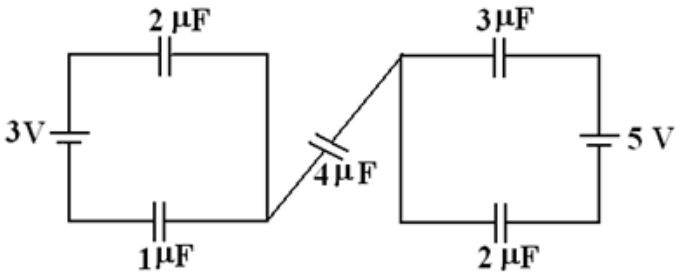
PART-1 : PHYSICS

SECTION-I

1) Which of the following statements is incorrect?

(A) Field obtained by the Superposition of two conservative fields is always conservative.
(B) Field obtained by the Superposition of two non conservative fields is always non-conservative
(C) Field obtained by the Superposition of two non-conservative fields can be non-conservative field
(D) Field obtained by the Superposition of a conservative & non-conservative field will always be non-conservative field

2) All the capacitors were uncharged before they are connected in circuit. Now the charge on



4μF capacitor is

(A) Zero
(B) $4\mu C$
(C) $8\mu C$
(D) $12\mu C$

3) **ASSERTION:** Electric current is a vector quantity
REASON : It has both magnitude & direction

(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) Assertion is true but Reason is false
(D) Assertion is false but Reason is true

4) When two identical voltmeters are connected in series to an emf source the readings of each of voltmeter is 6 V. When both of the Voltmeters are connected in parallel to the same emf source their reading is 10 V. Find emf (in Volt).

(A) 8
(B) $\frac{90}{7}$
(C) 12

(D) 30

5) A body of mass m rises to a height h = R/10 from the surface of earth, where R is the radius of earth. If g is the acceleration due to gravity at the surface of earth the increase in potential energy is

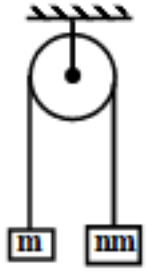
(A) (1/11) mgh

(B) (10/11) mgh

(C) (11/12) mgh

(D) mgh

6) Two blocks of masses m and nm are connected by a massless string passing over a frictionless pulley. The value of n for which both the blocks moves with an acceleration of g/6 is



(A) 5/7

(B) 7/5

(C) Both (A) and (B)

(D) None

7) Two steel wires having same length are suspended from a ceiling under the same load. If the ratio of their energy stored per unit volume u_1/u_2 is 1 : 9, the ratio of their diameters d_1/d_2 is

(A) $1 : \sqrt{3}$

(B) 3 : 1

(C) $\sqrt{3} : 1$

(D) 1 : 3

8) Force acting on a particle moving in a straight line varies with the velocity of the particle as $F = \frac{\alpha}{vt}$ where α is constant. The work done by this force from time t_1 to t_2 is :-

(A) $\alpha \ln \frac{t_2}{t_1}$

(B) $\alpha \ln \frac{t_1}{t_2}$

(C) $2\alpha (t_2 - t_1)$

(D) $\alpha^2 (t_2 - t_1)$

9) List-I gives same incomplete nuclear reactions. Match them with the reaction in List-II.

	List-I		**List-II**

P	$^{237}Np \longrightarrow {}^{233}Pa + \_\_\_\_$	1	β^+ decay
Q	$^{228}Ra \longrightarrow \_\_ + \_\_ + \bar{\nu}$ (antineutrino)	2	β^- decay
R	$^{41}Ca \longrightarrow \_\_ + \_\_ + \nu$ (neutrino)	3	α decay
S	$^{197}_{80}Hg^* \longrightarrow {}^{197}_{80}Hg + \_\_$	4	γ decay

(A) P → 4; Q → 2; R → 1; S → 3

(B) P → 3; Q → 2; R → 1; S → 4

(C) P → 3; Q → 1; R → 2; S → 4

(D) P → 4; Q → 1; R → 2; S → 3

10) A rod of length □ and cross-sectional area A has a variable conductivity given by $K = \alpha + \beta T$, where α, β are a positive constants and T is temperature (in Kelvin) of the isothermal surface. Two ends of the rod are maintained at temperatures T_1 and T_2 ($T_1 > T_2$). Heat current flowing through the rod will be

(A) $\frac{A(T_2-T_1)}{\ell}\left[\beta + \frac{\alpha}{2}(T_2+T_1)\right]$

(B) $\frac{A(T_2-T_1)}{\ell}\left[\beta - \frac{\alpha}{2}(T_2+T_1)\right]$

(C) $\frac{A(T_2-T_1)}{\ell}\left[\alpha - \frac{\beta}{2}(T_2+T_1)\right]$

(D) $\frac{A(T_2-T_1)}{\ell}\left[\alpha + \frac{\beta}{2}(T_2+T_1)\right]$

11) Which of the following phenomenon confirms the transverse nature of light?

(A) Interference

(B) Diffraction

(C) Polarization

(D) Scattering

12) A cubical room of side 5m has a uniform magnetic field B. Total magnetic energy in the room will be.

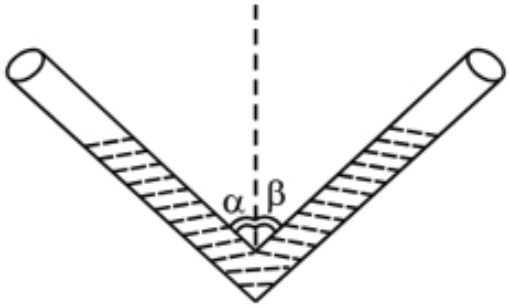
(A) $\frac{25B^2}{2\mu_0}$

(B) $\frac{125B^2}{2\mu_0}$

(C) $\frac{B^2}{50\mu_0}$

(D) $\frac{B^2}{250\mu_0}$

13) If the liquid is pushed & released, the time period of oscillations will be (length of liquid column = □) (assume the cross sectional area of both sides of the tube to be same)



(A) $2\pi\sqrt{\frac{\ell}{g(\sin\alpha-\sin\beta)}}$

(B) $2\pi\sqrt{\frac{\ell}{g(\sin\alpha+\sin\beta)}}$

(C) $2\pi\sqrt{\frac{\ell}{g(\cos\alpha+\cos\beta)}}$

(D) $2\pi\sqrt{\frac{\ell}{g(\cos\alpha-\cos\beta)}}$

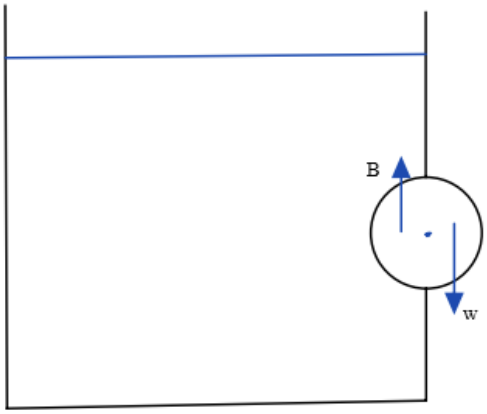
14) A rod of length L has non-uniform linear mass density which varies with distance x from left end of the rod as $\rho(x) = a + b\left(\frac{X}{L}\right)^2$, where a and b are constants and $0 \le x \le L$. The distance of the center of mass of the rod from its left end is :-

(A) $\frac{3}{2}\left(\frac{a+b}{2a+b}\right)L$

(B) $\frac{4}{3}\left(\frac{a+b}{2a+3b}\right)L$

(C) $\frac{3}{4}\left(\frac{2a+b}{3a+b}\right)L$

(D) $\frac{3}{2}\left(\frac{2a+b}{3a+b}\right)L$

15) 

One wall of a large container has a rectangular opening.

A uniform solid cylinder of density less than that of water is used to plug that rectangular opening as shown. The cylinder is free to rotate about its horizontal fixed axis. The cylinder is kept at rest till the container is filled with water above the top of cylinder as shown and then it is released.
Statement-1 : Just after the cylinder is released it will gain angular acceleration
Statement-2 : The cylinder will acquire zero steady state kinetic energy.

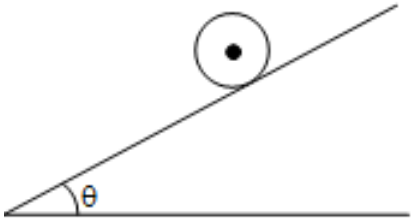
(A) Statement 1 is true, statement -2 is true and statement-2 is correct explanation for statement -1

(B) Statement 1 is true, statement -2 is true and statement-2 is NOT the correct explanation for statement -1

(C) Statement 1 is true, statement -2 is false

(D) Statement 1 is false, statement -2 is true

16) A uniform disc of mass m and radius R is rolling without slipping up a rough inclined plane which makes an angle 30° with the horizontal. If the coefficient of static and kinetic friction are each equal to μ and the only force acting on the disc are gravitational and frictional force then find the direction and magnitude of the frictional force acting on it.



(A) $\frac{mg}{6}$ down the incline

(B) $\frac{mg}{6}$ up the incline

(C) $\frac{mg}{3}$ down the incline

(D) $\frac{mg}{3}$ up the incline

17) A stone projected vertically upwards reaches up to a maximum height h. Assume the potential energy of stone at the point of projection to be zero. The ratio of its Kinetic Energy to its Potential energy at a height $\frac{3}{5}$ h, will be.

(A) 1 : 3

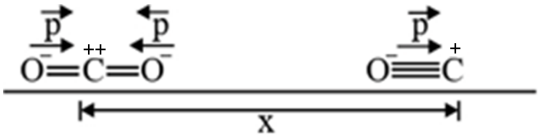
(B) 3 : 1

(C) 2 : 3

(D) 3 : 2

18) Carbon dioxide and Carbon monoxide molecules are placed at origin & at a large distance along x-axis respectively as shown. Carbon monoxide can be modelled as a dipole placed along x-axis & Carbon dioxide can be modelled as quadrupole (combination of two dipoles in opposite direction) as shown in diagram. Which of the following statement regarding electrostatic force F between Carbon

dioxide and Carbon monoxide is most appropriate?



(A) $F \propto \frac{1}{x^4}$

(B) F = 0

(C) $F \propto \frac{1}{x^5}$

(D) force F is attractive in them.

19) When a metallic surface is illuminated with monochromatic light of wavelength λ, the stopping potential is 5 V_0. When the same surface is illuminated with light of wavelength 3λ, the stopping potential is V_0. Then the work function of the metallic surface is :

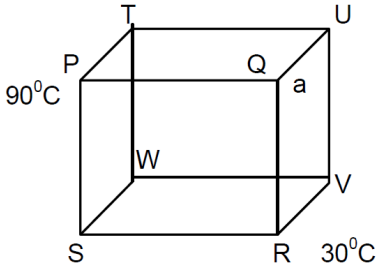
(A) $\frac{hc}{6\lambda}$

(B) $\frac{hc}{5\lambda}$

(C) $\frac{hc}{4\lambda}$

(D) $\frac{2hc}{4\lambda}$

20) 12 identical rods made of same material are arranged in the form of a cube. The temperature of 'P' and 'R' are maintained at 90° C and 30° C respectively. Then the temperature of point 'V', when steady state is reached is :-



(A) 65°C

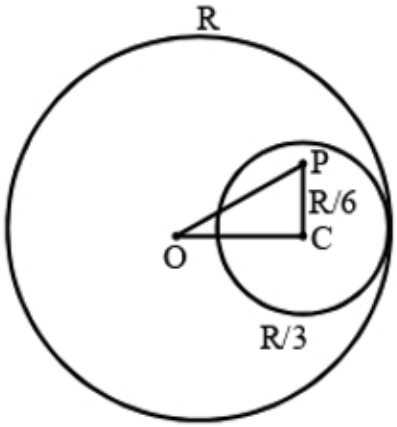
(B) 60°C

(C) 20°C

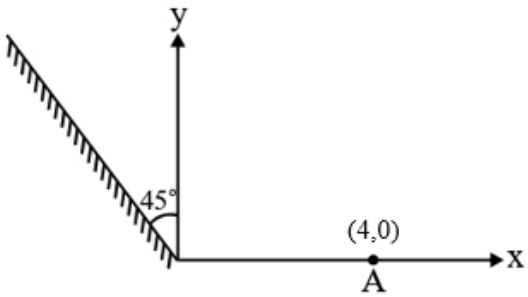
(D) 50°C

SECTION-II

1) A solid uniformly charged non-conducting sphere of radius R has a spherical cavity of radius $\frac{R}{3}$ as shown. The ratio of magnitudes of electric field at center of Cavity and that at a distance $\frac{R}{6}$ from



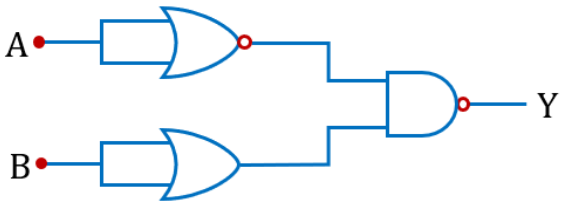
center of Cavity is

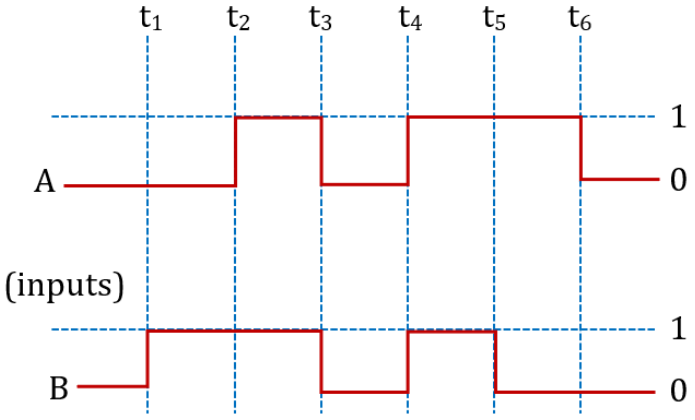


2) What will be magnitude of y - coordinate of image of point A?

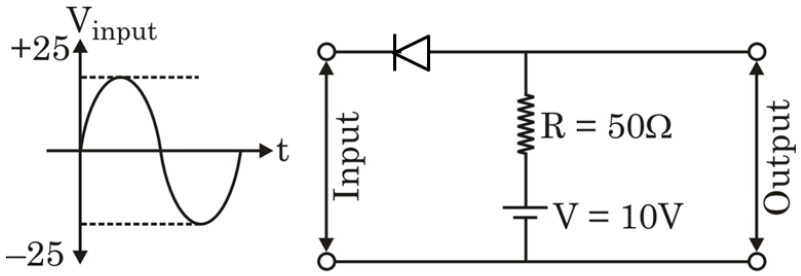
3) A stone is projected horizontally at a speed of 20 m/s from the top of a high tower. Simultaneously another stone is released from the same point. Find the distance in meters between stones after 1.4 seconds

4) For the following circuit and given inputs A and B, find output between t_5 to t_6.





5) An ideal diode is connected in a circuit with resistance R = 50Ω and V = 10 volt as shown in figure, maximum value of output voltage (in V) in the positive cycle will be :



PART-2 : CHEMISTRY

SECTION-I

1) 1 mole of borax reacts with how many mole of H_2SO_4 ?

(A) 1
(B) 2
(C) 4
(D) Reaction does not take place

2) In which of the following C-H bond has the highest 's' character ?

(A) acetylene
(B) ethylene
(C) methane
(D) Benzene

3) **Assertion :** The complex $[CoCl_2(en)_2]^+$ has an octahedral geometry
Reason : The complex has noble gas E.A.N

(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
(C) Assertion is true but Reason is false.
(D) Assertion is false but Reason is true.

4) The average value of C–C bond order in graphite is

(A) 1
(B) 3/2
(C) 3/4
(D) 4/3

5) Which of the following specie has the bond order of 0.5

(A) C_2^+

(B) B_2^+

(C) N_2^+

(D) O_2^+

6) Which of the following compound is formed in borax bead test ?

(A) Orthoborate

(B) Metaborate

(C) Double oxide

(D) Tetraborate

7) Weight ratio of Fe : C in $Fe_2[Fe(CN)_6]$ is : [Fe = 56]

(A) 3/7

(B) 7/5

(C) 7/3

(D) 5/7

8) The degree of dissociation of HI at a particular temperature is 0.8. The volume of 2M hypo solution required to react completely with the iodine present in an equilibrium mixture of reaction, which is started by 2 mole each of H_2 and I_2 in a vessel of two litre capacity, is

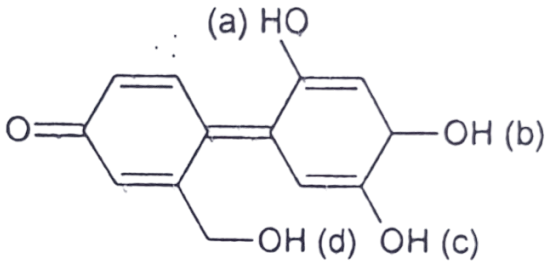
(A) 0.4 litre

(B) 0.8 litre

(C) 1.6 litre

(D) 3.2 litre

9) Most acidic hydrogen among the following is :



(A) a

(B) b

(C) c

(D) d

10)

The moles of H^+ from H_2O alone in a $1l,\ \sqrt{5} \times 10^{-7}$ M HCl solution at 25°C is $(\sqrt{5} = 2.23)$

(A) 10^{-7}

(B) 6.85×10^{-8}

(C) 3.85×10^{-8}

(D) 10^{-8}

11) 5 moles of an ideal gas undergoes isothermal expansion from 4.0 bar to 1.0 bar, at 27°C. The minimum amount of heat absorbed by the gas is (ln2 = 0.70)

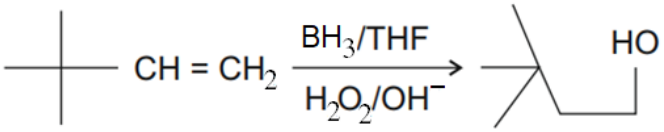
(A) 2250 cal

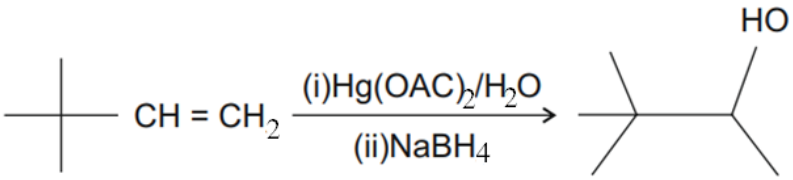
(B) 4200 cal

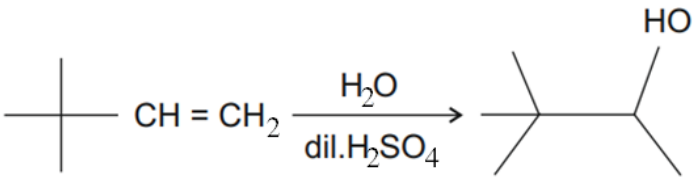
(C) 4500 cal

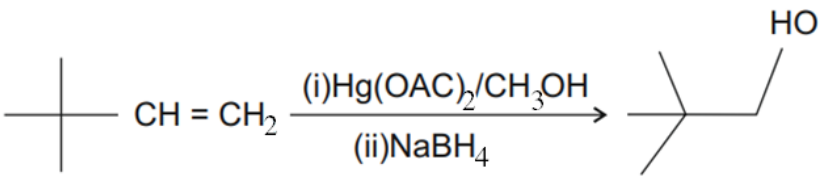
(D) 450 cal

12) Alkenes form alcohols by hydration reactions in which water is added in presence of dil. H_2SO_4. Addition of water follows Markownikoff's rule. For unsymmetrical alkenes, more than one product is formed. The major product is decided by stability of the intermediate carbocation which is formed by addition of H^+ . Alcohol formation is also done by treating alkenes with other reagents.
Answer the following question on the basis of above writer up.

(I) 

(II) 

(III) 

(IV) 

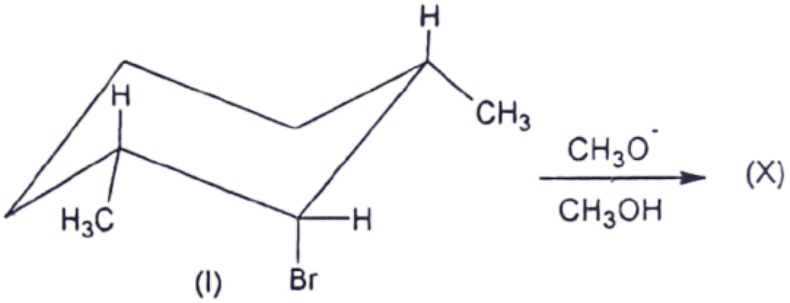
In which reactions, the product formed is correctly given?

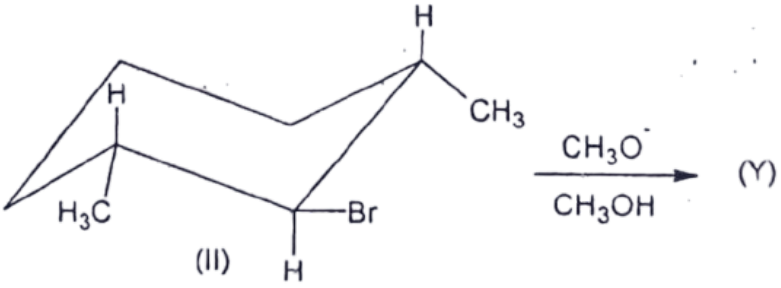
(A) I, II, III

(B) I, II

(C) I, III, IV

(D) III, IV





13)
Which of the following statement is NOT correct

(A) Compound (I) readily undergoes elimination than compound (II)

(B) Compound (II) readily undergoes elimination than compound (I)

(C) Elimination in (I) and (II) easily takes place when eliminating groups are anti periplanar to each other

(D) Product (X) forms via E_2 elimination

14) The values of conductance, specific conductance, equivalent conductance and molar conductance of a definite volume of an electrolyte at a particular temperature are A mho, B S cm^{-1}, C S cm^{-2} $equiv^{-1}$ and D S $cm^{-2}mole^{-1}$ respectively. Which of the following will decrease on dilution?

(A) D

(B) B

(C) C

(D) Only C and D

15) Match the isoelectric points with amino acids:

Amino acids	Isoelectric points
(W) H_2N - CH_2COOH	(I) 9.5
(X) HOOC - $CH_2CH_2CH(NH_2)COOH$	(II) 6.0
(Y) $H_2N(CH_2)_4CH(NH_2)COOH$	(III) 3.1
(Z) $H_2NCOCH_2CH(NH_2)COOH$	(IV) 5.6

(A) W - II, X - III, Y - I, Z - IV

(B) W - III, X - I, Y - IV, Z - II

(C) W - III, X - I, Y - II, Z - IV

(D) W - II, X - I, Y - III, Z - IV

16) The solubility (expressed as mole fraction of gas dissolved in final solution) of any gas in any liquid increases by :

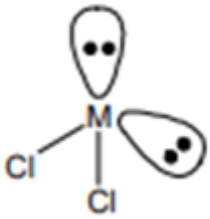
(A) Increase in temperature at constant pressure

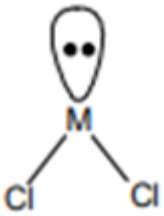
(B) Increase in amount of solvent at same temperature and pressure

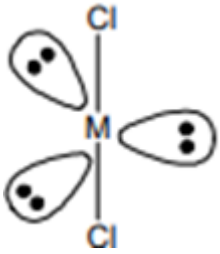
(C) Increase in pressure at constant temperature

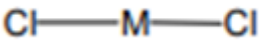
(D) Increase in moles of gas above solution keeping pressure and temperature constant.

17) If the atomic number of M is 50. The shape of gaseous MCl_2 is

(A) 

(B) 

(C) 

(D) 

18) When N_2 goes to N_2^+, the $N-N$ bond distance ..... and when O_2 goes to O_2^+ the $O-O$ bond distance....

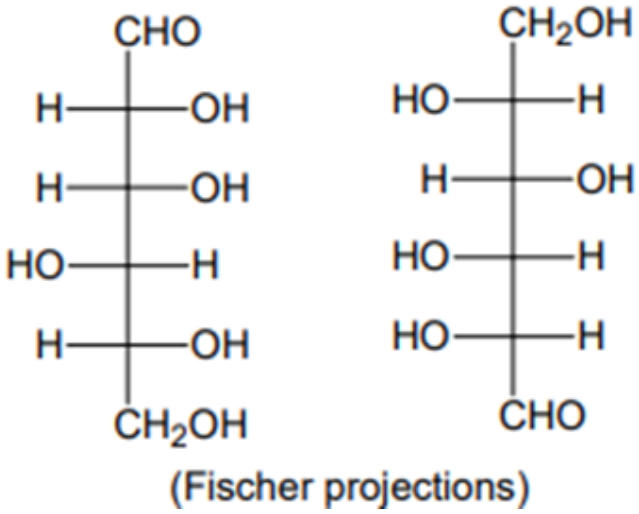
(A) increases, decreases

(B) decreases, increases

(C) increase in both case

(D) decrease in both case

19) What is the relationship between the molecules in the following pairs?



(Fischer projections)

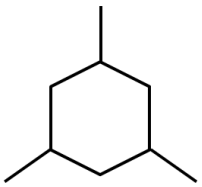
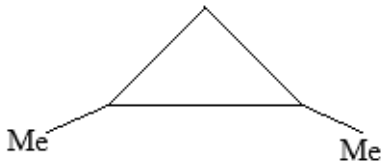
(A) enantiomers

(B) diastereomers

(C) identical

(D) structural isomers

20)

Column-I		Column-II	
(A)	$CH_3 - CH = CH - CH = N - OH$	(P)	2
(B)		(Q)	4
(C)		(R)	3
(D)	$CH_3 - CH = CH - CH = CH - CH(CH_3) - Ph$	(S)	8

Match stereo isomers for above compounds

(A) A $\rightarrow$ Q, B $\rightarrow$ P, C $\rightarrow$ R, D $\rightarrow$ S

(B) A $\rightarrow$ S, B $\rightarrow$ P, C $\rightarrow$ R, D $\rightarrow$ Q

(C) A $\rightarrow$ Q, B $\rightarrow$ R, C $\rightarrow$ P, D $\rightarrow$ S

(D) A $\rightarrow$ P, B $\rightarrow$ P, C $\rightarrow$ Q, D $\rightarrow$ S

SECTION-II

1) The total number of diprotic acids among the following is

H_3PO_4 H_2SO_4 H_3PO_3 H_2CO_3 $H_2S_2O_7$

H_3BO_3 H_3PO_2 H_2CrO_4 H_2SO_3

2) For a second order reaction, containing single reactant : A → B, it is given that :
$T_{75\%} = X \cdot t_{50\%}$
Find the value of X

3) The molecular mass of an aliphatic ketone is 86. It forms oxime with NH_2OH. The oxime is reduced to an resolved amine. How many structural isomer (s) of the ketone form (s) resolved amine?

4) $CH_2=C=C=C=CH_2$
How many maximum number atoms of the above compounds are present in one plane?

5) Total number of stereoisomerism present in complex compound [Cr(gly)(NH_3)(H_2O)C□Br].

PART-3 : MATHEMATICS

SECTION-I

1) Let $f(x) = \int \frac{x^2 dx}{(1+x^2)\left(1+\sqrt{1+x^2}\right)}$ and f (0) = 0. Then f (1) is equal to

(A) $\ln\left(1+\sqrt{2}\right)$

(B) $\ln\left(1+\sqrt{2}\right) - \frac{\pi}{4}$

(C) $\ln\left(1+\sqrt{2}\right) + \frac{\pi}{4}$

(D) None of these

2) A is 3 x 3 matrix whose entries belong to the set $\{-1, 0, -1\}$. Then the probability that A is neither symmetric nor skew-symmetric is

(A) $\frac{3^9 - 3^6 - 3^3 + 1}{3^9}$

(B) $\frac{3^9 - 3^6 + 3^3 + 1}{3^9}$

(C) $\frac{3^9 - 3^6 - 3^3}{3^9}$

(D) $\frac{3^9 - 3^6 + 3^3}{3^9}$

3) Consider the function $f(x) = \sin^{-1}\left(\frac{2x}{1+x^2}\right) + 2\tan^{-1}x$

Assertion (A) : $f(10) = \pi$
Reason (R) : $f(x) = \pi \; \forall \; x \geqslant 1$

(A) **A** is true, **R** is true and **R** is correct explanation for **A**

(B) **A** is true, **R** is true and **R** is NOT the correct explanation for **A**

(C) **A** is true, **R** is false

(D) **A** is false, **R** is true

4) If z is a complex number which satisfies the equation $|z-5-7i| = 9$, then the maximum value of $|z-2-3i|$ is equal to

(A) 4

(B) 9

(C) 12

(D) 14

5) A pair of mutually perpendicular lines is drawn from origin to form an isosceles triangle with the line $2x+3y=6$. The area of triangle thus formed is equal to

(A) $\frac{36}{13}$

(B) $\frac{12}{17}$

(C) $\frac{13}{5}$

(D) $\frac{6}{13}$

6) The curve passing through (0, 1) which satisfies the differential equation $\frac{xdy-ydx}{xdy+ydx} = y^2 \sin(xy)$, is given by

(A) $x+y(1+\cos(xy))=0$

(B) $x-y(1-\cos(xy))=0$

(C) $x+y(1-\cos(xy))=0$

(D) $x-y(1+\cos(xy))=0$

7) A latus rectum subtends a right angle at the other focus of the hyperbola. The eccentricity of the hyperbola must be

(A) $1-\sqrt{2}$

(B) $\sqrt{2}$

(C) $\sqrt{2}-1$

(D) $1+\sqrt{2}$

8) The first term of an Arithmetic Progression (AP) with real terms is -1 and the 8^{th} term of a Geometric Progression (GP) with real terms is 80. The 4^{th} terms of both progressions are equal. If

the 6^{th} term of the GP is equal to the sum of the 6^{th} and 7^{th} terms of the AP, then the smallest possible integral value of the 9^{th} term of the GP is equal to

(A) 160

(B) 2

(C) -160

(D) -2

9) Consider the following lists

	List-I		List-II
(A)	$\left\{x \in \left[-\frac{2\pi}{3}, \frac{2\pi}{3}\right] : \sin x + \cos x = 1\right\}$	(I)	Has elements 2
(B)	$\left\{x \in \left[-\frac{5\pi}{18}, \frac{5\pi}{18}\right] : \sqrt{3}\tan 3x = 1\right\}$	(II)	Has elements 3
(C)	$\left\{x \in \left[-\frac{6\pi}{5}, \frac{6\pi}{5}\right] : 2\cos(2x) = \sqrt{3}\right\}$	(III)	Has elements 4
(D)	$\left\{x \in \left[-\frac{7\pi}{4}, \frac{7\pi}{4}\right] : \sin x - \cos x = 1\right\}$	(IV)	Has elements 6

(A) $A \to I; B \to IV; C \to I; D \to IV$

(B) $A \to I; B \to I; C \to IV; D \to III$

(C) $A \to II; B \to I; C \to IV; D \to IV$

(D) $A \to II; B \to IV; C \to I; D \to III$

10) The value of $\int_0^{\infty} \left[\frac{3}{1+x^2}\right] dx$ ([.] denotes greatest integer function) is

(A) 3

(B) $\frac{3}{\sqrt{2}}$

(C) $3\sqrt{2}$

(D) infinite

11) The area of the region A represented by $A = \{(x, y) \mid (x, y) \in R \times R,\ 1 \leqslant |x-2| + |y+1| \leqslant 2\}$ is

(A) 9 sq. units

(B) 4 sq. units

(C) 5 sq. units

(D) 6 sq. units

12) If the line $y = 2 - x$ is tangent to the circle S at a point P (1,1) and circle S is orthogonal to the circle $x^2 + y^2 + 2x + 2y - 2 = 0$, then the equation of circle S is

(A) $x^2 + y^2 = 2$

(B) $x^2 + y^2 - 3x - 3y + 4 = 0$

(C) $x^2 + y^2 + x - 3y = 0$

(D) $x^2 + y^2 - x - y = 0$

13) A fair dice is thrown three times and the respective outcomes are named a, b and c. The probability that $f(x) = x^3 + ax^2 + bx + c$ is a increasing function is

(A) $\frac{5}{36}$

(B) $\frac{4}{9}$

(C) $\frac{1}{3}$

(D) None of these

14) A focal chord of the parabola $y^2 = 16x$ is a tangent to the circle $(x-6)^2 + y^2 = 2$. The length of this focal chord is equal to

(A) 32

(B) 16

(C) 512

(D) 64

15) Consider the following statements about the function $f : A \to A$
Statement-1 : If f is onto, then it must be one-one.
Statement-2 : If f is one - one, then it must be onto.

(A) Only (S1) is true

(B) Only (S2) is true

(C) Both (S1) and (S2) is true

(D) Both (S1) and (S2) is false

16) An ellipse having foci (3,1) and (1,1) and passing through the point (1,3) has eccentricity equal to

(A) $\sqrt{2}-1$

(B) $\frac{\sqrt{2}-1}{2}$

(C) $\sqrt{3}-1$

(D) $\frac{\sqrt{3}-1}{2}$

17) Let the observations $x_i (1 \le i \le 10)$ satisfy the equations, $\sum_{i=1}^{10}(x_i - 5) = 10$ and $\sum_{i=1}^{10}(x_i - 5)^2 = 40$.
If μ and λ are the mean and the variance of the observations, $x_1 - 3$, $x_2 - 3$, ..., $x_{10} - 3$, then the

ordered pair (μ, λ) is equal to :

(A) (6, 6)

(B) (3, 6)

(C) (6, 3)

(D) (3, 3)

18) The value of $\tan 70^{\circ} - \tan 50^{\circ} + \tan 10^{\circ}$ equals

(A) 0

(B) 2

(C) 3

(D) $\sqrt{3}$

19) Suppose $p, q, r \neq 0$ and the system of equations

$$(p+a)x + by + cz = 0$$
$$ax + (q+b)y + cz = 0$$
$$ax + by + (r+c)z = 0$$

has non-trivial solutions, then the value of $\frac{a}{p} + \frac{b}{q} + \frac{c}{r}$ is

(A) -1

(B) 0

(C) 1

(D) 2

20) If p, q, r and s are non-zero numbers such that r, s are roots of $x^2 + px + q = 0$ and p, q are the roots of $x^2 + rx + s = 0$, then the value of $(4p + q + 2r + s)$ is

(A) 0

(B) 1

(C) 2

(D) 4

SECTION-II

1) The value of $\lim\limits_{x \to 2} \frac{2^x + 2^{3-x} - 6}{2^{-\frac{x}{2}} - 2^{1-x}}$ is

2) If $\vec{a}$ and $\vec{b}$ are any two unit vectors, then the maximum possible integral value of $3\left|\vec{a} - \vec{b}\right| + \frac{7}{2}\left|\vec{a} + \vec{b}\right|$ is equal to

3) The shortest distance between the lines $\frac{x-1}{2} = \frac{y}{3} = \frac{z}{2}$ and $\frac{x-3}{2} = \frac{y}{5} = \frac{z-2}{4}$ is equal to

4) The remainder when 5^{99} is divided by 13 is

5) How many words with or without meaning formed using all the letters of the word ALLEN begin and ends with a consonant ?

ANSWER KEYS

PART-1 : PHYSICS

SECTION-I

Q.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A.	B	A	D	B	B	C	A	A	B	D	C	B	C	C	D	B	C	C	A	D

SECTION-II

Q.	21	22	23	24	25
A.	1	4	28	1	10

PART-2 : CHEMISTRY

SECTION-I

Q.	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
A.	A	A	B	D	B	B	C	C	C	C	A	B	B	B	A	C	B	A	C	A

SECTION-II

Q.	46	47	48	49	50
A.	6	3	2	7	24

PART-3 : MATHEMATICS

SECTION-I

Q.	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70
A.	B	A	A	D	A	C	D	C	B	B	D	D	B	A	D	A	D	D	A	C

SECTION-II

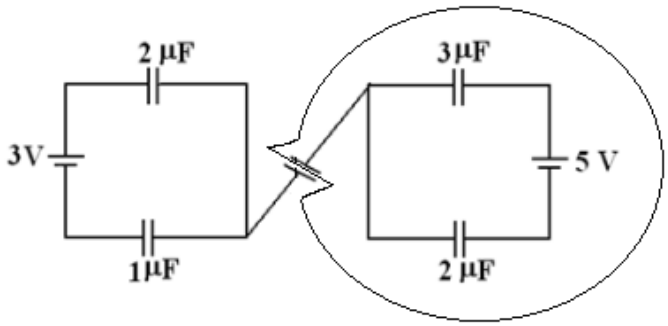
Q.	71	72	73	74	75
A.	8	9	2	8	18

SOLUTIONS

PART-1 : PHYSICS

1)

Conceptual.

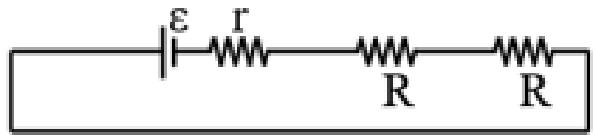


2)
Net charge on this isolated system shown continuous to be zero. The both plates of any capacitor contain zero charge. The middle capacitor has only one plate inside the isolated system taken as shown in diagram and therefore its single plate contains zero charge.

3)

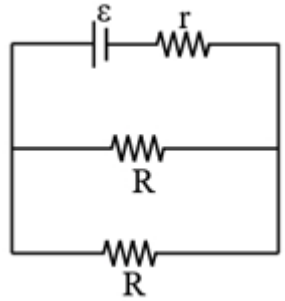
Electric current does not follow laws of vector edition and hence it is not a vector quantity

4)



$$\frac{ER}{r+2R} = 6.....1$$

$$\frac{E^{R}/_{2}}{(r+\frac{R}{2})} = 10$$



$$\frac{ER}{2r+R} = 10.....2$$

$$\frac{2r+R}{r+2R} = \frac{6}{10}$$

$10r + 5R = 3r + 6R$
$7r = R = \ldots\ldots\ldots 3$
using.....1
$\frac{E7r}{15r} = 6$
$E = \frac{90}{7}$v.....ans

5)

$$\Delta U = \left(\frac{GMn}{\frac{11R}{10}}\right) - \left(\frac{GMn}{R}\right)$$

6) Case--1 :
T-mg = mg/6.....1
nmg-T = nmg/6.....2
Solving (1) & (2) we get
n = 7/5

Case--2:
mg - T = mg/6.....1
T - nmg = nmg/6.....2
Solving (1) & (2) we get
5/7

8) $W = \int Fvdt$

10) $\frac{dQ}{dt} = -\frac{KAd\theta}{dx}$

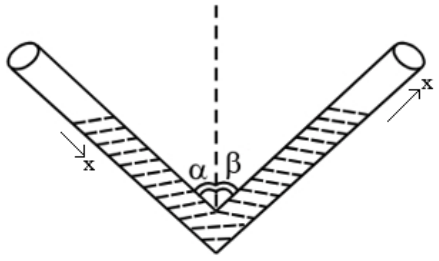
11)

Polarization takes place only in transverse waves and not in longitudinal waves.

12)

Magnetic energy density = $\frac{B^2}{2\mu_0}$

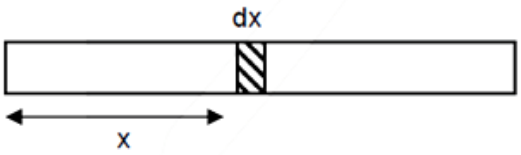
13)



$F = \Delta P.a = -\rho gA(x\cos\alpha + x\cos\beta)$
$a = -\frac{\rho gA(\cos\alpha + \cos\beta)}{m}x = \frac{\rho gA(\cos\alpha + \cos\beta)}{\ell.A.\rho}x$
$= -\omega^2 x$

$$\omega = \sqrt{\frac{g(\cos\alpha + \cos\beta)}{\ell}} \Rightarrow T = 2\pi\sqrt{\frac{\ell}{g(\cos\alpha + \cos\beta)}}$$

14)



$$X_{cm} = \frac{1}{M}\int_0^{\ell} X.dM$$

$$dM = \rho.dx = \left(a + b\left(\frac{X}{L}\right)^2\right).dx$$

$$x_{cm} = \frac{\int x dM}{\int dM} = \frac{\int \rho dx}{\rho dx} = \frac{\int_0^L x\left(a + \frac{bx^2}{L^2}\right)dx}{\int_0^L \left(a + \frac{bx^2}{L^2}\right)dx}$$

$$= \frac{a\left(\frac{x^2}{2}\right)_0^L + \frac{b}{L^2}\left(\frac{x^4}{4}\right)_0^L}{a(x)_0^L + \frac{b}{L^2}\left(\frac{x^3}{3}\right)_0^L} = \frac{(2a+b)L}{(3a+b)a} \times 3$$

16) For disk :

$mg \sin\theta - f_r = m(a)$

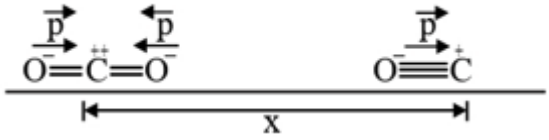
$$\& (f_r)R = I(\alpha) = \left(\frac{MR^2}{2}\right)\frac{a}{R}$$

$$\Rightarrow f_r = \frac{mg}{6}$$

17) $E_k = \frac{1}{2}mv^2 = \frac{2mgh}{5}$

pot. energy = $\frac{3mgh}{5}$

18)



$\vec{E}$ due to dipole $\propto \frac{1}{x^3}$

$\vec{E}$ due to quadmpole $\propto \frac{1}{x^4}$

$\therefore \vec{E}$ due to CO_2 molecules $\propto \frac{1}{x^4}$

force in dipole placed in that field $\propto \frac{1}{x^5}$

19) $\frac{hc}{\lambda} = 5\ eV^0 + \phi$

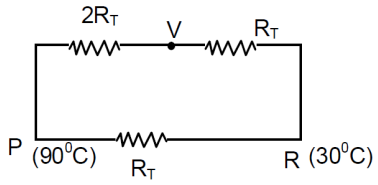
$\frac{hc}{3\lambda} = eV^0 + \phi$

$\Rightarrow \frac{2hc}{3\lambda} = 4eV^0$

$\Rightarrow \phi = \frac{hc}{6\lambda}$

20) Equivalent circuit is

$\frac{90-V}{2R_T} = \frac{20}{R_T} \Rightarrow V = 50°C$



21)

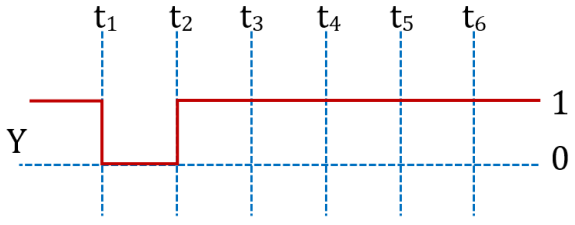
Magnitude of Electric field at both P and C is $\rho\frac{\overrightarrow{OC}}{3\varepsilon_0}$

22)

The image of +ve x-axis lies along -ve y-axis therefore coordinate of image is (0,-4)
Magnitude of y-coordinate of image point = 4.....Ans.

23) As relative acceleration of stones is 0 the relative motion will be uniform motion
S = vt
= 20 X 1.4
= 28

24) $Y = \overline{\overline{A}\cdot B} = A + \overline{B}$



25) Positive half cycle

V_{output} = 10V

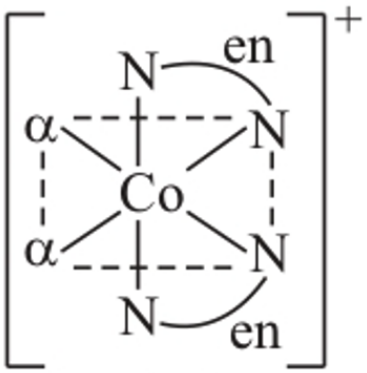
PART-2 : CHEMISTRY

26)

Ans. (A)
1 mole of borax reacts with H_2SO_4
$Na_2B_4O_7.10H_2O + H_2SO_4 \rightarrow 4H_3BO_3 + Na_2SO_4 + 5H_2O$

27)

Ans. (A)
Solution $\rightarrow$ In acetylene, $CH \equiv CH$ the C is sp hybridised with 50% character.



Octahedral
(cis)

28)
$[CoCl_2(en)_2]^+$
$Co^{3+} \rightarrow 24$
EAN = 24 + 2(2) + 2(4) = 36
36 is atomic no. of Kr.

29)

The average value of C-C bond order in graphite is 1.33

30)

Specie	B.O.
C_2^+	1.5
B_2^+	0.5
N_2^+	2.5
O_2^+	2.5

31)

Borax + CuO → $2NaBO_2 + Cu(BO_2)_2 + H_2O$) blue metaborate

32)

mass of Fe in $Fe_2[Fe_2(CN)_6]$ is 168
mass of C in $Fe_2[Fe_2(CN)_6]$ is 72
Weight ratio of Fe:C is $\frac{7}{3}$

33)

Keq = 4
$2Na_2S_2O_3 + I_2 \rightarrow 2NaI + Na_2S_4O_6$

34)

Most stable extented conjugation.

35)

$HCl \rightarrow H^+ + Cl^-$

$\left(\sqrt{5} \times 10^{-7} + x\right)$

$H_2O \quad \rightarrow \quad H^+ \quad + \quad HO^-$

$\sqrt{5}\times10^{-7}+x \qquad x$

$x \times \left(x + \sqrt{5} \times 10^{-7}\right) = 10^{-14}$

$x^2 + \sqrt{5}x \times 10^{-7} - 10^{-14} = 0$

$$x = \frac{-\sqrt{5} \times 10^{-7} + \sqrt{5 \times 10^{-14} + 4 \times 10^{-14}}}{2}$$

$$= \frac{-\sqrt{5} \times 10^{-7} + \sqrt{9 \times 10^{-14}}}{2} = \frac{3 - \sqrt{5}}{2} \times 10^{-7}$$

$x = 3.85 \times 10^{-8}$

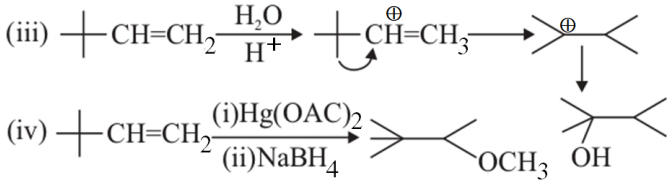
36) For minimum heat absorbed, process will be single step irreversible.
$q = \Delta U - W = 0 - [-P_{ext}(V_2.V_1)]$

$$= P_2\left(\frac{nRT}{P_2} - \frac{nRT}{P_1}\right)$$

$$= nRT\left(1 - \frac{P_2}{P_1}\right)$$

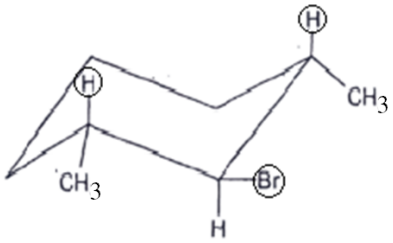
$$= 5 \times 2 \times 300\left(1 - \frac{1}{4}\right) = 2250 \text{ cal.}$$

37)



38)

In (II) compound the eliminating groups are not anti-periplanar to each other



39)

Specific conductance decreases on dilution

40)

Ans. (A)
W - Neutral Amino Acid
X - Acidic Amino Acid
Y - Basic Amino Acid
Z - Neutral Amino Acid

41) Theory based (Henry's law)

42)

Ans. (B)
Atomic no. 50 is Sn
gaseous $SnCl_2$ is bent.

43)

Ans (A)

Bond distance $\propto \frac{1}{\text{Bondorder}}$

BO of N_2 is 3
BO of N_2 is 2.5
BO of O_2 is 2
BO of O_2^+ is 2.5

44)

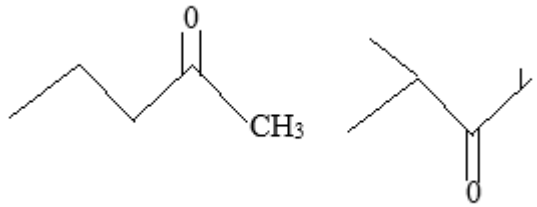
Ans (C)
they are identical

46) Ans (6)
H_2SO_4, H_3PO_3, H_2CO_3, H_2S_2O7, H_2CrO_4, H_2SO_3

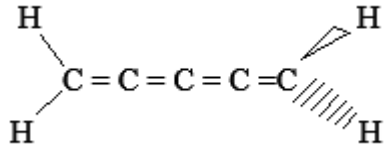
47) Ans 3.

$\frac{I}{At} - \frac{1}{A_0} = Kt,$ $\frac{3}{AO} = Kt75\%$ $\frac{1}{AO} = Kt50\%$

48) Ans. 2



49) Ans. 0



PART-3 : MATHEMATICS

51) Let $\tan^{-1} x = \theta$. Then $x = \tan\theta$ and $dx = \sec^2\theta d\theta$

$$f(\tan\theta) = \int \frac{\tan^2\theta.\sec^2\theta}{\left(1+\tan^2\theta\right)(1+\sec\theta)}d\theta = \int \frac{\tan^2\theta}{(1+\sec\theta)}d\theta = \int \frac{\left(\sec^2\theta-1\right)}{(1+\sec\theta)}d\theta$$

$$= \int (\sec\theta - 1)\,d\theta = \ln|\sec\theta+\tan\theta| - \theta + c$$

Thus, $f(0) = 0 \Rightarrow c = 0$

Therefore, $f(1) = \ln\left(1+\sqrt{2}\right) - \frac{\pi}{4}$

52) Total number of matrices = 3^9
Number of symmetric matrices = 3^6
Number of skew-symmetric matrices = 3^3
Since, Null matrix is neither symmetric nor skew-symmetric, the required probability is =

$$\frac{3^9-3^6-3^3+1}{3^9}$$

53) $\sin^{-1}\left(\frac{2x}{1+x^2}\right)=\pi-2\tan^{-1}x$ when $x\geqslant 1$

Thus, both statements are true and the second statement is the correct explanation of the first statement.

54) $|z-2-3i|=|(z-5-7i)+(3+4i)|\leqslant|z-5-7i|+|3+4i|$

Thus, $|z-2-3i|\leqslant 9+5=14$

55)

The triangle is isosceles as well as right-angled. In such triangle, the area is equal to the square of length of altitude from the vertex upon the base.

Thus, Area $=\left|\frac{2(0)+3(0)-6}{\sqrt{2^2+3^2}}\right|^2=\frac{36}{13}$ sq. units

56) The differential equation can be re-written as

$$-\left(\frac{ydx-xdy}{y^2}\right)=(xdy+ydx)\sin(xy)$$

or $$-d\left(\frac{x}{y}\right)=\sin(xy).d(xy)$$

Integrating both sides, we get

$$-\frac{x}{y}=-\cos(xy)+c$$

Since, the curve passes through (0,1), therefore putting x = 0 , y = 1 gives c = 1

57) Consider the hyperbola $\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$

Since, the latus rectum subtends a right angle at the other focus, therefore $\frac{b^2}{a}=2ae$

Thus, $\frac{b^2}{a^2}=2e$ or $e^2-1=2e$. Then, $e^2-1=0$ which gives $e=\sqrt{2}+1$

58) We represent the terms of the progressions through the following table:

Terms	1	2	3	4	5	6	7	8	9
AP	$a-3d$	$a-2d$	$a-d$	a	$a+d$	$a+2d$	$a+3d$	$a+4d$	$a+5d$
GP	a/r^3	a/r^2	a/r	a	ar	ar^2	ar^3	ar^4	ar^5

Given, $a-3d=-1\Rightarrow d=\frac{a+1}{3}$

Also, $ar^4=80\Rightarrow r^2=\sqrt{\frac{80}{a}}$

And, $(a+2d)+(a+3d)=ar^2 \Rightarrow 2a+5d=ar^2$

Eliminating d and r, we get the equation

$2a+5\frac{(a+1)}{3}=a\sqrt{\frac{80}{a}}$

Squaring the equation, we get

$12la^2-610a+25=0 \text{ or } a=5, a=\frac{5}{121}$

For $a=\frac{5}{121}$, the 9^{th} term is not an integer

For $a=5, r^2=\sqrt{16}$ and $r=\pm 2$ and the smallest 9^{th} term is -160

59) (P) $\sin x+\cos x=1 \Rightarrow \cos\left(x-\frac{\pi}{4}\right)=\frac{1}{2} \Rightarrow x-\frac{\pi}{4}=2nx\pm\frac{\pi}{4}=2n\pi \text{ or } x=2n\pi+\frac{\pi}{2}$

Thus, there are 2 solutions in the given interval

(Q) $\sqrt{3}\tan(3x)=1 \Rightarrow \tan(3x)=\frac{1}{\sqrt{3}} \Rightarrow 3x=n\pi+\frac{\pi}{6} \Rightarrow x=\frac{(6n+1)\pi}{18}$

Thus, there are 2 solutions in the given interval

(R) $2\cos(2x)=\sqrt{3} \Rightarrow \cos 2x=\frac{\sqrt{3}}{2} \Rightarrow 2x=2n\pi\pm\frac{\pi}{6}=x=\frac{(12n\pm 1)\pi}{12}$

Thus, there are 6 solutions in the given interval

(S) $\cos x-\sin x=-1 \Rightarrow \cos\left(x+\frac{\pi}{4}\right)=-\frac{1}{\sqrt{2}} \Rightarrow x+\frac{\pi}{4}=2n\pi\pm\frac{3\pi}{4}$

$\Rightarrow x=2n\pi+\frac{\pi}{2} \text{ or } x=(2n+1)\pi$. Thus, there are 4 solutions in the given interval.

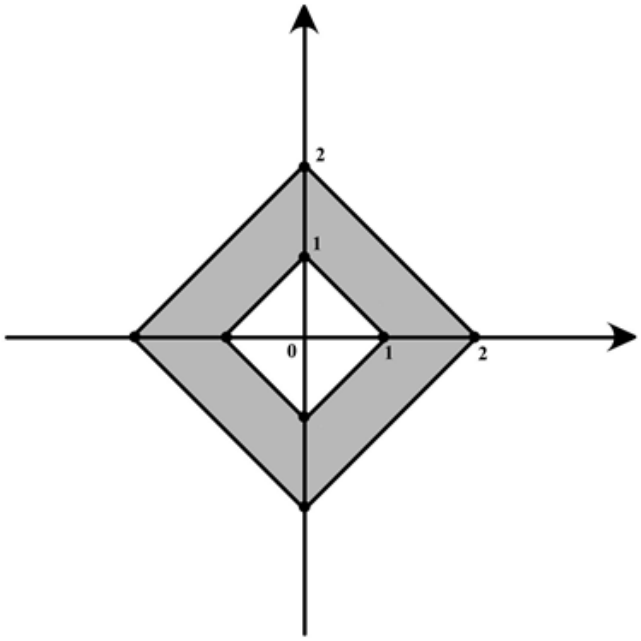
60) $\frac{3}{1+x^2}\in(2,3) \text{ when } x\in\left(0,\frac{1}{\sqrt{2}}\right)$

$\frac{3}{1+x^2}\in(1,2) \text{ when } x\in\left(\frac{1}{\sqrt{2}},\sqrt{2}\right)$

$\frac{3}{1+x^2}\in(0,1) \text{ when } x\in\left(\sqrt{2},\infty\right)$

Thus, $\int_0^{\infty}\left[\frac{3}{1+x^2}\right]dx=\int_0^{\frac{1}{\sqrt{2}}}2dx+\int_{\frac{1}{\sqrt{2}}}^{\sqrt{2}}1dx+\int_{\sqrt{2}}^{\infty}0\,dx=\sqrt{2}+\sqrt{2}-\frac{1}{\sqrt{2}}=\frac{3}{\sqrt{2}}$

61) The area of the figure would remain unchanged by shifting of origin. Therefore, replace $x-2\rightarrow X \text{ and } y+1\rightarrow Y$. The new region is now represented by the inequility $1\leqslant|X|+|Y|\leqslant 2$ This area is the area between two squares repesented by $|X|+|Y|=1 \text{ and } |X|+|Y|=2$ which is shaded in the figure below :



The required area $= 4\left(\frac{1}{2}\times 2\times 2\right) - 4\left(\frac{1}{2}\times 1\times 1\right) = 6\,\text{sq. units}$

62) The equation of family of circles touching the given line at (1,1) is given by
$(x-1)^2+(y-1)^2+\lambda(x+y-2)=0$ or $x^2+y^2+(\lambda-2)x+(\lambda-2)y+(2-2\lambda)=0$
Using condition of orthogonality with the circle $x^2+y^2+2x+2y-2=0$, we get
$(\lambda-2)+(\lambda-2)=(2-2\lambda)+(-2)\Rightarrow\lambda=1$
Therefore, the equation of circle S is $x^2+y^2-x-y=0$

63) $f'(x)=3x^2+2ax+b$
The function f (x) will be strictly increasing when $D\leqslant 0$ i.e. $a^2\leqslant 3b$
The favourable ordered pairs (a,b) are
$(1,1),(2,2),(3,3),(1,4),(2,4),(3,4),(1,5),(2,5),(3,5),(1,6),(2,6),(3,6),(4,6)$ i.e. 16 pairs
The required probability is $\frac{16}{36}$ i.e. $\frac{4}{9}$

64)

The focus of the parabola is (4,0). Focus lies on the director circle of the given circle and hence the slope of this focal chord must be 1. The length of this focal chord will be $16.\text{cose}\text{s}^2 45^\circ$ which is 32 units.

65) Both statements are true only when A is a finite set. Consider the following functions :
$f:R\to R, f(x)=e^x$ is one-one but not onto and $f:R\to R, f(x)=x^3-x$ is onto but not one-one

66)

We know that the sum of focal distances of any point on the ellipse is equal to length of major

axis (i.e. 2a) and the distance between foci is 2ae.

Thus, eccentricity $e = \frac{2}{2\sqrt{2}+2} = \frac{1}{\sqrt{2}+1} = \sqrt{2}-1$

67)

$$\sum_{i=1}^{10}(x_i - 5) = 10$$

$$x_i - 5 = \frac{1}{10}\sum_{i=1}^{3}(x_i - 5) = 1$$

⇒ Mean of observation

⇒ μ = mean of observation $(x_i - 3)$

= (mean of observation $(x_i - 5)$) + 2

= 1 + 2 = 3

Variance of observation

$$x_i - 5 = \frac{1}{10}\sum_{i=1}^{10}(x_i - 5)^2$$

– (Mean of $(x_i - 5)$)^2 = 3

⇒ λ = variance of observation $(x_i - 3)$

= variance of observation $(x_i - 5)$ = 3

∴ (μ, λ) = (3, 3)

68) Using the identity : $\tan\theta + \tan(\theta + 60^\circ) + \tan(\theta - 60^\circ) = 3\tan 3\theta$ and putting the value of $\theta = 10^\circ$, we get the value as $3\tan 30^\circ$ or $\sqrt{3}$

69) The system has non-trivial solutions if

$$\begin{vmatrix} p+a & b & c \\ a & q+b & c \\ a & b & r+c \end{vmatrix} = 0 \Rightarrow aqr + bpr + pqr = 0 \Rightarrow \frac{a}{p} + \frac{b}{q} + \frac{c}{r} = -1$$

70) $x^2 + px + q = 0$ has roots r, s and $x^2 + rx + s = 0$ has roots p, q

$r + s = -p$ (1)

$rs = q$ (2)

$p + q = -r$ (3)

$pq = s$ (4)

$(2) \times (4) \Rightarrow pqrs = qs \Rightarrow pr = 1$ (5)

$(1) + (3) \Rightarrow p + q + r + s = -p - r$

$\Rightarrow 2(p + r) + q + s = 0$ (6)

Now p is a root of

$x^2 + rx + s = 0 \Rightarrow p^2 + rp + s = 0$

And r is a root of $x^2 + px + q = 0 \Rightarrow r^2 + pr + q = 0$

Adding those two

$\Rightarrow (p + r)^2 - 2(p + r) = 0 \Rightarrow p + r = 0, p + r = 2$

Also $pr = 1 \Rightarrow p = 1, r = 1$

From (4) $pq = s \Rightarrow q = s$

$\therefore q + s = -2(p + r)$

$\Rightarrow q + s = -4 \Rightarrow q = s = -2$

$\therefore (4p+q+2r+s) = 4-2+2-2 = 2$

71)

$$\lim_{x\to 2} \frac{2^x + 2^{3-x} - 6}{2^{-\frac{x}{2}} - 2^{1-x}} = \lim_{x\to 2} \frac{2^{2x} - 6.2^x + 8}{2^{\frac{x}{2}} - 2} = \lim_{x\to 2} \frac{(2^x - 4)(2^x - 2)}{2^{\frac{x}{2}} - 2} = \lim_{x\to 2} \left(2^{\frac{x}{2}} + 2\right)(2^x - 2) = 8$$

72) If θ is the angle between unit vectors $\vec{a}$ and $\vec{b}$, then we have

$$\left|\vec{a} - \vec{b}\right| = \sqrt{1+1-2\cos\theta} = 2\sin\frac{\theta}{2} \text{ and } \left|\vec{a} + \vec{b}\right| = \sqrt{1+1+2\cos\theta} = 2\cos\frac{\theta}{2}$$

Therefore, $3\left|\vec{a} - \vec{b}\right| + \frac{7}{2}\left|\vec{a} + \vec{b}\right| = 6\sin\frac{\theta}{2} + 7\cos\frac{\theta}{2} \in \left[-\sqrt{85}, \sqrt{85}\right]$

Hence, the maximum possible integral value is 9

73) Shortest distance between lines

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

74) $5^{99} = 5\left(5^{98}\right) = 5\left(25^{49}\right) = 5(26-1)^{49}$

$$= 5\left(\underbrace{{}^{49}C_0 26^{49} - {}^{49}C_1 26^{48} + \ldots + {}^{49}C_{48}26}_{\text{Multiple of 13}} - {}^{49}C_{49}\right)$$

$= 5$ (multiple of 13)$-5 = 5$ (Multiple of 13)$-13 + 8$

Thus, the remainder is 8

75) Consider both L's to be distinct. The number of such words is then $3 \times 2 \times 3! = 36$. Since, both L's are now idnetical, therefore the number of such words must be $\frac{36}{2!} = 18$