Section-I (PHYSICS)

Single Correct Type Questions

1. A man starts running along a straight road with uniform velocity $\vec{u} = u\hat{i}$ feels that the rain is falling vertically down along $\hat{j}$. If he doubles his speed, he finds that the rain is coming at an angle θ to the vertical. The velocity of rain with respect to the ground is

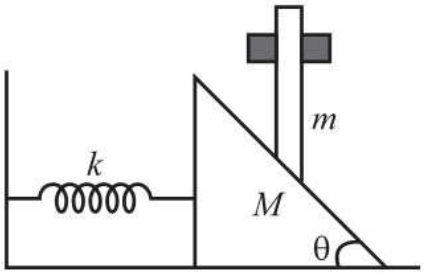
(1) $u\hat{i} - u\tan\theta\hat{j}$

(2) $u\hat{i} - \frac{u}{\tan\theta}\hat{j}$

(3) $u\tan\theta\hat{i} - u\hat{j}$

(4) $\frac{u}{\tan\theta}\hat{i} - u\hat{j}$

2. A wedge of mass *M* fitted with a spring of stiffness '*k*' is kept on a smooth horizontal surface. A rod of mass *m* is kept on the wedge as shown in the figure. System is in equilibrium. Assuming that all surfaces are smooth, the potential energy stored in the spring is



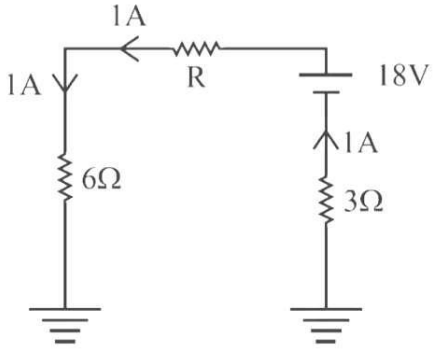
(1) $\frac{mg^2\tan^2\theta}{2K}$

(2) $\frac{m^2g\tan^2\theta}{2K}$

(3) $\frac{m^2g^2\tan^2\theta}{2K}$

(4) $\frac{m^2g^2\tan^2\theta}{K}$

3. If 1 A current flows in the circuit as shown then the value of R is



(1) 2 Ω (2) 3 Ω

(3) 9 Ω (4) 10 Ω

4. When radiation with a continuous spectrum is passed through a volume of hydrogen gas whose atoms are all in the ground state, which spectral series will be present in the resulting absorption spectrum?

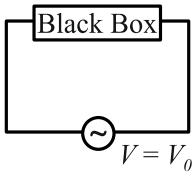
(1) Lyman

(2) Balmer

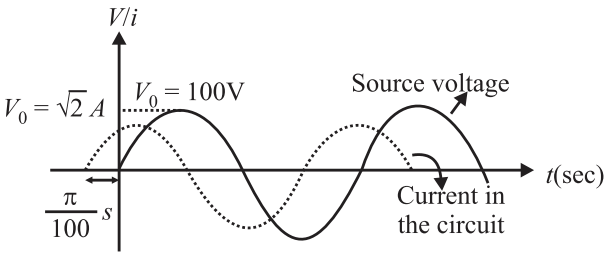
(3) Paschen

(4) Brackett

5. A voltage source $V = V_0\sin(100t)$ is connected to a black box in which there can be either one element out of L, C, R or any two of them connected in series.



At steady state, the variation of current in the circuit and the source voltage are plotted together with time, using an oscilloscope, as shown

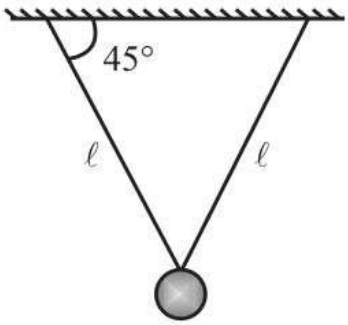


The element(s) present in black box is/are :

(1) only C (2) L and C

(3) L and R (4) R and C

6. Time period of small oscillation (in a vertical plane normal to the plane of strings) of the bob in the arrangement shown will be



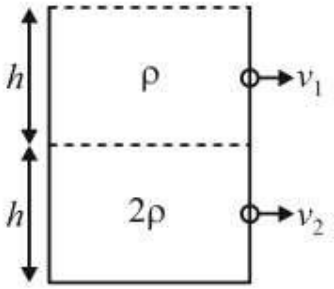
(1) $2\pi\sqrt{\frac{\ell}{g}}$

(2) $2\pi\sqrt{\frac{\ell}{\sqrt{2}g}}$

(3) $2\pi\sqrt{\frac{\sqrt{2\ell}}{g}}$

(4) $2\pi\sqrt{\frac{2\ell}{g}}$

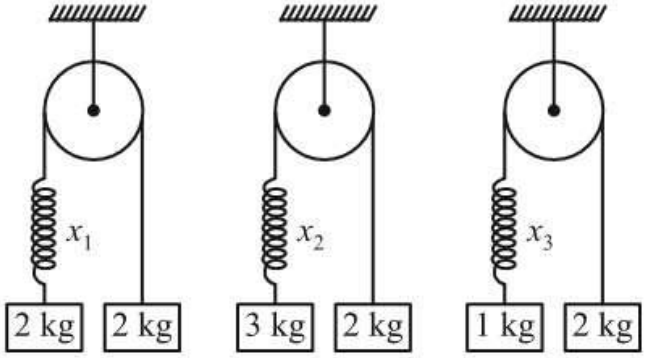
7. Equal volume of two immiscible liquids of densities ρ and 2ρ are filled in a vessel as shown in figure. Two small holes are punched at depth $\frac{h}{2}$ and $\frac{3h}{2}$ from the surface of lighter liquid. If v_1 and v_2 are the velocities of efflux at these two holes, then $\frac{v_1}{v_2}$ is



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

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

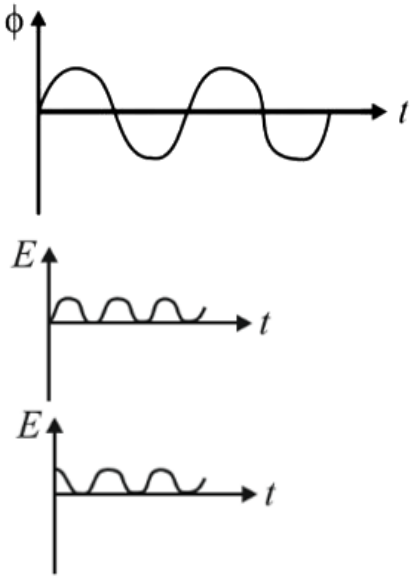
8. Same spring is attached with 2kg, 3kg and 1kg blocks in three different cases as shown in figure. If x_1, x_2 and x_3 be the extensions in the spring in these three cases then



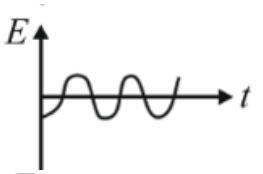
(1) $x_1 = 0, x_3 > x_2$ (2) $x_2 > x_1 > x_3$

(3) $x_3 > x_1 > x_2$ (4) $x_1 > x_2 > x_3$

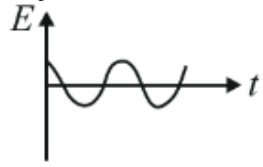
9. The magnetic flux through a coil varies with time t as shown in the diagram. Which graph best represents the variation of the e.m.f. E induced in the coil with time t?



(3)



(4)

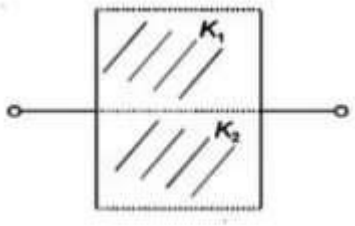


10. An emf of 15 volt is applied in a circuit containing 5 henry inductance and 10 ohm resistance in series. The ratio of the currents at time $t = \infty$ and at $t = 1$ second is

(1) $\frac{e^{1/2}}{e^{1/2}-1}$ (2) $\frac{e^2}{e^2-1}$

(3) $1-e^{-1}$ (4) e^{-1}

11. A capacitor of plate area A and separation d is filled with two dielectrics of dielectric constant $K_1 = 6$ and $K_2 = 4$. New capacitance will be



(1) $4\frac{A\varepsilon_0}{d}$ (2) $4.8\frac{A\varepsilon_0}{d}$

(3) $5\frac{A\varepsilon_0}{d}$ (4) $2.4\frac{A\varepsilon_0}{d}$

12. Identify the correct statement(s) from the following.

I. Work-energy theorem is not independent of Newton's second law.

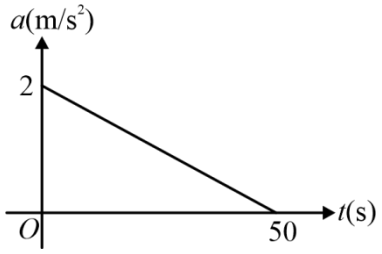
II. Work-energy theorem holds in all inertial frames.

III. Work done by friction over a closed path is zero.

(1) I only (2) II and III

(3) I and II (4) I, II and III

13. Referring to a-t diagram, find the velocity of the particle at t = 20 s. Assume that the particle was at the origin at t = 0 and was moving with a velocity of 10 m/s in negative x-direction:-



(1) 20 m/s

(2) 22 m/s

(3) 18 m/s

(4) 42 m/s

14. Match the List I and II.

	List I		List II
(A)	Joule	(1)	MLT^{-2}
(B)	Newton	(2)	$ML^{-1}T^{-2}$
(C)	Hertz	(3)	$ML^{2}T^{-2}$
(D)	Pascal	(4)	$M^{0}L^{0}T^{-1}$

(1) (A) → (4); (B) → (2); C→ (1); (D) → (3)
(2) (A) → (1); (B) → (2); C→ (4); (D) → (3)
(3) (A) → (3); (B) → (1); C→ (4); (D) → (2)
(4) (A) → (2); (B) → (4); C→ (1); (D) → (3)

15. A small mass slides down an inclined plane of inclination θ with the horizontal. The coefficient of friction is $\mu = \mu_0 x$, where x is the distance through which the mass slides down and μ_0 is a positive constant. Then, the distance covered by the mass before it stops is

(1) $\frac{2}{\mu_0}\tan\theta$ (2) $\frac{4}{\mu_0}\tan\theta$

(3) $\frac{1}{2\mu_0}\tan\theta$ (4) $\frac{1}{\mu_0}\tan\theta$

16. Two bar magnets oscillate in a horizontal plane in earth's magnetic field with time periods of 3s and 4s respectively. If their moments of inertia are in the ratio of 3:2, then the ratio of their magnetic moments will be:

(1) 2:1
(2) 8:3
(3) 1:3
(4) 27:16

17. In an L-R series circuit $\left(L = \frac{175}{11}\text{mH} \text{ and } R = 12\Omega\right)$, a variable emf source $\left(V = V_0 \sin\omega t\right)$ of $V_{\text{rms}} = 130\sqrt{2}$ V and frequency 50 Hz is applied. The current amplitude in the circuit and phase of current with respect to voltage are respectively (Use $\pi = 22/7$)

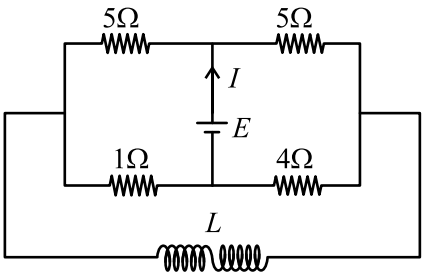
(1) $14.14\ A, 30^\circ$

(2) $10\sqrt{2}\ A, \tan^{-1}\frac{5}{12}$

(3) $10\ A, \tan^{-1}\frac{5}{12}$

(4) $20\ A, \tan^{-1}\frac{5}{12}$

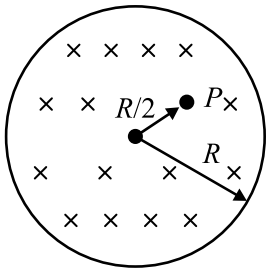
18. The current (I) at time $t = 0$ and $t = \infty$ respectively for the given circuit is:



(1) $\frac{5E}{18}, \frac{18E}{55}$ (2) $\frac{18E}{55}, \frac{5E}{18}$

(3) $\frac{5E}{18}, \frac{10E}{33}$ (4) $\frac{10E}{33}, \frac{5E}{18}$

19. A uniform but time varying magnetic field $B = \left(2t^3 + 24t\right)$ T is present in a cylindrical region of radius R = 2.5 cm as shown in figure. The direction of circular electric lines at t = 1s is



(1) Clockwise
(2) Anticlockwise
(3) No current is induced
(4) Cannot be predicted

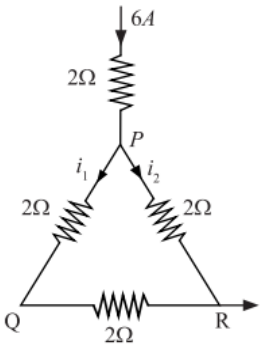
20. A current I is passing through a wire having two section P and Q of uniform diameters d and $d/2$ respectively. If the mean drift velocity of electron in sections P and Q is denoted by v_P and v_Q respectively, then

(1) $v_P = v_Q$ (2) $v_P = \frac{1}{2}v_Q$

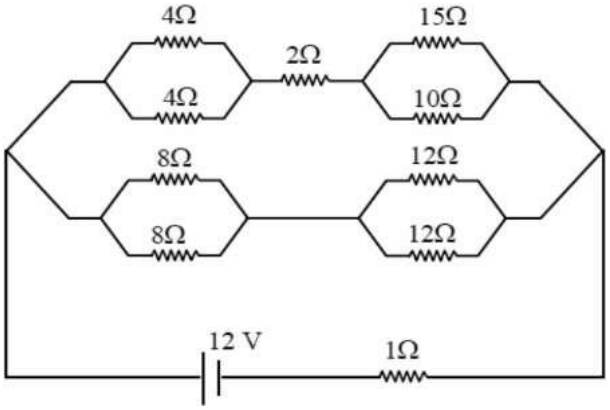
(3) $v_P = \frac{1}{4}v_Q$ (4) $v_P = 2v_Q$

Integer Type Questions

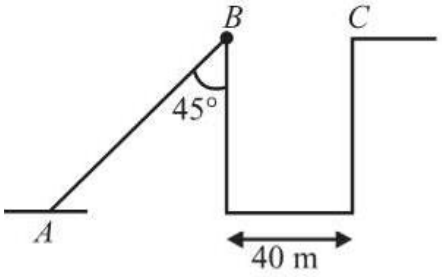
21. A current of 6 A enters one corner P of an equilateral triangle PQR having 3 wires of resistance 2Ω each and leaves by the corner R. The current i_1 in ampere is _____



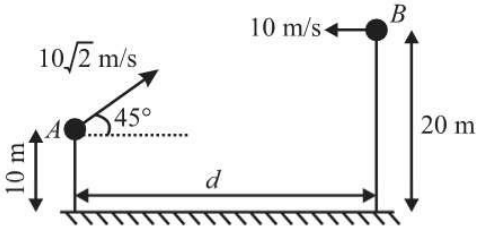
22. The voltage drop across $15\,\Omega$ resistance in the given figure will be ____ V.



23. A body is projected up a smooth inclined plane with a velocity u from the point A as shown in the Figure. The angle of inclination is 45° and the top is connected to a well of diameter 40m. If the body just manages to cross the well. Length of inclined plane is $20\sqrt{2}m$. If the value of $u = n\sqrt{2}$ m / s . Find n.



24. Two particles are projected from the two towers simultaneously, as shown in the figure. What should be value of 'd' (in m) for their collision.

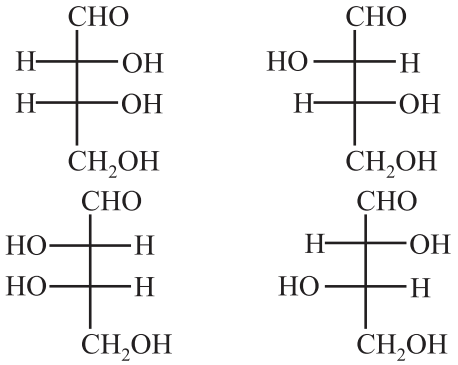


25. A new system of unit is evolved in which the values of μ_o and ε_0 are 2 and 8 respectively. Then the speed of light in this system will be $\frac{x}{100}$ m/sec. Find x.

Section-II (CHEMISTRY)

Single Correct Type Questions

26. The correct corresponding order of names of four aldoses with configuration given below respectively, is

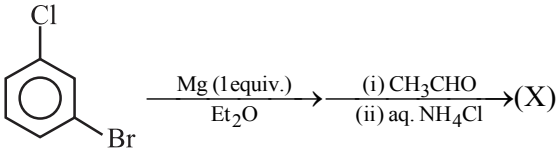


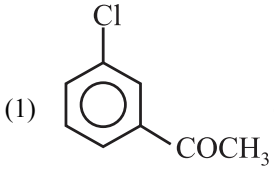
(1) L-erythrose, L-threase. L-erythrose. D-threase
(2) D-threose, D-erythrose. L-threose, L-erythrose
(3) L-erythrose, L-threose. D-erythrose. D-threose
(4) D-erythrose, D-threose, L-erythrose, L-threose

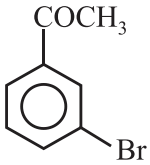
27. The weight of AgCl precipitated when a solution containing 5.85 g of NaCl is added to a solution containing 3.4 g of $AgNO_3$ is

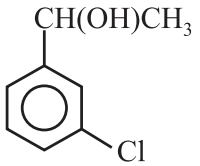
(1) 28 g (2) 9.25 g
(3) 2.870 g (4) 58 g

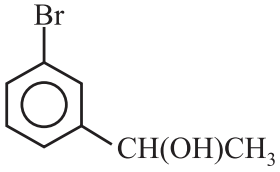
28. The product (X) of the following reaction is



(1) 

(2) 

(3) 

(4) 

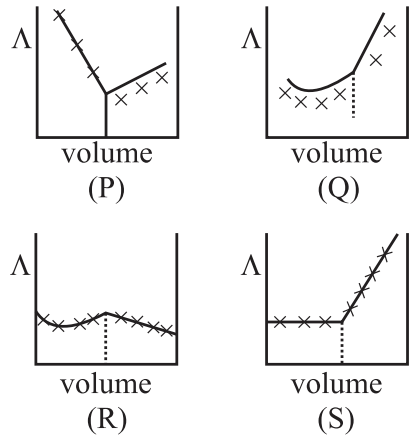
29. According to VBT the extent of overlapping depends upon types of orbitals involved in overlapping and nature of overlapping. More will be the overlapping and the bond energy will also be high.
Which of the following compound does not form $p\pi - p\pi$ bond ?

(1) SO_3 (2) NO_3^-
(3) SO_4^{2-} (4) CO_3^{2-}

30. Which one of the following cyano complexes would exhibit the lowest value of paramagnetic behaviour?

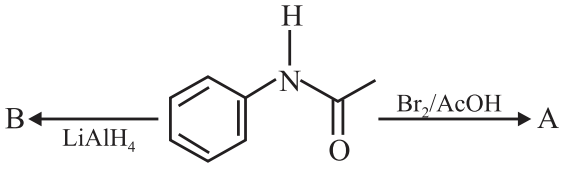
(1) $\left[Cr(CN)_6\right]^{3-}$
(2) $\left[Co(CN)_6\right]^{3-}$
(3) $\left[Fe(CN)_6\right]^{3-}$
(4) $\left[Mn(CN)_6\right]^{3-}$

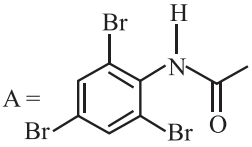
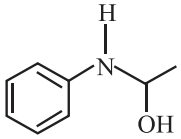
31. $AgNO_3$ (aq.) was added to an aqueous KCl solution gradually and the conductivity of the soluiton was measured. The plot of conductacne (Λ) versus the volume of $AgNO_3$ is

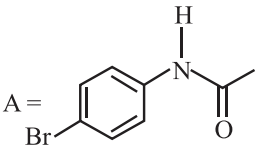
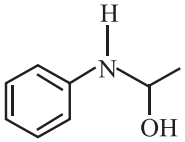


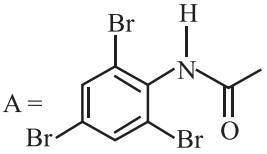
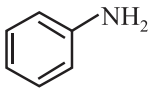
(1) (P) (2) (Q)
(3) (R) (4) (S)

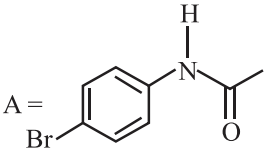
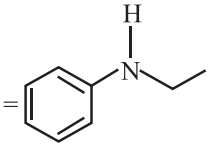
32. The major products A and B from the following reactions are:



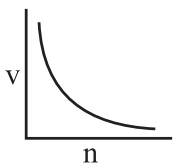
(1) A =  , B = 

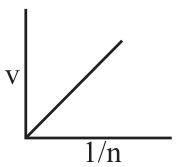
(2) A =  , B = 

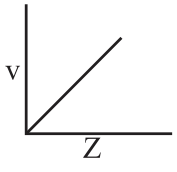
(3) A =  , B = 

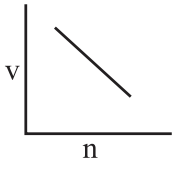
(4) A =  , B = 

33. Select the incorrect graph for velocity of electrons in an orbit vs. Z, $\frac{1}{n}$ and n .

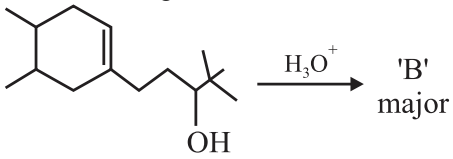
(1) 

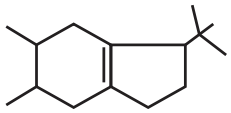
(2) 

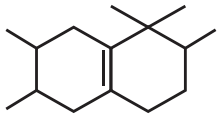
(3) 

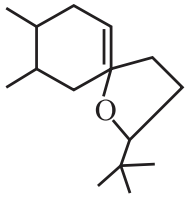
(4) 

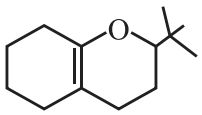
34. In the following reaction, 'B' is



(1) 

(2) 

(3) 

(4) 

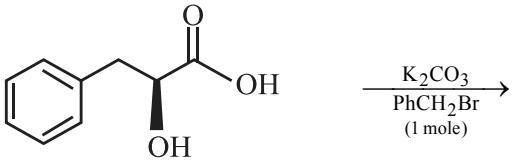
35. Consider the following reaction.

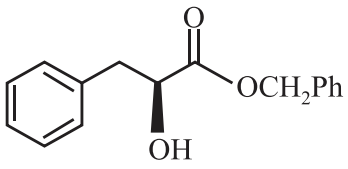
$$aMnO_4^{-1} + bH_2O_2 + cH^+ \rightarrow dMn^{2+} + eO_2 + fH_2O$$

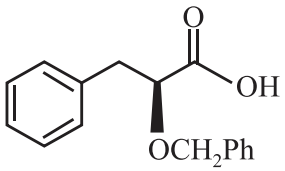
On balancing ratio of the coefficients of H_2O_2 and O_2 will be

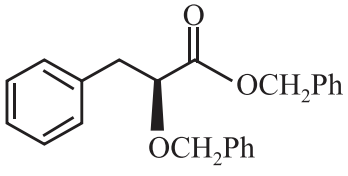
(1) 4 : 1 (2) 1 : 4
(3) 2 : 3 (4) 1 : 1

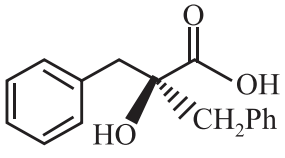
36. The major product in the following reaction :



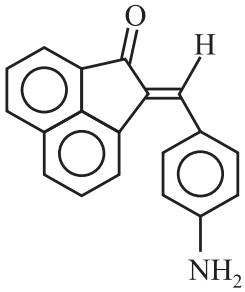
(1) 

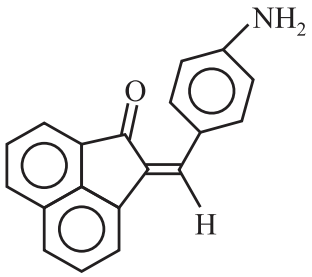
(2) 

(3) 

(4) 

37. Chalcone is anticancer and antiviral drug exist in two forms

A. 

B. 

The compound (A) and (B) are respectively

(1) E and E isomers

(2) E and Z isomers

(3) Z and Z isomers

(4) Z and E isomers

38. In the wet tests for identification of various cations by precipitation, which transition element cation doesn't belong to group IV in qualitative inorganic analysis?

(1) Fe^{3+} (2) Zn^{2+}

(3) Co^{2+} (4) Ni^{2+}

39. Triad - I $\left[N^{3-}, O^{-}, Na^{+}\right]$

Triad – II $\left[N^{+}, C^{+}, O^{+}\right]$

Choose the species of lowest I.P from triad-I and highest I.P from triad-II respectively

(1) N^{3-}, O^{+} (2) Na^{+}, C^{+}

(3) N^{3-}, N^{+} (4) O^{-}, C^{+}

40. The correct order of decreasing ionic nature of lead dihalides is:

(1) $PbF_2 > PbCl_2 > PbBr_2 > PbI_2$

(2) $PbF_2 > PbBr_2 > PbCl_2 > PbI_2$

(3) $PbF_2 \langle PbCl_2 \rangle PbBr_2 < PbI_2$

(4) $PbI_2 < PbBr_2 < PbCl_2 < PbF_2$

41. The major product of the following reaction is

$$CH_3CH_2-\underset{\underset{Br}{|}}{CH}-\underset{\underset{Br}{|}}{CH_2} \xrightarrow[(ii)\ NaNH_2 \text{ in liq. } NH_3]{(i)\ \text{alc. KOH}}$$

(1) $CH_3CH=C=CH_2$

(2) $CH_3CH_2C\equiv CH$

(3) $CH_3CH_2-\underset{\underset{NH_2}{|}}{CH}-\underset{\underset{NH_2}{|}}{CH_2}$

(4) $CH_3CH=CHCH_2NH_2$

42. A solution containing 4 g of polyvinyl chloride in 1 litre of dioxane was found to have an osmotic pressure of 6×10^{-4} atm at 300 K. The molecular mass of polymer is -

(1) 3×10^{3} (2) 1.6×10^{5}

(3) 5×10^{4} (4) 6.4×10^{2}

43. What is the pH of a solution of 0.28M acid and 0.84 M of its conjugate base if the ionization constant of acid is 4×10^{-4}

(1) 3.88 (2) 3.34

(3) 7 (4) 10.12

44. The rate constant for a chemical reaction taking place at 500 K is expressed as $k = Ae^{-1000}$. The activation energy of the reaction is y × 10^6 cal mol^{-1}. The value of 'y' is:

(Take R = 2 cal mol^{-1} K^{-1})

(1) 100 (2) 1

(3) 10^4 (4) 10^6

45. The standard enthalpies of formation of $H_2O(l)$, $Li^{+}(aq)$ and $OH^{-}(aq)$ are –285.8, –278.5 and –228.9 kJ / mol, respectively. The standard enthalpy change for the below reaction is

$$2Li(s)+2H_2O(l)\rightarrow 2Li^{+}(aq)+2OH^{-}(aq)+H_2(g)$$

(1) +443.2 kJ (2) –443.2 kJ

(3) –221.6 kJ (4) +221.6 kJ

Integer Type Questions

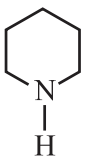
46. Amongst the following Kjeldahls method cant be used for

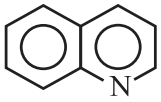
I. $PhNO_2$

II. $Ph-N=N-Ph$

III. PhNHCOPh

IV. 

V. 

VI. 

VII. $PhNH_2$

VIII. Acetone

IX. Ethane nitrile

X. Urea

47. Thermal decomposition of $AgNO_3$ produces two paramagnetic gases. The total number of electrons present in the antibonding molecular orbitals of the gas that has the higher number of unpaired electrons is

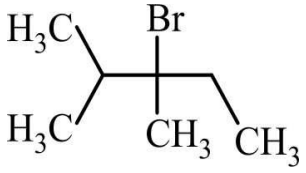
48. $\left[Ti(H_2O)_6\right]^{3+}$ absorbs light of wavelength $498\,nm$ during a d-d transition. The octahedral splitting energy for the above complex is ____ $\times 10^{-19}$ J . (Round off to the Nearest Integer).
$h = 6.626\times10^{-34} Js; c = 3\times10^{8}\ ms^{-1}$

49. The sum of stereoisomers of complex-A, complex-B and complex-C in following reaction is ...

$$[PtCl_4]^{2-} \xrightarrow[-2Cl^-]{+2\text{ (Pyridine)}} [\text{Complex} - A] \xrightarrow[-Cl^-]{+NH_3}$$

$$[\text{Complex} - B] \xrightarrow[-\text{(Pyridine)}]{+Br^-} [\text{Complex} - C]$$

50. Number of structural isomers products in β-E_2 elimination of following compound is



Section-III (MATHEMATICS)

Single Correct Type Questions

51. If $\vec{a},\vec{b},\vec{c}$ are non coplanar vectors and λ is a real number then
$\left[\lambda\left(\vec{a}+\vec{b}\right)\lambda^2\vec{b}\lambda\vec{c}\right]=\left[\vec{a}\vec{b}+\vec{c}\vec{b}\right]$ for

(1) exactly one value of λ
(2) no value of λ
(3) exactly three values of λ
(4) exactly two values of λ

52. The image of circle $x^2+y^2-2x+4y-4=0$ with respect to line $x-y+5=0$ is

(1) $x^2+y^2+14x-12y+76=0$
(2) $x^2+y^2-14x-12y+76=0$
(3) $x^2+y^2-14x+12y+76=0$
(4) $x^2+y^2-14x-12y-76=0$

53. Let $R=\{(x,y);x,y\in N \text{ and } x^2-4xy+3y^2=0\}$, where N is the set of all natural numbers. Then the relation R is:

(1) reflexive but neither symmetric nor transitive.
(2) symmetric and transitive.
(3) reflexive and symmetric,
(4) reflexive and transitive.

54. If the ellipse $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ is inscribed in a rectangle whose length to breadth ratio is 3 : 2, then the area of rectangle is

(1) $\frac{2}{13}\left(a^2+b^2\right)$ (2) $\frac{24}{13}\left(a^2+b^2\right)$
(3) $\frac{9}{13}\left(a^2+b^2\right)$ (4) $\frac{8}{9}\left(a^2+b^2\right)$

55. A fair die is tossed eight times. The probability that a third six is observed on the eighth throw is

(1) ${}^7C_2\frac{5^5}{6^8}$ (2) ${}^7C_3\frac{5^3}{6^8}$
(3) ${}^7C_6\frac{5^6}{6^8}$ (4) None of these

56. If $x^2+2ax+b\ge c, \forall x\in R$, then

(1) $b-c\ge a^2$
(2) $a-b\ge c^2$
(3) $c-a\ge b^2$
(4) none of these

57. If tangents be drawn to the circle $x^2+y^2=12$ at its points of intersection with the circle $x^2+y^2-5x+3y-2=0$, then the tangents intersect at the point

(1) $\left(-6,\frac{18}{5}\right)$ (2) $\left(6,\frac{18}{5}\right)$
(3) $\left(-6,-\frac{18}{5}\right)$ (4) $\left(6,-\frac{18}{5}\right)$

58. If $x_1^2+x_2^2+2x_2+1=0$ and $y_1^2+y_2^2+2y_2+2y_1+2=0$, then the equation of the line joining (x_1,y_1) and (x_2,y_2) is

(1) $x=0$
(2) $x=-1$
(3) $y=1$
(4) $y=-1$

59. A hyperbola passes through the foci of the ellipse $\frac{x^2}{25}+\frac{y^2}{16}=1$. The transverse and conjugate axes of the hyperbola coincide with major and minor axes of the given ellipse. If the product of eccentricities of the given ellipse and the hyperbola is 1 and a focus of hyperbola is (k , 0) then | k | equals

(1) $\frac{10}{7}$ (2) 5

(3) 10 (4) None of these

60. Values of *a* and *b* are obtained by throwing an unbiased die for two times. What is the probability that roots of the equation $ax^2-2bx+7=0$ are real and distinct?

(1) $\frac{1}{2}$ (2) $\frac{13}{36}$

(3) $\frac{11}{36}$ (4) $\frac{7}{36}$

61. The equation of the common tangent to the parabolas $y^2=4ax$ and $x^2=4by$ is given by

(1) $xa^{1/3}+yb^{1/3}+a^{2/3}b^{2/3}=0$

(2) $xb^{1/3}+ya^{1/3}+a^{2/3}b^{2/3}=0$

(3) $xa^{1/3}+yb^{1/3}-a^{2/3}b^{2/3}=0$

(4) None of these

62. The coefficient of x^{20} in the polynomial $(1+x)^{22}+x(1+x)^{21}+x^2(1+x)^{20}+...+x^{20}(1+x)^2$ is

(1) ${}^{22}C_{19}$ (2) ${}^{23}C_3$

(3) ${}^{22}C_2$ (4) ${}^{23}C_{19}$

63. Equation of the line through the point (2,3,1) and parallel to the line of intersection of the planes $x-2y-z+5=0$ and $x+y+3z=6$ is

(1) $\frac{x-2}{-5}=\frac{y-3}{-4}=\frac{z-1}{3}$

(2) $\frac{x-2}{5}=\frac{y-3}{-4}=\frac{z-1}{3}$

(3) $\frac{x-2}{5}=\frac{y-3}{4}=\frac{z-1}{3}$

(4) $\frac{x-2}{4}=\frac{y-3}{3}=\frac{z-1}{2}$

64. The equation

$(2+\log_{10}x)^3+(\log_{10}x-\log_{10}10)^3$

$=\left(1+\log_{10}(x)^2\right)^3$ has

(1) Two irrational and one rational solutions

(2) One irrational and two rational solutions

(3) One irrational and two prime number solutions

(4) All rational solutions

65. Let coordinates of a point 'P' with respect to the system of non-coplanar vectors $\vec{a},\vec{b}$ and $\vec{c}$ is (3, 2, 1). Then coordinates of 'P' with respect to the system of vectors $\vec{a}+\vec{b}+\vec{c},\vec{a}-\vec{b}+\vec{c}$ and $\vec{a}+\vec{b}-\vec{c}$ is

(1) $\left(\frac{3}{2},\frac{1}{2},1\right)$ (2) $\left(\frac{3}{2},1,\frac{1}{2}\right)$

(3) $\left(\frac{1}{2},\frac{3}{2},1\right)$ (4) None

66. If number of words formed by rearranging all the letters of the YUVRAJSINGH such that, It must contains the phrase "YUVI" but not the phrase "IRA" is n, then the value of $\frac{n}{5!}$ is :

(1) 550 (2) 330

(3) 165 (4) 530

67. The area under the curve $y=|\cos x-\sin x|$, $0\le x\le\frac{\pi}{2}$ and above x-axis is:

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

(3) $2\sqrt{2}+2$ (4) None of these

68. Let $x_1,x_2,x_3,\ldots\ldots\ldots x_{10}$ be ten observations of a random variable *x*.

If $\sum_{i=1}^{10}(x_i-\lambda)=3$ and $\sum_{i=1}^{10}(x_i-\lambda)^2=13$

then variance of these observations is :

(1) 1.35 (2) 1.31

(3) 1.21 (4) 1.25

69. If $f'(x)=f(x)$ and $f(0)=2$, then

$\int\frac{f(x)}{3+4f(x)}dx=$

(1) $\log\left(3+8e^x\right)+C$

(2) $\frac{1}{4}\log\left(3+8e^x\right)+C$

(3) $\frac{1}{2}\log\left(3+8e^x\right)+C$

(4) None of these

70. The asymptotes of a hyperbola, having centre at the point (1, –1), are parallel to the lines $x + 2y – 3 = 0$ and $2x + y + 5 = 0$. If the hyperbola passes through the point (2, 1), then its equation is

(1) $2x^2 + 2y^2 + 5xy + x + y – 21 = 0$

(2) $2x^2 + 2y^2 + 5xy + x – y – 21 = 0$

(3) $2x^2 + 2y^2 – 5xy + x – y – 21 = 0$

(4) $2x^2 + 2y^2 – 5xy + x – y + 21 = 0$

Integer Type Questions

71. a, b, c are three complex numbers on the unit circle $|z| = 1$ such that $abc = a + b + c$, then $|ab + bc + ca|$ is equal to

72. If $\sum_{r=0}^{n}\left(\frac{r+2}{r+1}\right) = \frac{2^{17}-1}{14}$, then the value of n is equal to

73. The value of $S = \frac{5}{1^2 \cdot 4^2} + \frac{11}{4^2 \cdot 7^2} + \frac{17}{7^2 \cdot 10^2} + \ldots\ldots\infty$, is μ then $|6\mu| + 2$ is

74. Let $A = \begin{pmatrix} 1 & -1 & 1 \\ 2 & 1 & -3 \\ 1 & 1 & 1 \end{pmatrix}$ and $(10)B = \begin{pmatrix} 4 & 2 & 2 \\ -5 & 0 & \alpha \\ 1 & -2 & 3 \end{pmatrix}$

.

If B is the inverse of matrix A, then value of α is _____.

75. If $Z_1 \neq 0$ and Z_2 be two complex numbers such that $\frac{Z_2}{Z_1}$ is a purely imaginary number, then $\left|\frac{2Z_1 + 3Z_2}{2Z_1 - 3Z_2}\right|$ is