sqrt{2}\right)^{x^2-4}+\left(\sqrt{3}-\sqrt{2}\right)^{x^2-4}=10\right\}$. Then $n(S)$ is equal to

1) 2 2) 4 3) 0 4) 6

Key: 2

SOL: Let $\left(\sqrt{3}+\sqrt{2}\right)^{x^2-4}=t\Rightarrow t^2-10t+1=0$

$\Rightarrow t=5\pm2\sqrt{6}$

If $\left(\sqrt{3}+\sqrt{2}\right)^{x^2-4}=5+2\sqrt{6}=\left(\sqrt{3}+\sqrt{2}\right)^2$

$\Rightarrow x=\pm\sqrt{6}$

If $\left(\sqrt{3}+\sqrt{2}\right)^{x^2-4}=5-2\sqrt{6}=\left(\sqrt{3}+\sqrt{2}\right)^{-2}\quad\Rightarrow x=\pm\sqrt{2}$

66. The mean and variance of 5 observations are 5 and 8 respectively. If 3 observations are 1, 3, 5, then the sum of cubes of the remaining two observations is

1) 1216 2) 1456 3) 1072 4) 1792

Key: 3

SOL: Let the observations x and y $\frac{1+3+5+x+y}{5}=5 \Rightarrow x+y=16$

$\frac{\sum x_i^2}{5}-(\overline{x})^2=8 \Rightarrow x^2+y^2=130$

$\therefore x=7,\ y=9$

$x^3+y^3=1072$

67. Let S be the set of all solutions of the equation $\cos^{-1}(2x)-2\cos^{-1}\left(\sqrt{1-x^2}\right)=\pi, x\in\left[-\frac{1}{2},\frac{1}{2}\right]$.

Then $\sum_{x\in S}2\sin^{-1}\left(x^2-1\right)$ is equal to

1) 0 2) $\frac{-2\pi}{3}$ 3) $\pi-2\sin^{-1}\left(\frac{\sqrt{3}}{4}\right)$ 4) $\pi-\sin^{-1}\left(\frac{\sqrt{3}}{4}\right)$

Key: 2

SOL: $\cos^{-1}(2x)-2\cos^{-1}\left(\sqrt{1-x^2}\right)=\pi$

$\Rightarrow 2x=-\cos\left(2\cos^{-1}\sqrt{1-x^2}\right)$ $\Rightarrow x=\frac{1-\sqrt{3}}{2}$

$\sum_{x\in S}2\sin^{-1}\left(x^2-1\right)=\frac{-2\pi}{3}$

68. The value of $\frac{1}{1!50!}+\frac{1}{3!48!}+\frac{1}{5!46!}+.....+\frac{1}{49!2!}+\frac{1}{51!1!}$ is :

1) $\frac{2^{51}}{50!}$ 2) $\frac{2^{50}}{50!}$ 3) $\frac{2^{51}}{51!}$ 4) $\frac{2^{50}}{51!}$

Key: 4

SOL: $\frac{1}{(51)!}\left[\frac{(51)!}{1!50!}+\frac{(51)!}{3!48!}+.....+\frac{(51)!}{51!0!}\right]$

$\frac{1}{(51)!}\left[{}^{51}C_1+{}^{51}C_3+.....+{}^{51}C_{51}\right]$ $=\frac{1}{(51)!}\left[\frac{2^{51}}{2}\right]=\frac{2^{50}}{(51)!}$

69. $\lim\limits_{n\to\infty}\left[\frac{1}{1+n}+\frac{2}{2+n}+\frac{1}{3+n}+.....+\frac{1}{2n}\right]$ is equal to

1) $\log_e 2$ 2) $\log_e\left(\frac{2}{3}\right)$ 3) 0 4) $\log_e\left(\frac{3}{2}\right)$

Key: 1

SOL: $\lim\limits_{n\to\infty}\left[\frac{1}{1+n}+\frac{2}{2+n}+\frac{1}{3+n}+.....+\frac{1}{2n}\right]$

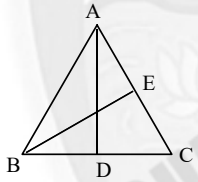
$=\lim\limits_{n\to\infty}\sum_{r=1}^{n}\left(\frac{1}{r+n}\right)$ $=\lim\limits_{n\to\infty}\sum_{r=1}^{n}\frac{1}{n}\left(\frac{1}{\frac{r}{n}+1}\right)$ $=\int_0^1\frac{dx}{x+1}=\log_e 2$

70. If the orthocentre of the triangle, whose vertices are (1,2), (2,3), and (3,1) is (α,β), then the quadratic equation whose roots are $\alpha+4\beta$ & $4\alpha+\beta$, is

1) $x^2-19x+90=0$ 2) $x^2-20x+99=0$ 3) $x^2-18x+80=0$ 4) $x^2-22x+120=0$

Key: 2

SOL:



Equation of altitude $AD \Rightarrow x-3y+3=0$

Equation of altitude $BE \Rightarrow 2x-y-1=0$

Orthocentre of the triangle $=\left(\frac{5}{3},\frac{7}{3}\right)=(\alpha,\beta)$

Quadratic equation whose roots are $\alpha+4\beta$ & $4\alpha+\beta$, is $x^2-20x+99=0$

71. Let the image of the point $P(2,-1,3)$ in the plane $x+2y-z=0$ be Q. Then the distance of the plane $3x+2y+z+29=0$ from the point Q is

1) $2\sqrt{14}$ 2) $\frac{22\sqrt{2}}{7}$ 3) $3\sqrt{14}$ 4) $\frac{24\sqrt{2}}{7}$

Key: 3

SOL: Foot of $P(2,-1,3)$ in the plane $x+2y-z=0$ is $\left(\frac{5}{2},0,\frac{5}{2}\right)$

Image of $P(2,-1,3)$ in the plane $x+2y-z=0$ is $(3,1,2)$

Distance of the plane $3x+2y+z+29=0$ from the point Q is $=\left|\frac{9+2+2+29}{\sqrt{14}}\right|=3\sqrt{14}$

72. Let S denote the set of all real values of λ such that the system of equations $\lambda x+y+z=1,\ x+\lambda y+z=1,\ x+y+\lambda z=1$ is inconsistent, then $\sum_{\lambda\in S}\left(|\lambda|^2+|\lambda|\right)$ is equal to

1) 12 2) 4 3) 2 4) 6

Key: 4

SOL: $\begin{vmatrix}\lambda & 1 & 1\\ 1 & \lambda & 1\\ 1 & 1 & \lambda\end{vmatrix}=0\Rightarrow\lambda^3-3\lambda+2=0$

$\Rightarrow\lambda=-2,\ \lambda=1$

If $\lambda=1$ the system has infinitely many solutions

If $\lambda=-2$ the system is inconsistent

$\sum_{\lambda\in S}\left(|\lambda|^2+|\lambda|\right)=4+2=6$

73. Let $f(x)=\begin{vmatrix}1+\sin^2 x & \cos^2 x & \sin 2x\\ \sin^2 x & 1+\sin^2 x & \sin 2x\\ \sin^2 x & \cos^2 x & 1+\sin^2 x\end{vmatrix}$, $x\in\left[\frac{\pi}{6},\frac{\pi}{3}\right]$. If α and β respectively are the maximum and the minimum values of f, then

1) $\beta^2+2\sqrt{\alpha}=\frac{19}{4}$ 2) $\alpha^2+\beta^2=\frac{9}{2}$ 3) $\alpha^2-\beta^2=4\sqrt{3}$ 4) $\beta^2-2\sqrt{\alpha}=\frac{19}{4}$

Key: 4

SOL: Performing row wise operations $(R_1-R_3)\&(R_2-R_3)$ and expand

$f(x)=2+\sin 2x$ $f'(x)=2\cos 2x=0\Rightarrow x=\frac{\pi}{4}$ $f\left(\pi/6\right)=2+\frac{\sqrt{3}}{2}=\beta$

$f\left(\pi/3\right)=2+\frac{\sqrt{3}}{2}$ $f\left(\pi/4\right)=3=\alpha$ $\beta^2-2\sqrt{\alpha}=\frac{19}{4}$

74. The combined equation of the two lines $ax+by+c=0$ and $a'x+b'y+c'=0$ can be written as $(ax+by+c)(a'x+b'y+c')=0$. The equation of the angle bisectors of the lines represented by the equation $2x^2+xy-3y^2=0$ is

1) $3x^2+5xy+2y^2=0$ 2) $x^2-y^2-10xy=0$

3) $3x^2+xy-2y^2=0$ 4) $x^2-y^2+10xy=0$

Key: 2

SOL: Pair of angular bisector equation $\frac{x^2-y^2}{2-(-3)}=\frac{xy}{\frac{1}{2}},\Rightarrow x^2-y^2-10xy=0$

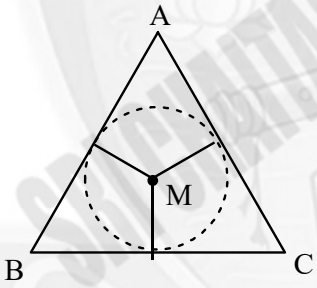
75. For a triangle ABC, the value of $\cos 2A+\cos 2B+\cos 2C$ is least. If its in radius is 3 and in centre is M, then which of the following is NOT correct?

1) area of ΔABC is $\frac{27\sqrt{3}}{2}$ 2) $\sin 2A+\sin 2B+\sin 2C=\sin A+\sin B+\sin C$

3) perimeter of ΔABC is $18\sqrt{3}$ 4) $\overrightarrow{MA}.\overrightarrow{MB}=-18$

Key: 1

SOL:



Let $K=\cos 2A+\cos 2B+\cos 2C$, is minimum if A = B = C = $60°$ i.e $K=-\frac{3}{2}$

ΔABC is equilateral triangle .

In radius $r=3\ \Rightarrow side=2\sqrt{3}r=6\sqrt{3}$

$Area=\frac{\sqrt{3}}{4}(side)^2=27\sqrt{3}$

Perimeter $=3a=18\sqrt{3}$

$\overline{MA}.\overline{MB}=6.6\left(-\frac{1}{2}\right)=-18$

$\sin 2A+\sin 2B+\sin 2C=\sin A+\sin B+\sin C$

76. If $y = y(x)$ is the solution curve of the differential equation

$\frac{dy}{dx} + y\tan x = x\sec x, 0 \le x \le \frac{\pi}{3}, y(0) = 1$, then $y\left(\frac{\pi}{6}\right)$ is equal to

1) $\frac{\pi}{12} - \frac{\sqrt{3}}{2}\log_e\left(\frac{2}{e\sqrt{3}}\right)$ 2) $\frac{\pi}{12} + \frac{\sqrt{3}}{2}\log_e\left(\frac{2}{e\sqrt{3}}\right)$

3) $\frac{\pi}{12} + \frac{\sqrt{3}}{2}\log_e\left(\frac{2\sqrt{3}}{e}\right)$ 4) $\frac{\pi}{12} - \frac{\sqrt{3}}{2}\log_e\left(\frac{2\sqrt{3}}{e}\right)$

Key: 1

SOL: Integrating factor = $\sec x$

$y(\sec x) = x\tan x - In(\sec x) + c$

$y(o) = 1 \Rightarrow c = 1$

$y(\sec x) = x\tan x - in(\sec x) + 1$

$x = \frac{\pi}{6}, y = \frac{\pi}{12} + \frac{\sqrt{3}}{2}In\left(\frac{\sqrt{3}}{2}\right) + \frac{\sqrt{3}}{2}In_e^e$

$y = \frac{\pi}{12} + \frac{\sqrt{3}}{2}In\left(\frac{\sqrt{3}e}{2}\right) n = \frac{\pi}{12} - \frac{\sqrt{3}}{2}In\left(\frac{2}{13e}\right)$

77. If the center and radius of the circle $\left|\frac{z-2}{z-3}\right| = 2$ are respectively (α, β) and γ, then

$3(\alpha + \beta + \gamma)$ is equal to

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

Key: 1

SOL: $|z-2|^2 = 4|z-3|^2$

$(x-2)^2 + y^2 = 4(x-3)^2 + 4y^2$

$\left(x - \frac{10}{3}\right)^2 + y^2 = \left(\frac{2}{3}\right)^2$

$3(\alpha + \beta + \gamma) = 1\bar{2}$

78. In a binomial distribution $B(n, p)$, the sum and the product of the mean and the variance are 5 and 6 respectively, then $6(n + p - q)$ is equal to

1) 50 2) 53 3) 52 4) 51

Key: 3

SOL: $np+npq=5,\ \ np.npq=6, p+q=1$

on solving $(3q-2)(2q-3)=0$, $q=\frac{3}{2}$ *rejected* $q=\frac{2}{3}$ *accepted*, $p=\frac{1}{3}, n=9$

$6(n+p-q)=52.$

79. The area enclosed by the closed curve C given by the differential equation

$\frac{dy}{dx}+\frac{x+a}{y-2}=0, y(1)=0$ is 4π.

Let P and Q be the points of intersection of the curve C and the y-axis. If normals at P and Q on the curve C intersect x-axis at points R and S respectively, then the length of the line segment RS is

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

Key: 1

SOL: $(y-2)dy+(x+a)dx=0$

$\frac{y^2}{2}-2y+\frac{x^2}{2}+ax+c=0;\ y(1)=0\Rightarrow c=-1-2a.$

$(x+a)^2+(y-2)^2=(a+11^2+4);\ r=2\Rightarrow a=-1$

$C:(x-11^2+(y-2)^2=2^2$

$y-axis\ x=o;\ \ P,Q=(0,2\pm\sqrt{3})$

$Normal\ P;\ y-2=\frac{2+\sqrt{3}-2}{-1}(x-1),\ Normal\ Q;\ y-2=\frac{2-\sqrt{3}-2}{-1}(x-1)$

$y-2=-\sqrt{3}(x-1)\Rightarrow x-axis; y=0:1+\frac{29}{\sqrt{3}}$

$y-2=\sqrt{3}(x-1)$ $y=0:x=1-\frac{2}{\sqrt{3}}$ $Rs=\frac{4}{\sqrt{3}}=\frac{4\sqrt{3}}{3}$

80. The negation of the expression $q\vee((\sim q)\wedge p)$ is equivalent to

1) $p\wedge(\sim q)$ 2) $(\sim p)\wedge(\sim q)$ 3) $(\sim p)\vee(\sim q)$ 4) $(\sim p)\vee q$

Key: 2

SOL: $\sim(q\Lambda\sim(\sim q\Lambda p))$

$\sim q\Lambda(qV\sim p)$

$(\sim q\Lambda q)V(\sim q\Lambda\sim p)$

$CV\sim(pVq)$

$\sim p\Lambda\sim q$

(NUMERICAL VALUE TYPE)

Section-II contains 10 **Numerical Value Type** questions. Attempt any 5 questions only. If more than 5 questions attempted, First 5 Attempted questions will be considered. The Answer should be within **0 to 9999.** If the Answer is in **Decimal** then round off to the **nearest Integer** value (Example i,e. If answer is above 10 and less than 10.5 round off is 10 and if answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if **not attempt** and **-1** in all other cases.

81. If $\int_0^1\left(x^{21}+x^{14}+x^7\right)\left(2x^{14}+3x^7+6\right)^{1/7}dx=\frac{1}{l}(11)^{m/n}$ where $l,m,n\in\mathbb{N},m$ and n are coprime then $l+m+n$ is equal to _____

Key: 63

SOL $\int_0^1\left(x^{20}+x^{13}+x^6\right)\left(2x^{14}+3x^{14}+6x^7\right)^{\frac{1}{7}}dx=\frac{t^{\frac{8}{7}}}{48}\int_{x=0}^{x=1}=\frac{(11)^{\frac{8}{7}}}{48}$

$l=48,m=8,n=7;l+m+n=63$

82. Let $\vec{\upsilon}=\alpha\hat{i}+2\hat{j}-3\hat{k},\vec{w}=2\alpha\hat{i}+\hat{j}-\hat{k}$ and $\vec{u}$ be a vector such that $|\vec{u}|=\alpha>0$. If the minimum value of the scalar triple product $|\vec{u}\ \vec{\upsilon}\ \vec{w}|$ is $-\alpha\sqrt{3401}$, and $|\vec{u}.\hat{i}|^2=\frac{m}{n}$ where m and n are coprime natural numbers, then m+n is equal to _____

Key: 9

SOL: $[uvw]=\begin{vmatrix}\frac{\alpha}{3} & \frac{\alpha}{3} & \frac{\alpha}{3}\\ \alpha & 2 & -3\\ 2\alpha & 1 & -1\end{vmatrix}\Rightarrow\alpha=\frac{1}{8}$

83. The number of 3-digit numbers, that are divisible by either 2 or 3 but not divisible by 7, is ____

Key: 514

SOL: $n(2)=450,\ n(3)=300,\ n(7)=128,\ n(2\cap 7)=64,\ n(3\cap 7)=43,\ n(2\cap 3)=150,\ n(2\cap 3\cap 7)=21$

$450+300-150-(64+43-21)$

$=514$

84. Let A be the area bounded by the curve $y=x|x-3|$, the x-axis the ordinates x= -1 and x = 2. Then 12 A equal to _____

Key: 62

SOL: $A=0-\int_{-1}^{0}\left(3x-x^2\right)dx+\int_{0}^{2}\left(3x-x^2\right)dx=\frac{11}{6}+\frac{10}{3}=\frac{31}{6}$

$A=62$

85. The number of words, with or without meaning, that can be formed using all the letters of the word ASSASSINATION so that the vowels occur together, is _____

Key: 50400

SOL: vowels: A, A, A, I, I, O

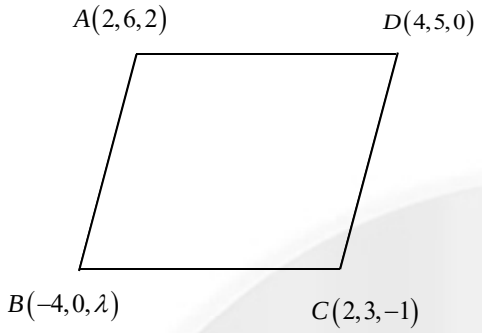
Consonants: S, S, S, S, N, N, T

$\frac{8!}{4!2!}\times\frac{6!}{3!2!}=50400$

86. $A(2,6,2), B(-4,0,\lambda), C(2,3,-1)$ and $D(4,5,0), |\lambda|\le 5$ are the vertices of a quadrilateral ABCD. If its area is 18 square units, then $5-6\lambda$ is equal to _____

Key: 11

SOL:



$$\frac{1}{2}\left(\overline{AB}\times\overline{AD}+\overline{CD}\times\overline{CB}\right)=36$$

$$\begin{vmatrix} i & j & k \\ -6 & -6 & \lambda 2 \\ 2 & -1 & -2 \end{vmatrix}+\begin{vmatrix} i & j & k \\ 2 & 2 & 1 \\ -6 & -3 & \lambda+1 \end{vmatrix}$$

$$\left|(15+3\lambda)\hat{i}-24\hat{j}+24\hat{k}\right|=36 \qquad \lambda=-1$$

87. If $f(x)=x^2+g'(1)x+g''(2)$ and $g(x)=f(1)x^2+xf'(x)+f''(x)$, then the value of $f(4)-g(4)$ is equal to _____

Key: 14

SOL: $f(x)=x^2+ax+b;\ f''(x)=2;\ g''(x)=2f(1);\ g(x)=(3+a+b)x^2+ax+2$

$a+b=-3$

$2a+b=-6$

$f(x)=x^2-3x;\ g(x)=-3x+2\Rightarrow g(4)=-10,\ f(4)=4$

88. Let $f:\mathbb{R}\to\mathbb{R}$ be a differentiable function such that $f'(x)+f(x)=\int_0^2 f(t)dt$. If $f(0)=e^{-2}$, then $2f(0)-f(2)$ is equal to _____

Key: 1

SOL: $\frac{dy}{dx}+y=K \qquad y\cdot e^x=Ke^x+C$

$f(0)=e^{-2}\Rightarrow C=e^{-2}-K \qquad y=K+\left(e^{-2}-K\right)e^{-x}$

$$K=\int_0^2\left(K+\left(e^{-2}-K\right)e^{-x}\right)dx\Rightarrow K=e^{-2}-1$$

$y=\left(e^{-2}-1\right)+e^{-x}=f(x)$

$f(2)-2f(0)=-1$

89. Let $a_1 = 8, a_2, a_3, ..., a_n$ be an A.P. If the sum of its first four terms is 50 and the sum of its last four terms is 170, then the product of its middle two terms is_____.

Key: 754

SOL: $4a + 6d = 50 \Rightarrow d = 3$

$4a + (4n - 10) \cdot 3 = 170 \Rightarrow n = 14$

$a_7 = 26,\ a_8 = 29$

$a_7 a_8 = 754$

90. The remainder, when $19^{200} + 23^{200}$ is divided by 49, is_____

Key: 29

SOL: $(21-2)^{200} + (21+2)^{200} = 2\left[{}^{200}C_0 (21)^{200} + {}^{200}C_0 (21)^{200} + ... + {}^{200}C_{198} (21)^{198} + (2)^{200}\right]$

$= 49K_1 + 2^{201}$

$2^{201} = 8^{67} = (1+7)^{67} = 49K_2 + 470 = 49K_2 + 49 \times 9 + 29$