JEE MAIN 2025

Sample Paper - 7

Time Allowed: 3 hours **Maximum Marks: 300**

General Instructions:

1. There are three subjects in the question paper consisting of Physics (Q. no. 1 to 25), Chemistry (Q, no. 26 to 50), and Mathematics (Q. no. 51 to 75).

2. Each subject is divided into two sections. Section A consists of 20 multiple-choice questions & Section B consists of 5 numerical value-type questions.

3. There will be only one correct choice in the given four choices in Section A. For each question for Section A, 4 marks will be awarded for correct choice, 1 mark will be deducted for incorrect choice questions and zero marks will be awarded for not attempted questions.

4. For Section B questions, 4 marks will be awarded for correct answers and zero for unattempted and incorrect answers.

5. Any textual, printed, or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.

6. All calculations/written work should be done in the rough sheet is provided with the Question Paper.

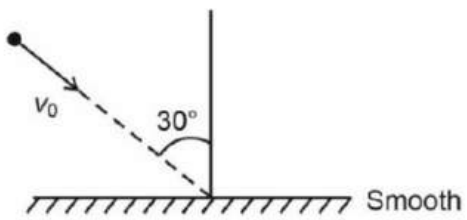
PHYSICS **MAX.MARKS: 100**

SECTION – I
(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 if not correct.

1. A billiard ball of mass m moving with speed v_0 strikes a smooth floor at an angle of 30^0 with normal to floor. If ball rebounds at an angle of 60^0 with vertical, then coefficient of restitution is



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

2. A plano-convex lens of refractive index 1.5 and radius of curvature 30 cm is silvered at the curved surface. Now this lens has been used to form the image of an object. At what distance from this lens an object is placed in order to have a real image of the size of the object ?

1)20 cm 2)80cm 3)60 cm 4)30 cm

3. **STATEMENT – 1:** Kinetic energy of a particle is conserved if it is acted upon by a conservative force only.

STATEMENT – 2: Work done by a conservative force in a closed path is zero.

(A) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is** a correct explanation for Statement – 1.

(B) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is NOT** a correct explanation for Statement – 1.

(C) Statement – 1 is True, Statement – 2 is False.

(D) Statement – 1 is False, Statement – 2 is True.

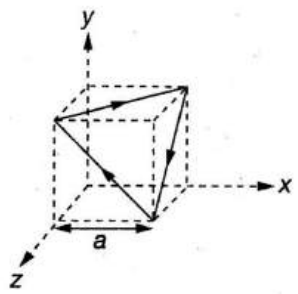
4. A thick-walled hollow sphere has outer radius R. It rolls down on an inclined plane without slipping and its speed at bottom is v_0. Now the incline is waxed so that the friction becomes zero. The sphere is observed to slide down without rolling and the speed now is $(5v_0/4)$. The radius of gyration of the hollow sphere about the axis through center is $\frac{nR}{4}$. Then the value of n is

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

5. Electric potential V in volt in a region is given by $V = ax^2 + ay^2 + 2az^2$, where a is a constant. Work done by the field when a $2\mu c$ charge moves from point (0,0,0.1m) to origin is $5\times10^{-5}J$. Find a? (in V/m^2)

1)1250 2)1520 3)1750 4)1500

6. Calculate the magnetic moment associated with the loop carrying current I_0 as shown in figure is



1) $\frac{3\sqrt{3}}{2}I_0a^2$ 2) $\frac{2\sqrt{3}}{2}I_0a^2$ 3) $\frac{2}{3}I_0a^2$ 4) $\frac{\sqrt{3}}{2}I_0a^2$

7. What mass (approximately) of coal with calorific value of 30 kJ/g is thermally equivalent to the heat liberated during the formation of one gram of He^4 from deuterium H^2?

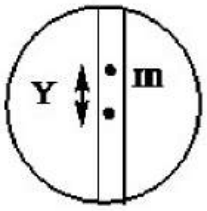
$m(H^2) = 2.01410$ amu, $m(He^4) = 4.002603$amu

1) 1×10^4kg 2) 2×10^4kg 3) 3×10^4kg 4) 4×10^4kg

8. A lamp emits monochromatic green light uniformly in all directions. The lamp is 3% efficient in converting electrical power to electromagnetic waves and consumes 100 W of power. The amplitude of the electric field associated with the electromagnetic radiation at a distance of 10 m from the lamp will be

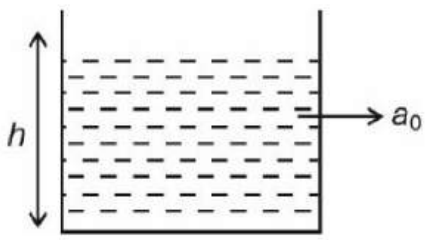
1)1.34 V/m 2)2.68 V/m 3)5.36 V/m 4)9.37 V/m

9. Suppose a vertical tunnel is dug along the diameter of the earth assumed to be a sphere of uniform mass having density ρ. If a body of mass m is thrown in this tunnel, its acceleration at a distance y from a centre is given by



1) $\frac{4\pi}{3} g \rho y$ 2) $\frac{3}{4}\pi G \rho y$ 3) $\frac{4}{3}\pi \rho y$ 4) $\frac{4}{3}\pi G \rho y$

10. A vessel contains liquid of density ρ up to height h. Vessel is given horizontal acceleration a_0 such that free surface of liquid makes an angle of 30° with horizontal. Value of a_0 is



1) g/2 2) g/3 3) $g/\sqrt{3}$ 4) $\sqrt{3}g/2$

11. A projectile is projected with velocity 20 m/s at an angle of 53° with horizontal. Speed of the projectile when its velocity is perpendicular to its initial velocity, is

1) 16 m/s 2) 12 m/s 3) 15 m/s 4) 18 m/s

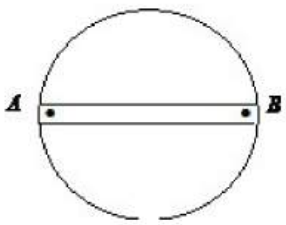
12. A wire of length $l = 6 \pm 0.06\,cm$ and radius of cross-section $r = 0.5 \pm 0.005\,cm$ and mass $m = 0.3 \pm 0.003\,gm$. Maximum percentage error in density is

1) 4 2) 2 3) 1 4) 6.8

13. In Young's double slit experiment using monochromatic light, the fringe patterns shifts by a certain distance on the screen when a mica sheet of refractive index 1.6 and thickness 1.964 micron is introduced in the path of one of the interfering waves. The mica sheet is then removed and the distance between the plane of slits and the screen is doubled. It is found that the distance between successive maxima now is the same as the observed fringe shift upon the introduction of the mica sheet. The wavelength of light is

1) 5762 $\mathring{A}$ 2) 5825 $\mathring{A}$ 3) 5892 $\mathring{A}$ 4) 6500 $\mathring{A}$

14. Suppose a narrow, and straight tunnel passes through the center of earth as shown in the figure. Two small balls A and B are released simultaneously at the two ends of the tunnel. The balls collide with each other and after collision one ball comes to rest and the other ball just manages to escape the earth's gravitational field. If the coefficient of restitution between the balls is e , then select the correct option.



1) $e=\frac{\sqrt{3}}{2}$

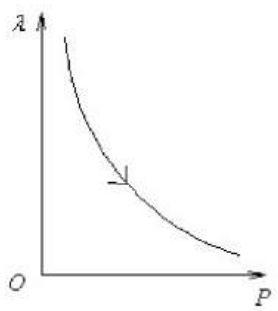
2) $e=\frac{1}{\sqrt{2}}$

3) $\frac{1}{\sqrt{2}}<e<\frac{\sqrt{3}}{2}$

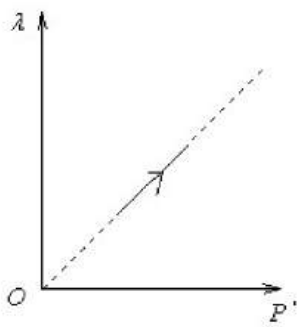
4) information is insufficient to predict

15. An ideal gas undergoes an isothermal process. The pressure (P) of the gas is plotted against the mean free path λ of the molecules. Select the correct graph.

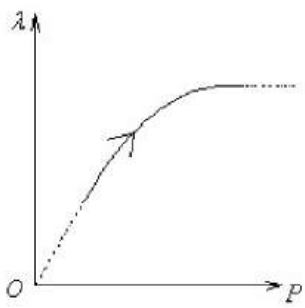
1)



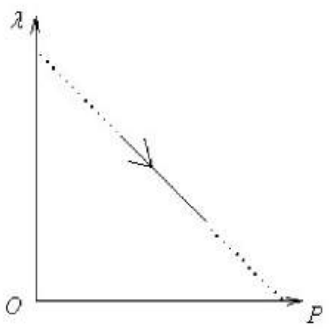
2)



3)



4)



16. If two soap bubbles of different radii are in communication with each other, then

1) air flows from the larger bubble into the smaller one until their sizes become equal

2) the sizes of the bubbles remain unchanged

3) air flows from the smaller bubbles into the larger one and the larger bubble grows at the expense of the smaller one

4) air flows from the larger into the smaller bubble until their radii interchange

17. A copper wire and a steel wire of the same diameter and length are connected end to end. A force is applied which stretches their combined length by 1 cm. Then the two wires have

1) the same stress and strain

2) the same stress but different strains

3) the same strain but different stresses

4) different stresses and strains

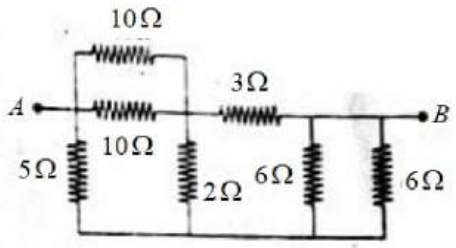
18. An energy of 24.6eV is required to remove one of the electrons from a helium atom. The energy (in eV) required to remove both the electrons from a neutral helium atom is

1) 38.2 2) 49.2 3) 51.8 4) 79.0

19. If 200 MeV energy is released per fission of $_{92}U^{235}$, how many fissions must occur per second to produce a power of 1 mW?

1) 6.25×10^{7} 2) 12.25×10^{7} 3) 25×10^{7} 4) 3.125×10^{7}

20. Find the equivalent resistance between points A and B (in Ω)_



1) 4 2) 6 3) 11.2 4) 10.4

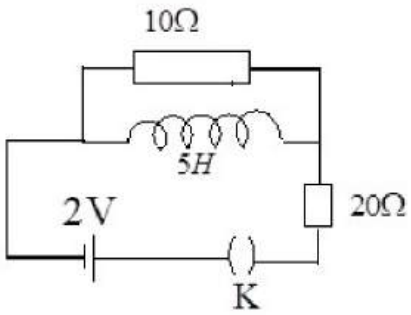
SECTION-II
(NUMERICAL VALUE ANSWER TYPE)

This section contains 5 questions. The answer to each question is a Numerical value. If the Answer in the decimals , **Mark nearest Integer only.**
Marking scheme: +4 for correct answer, -1 in all other cases.

---

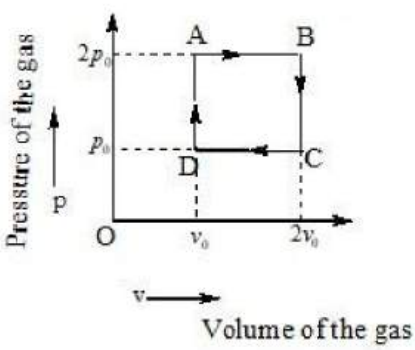
21. A uniform string of length 9m and mass 4.5 kg is fixed at one end and hangs freely under its own weight. A wave pulse is generated at top end which runs down to other end. At the same moment a stone is released from rest and falls freely from the top of string. How far from the top does stone pass the wave ?

22. Two resistors of 10Ω and 20Ω and an ideal inductor of 5 H are connected to a 2 V battery as shown in the below figure. The key is plugged in at $t = 0$ the value of the current in the 10Ω resistor at steady state is

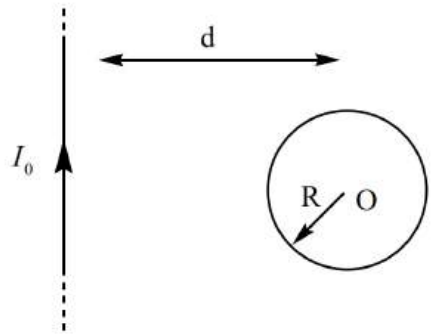


23. A person can throw a ball upto a maximum range of 100m. The maximum height of this projectile is

24. The p-v diagram represents the thermodynamic cycle of an engine, operating with an ideal monoatomic gas. The amount of heat extracted from the source in a single cycle is $\left(\frac{x}{2}\right)p_0v_0$. Find the value of x.



25. Current, I_0 flows in long straight conductor as shown. If magnetic field at center of circular loop in the same plane is zero, then current in the circular loop is $\frac{|n|I_0R}{\pi d}$, then the value of $|n|$ is



CHEMISTRY **MAX.MARKS: 100**

SECTION – I
(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 if not correct.

26. Match the Column-I with Column-II

Species	Shape
A) $S_2O_3^{-2}$	1) pyramidal
B) ClO_3^-	2) linear
C) C_3O_2	3) squarepalanar
D) $Ni(CO)_4$	4) tetrahedral

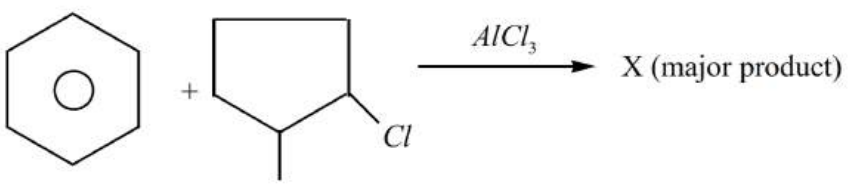
1)A-3,B-1,C-2,D-4 2) A-4,B-1,C-2,D-3

3)A-2,B-1,C-3,D-4 4)A-4,B-1,C-2,D-4

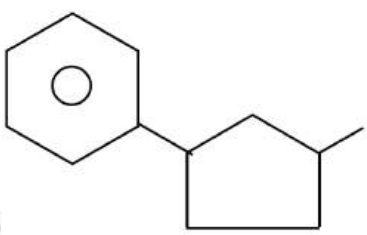
27. The Solubility of Calcium fluoride in water is $7.8\times10^{-4} g/L$. The value of $\log_{10} K_{sp}$ of calcium fluoride is

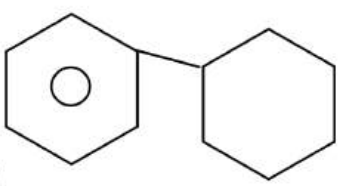
1) 4×10^{-15} 2) -14.4 3)14.4 4) -4×10^{15}

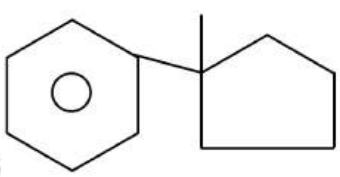
28.

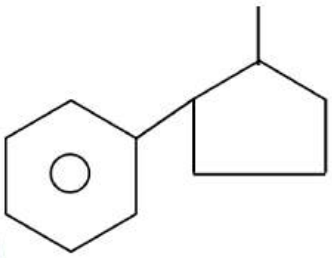


X (major product)

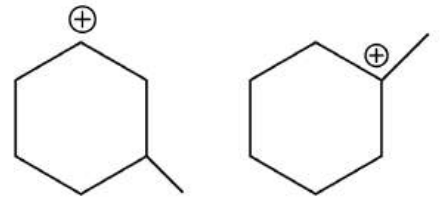
1) 

2) 

3) 

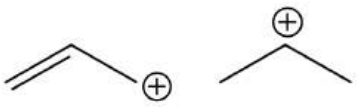
4) 

29. In which of following pairs "A'" is less stable than "B"?

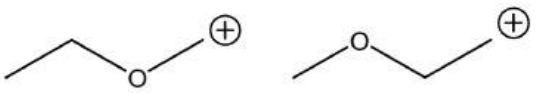


1) (A) (B)

2) $Ph-\underset{(A)}{CH_2^{\oplus}}$ $\underset{(B)}{C_6H_5^{\oplus}}$

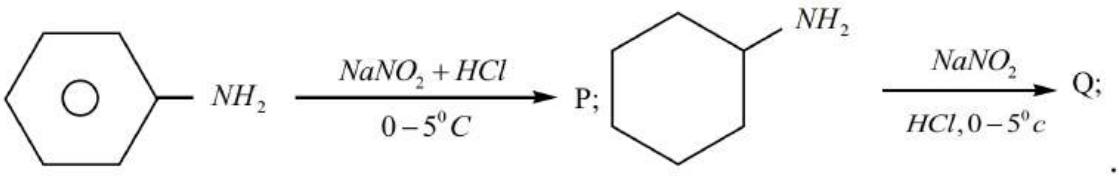


3) (A) (B)

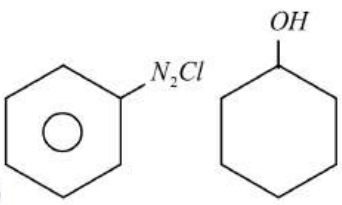


4) (A) (B)

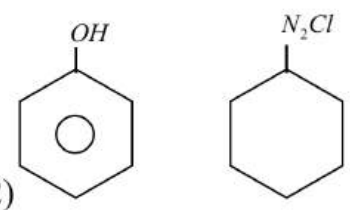
30.



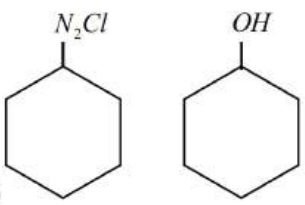
P and Q are



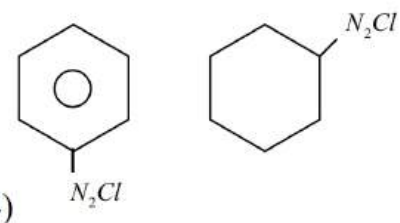
1)



2)



3)



4)

31. Electromotive force of the following cell at 298K

$Pt, \underset{(1atm)}{H_2} / \underset{(0.001M)}{H^+} // \underset{(0.2M)}{H^+} / \underset{(1atm)}{H_2}, Pt \quad \left[\frac{2.303RT}{P} = 0.06\right]$

1) 120mv 2) 0.12V 3) 138mv 4) 0.138mv

32. $2MnO_4^- + 10I^- + 16H^+ \rightarrow 2Mn^{+2} + 8H_2O + A,$

$2MnO_4^- + H_2O + I^- \rightarrow 2MnO_2 + 2OH^- + B.$

A & B respectively are

1) IO_3^-, I_2 2) I_2, IO_3^- 3) I_2, I_2 4) IO_3^-, IO_3^-

33. The number of geometric isomers possible for square planar complex $[Pt(Cl)(py)(NH_3)(NO_2)]$ is $(py = pyridine)$

1) 6 2) 8 3) 3 4) 12

34. Correct statements among the following are

A) At isoelectric point amino acids having least solubility

B) All natural amino acids are optically active

C) Globular protiens have coiled (spherical) like structure and are water soluble

D) Fibrous protiens have sheet like (run in parallel) structure and are water soluble

1)A, B only 2) B, C only 3)C, Donly 4) A, C only

35. The radius of $La^{+3}(z=57)$ is $108Pm$. The radius of $Lu^{+3}(z=71)$ will be closest to

1)$85Pm$ 2)$108Pm$ 3)$180Pm$ 4)$160Pm$

36. Consider following statements about complexes

A) $FeSO_4.(NH_4)_2SO_4.6H_2O$ and $FeSO_4.4KCN$ are complex compounds

B) All Zn^{+2} complexes (C.N=4 and 6) are diamagnetic

C) In $K_4[Fe(CN)_6]$, iron undergoes d^2sp^3 hybradisation

D) $[Cu(NH_3)_4]SO_4$ is square planar complex

Select the correct statement(s) from the above?

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

37. Enthalpy change for the conversion of $\frac{1}{2}Cl_2(g)\ to\ Cl^{-1}(aq)$ is _____ KJ/mole

(Given that $\Delta_{dis}H(Cl_2)=240KJ/mol$, $\Delta_{eg}H(Cl_g^-)=-350KJ/mol$ and $\Delta_{hyd}H(Cl_g^-)=-380KJ/mol$)

1)-610 2)610 3)-490 4)490

38. The species given that doesn't undergoes disproportionation reaction is

1)Cl_2 2)MnO_4^- 3)BrO_2^- 4)H_2O_2

39. Match List-I & List-II

List-I (Atomic Number)	List-II (Block of periodic table)
A) 56	P) d-block
B) 49	Q) f-block
C) 79	R) p-block
D) 64	S) s-block

1)A-R,B-P,C-S,D-Q 2)A-S,B-P,C-Q,D-P

3)A-S,B-R,C-P,D-Q 4)A-S,B-R,C-Q,D-P

40. The chalcogen with highest negative electron gain enthalpy is

1) O 2) Se 3) S 4) Te

41. The nitrogen of following compound doesn't converted into ammonium sulphate, in estimation of Nitrogen by Kjeldhal's method.

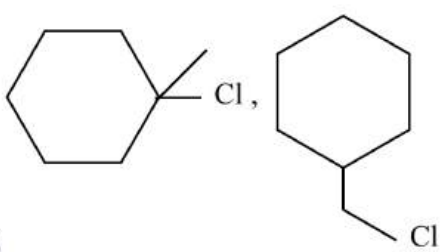
1) propanamine 2) urea 3) Aniline 4) Nitro benzene

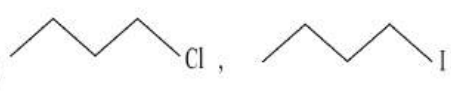
42. Identify the INCORRECT combination

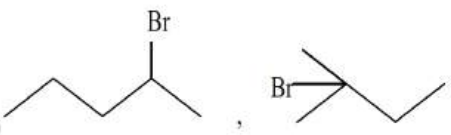
1) Oxidising power - $F_2 > Cl_2 > Br_2 > I_2$ 2) *Bond energy* $- Cl_2 > Br_2 > F_2 > I_2$

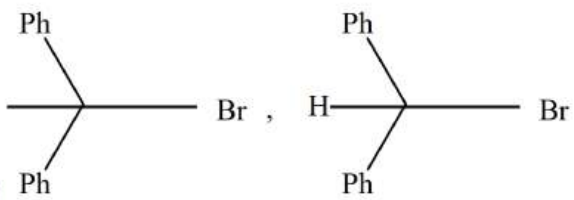
3) $S.R.P - F_2 < Cl_2 < Br_2 < I_2$ 4) Water solubility at 25^0C $- Ne < Ar < Kr < Xe$

43. In which of following pairs of halogen compounds first one undergoes SN^2 reaction faster.

1) 

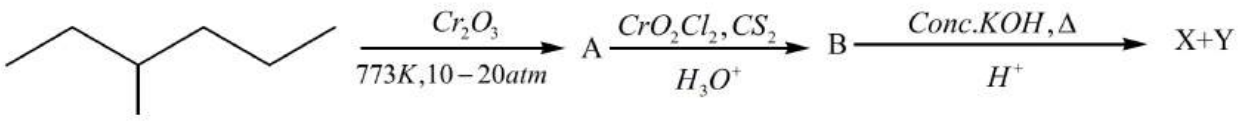
2) 

3) 

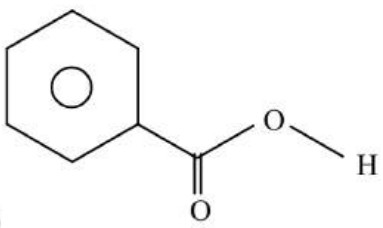
4) 

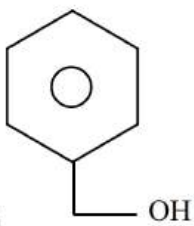
44. Molal depression constant for a solvent 5.0kkgmol^{-1}. The depression in freezing point of solvent for 0.4 mole kg^{-1} solution of Na_2SO_4 is (undergoes 100% ionisation).

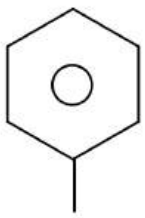
1) 3 2) 4 3) 2 4) 6

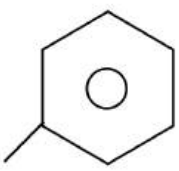
45. 

X gives "B" when treated with MnO_2. Then Y is

1) 

2) 

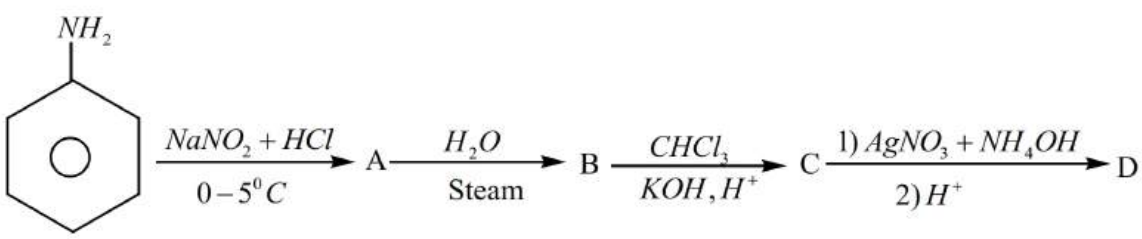
3) 

4) 

SECTION-II
(NUMERICAL VALUE ANSWER TYPE)

This section contains 5 questions. The answer to each question is a Numerical value. If the Answer in the decimals , **Mark nearest Integer only.**
Marking scheme: +4 for correct answer, -1 in all other cases.

46. The de-Broglie wave length of electron present in second Bohr orbit of H-atom is __ πA^0 (Round off to nearest integer)

47. 

Molecular weight of D is_____ g/mol.

(Atomic weight of H=1, C=12,N=14, O=16 g/mol).

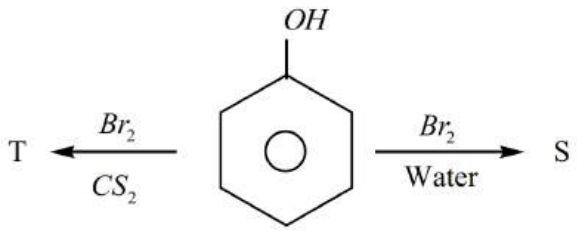
48. At 25^{0}C, the pH of 1.0×10^{-8} M HCl aqueous solution is _____

(Round off to nearest integer).

49. The number of molecules or ions from the following having non-planar structure is ___

$BF_3, H_2O_2, SO_3, CH_4, CH_3^{\oplus}, NO_3^-, SF_6, BF_4^-, PH_4^+, PCl_5, SF_4, PCl_3, B_2H_6$

50.



The difference between molecular weights of "S" and "T" is _____ (g)
(Atomic weight H=1, C=12, O=16, Br=80 g/mol).

MATHEMATICS **MAX.MARKS: 100**

SECTION – I
(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 if not correct.

51. If $\alpha = \cos\left(\frac{8\pi}{11}\right) + i\sin\left(\frac{8\pi}{11}\right)$, then $\mathrm{Re}\left(\alpha + \alpha^2 + \alpha^3 + \alpha^4 + \alpha^5\right)$ is equal to

1) $\frac{1}{2}$ 2) $-\frac{1}{2}$ 3) 0 4) 11

52. The mean of two samples of sizes 200 and 300 were found to be 25, 10 respectively. Their standard deviations were 3 and 4 respectively. The variance of combined sample of size 500 is

1) 6.72 2) 67.2 3) 672 4) 0.672

53. The sum of the series $\frac{7}{2^3} + \frac{19}{6^3} + \frac{37}{12^3} + \frac{61}{20^3} + \text{------}\infty$

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

54. If x_1, x_2 and x_3 are the positive roots of the equation $x^3 - 6x^2 + 3px - 2p = 0, p \in R - \{0\}$ then the value of $\sin^{-1}\left(\frac{1}{x_1} + \frac{1}{x_2}\right) + \cos^{-1}\left(\frac{1}{x_2} + \frac{1}{x_3}\right) - \tan^{-1}\left(\frac{1}{x_3} + \frac{1}{x_1}\right)$ is equal to

1) $\frac{\pi}{4}$ 2) $\frac{\pi}{2}$ 3) $\frac{3\pi}{4}$ 4) π

55. Let $f(x) = -4e^{\frac{1-x}{2}} + 1 + x + \frac{x^2}{2} + \frac{x^3}{3}$ for any real number x, and let g be the inverse function of f. Then the value of $g'\left(-\frac{7}{6}\right)$ is

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

56. Let the function $g : R \to \left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ be given by $g(t) = \frac{\pi}{2} - 2\cot^{-1}\left(3^{-t}\right)$.

P : g is an odd function

Q : g is strictly increasing in $(-\infty, \infty)$.

1) P is true ; Q is true 2) P is true ; Q is false

3) P is false ; Q is true 4) P is false ; Q is false

57. $y = f(x)$ is a solution of $\frac{dy}{dx}\left(\frac{1+\cos x}{y}\right) = -\sin x$ and $f\left(\frac{\pi}{2}\right) = 1$ then $f(0)$ is

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

58. Let a straight line passing through P(1, 4) with negative slope cuts the coordinate axes at A, B then the area of the triangle OAB when OA + OB is minimum is _____

1) 9 2) 18 3) 4 4) 14

59. If $\bar{a}, \bar{b}$ & $\bar{c}$ are such that $(\bar{a} \times \bar{b}).\bar{c} = 1$, $\bar{c} = \lambda \bar{a} \times \bar{b}$, $|\bar{a}| = \sqrt{2}$, $|\bar{b}| = \sqrt{3}$ & $|\bar{c}| = \frac{1}{\sqrt{3}}$, then the angle between $\bar{a}$ & $\bar{b}$ is

1) $\frac{\pi}{6}$ 2) $\frac{\pi}{4}$ 3) $\frac{\pi}{3}$ 4) $\frac{\pi}{2}$

A) Assertion: There exists two points on the line $\frac{x-1}{1} = \frac{y}{-1} = \frac{z+2}{2}$ which are at a distance of 2 units from the point (1,2,-4)

(R) Reason : Perpendicular distance of point (1,2,-4) from the line $\frac{x-1}{1} = \frac{y}{-1} = \frac{z+2}{2}$ is 1 unit,

1) A,R are true and R is correct explanation of A

2) A,R are true but R is not correct explanation of A

3) A is true and R is false

4) R is true and A is false

61. If ABCD is a square of unit side, 4-circles of unit radius are described with centres at A,B,C,D then area common to 4 – circles is

1) $1 - \frac{\pi}{4} + \sqrt{3}$ 2) $1 + \frac{\pi}{4} - \frac{\sqrt{3}}{2}$ 3) $1 + \frac{\pi}{3} - \sqrt{3}$ 4) $1 - \frac{\pi}{3} + \sqrt{3}$

62. Let $ax^7 + bx^6 + cx^5 + dx^4 + ex^3 + fx^2 + gx + h = \begin{vmatrix} x+1 & x^2+2 & x^2+x \\ x^2+x & x+1 & x^2+1 \\ x^2+2 & x^2+x & x+1 \end{vmatrix}$ then

1) g = 3 and h = -5 2) g = -3 and h = -5

3) g = 3 and h = 9 4) g = -2 and h = 5

63. If the equation $\sin^4 x-(k+2)\sin^2 x-(k+3)=0$ has a solution then k must lie in the interval:

1) $(-4,-3)$ 2) $(-2,0)$ 3) $(-2,2)$ 4) $[-3,-2]$

64. If 'a' be the digit at unit`s place in $11^{2012}+23^{2012}-3^{2012}$, then $\int_{a-1}^{a}\frac{dx}{\sqrt{1-x^2}-x+\frac{1}{x}}=$

1) $\frac{\pi}{6}$ 2) $\frac{\pi}{3}$ 3) $\frac{\pi}{2}$ 4) $\frac{\pi}{4}$

65.

	Column-I		Column-II
A	Area bounded by $y=\|x\|$ and y=2 is	p	4
B	Area bounded by $\frac{\|x\|}{a}+\frac{\|y\|}{b}=1, when\ a,b>0$ is	q	$\frac{(\pi-2)ab}{4}$
C	Area between the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ and the chord $\frac{x}{a}+\frac{y}{b}=1$ (a,b>0) is	r	1
D	Area bounded by $y=[x]$, the x-axis and $x=1, x=2$ is [.] denotes greatest integer function	s	2ab

1) A-S,B-P,C-Q,D-R 2) A-P,B-S,C-Q,D-R

3)A-S,B-P,C-R,D-Q 4) A-Q,B-S,C-R,D-P

66. If the probability that the random variable X takes values x is given by $P(X=x)=\frac{K}{3^x}$ $x=0,1,2,3,...$ where K is constant then $P(x\geq 2)=$

1) $\frac{1}{3}$ 2) $\frac{1}{27}$ 3) $\frac{1}{18}$ 4) $\frac{1}{9}$

67. Let $S=\{1,2,3,.....50\}$. The number of non empty subsets A of S such that the product of elements of A is even

1) $2^{25}\left(2^{25}-1\right)$ 2) $2^{25}-1$ 3) $2^{25}+1$ 4) $2^{50}-1$

68. The number of ordered pairs (m, n) where $m,n \in \{1,2,3,.....,50\}$, such that $6^m + 9^n$ is a multiple of 5 is

1) 1250 2) 2500 3) 625 4) 500

69. A set S contains 7 elements. A non-empty subset A of S and an element x of S are chosen at random. Then the probability that $x \in A$ is:

1) $\frac{1}{2}$ 2) $\frac{64}{127}$ 3) $\frac{63}{128}$ 4) $\frac{31}{128}$

70. $\lim\limits_{x\to 0} \frac{\tan(1-\{x\})\sin\{x\}\cos\{x\}}{\{x\}(1-\{x\})}$

(where $\{x\}$ denotes fractional part and $[x]$ denotes greatest integer)

1) 1 2) tan 1 3) cos 1 4) does not exist

SECTION-II
(NUMERICAL VALUE ANSWER TYPE)

This section contains 5 questions. The answer to each question is a Numerical value. If the Answer in the decimals , **Mark nearest Integer only.**
Marking scheme: +4 for correct answer, -1 in all other cases.

---

71. Consider the set of eight vectors $V = \{a\hat{i} + b\hat{j} + c\hat{k} \; ; a,b,c \in \{-1,1\}\}$. Three non-coplanar vectors can be chosen from V in 2^p ways. Then p is

72. Let $0 \le a,b,c,d \le \pi$, where b and c are not complementary, such that $2\cos a + 6\cos b + 7\cos c + 9\cos d = 0$ and such that

$2\sin a - 6\sin b + 7\sin c - 9\sin d = 0$, then the value of $3\frac{\cos(a+d)}{\cos(b+c)}$ is _____

73. Given $(1+x+x^2)^8 = \sum\limits_{k=0}^{16} a_k x^k$ then the value of $\begin{pmatrix} a_3 & a_7 & a_{13} \\ a_4 & a_6 & a_{12} \\ a_5 & a_4 & a_{11} \end{pmatrix}$ = ...

74. If $S_n = \sum\limits_{r=1}^{n} \tan^{-1}\left(\frac{2(2r-1)}{4+r^2(r^2-2r+1)}\right)$ then find the value of $\lim\limits_{n\to\infty} \sum\limits_{k=2}^{n} (\cot(S_{k-1}) - \cot(S_k))$.

75. If $I=\int\left(x^2+1\right)\left((x+1)e^x\right)^2 dx=A\left(f\left(x\right)\right)^2+C$, where C is constant of integration and $f\left(-1\right)=\frac{2}{e}$, then $2A+f\left(0\right)$ is

KEY SHEET

PHYSICS

1	**2**	2	**1**	3	**4**	4	**3**	5	**1**
6	**4**	7	**2**	8	**1**	9	**4**	10	**3**
11	**3**	12	**1**	13	**3**	14	**1**	15	**1**
16	**3**	17	**2**	18	**4**	19	**4**	20	**1**
21	**8**	22	**0**	23	**25**	24	**13**	25	**1**

CHEMISTRY

26	**4**	27	**2**	28	**3**	29	**1**	30	**1**
31	**3**	32	**2**	33	**1**	34	**4**	35	**1**
36	**2**	37	**1**	38	**2**	39	**3**	40	**3**
41	**4**	42	**3**	43	**3**	44	**4**	45	**1**
46	**2**	47	**138**	48	**7**	49	**9**	50	**158**

MATHEMATICS

51	**B**	52	**B**	53	**A**	54	**A**	55	**B**
56	**B**	57	**A**	58	**A**	59	**B**	60	**C**
61	**C**	62	**D**	63	**D**	64	**D**	65	**B**
66	**D**	67	**A**	68	**A**	69	**B**	70	**D**
71	**5**	72	**7**	73	**0**	74	**2**	75	**2**

SOLUTIONS
PHYSICS

1. $v\cos\left(30^0\right)=v_0\cos 60^0$

$$v=\frac{v_0}{\sqrt{3}}$$

$$e=\frac{\frac{v_0}{2\sqrt{3}}}{\frac{v_0\sqrt{3}}{2}}=\frac{1}{3}$$

2. $P=2P_l+P_m$
3. Conceptual
4. Applying conservation of energy

$$Mgh=\frac{1}{2}Mv_0^2+\frac{1}{2}I\omega_0^2=\frac{1}{2}M\left(\frac{5v_0}{4}\right)^2\Rightarrow I=\frac{9MR^2}{16}$$

$$Mx^2=I\Rightarrow x=\frac{3R}{4}$$

$n=3$

5. For conservative forces, $dU=-dW$

$U_f-U_i=-W_{i-f}$

Or $W_{i\to f}=U_i-U_f=q\left(V_i-V_f\right)$

$5\times10^{-5}=2\times10^{-6}\left[2a\left(0.1\right)^2-0\right]$

Or $a=1.25\times10^3\ V/m^2=1250\ V/m^2$

6. Magnetic moment $M=NIA$

$$M=I_0\frac{\sqrt{3}}{4}\left(\sqrt{2}a\right)^2=\frac{\sqrt{3}}{2}I_0a^2$$

7.

$H^2+H^2\to He^4+E$

$Q=\left(2m_4-m_{He}\right)C^2=23.83Mev$

For one gram of He

$E=\frac{1}{4}\times6.022\times10^{23}\times23.83Mev$

Mass of coal

$$m=\frac{E}{30Kj/gm}\times2\times10^4\ kg$$

8. $S_{av}=\frac{P}{4\pi R^2}=\frac{1}{2}\epsilon_0\,cE_0^2$

$$\therefore E_0=\sqrt{\frac{P}{2\pi R^2\,\epsilon_0\,c}}$$

$$=\sqrt{\frac{3}{2\times3.14\times100\times8.85\times10^{-12}\times3\times10^8}}$$

=1.34 V/m

9. Mass of the sphere is given by $M=\frac{4}{3}\pi y^3\rho$

Gravitational force $F=\frac{G\left(\frac{4}{3}\pi y^3\rho\right)m}{y^2}$

$a=\frac{F}{m}$.

10. $\frac{a_0}{g}=\tan\theta\Rightarrow a_0=\frac{g}{\sqrt{3}}$

11. $v\cos 37^0=20\cos 53^0$

$v\cos 37^0=20\times\frac{3}{5}\Rightarrow v=15m/s$

12. $\rho=\frac{m}{l\pi r^2}$

$\frac{\Delta\rho}{\rho}=\frac{\Delta m}{m}+\frac{2\Delta r}{r}+\frac{\Delta l}{l}$

$=\frac{0.003}{0.3}+\frac{2\times 0.005}{0.5}+\frac{0.06}{6}\quad=\frac{4}{100}=4\%$

13. $\left[(n-1)t\right]\frac{D}{d}=\frac{\lambda(2D)}{d}$

$\Rightarrow\lambda=\frac{(n-1)t}{2}=5892\ A$

14. $(2v_0)\times e\geq v_0\times\sqrt{3}\Rightarrow e\geq\frac{\sqrt{3}}{2}$

Here, $v_0=\sqrt{gR}$

15. $\lambda=\frac{kT}{\sqrt{2}\pi D^2 p}\Rightarrow\lambda p=\text{constant}$

16. Conceptual

17. Since ML = Pt

$\Rightarrow L=\frac{Pt}{M}$

18. When one e^- is removed from neutral helium atom, it

For one e^- species we know

$E_n=\frac{-13.6Z^2}{n^2}\text{eV/atom}$

For helium ion, Z=2 and for first orbit n=1

$\therefore E_1=\frac{-13.6}{(1)^2}\times 2^2=-54.4eV$

$\therefore$ Energy required to removed this e^- =+54.4eV

$\therefore$ total energy required =54.4+24.6=79eV

19. $n=\frac{10^{-3}}{200\times 10^6\times 1.6\times 10^{-19}}$

20. use wheatstone bridge condition

21. Wave velocity as a function of distance (x) from top is

$$v=\sqrt{\frac{T}{\mu}}=\sqrt{g(9-x)}$$

$$\therefore \int_0^h \frac{dx}{\sqrt{g(9-x)}}=\int_0^{\sqrt{\frac{2h}{g}}} dt \left(time\ takenby\ stone=\sqrt{\frac{2h}{g}} \right)$$

$$\Rightarrow h=8m$$

22. At steady state 10Ω resistor will be short circuited

23. $$\frac{u^2}{g}=100$$

$$\theta=45^0$$

$$\frac{u^2\sin^2\theta}{2g}=25m$$

24. Heat is extracted from the source in path DA and AB is

$$\Delta Q=\frac{3}{2}R\left(\frac{P_0V_0}{R}\right)+\frac{5}{2}R\left(\frac{2P_0V_0}{R}\right)=\frac{13}{2}P_0V_0$$

25. $$\vec{B}=\vec{B_1}+\vec{B_2}$$

$$\vec{B}=0\Rightarrow \vec{B_1}=-\vec{B_2}$$

$$\frac{\mu_0 I_0}{2\pi d}+\frac{\mu_0 I_1}{2R}=0$$

$$I_1=\frac{-I_0R}{\pi d}$$

CHEMISTRY

26. Hybradisation

27. $S = \frac{7.8}{78} \times 10^{-4} mol/l = 10^{-5} mol/l$

$K_{SP} = 4S^3 = 4 \times 10^{-15}$

$\therefore log_{10} K_{SP} = \log 4 - 15 = -14.4$

28. Friedal Crafts alkylation, rearrangement

29.

30. Conceptual

31. $\underset{(C)}{H^+} \rightleftharpoons \underset{(A)}{H^+}$

$E_{cell} = -\frac{0.06}{1} \log \frac{0.001}{0.2} = 0.06 \log 2 \times 10^2 = 0.06(0.3 + 2) = 0.06 \times 2.3 = 138V$

32. $A = I_2, B = IO_3^-$

33. Conceptual

34. Ncert Points

35. Conceptual

36. BCD are correct

37. $\Delta H = 120 - 350 - 380 = -610 Kj/\text{mol}$

38. Conceptual

39. Conceptual

40. Sulphur

41. Conceptual

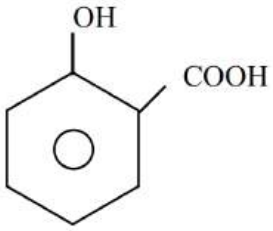
42. Conceptual

43. Conceptual

44. $\Delta T_f = K_f mi = 5 \times 0.4 \times 3 = 6$

45. Conceptual

46. $2\pi r = n\lambda, 2\pi \times 0.53 \times 2 = \lambda$

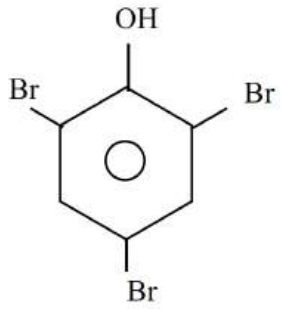


47.

48. Conceptual

49. Conceptual

50.

S= 

=331 T= 

=173

MATHS

51. 61 $\alpha = \text{cis}\left(\frac{8\pi}{11}\right)$

$\text{Re}\left(\alpha+\alpha^2+\alpha^3+\alpha^4+\alpha^5\right)=-\frac{1}{2}$

$1+\alpha+\alpha^2+\alpha^3+\alpha^4+....+\alpha^{10}=0$

$\Rightarrow 2\,\text{Re}\left(\alpha+\alpha^2+....+\alpha^5\right)=-1$

52. Use the theory of combined mean and combined variance formulae

53. $\left(1-\frac{1}{2^3}\right)+\left(\frac{1}{2^3}-\frac{1}{3^3}\right)+\left(\frac{1}{3^3}-\frac{1}{4^3}\right)+----=1$

54. $x^3-6x^2+3px-2p=0$

$x_4=x_2=x_3=2$

$=\frac{\pi}{2}+0-\frac{\pi}{4}=\frac{\pi}{4}$

55. $f(x)=-4e^{\frac{1-x}{2}}+1+x+\frac{x^2}{2}+\frac{x^3}{3}$

$g'\left(-\frac{7}{6}\right)=\frac{1}{f'(1)}=\frac{1}{5}$

56. $g(t)=\frac{\pi}{2}-2\cot^{-1}\left(3^{-t}\right)$

$g(-t)=\frac{\pi}{2}-2\tan^{-1}\left(3^{-t}\right)=-\frac{\pi}{2}+2\cot^{-1}\left(3^{-x}\right)$

$\Rightarrow$ odd

$g'(t)=2.\frac{1}{1+3^{-2t}}.3^{-t}(-\log 3)$

$\Rightarrow$ decreasing

57. $\frac{dy}{dx}\left(\frac{1+\cos x}{y}\right)=-\sin x,\ f\left(\frac{\pi}{2}\right)=1$

$\Rightarrow \frac{dy}{dx}=\frac{-\sin x.y}{1+\cos x}$

$\Rightarrow \frac{1}{y}dy=-\tan\frac{x}{2}dx$

$\log y=-2\log\sec\left(\frac{x}{2}\right)+c$

$0=-\log 2+c$

$\Rightarrow y=2\cos^2\left(\frac{x}{2}\right)$

$y(0)=2$

58. $\frac{x}{a}+\frac{y}{b}=1$

$\frac{1}{a}+\frac{4}{b}=1$

$S=a+b=b+\frac{b}{b-4}$

$=1+b+\frac{4}{b-4}$

$\frac{ds}{db}=1-\frac{4}{(b-4)^2}$

$b-4=2,-2$

$b=6,2$

$\Rightarrow b=6\ ;\ a=3$

$A=9$

59. $(\bar{a}\times\bar{b}).\bar{c}=1$

$\bar{c}=\lambda\,\bar{a}\times\bar{b}$

$|\bar{a}|=\sqrt{2},\ |\bar{b}|=\sqrt{3},\ |c|=\frac{1}{\sqrt{3}}$

$\Rightarrow \frac{1}{\sqrt{3}}=\lambda\sqrt{2}\times\sqrt{3}(\sin\theta)$

$\lambda\sin\theta=\frac{1}{3\sqrt{2}}$

$\Rightarrow (\bar{a}\times\bar{b}).\bar{c}=\lambda\left(2\times3\times\sin^2\theta\right)=1$

$6\sin\theta=3\sqrt{2}$

$\sin\theta=\frac{1}{\sqrt{2}}$

$\theta=\frac{\pi}{4}$

60. Any point on the line $\frac{x-1}{1}=\frac{y}{-1}=\frac{z+2}{2}$ is B $(t+1,-t,2t-2)$, t $\in$ R

Also AB is perpendicular true the line where A is (1,2,-4)

That is $1(t)-(-t-2)+2\times(2t+2)=0$

$\Rightarrow t=-1$

$\Rightarrow$ B=$(0,1,-4)$

$\Rightarrow AB=\sqrt{2}$

61. Standard problem

62. $ax^2+bx^6+cx^5+....+h=\begin{vmatrix} x+1 & x^2+2 & x^2+x \\ x^2+x & x+1 & x^2+1 \\ x^2+2 & x^2+x & x+1 \end{vmatrix}$

$\Rightarrow h=\begin{vmatrix} 1 & 2 & 0 \\ 0 & 1 & 1 \\ 2 & 0 & 1 \end{vmatrix}=1-2(-2)=5$

63. $\sin^4 x-(k+2)\sin^2 x-(k+3)=0$

$k+2=k+3-1$

$(\sin^2 x-(k+3))(\sin^2 x+1)=0$

$\Rightarrow 0\le k+3\le 1$

$(-3\le k\le -2)$

64. $11^{2012}+23^{2014}-3^{2012}=1$

$I=\int_0^1 \frac{1}{\sqrt{1-x^2}-x+\frac{1}{x}}dx$

$=\int_0^1 \frac{x}{1-x^2+x\sqrt{1-x^2}}dx=\frac{\pi}{4}$

65. A) Area $=2\int_0^2 ydy$

B) Standard formula

C) Area $=\frac{\pi}{4}ab-\frac{1}{2}ab.$

D) Area $=\int_1^2 1dx$

67. $S=\{1,2,3,.....,50\}$

Ways $=2^{50}-2^{25}$

$=2^{25}(2^{25}-1)$

68. $\{1,2,3,.....,50\}$

6^m+9^n multiple of 5

$6^m\rightarrow 6$

$9^n\rightarrow 9/1$

ways $=50\times 25$

69. $P(E)=1-\frac{63}{127}$

70. $\lim\limits_{x\to 0}\dfrac{\tan(1-\{x\})\sin\{x\}\cos\{x\}}{\{x\}(1-\{x\})}$

$x\to 0^+,\ \{n\}\to 0^+\Rightarrow\{x\}=x$

$x\to 0^-,\ \{n\}\to 1^-\Rightarrow\{x\}=x+1$

71. $V=\{ai+bj+ck\ ;\ a,b,c\in\{-1,1\}\}$

ways $={}^8C_3-6\times{}^4C_3=8\times 7-6\times 4=2^5$

72. $0\le a,b,c,d\le\pi$

$2\cos a+6\cos b+7\cos c+9\cos d=0$

$2\cos a-6\sin b+7\cos c-9\sin d=0$

$\Rightarrow 4+81+36\cos(a+d)=36+4+84\cos(b+c)$

$\dfrac{\cos(a+d)}{\cos(b+c)}=\dfrac{21}{9}=\dfrac{7}{3}$

73. $\begin{vmatrix}a_3 & a_7 & a_{13}\\ a_4 & a_6 & a_{12}\\ a_5 & a_4 & a_{11}\end{vmatrix}=$

$\Rightarrow(1+x+x^2)^8=\sum\limits_{r=0}^{16}a_r\ x^{16-r}$

So, $\Delta=0$

74. $S_n=\sum\limits_{r=1}^{n}\tan^{-1}\left(\dfrac{2(2r-1)}{4+r^2(r^2-2r+1)}\right)$

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

$\Rightarrow \ell=\lim\limits_{n\to\infty}\sum\limits_{x=2}^{n}(\cot S_{n-1}-\cot S_n)$

$=(\cot S_1-\cot S_n)$

75. $I=\int(x^2+1)\left((x+1)e^x\right)^2\ dx$

$(x^2+1)e^x=t$

$\Rightarrow(x+1)^2e^x dx=dx$

$I=\dfrac{1}{2}\left((x^2+1)e^x\right)^2+c$

$=\dfrac{1}{2}(f(x))^2+c$

$2A+f(0)=1+1=2$