KVPY – XII CLASS - STREAM – SB/SX
(Held on 1st November 2015)

PART – I
MATHEMATICS

1. The number of ordered pairs(x, y) of real numbers that satisfy the simultaneous equations $x+y^2=x^2+y=12$

(A) 0 (B) 1
(C) 2 (D) 4

2. If z is a complex number satisfying $|z^3 + z^{-3}| \le 2$, then the maximum possible value of $|z + z^{-1}|$ is

(A) 2 (B) $\sqrt[3]{2}$
(C) $2\sqrt{2}$ (D) 1

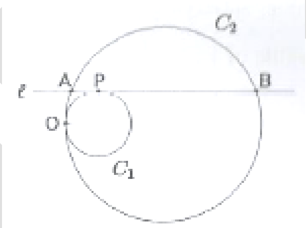
3. The largest perfect square that divides $2014^3 - 2013^3 + 2012^3 - 2011^3 + \ldots + 2^3 - 1^3$ is

(A) 1^2 (B) 2^2
(C) 1007^2 (D) 2014^2

4. Suppose OABC is a rectangle in the xy-plane where O is the origin and A, B lie on the parabola $y = x^2$. Then C must lie on the curve

(A) $y = x^2 + 2$ (B) $y = 2x^2 + 1$
(C) $y = -x^2 + 2$ (D) $y = -2x^2 + 1$

5. Circle C_1 and C_2 of radii r and R respectively, touch each other as shown in figure. The line ℓ, which is parallel to the line joining the centres of C_1 and C_2 is tangent to C_1 at P and intersects C_2 at A, B. If $R^2 = 2r^2$, then $\angle AOB$ equals



(A) $22\frac{1}{2}^{\circ}$ (B) 45°
(C) 60° (D) $67\frac{1}{2}^{\circ}$

6. The shortest distance from the origin to a variable point on the sphere $(x - 2)^2 + (y - 3)^2 + (z - 6)^2 = 1$ is

(A) 5 (B) 6
(C) 7 (D) 8

7. The number of real numbers λ for which the equality

$$\frac{\sin(\lambda\alpha)}{\sin\alpha} - \frac{\cos(\lambda\alpha)}{\cos\alpha} = \lambda - 1$$

Holds for all real α which are not integral multiples of $\pi/2$ is

(A) 1 (B) 2
(C) 3 (D) Infinite

8. Suppose ABCDEF is a hexagon such that AB = BC = CD = 1 and DE = EF = FA = 2. If the vertices A, B, C, D, E, F are concylic the radius of the circle passing through them is

(A) $\sqrt{\frac{5}{2}}$ (B) $\sqrt{\frac{7}{3}}$
(C) $\sqrt{\frac{11}{5}}$ (D) $\sqrt{2}$

9. Let p(x) be a polynomial such that $p(x) - p'(x) = x^n$, where n is a positive integer. Then p(0) equals
(A) n! (B) (n – 1)!
(C) $\frac{1}{n!}$ (D) $\frac{1}{(n-1)!}$

10. The value of the limit
$\lim\limits_{x\to 0}\left(\frac{x}{\sin x}\right)^{6/x^2}$ is
(A) e (B) e^{-1}
(C) $e^{-1/6}$ (D) e^{6}

11. Among all sectors of a fixed perimeter, choose the one with maximum area. Then the angle at the centre of this sector(i.e. the angle between the bounding radii) is
(A) $\frac{\pi}{3}$ (B) $\frac{3}{2}$
(C) $\sqrt{3}$ (D) 2

12. Define a function f: $\mathbb{R} \to \mathbb{R}$ by
f(x) = max {|x|, |x -1|, ….|x – 2n|},
where n is a fixed natural number, Then $\int_0^{2n} f(x)\,dx$ is
(A) n (B) n^2
(C) 3n (D) $3n^2$

13. If p(x) is a cubic polynomial with p(1) = 3, p(0) = 2 and p(-1) = 4, then $\int_{-1}^{1} p(x)\,dx$ is
(A) 2 (B) 3
(C) 4 (D) 5

14. Let x > 0 be a fixed real number. Then the integral $\int_0^{\infty} e^{-t}\,|x-t|\,dt$ is equal to
(A) $x + 2e^{-x} - 1$ (B) $x - 2e^{-x} + 1$
(C) $x + 2e^{-x} + 1$ (D) $-x - 2e^{-x} + 1$

15. An urn contains marbles of four colours: red, white, blue and green. When four marbles are drawn without replacement, the following events are equally likely
(1) the selection of four red marbles
(2) the selection of one white and three red marbles
(3) the selection of one white, one blue and two red marbles
(4) the selection of one marble of each colour
The smallest total number of marbles satisfying the given condition is
(A) 19 (B) 21
(C) 46 (D) 69

16. There are 6 boxes labeled B_1, B_2, ….., B_6. In each trial, two fair dice D_1, D_2 are thrown. If D_1 shows j and D_2 shows k, then j balls are put into the box B_k. After n trials, what is the probability that B_1 contains atmost one ball?

(A) $\left(\frac{5^{n-1}}{6^{n-1}}\right)+\left(\frac{5^n}{6^n}\right)\left(\frac{1}{6}\right)$
(B) $\left(\frac{5^n}{6^n}\right)+\left(\frac{5^{n-1}}{6^{n-1}}\right)\left(\frac{1}{6}\right)$
(C) $\left(\frac{5^n}{6^n}\right)+n\left(\frac{5^{n-1}}{6^{n-1}}\right)\left(\frac{1}{6}\right)$
(D) $\left(\frac{5^n}{6^n}\right)+n\left(\frac{5^{n-1}}{6^{n-1}}\right)\left(\frac{1}{6^2}\right)$

17. Let $\vec{a}=6\vec{i}-3\vec{j}-6\vec{k}$ and $\vec{d}=\vec{i}+\vec{j}+\vec{k}$. Suppose that $\vec{a}=\vec{b}+\vec{c}$ where $\vec{b}$ is parallel to $\vec{d}$ and $\vec{c}$ is perpendicular to $\vec{d}$. Then $\vec{c}$ is
(A) $5\vec{i}-4\vec{j}-\vec{k}$
(B) $7\vec{i}-2\vec{j}-5\vec{k}$
(C) $4\vec{i}-5\vec{j}+\vec{k}$
(D) $3\vec{i}+6\vec{j}-9\vec{k}$

18. If $\log_{(3x-1)}(x-2)=\log_{(9x^2-6x+1)}(2x^2-10x-2)$, then x equals
(A) $9-\sqrt{15}$
(B) $3+\sqrt{15}$
(C) $2+\sqrt{5}$
(D) $6-\sqrt{5}$

19. Suppose a, b, c are positive integers such that $2^a+4^b+8^c=328$. Then $\frac{a+2b+3c}{abc}$ is equal to
(A) $\frac{1}{2}$
(B) $\frac{5}{8}$
(C) $\frac{17}{24}$
(D) $\frac{5}{6}$

20. The sides of a right – angled triangle are integers. The length of one of the sides is 12. The largest possible radius of the incircle of such a triangle is
(A) 2
(B) 3
(C) 4
(D) 5

PHYSICS

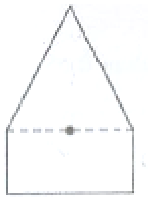
21. A small box resting on one edge of the table is stuck in such a way that it slides off the other edge, 1 m away, after 2 seconds. The coefficient of kinetic friction between the box and the table
(A) must be less than 0.05
(B) must be exactly zero
(C) must be more than 0.05
(D) must be exactly 0.05

22. Carbon – 11 decays to boron – 11 according to the following formula.

$${}^{11}_{6}C \rightarrow {}^{11}_{5}B+e^{+}+V_e+0.96\text{ MeV}$$

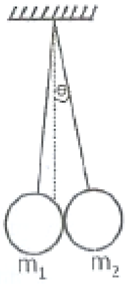
Assume that positrons (e^+) produced in the decay combine with free electrons in the atmosphere and annihilate each other almost immediately. Also assume that the neutrinos (V_e) are massless and do not interact with the environment. At t = 0 we have $1\,\mu g$ of ${}^{12}_{6}C$. If the half – life of the decay process is t_0, then net energy produced between time t = 0 and $t=2t_0$ will be nearly
(A) 8×10^{18}MeV
(B) 8×10^{16}MeV
(C) 4×10^{8}MeV
(D) 4×10^{16}MeV

23. Two uniform plates of the same thickness and area but of different materials, one shaped like an isosceles triangle and the other shaped like a rectangle are joined together to form a composite body as shown in the figure. If the centre of mass of the composite body is located at the mid point of their common side, the ratio between masses of the triangle to that of the rectangle is



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

24. Two spherical objects each of radii R and masses m_1 and m_2 are suspended using two strings of equal length L as shown in the figure $(R \ll L)$. The angle, θ which mass m_2 makes with the vertical is approximately

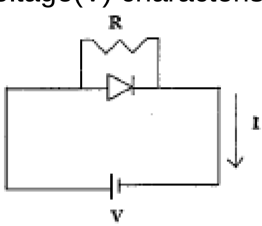


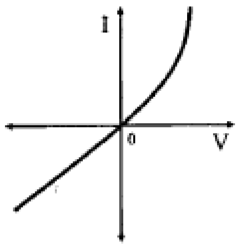
(A) $\frac{m_1R}{(m_1+m_2)L}$ (B) $\frac{2m_1R}{(m_1+m_2)L}$
(C) $\frac{2m_2R}{(m_1+m_2)L}$ (D) $\frac{m_2R}{(m_1+m_2)L}$

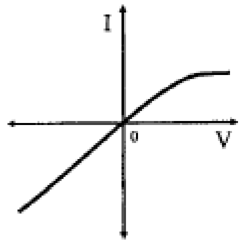
25. A horizontal disk of moment of inertia 4.25 kg – m^2 with respect to its axis of symmetry is spinning counter clockwise at 15 revolutions per seconds about its axis, as viewed from above. A second disk of moment of inertia 1.80 kg – m^2 with respect to its axis of symmetry is spinning clockwise at 25 revolutions per second as viewed from above about the same axis and is dropped on top of the first disk. The two disks stick together and rotate as one about their axis of symmetry. The new angular velocity of the system as viewed from above is close to
(A) 18 revolutions/second and clockwise
(B) 18 revolutions/second and counter clockwise
(C) 3 revolutions/second and clockwise.
(D) 3 revolutions/second and counter clockwise

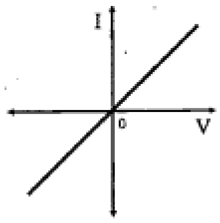
26. A boy is standing on top of a tower of height 85 m and throws a ball in the vertically upward direction with a certain speed. If 5.25 seconds later he hears the ball hitting the ground, then the speed with which the boy threw the ball is (take g = 10 m/s^2, speed of sound in air = 340 m/s)
(A) 6 m/s (B) 8 m/s
(C) 10 m/s (D) 12 m/s

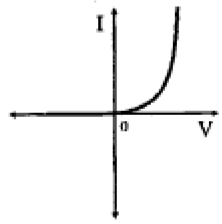
27. For a diode connected in parallel with a resistor, which is the most likely current(I) – voltage(V) characteristic?



(A) 

(B) 

(C) 

(D) 

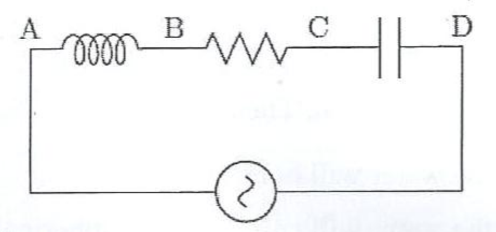
28. A beam of monoenergetic electrons, which have been accelerated from rest by a potential U. is used to form an interference pattern in a Young's Double Slit experiment. The electrons are now accelerated by potential 4 U. Then the fringe width
(A) remains the same
(B) is half the original fringe width.
(C) is twice the original fringe width.
(D) is one-fourth the original fringe width.

29. A point charge Q (= 3×10^{-12} C) rotates uniformly in a vertical circle of radius R = 1 mm. the axis of the circle is aligned along the magnetic axis of the earth. At what value of the angular speed ω, the effective magnetic field at the center of the circle will be reduced to zero? (Horizontal component of Earth's magnetic field is 30 micro Tesla)
(A) 10^{11} rad/s
(B) 10^{9} rad/s
(C) 10^{13} rad/s
(D) 10^{7} rad/s

30. A closed bottle containing water at 30°C is open on the surface of the moon. Then
(A) the water will boil
(B) the water will come out as a spherical ball.
(C) the water will freeze
(D) the water will decompose into hydrogen and oxygen

31. A simple pendulum of length ℓ is made to oscillate with an amplitude of 45 degrees. The acceleration due to gravity is g. Let $T_0 = 2\pi\sqrt{\ell / g}$. The time period of oscillation of this pendulum will be
(A) T_0 irrespective of the amplitude
(B) slightly less than T_0
(C) slightly more than T_0
(D) dependent on whether it swings in a plane aligned with the north-south or east-west directions.

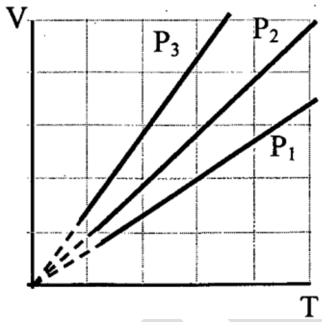
32. An ac voltmeter connected between points A and B in the circuit below reads 36 V. If it is connected between A and C, the reading is 39 V. The reading when it is connected between B and D is 25 V. What will the voltmeter read when it is connected between A and D? (Assume that the voltmeter reads true rms voltage values and that the source generates a pure ac)



(A) $\sqrt{481}$ V
(B) 31 V
(C) 61 V
(D) $\sqrt{3361}$ V

33. A donor atom in a semiconductor has a loosely bound electron. The orbit of this electron is considerably affected by the semiconductor material but behaves in many ways like an electron orbiting a hydrogen nucleus. Given that the electron has an effective mass of 0.07 m_e, (where m_e is mass of the free electron) and the space in which it moves has a permittivity $13\varepsilon_0$, then the radius of the electron's lowermost energy orbit will be close to (The Bohr radius of the hydrogen atom is 0.53 Å)
(A) 0.53 Å
(B) 243 Å
(C) 10 Å
(D) 100 Å

34. The state of an ideal gas was changed isobarically. The graph depicts three such isobaric lines. Which of the following is true about the pressures of the gas?



(A) $P_1 = P_2 = P_3$
(B) $P_1 > P_2 > P_3$
(C) $P_1 < P_2 < P_3$
(D) $P_1/P_2 = P_3/P_1$

35. A metallic ring of radius a and resistance R is held fixed with its axis along a spatially uniform magnetic field whose magnitude is $B_0 \sin(\omega t)$. Neglect gravity. Then,
(A) the current in the ring oscillates with a frequency of 2ω.
(B) the Joule hating loss in the ring is proportional to a^2
(C) the force per unit length on the ring will be proportional to B_0^2.
(D) the net force on the ring is non-zero.

36. The dimensions of the area A of a black hole can be written in terms of the universal gravitational constant G, its mass M and the speed of light C as $A = G^{\alpha}M^{\beta}c^{\gamma}$. Here
(A) $\alpha = -2$, $\beta = -2$, and $\gamma = 4$
(B) $\alpha = 2$, $\beta = 2$, and $\gamma = -4$
(C) $\alpha = 3$, $\beta = 3$, and $\gamma = -2$
(D) $\alpha = -3$, $\beta = -3$, and $\gamma = 2$

37. A 160 watt infrared source is radiating light of wavelength 50000 Å uniformly in all directions. The photon flux at a distance of 1.8 m is of the order of
(A) 10 $m^{-2}\ s^{-1}$
(B) $10^{10}\ m^{-2}\ s^{-1}$
(C) $10^{15}\ m^{-2}\ s^{-1}$
(D) $10^{20}\ m^{-2}\ s^{-1}$

38. A wire bent in the shape of a regular n – polygonal loop carries a steady current I. Let l be the perpendicular distance of a given segment and R be the distance of a vertex both from the centre of the loop. The magnitude of the magnetic field at the centre of the loop is given by
(A) $\frac{n\mu_0 I}{2\pi l}\sin(\pi/n)$
(B) $\frac{n\mu_0 I}{2\pi R}\sin(\pi/n)$
(C) $\frac{n\mu_0 I}{2\pi l}\cos(\pi/n)$
(D) $\frac{n\mu_0 I}{2\pi R}\cos(\pi/n)$

39. The intensity of sound during the festival season increased by 100 times. This could imply a decibel level rise from
(A) 20 to 120 dB
(B) 70 to 72 dB
(C) 100 to 10000 dB
(D) 80 to 100 dB

40. One end of a slack wire (Young's modulus Y, length L and cross – sectional area A) is clamped to a rigid wall and the other end to a block (mass m) which rests on a smooth horizontal plane. The bock is set in motion with a speed v. What is the maximum distance the block will travel after the wire becomes taut?

(A) $v\sqrt{\frac{mL}{Ay}}$ (B) $v\sqrt{\frac{2mL}{AY}}$

(C) $v\sqrt{\frac{mL}{2AY}}$ (D) $L\sqrt{\frac{mv}{AY}}$

CHEMISTRY

41. The Lewis acid strength of BBr_3, BCl_3 and BF is in the order

(A) $BBr_3 < BCl_3 < BF_3$ (B) $BCl_3 < BF_3 < BBr_3$

(C) $BF_3 < BCl_3 < BBr_3$ (D) $BBr_3 < BF_3 < BCl_3$

42. O^{2-} is isoelectronic with

(A) Zn^{2+} (B) Mg^{2+}

(C) K^{+} (D) Ni^{2+}

43. The $H-C-H, H-N-H$, and $H-O-H$ bond angles (in degrees) in methane, ammonia and water are respectively, closest to

(A) 109.5, 104.5, 107.1 (B) 109.5, 107.1, 104.5

(C) 104.5, 107.1, 109.5 (D) 107.1, 104.5, 109.5

44. In alkaline medium, the reaction of hydrogen peroxide with potassium permanganate produces a compound in which the oxidation state of Mn is

(A) 0 (B) +2

(C) +3 (D) +4

45. The rate constant of a chemical reaction at a very high temperature will approach

(A) Arrhenius frequency factor divided by the ideal gas constant

(B) activation energy

(C) Arrhenius frequency factor

(D) activation energy divided by the ideal gas constant

46. The standard reduction potentials (in V) of a few metal ion/metal electrodes are given below. $Cr^{3+}/Cr = -0.75$; $Cu^{2+}/Cu = +0.34$; $Pb^{2+}/Pb = -0.13$; $Ag^{+}/Ag = +0.8$. The reducing strength of the metals follows the order.

(A) $Ag > Cu > Pb > Cr$ (B) $Cr > Pb > Cu > Ag$

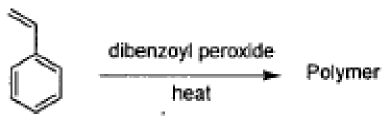
(C) $Pb > Cr > Ag > Cu$ (D) $Cr > Ag > Cu > Pb$

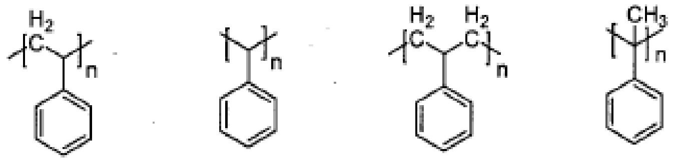
47. Which of the following molecules can exhibit optical activity?

(A) 1 - bromopropane (B) 2 - bromobutane

(C) 3 - bromopentane (D) bromocyclohexane

48. The structure of the polymer obtained by the following reaction is





I II III IV

(A) I
(B) II
(C) III
(D) IV

49. The major product of the reaction between CH_3CH_2ONa and $(CH_3)_3CCl$ in ethanol is
(A) $CH_3CH_2OC(CH_3)_3$
(B) $CH_2=C(CH_3)_2$
(C) $CH_3CH_2C(CH_3)_3$
(D) $CH_3CH=CHCH_3$

50. When H_2S gas is passed through a hot acidic aqueous solution containing $Al^{3+}, Cu^{2+}, Pb^{2+}$ and Ni^{2+}, a precipitate is formed which consists of
(A) Cus and Al_2S_3
(B) PuS and NiS
(C) CuS and NiS
(D) PbS and CuS

51. The electronic configuration of an element with the largest difference between the 1st and 2nd ionization energies is
(A) $1s^2 2s^2 2p^6$
(B) $1s^2 2s^2 2p^6 3s^1$
(C) $1s^2 2s^2 2p^6 3s^2$
(D) $1s^2 2s^2 2p^1$

52. The order of electronegativity of carbon is sp, sp^2 and sp^3 hybridized states follows
(A) $sp > sp^2 > sp^3$
(B) $sp^3 > sp^2 > sp$
(C) $sp > sp^3 > sp^2$
(D) $sp^2 > sp > sp^3$

53. The most abundant transition metal in human body is
(A) copper
(B) iron
(C) zinc
(D) manganese

54. The moral conductivities of HCl, NaCi, CH_3COOH, and CH_3COONa at infinite dilution follow the order
(A) $HCl > CH_3COOH > NaCl > CH_3COONa$
(B) $CH_3COONa > HCl > NaCO > CH_3COOH$
(C) $HCl > NaCl > CH_3COOH > CH_3COONa$
(D) $CH_3COOH > CH_3COONa > HCl > NaCl$

55. The spin only magnetic moment of $[ZCl_4]^{2-}$ is 3.87 BM where Z is
(A) Mn
(B) Ni
(C) Co
(D) Cu

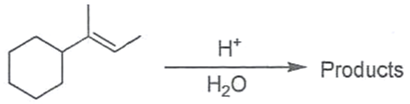
56. If α - D – Glucose is dissolved in water and kept for a few hours, the major constituent(s) present in the solution is (are)
(A) α - D - glucose
(B) mixture of β - D – glucose and open chain D - glucose
(C) open chain D - glucose
(D) mixture of α - D – glucose and β - D – glucose

57. The pH of I=1N aqueous solutions of HCl, CH_3COOH and HCOOH follows the order

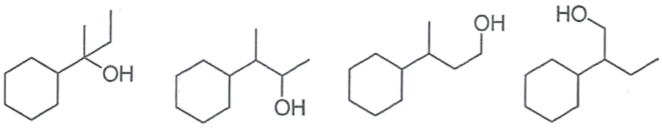
(A) $HCl > HCOOH > CH_3COOH$ (B) $HCl = CHOOH > CH_3COOH$

(C) $CH_3COOH > CHOOH > HCl$ (D) $CH_3COOH = HCOOH > HCl$

58. The major product of the reaction



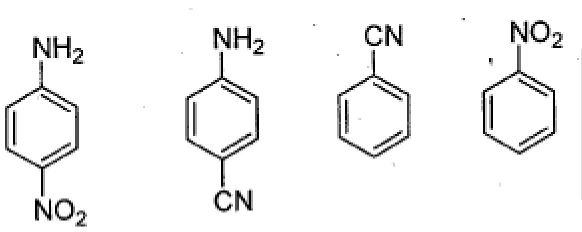
is



I II III IV

(A) I (B) II
(C) III (D) IV

59. Reaction of aniline with $NaNO_2$ + dil. HCl at 0^oC followed by reaction with CuCN yields



I II III IV

(A) I (B) II
(C) III (D) IV

60. Schottky defect in a crystal arises due to
(A) creation of equal number of cation and anion vacancies
(B) creation of unequal number of cation and anion vacancies
(C) migration of cations to interstitial voids
(D) migration of anions to interstitial voids

PART – II
MATHEMATICS

81. Let $x = \left(\sqrt{50}+7\right)^{1/3} - \left(\sqrt{50}-7\right)^{1/3}$. Then
(A) x = 2
(B) x = 3
(C) x is a rational number, but not an integer
(D) x is an irrational number

82. Let $\left(1+x+x^2\right)^{2014} = a_0 + a_1x + a_2x^2 + a_3x^3 + ...a_{4028}x^{4028,}$ and let

A = $a_0 - a_3 + a_6 - ... + a_{4026}$,

B = $a_1 - a_4 + a_7 - ... - a_{4027}$,

C = $a_2 - a_5 + a_8 - ... + a_{4028}$

(A) $|A| = |B| > |C|$ (B) $|A| = |B| < |C|$

(C) $|A| = |C| > |B|$ (D) $|A| = |C| < |B|$

83. A mirror in the first quadrant is in the shape of a hyperbola whose equation is xy = 1. A light source in the second quadrant emits a beam of light that hits the mirror at the point (2, 1/2). If the reflected ray is parallel to the y – axis, the slope of the incident beam is

(A) 13/8 (B) 7/4
(C) 15/8 (D) 2

84. Let $C(\theta)=\sum_{n=0}^{\infty}\frac{\cos(n\theta)}{n!}$. Which of the following statements if FALSE?

(A) $C(0).C(\pi)=1$ (B) $C(0)+C(\pi)>2$
(C) $C(\theta)>0$ for all $\theta\in R$ (D) $C'(\theta)\neq 0$ for all $\theta\in R$

85. Let a > 0 be a real number. Then the limit

$\lim_{x\to 2}\frac{a^x+a^{3-x}-(a^2+a)}{a^{3-x}-a^{x/2}}$ is

(A) 2 log a (B) $-\frac{4}{3}a$
(C) $\frac{a^2+a}{2}$ (D) $\frac{2}{3}(1-a)$

86. Let $f(x)=ax^2-2+\frac{1}{x}$ where α is a real constant. The smallest α for which $f(x)\geq 0$ for all x > 0 is

(A) $\frac{2^2}{3^3}$ (B) $\frac{2^3}{3^3}$
(C) $\frac{2^4}{3^3}$ (D) $\frac{2^5}{3^3}$

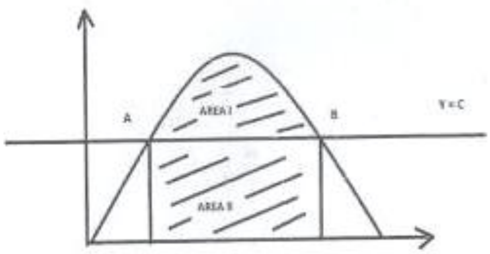
87. Let f: R $\to$ R be a continuous function satisfying

$f(x)+\int_0^x tf(t)dt+x^2=0$

For all x $\in$ R. Then

(A) $\lim_{x\to\infty}f(x)=2$
(B) $\lim_{x\to-\infty}f(x)=-2$
(C) f(x) has more than one point in common with the x – axis
(D) f (x) is an odd function

88. The figure shows a portion of the graph y = 2x – 4x^3. The line y = c is such that the areas of the regions marked I and II are equal. If a, b are the x – coordinates of A, B respectively, then a + b equals



(A) $\frac{2}{\sqrt{7}}$ (B) $\frac{3}{\sqrt{7}}$
(C) $\frac{4}{\sqrt{7}}$ (D) $\frac{5}{\sqrt{7}}$

89. Let $X_n = \{1, 2, 3, \ldots, n\}$ and let a subset A of X_n be chosen so that every pair of elements of A differ by at least 3. (For example, if n = 5, A can be ϕ, {2} or {1,5} among others). When n = 10, let the probability that $1 \in$ A be p and let the probability that $2 \in$ A be q. Then

(A) p > q and $p - q = \frac{1}{6}$
(B) p< q and $q - p = \frac{1}{6}$
(C) p > q and $p - q = \frac{1}{10}$
(D) p < q and $q - p = \frac{1}{10}$

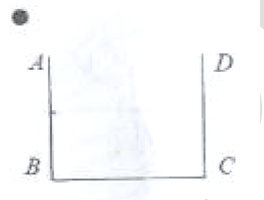
90. The remainder when the determinant

$$\begin{vmatrix} 2014^{2014} & 2015^{2015} & 2016^{2016} \\ 2017^{2017} & 2018^{2018} & 2019^{2019} \\ 2020^{2020} & 2021^{2021} & 2022^{2022} \end{vmatrix}$$

Is divided by 5 is
(A) 1
(B) 2
(C) 3
(D) 4

PHYSICS

91. A cubical vessel has opaque walls. An observer (dark circle is figure below) is located such that she can see only the wall CD but not the bottom. Nearly to what height should water be poured so that she can see an object placed at the bottom at a distance of 10 cm from the corner C? Refractive index of water is 1.33.



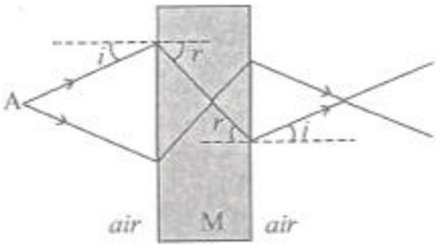
(A) 10 cm
(B) 16 cm
(C) 27 cm
(D) 45 cm

92. The moments of inertia of a non-uniform circular disc (of mass M and radius R) about four mutually perpendicular tangents AB, ,BC, CD, DA are I_1, I_2, I_3 and I_4, respectively (the square ABCD circumscribes the circle). The distance of the center of mass of the disc from its geometrical center is given by

(A) $\frac{1}{4MR}\sqrt{(I_1 - I_3)^3 + (I_2 - I_4)^2}$
(B) $\frac{1}{12MR}\sqrt{(I_1 - I_3)^2 + (I_2 - I_4)^2}$
(C) $\frac{1}{3MR}\sqrt{(I_1 - I_2)^2 + (I_3 - I_4)^2}$
(D) $\frac{1}{2MR}\sqrt{(I_1 - I_3)^2 + (I_2 + I_4)^2}$

93. A horizontal steel railroad track has a length of 100 m when the temperature is 25°C. The track is constrained fro expanding or bending. The stress on the track on a hot summer day, when the temperature is 40°C, is (Note: the linear coefficient of thermal expansion for steel is 1.1×10^{-5}/°C and the Young's modulus of steel is 2×10^{11} Pa)
(A) 6.6×10^{7} Pa
(B) 8.8×10^{7} Pa
(C) 3.3×10^{7} Pa
(D) 5.5×10^{7} Pa

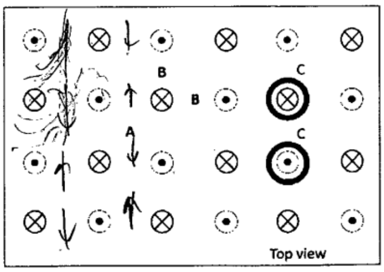
94. Electromagnetic waves emanating from a point A (in air) are incident on a rectangular block of material M and emerge fro the other side as shown. The angles I and r are angles of incidence and refraction when the wave travels from air to the medium. Such paths of the rays are possible



(A) if the material has a refractive index very nearly equal to zero.
(B) only with gamma rays with a wavelength smaller than the atomic nuclei of the material
(C) if the material has a refractive index less than zero.
(D) only if the wave travels in M with a speed faster than the speed of light in vacuum.

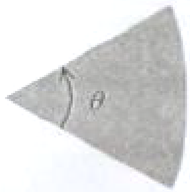
95. Two small metal balls of different mass m_1 and m_2 are connected by strings of equal length to a fixed point. When the balls are given equal charges, the angles that the two strings make with the vertical are 30° and 60°, respectively. The ratio m_1/m_2 is close to
(A) 1.7 (B) 3.0
(C) 0.58 (D) 2.0

96. Consider the regular array of vertical identical current carrying wires (with direction of current flow as indicated in the figure below) protruding through a horizontal table. If we scatter some diamagnetic particles on the table, they are likely to accumulate



(A) around regions such as A.
(B) around regions such as B.
(C) in circular regions around individual wires such as C.
(D) uniformly every where.

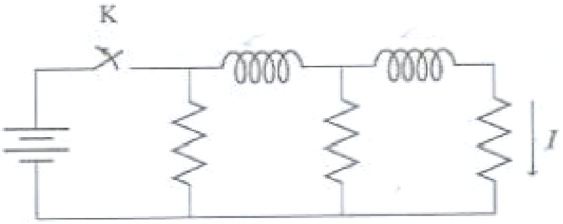
97. The distance between the vertex and the centre of mass of a uniform solid planar circular segment of angular size θ and radius R is given by



(A) $\frac{4}{3}R\frac{\sin(\theta/2)}{\theta}$ (B) $R\frac{\sin(\theta/2)}{\theta}$
(C) $\frac{4}{3}R\cos\left(\frac{\theta}{2}\right)$ (D) $\frac{2}{3}R\cos(\theta)$

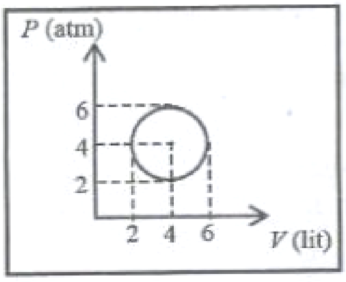
98. An object is propelled vertically to a maximum height of 4R from the surface of a planet of radius R and mass M. The speed of object when it returns to the surface of the plane is
(A) $2\sqrt{\frac{2GM}{5R}}$ (B) $\sqrt{\frac{GM}{2R}}$
(C) $\sqrt{\frac{3GM}{2R}}$ (D) $\sqrt{\frac{GM}{5R}}$

99. In the circuit shown below, all the inductors (assumed ideal) and resistors are identical. The current through the resistance on the right is I after the key K has been switched on for a long time. The currents through the three resistors (in order, from left to right) immediately after the key is switched off are



(A) 2I upwards, I downwards and I downwards
(B) 2I downwards, I downwards and I downwards
(C) I downwards, I downwards and I downwards
(D) 0, I downwards and I downwards.

100. An ideal gas undergoes a circular cycle centered at 4 atm, 4 lit as shown in the diagram. The maximum temperature attained in this process is close to



(A) $\frac{30}{R}$ (B) $\frac{36}{R}$
(C) $\frac{24}{R}$ (D) $\frac{16}{R}$

CHEMISTRY

101. For the reaction $N_2 + 3X_2 \rightarrow 2NX_3$ where $X = F, Cl$ (the average bond energies are F – F = 155 KJ mol^{-1} N – F = 272 kJ mol^{-1} Cl – Cl = 242 kJ mol^{-1}, N- Cl = 200 kJ mol^{-1} and $N \equiv N = 941\,kJmol^{-1}$), the heats of formation of NF_3 and NCl_3 in kJ mol^{-1}, respectively, are closest to
(A) – 226 and +467 (B) + 226 and – 467
(C) –151 and +311 (D) +151 and –311

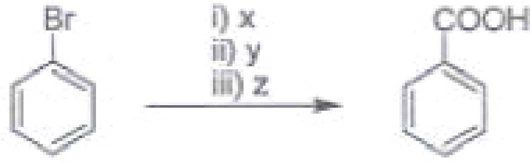
102. The equilibrium constants for the reaction X = 2Y and Z = P + Q are K_1 and K_2, respectively. If the initial concentrations and the degree of dissociation of X and Z are the same, the ratio $\frac{K_1}{K_2}$ is:
(A) 4 (B) 1
(C) 0.5 (D) 2

103. The geometry and the number of unpaired electron(s) of $[MnBr_4]^{2-}$, respectively, are
(A) tetrahedral and 1 (B) square planar and 1
(C) tetrahedral and 5 (D) square planar and 5

104. The standard cell potential for $Zn|Zn^{2+}||Cu^{2+}|Cu$ is 1.10V. When the cell is completely discharged, $\frac{\log[Zn^{2+}]}{[Cu^{2+}]}$ is closest to

(A) 37.3 (B) 0.026
(C) 18.7 (D) 0.052

105. In the reaction

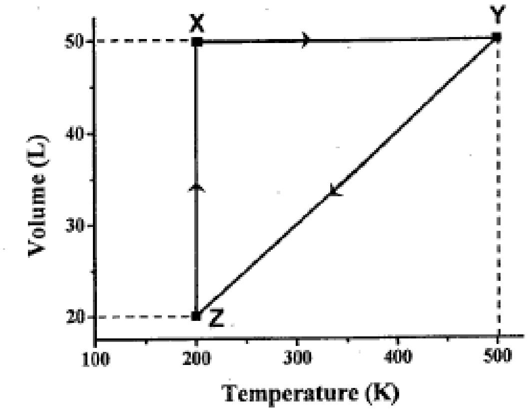


x, y and z are
(A) x = Mg, dry ether; $y = CH_3Cl$; $z = H_2O$
(B) x = Mg, dry methanol; $y = CO_2$; $z = \text{dil.}HCl$
(C) x = Mg, dry ether; $y = CO_2$; $z = \text{dil.}HCl$
(D) $x = Mg$, dry methanol; $y = CH_3Cl$; $z = H_2O$

106. An organic compound having molecular formula C_2H_6O undergoes oxidation with K_2Cr_2O / H_2SO_4 to produce X which contains 40% carbon, 6.7% hydrogen and 53.3% oxygen. The molecular formula of the compound X is
(A) CH_2O (B) $C_2H_4O_2$
(C) C_2H_4O (D) $C_2H_6O_2$

107. The maximum number of cyclic isomers (positional and optical) of a compound having molecular formula $C_3H_2Cl_2$ is
(A) 2 (B) 3
(C) 4 (D) 5

108. The volume vs. temperature graph of 1 mole of an ideal gas it given below



The pressure of the gas (in atm) at X, Y and Z, respectively are
(A) 0.328, 0.820, 0.820 (B) 3.28, 8.20, 3.28
(C) 0.238, 0.280, 0.280 (D) 32.8. 0.280, 82.0

109. MnO_2 when fused with KOH and oxidized in air gives a dark green compound X. In acidic solution, X undergoes disproportionation to give an intense purple compound Y and MnO_2. The compound X and Y, respectively, are
(A) K_2MnO_4 and $KMnO_4$ (B) Mn_2O_7 and $KMnO_4$
(C) K_2MnO_4 and Mn_2O_7 (D) $KMnO_4$ and K_2MnO_4

110. A metal (X) dissolves both in dilute HCl and dilute NaOH to liberate H_2. Addition of NH_4Cl and excess NH_4O to an HCl solution of X produces Y as a precipitate. Y is also produced by adding NH_4Cl to the NaOH solution of X.
The species X and Y, respectively, are
(A) Zn and $Zn(OH)_2$ (B) Al and $Al(OH)_3$
(C) Zn and Na_2ZnO_2 (D) Al and $NaAlO_2$

KVPY 2015 OFFICIAL ANSWER KEYS FOR SB/SX

Q. No	**Key**	Q. No	**Key**	Q. No.	**Key**
1	**D**	31	**C**	81	**A**
2	**A**	32	**A**	82	**D**
3	**C**	33	**D**	83	**C**
4	*	34	**B**	84	**D**
5	**B**	35	**C**	85	**D**
6	**B**	36	**B**	86	**D**
7	**C**	37	**D**	87	**B**
8	**B**	38	**A**	88	**A**
9	**A**	39	**D**	89	**C**
10	**A**	40	**A**	90	**D**
11	**D**	41	**C**	91	**C**
12	**D**	42	**B**	92	**A**
13	**D**	43	**B**	93	**C**
14	**A**	44	**D**	94	**C**
15	**B**	45	**C**	95	**A**
16	**D**	46	**B**	96	**A**
17	**B**	47	**B**	97	**A**
18	**B**	48	**A**	98	**A**
19	**C**	49	**B**	99	**A**
20	**D**	50	**D**	100	**A**
21	**A**	51	**B**	101	**
22	*	52	**A**	102	**A**
23	**C**	53	**B**	103	**C**
24	**B**	54	**A**	104	**A**
25	**D**	55	**C**	105	**C**
26	**B**	56	**D**	106	**B**
27	**A**	57	**C**	107	**C**
28	**B**	58	**A**	108	**A**
29	**A**	59	**C**	109	**A**
30	**A**	60	**A or B**	110	**B**

*Candidates who have attempted this section will be awarded One mark.

**Candidates who have attempted this section will be awarded Two mark.