INDIAN INSTITUTE OF SCIENCE
BANGALORE - 560012

ENTRANCE TEST FOR ADMISSIONS - 2008

Program : Integrated Ph.D
Entrance Paper : Chemical Sciences
Paper Code : CS

Day & Date
SUNDAY, 27TH APRIL 2008

Time
2.00 P.M. TO 5.00 P.M.

INSTRUCTIONS

1. This question paper consists of only multiple-choice questions. **All questions carry one mark each.**
2. Answers are to be marked in the OMR sheet provided.
3. For each question, darken the appropriate bubble to indicate your answer.
4. Use only HB pencils for bubbling answers.
5. Mark only one bubble per question. If you mark more than one bubble, the answer will be evaluated as incorrect.
6. If you wish to change your answer, please erase the existing mark completely before marking the other bubble.
7. **There will be NEGATIVE marking. NEGATIVE** marking for each wrong answer will be 1/3.
8. Some useful physical constants:

(A) Universal gas constant	R =	8.31451 J mol^{-1} K^{-1}
		0.08206 L atm mol^{-1} K^{-1}
(B) Planck's constant,	h =	6.626×10^{-34} J.s
(C) Acceleration due to gravity	g =	9.8 m s^{-2}
(D) Speed of light in vacuum	c =	2.998×10^{8} m s^{-1}
(E) Avogadro's number	N =	6.023×10^{23} mol^{-1}
(F) Boltzmann constant	k =	1.380×10^{-23} J K^{-1}
(G) Electron charge	e =	1.602×10^{-19} C
(H) Electron mass	m_e =	9.109×10^{-31} Kg
(I) Permittivity of the vacuum	ε_o =	8.854×10^{-12} F m^{-1}
(J) Faraday constant	F =	9.65×10^{4} C mol^{-1}
(K) 1 Calorie	=	4.184 J
(L) 1 atm	=	760 Torr

1. Among the following species, all in the gaseous state, the one that requires the largest amount of energy for removal of an electron is:

   (A) K^+
   (B) Cs^+
   (C) Ar
   (D) Kr

2. $3NH_4^+ + BiN(s) \longrightarrow Bi^{3+} + 4NH_3$
   The above reaction occurs in liquid ammonia. In this reaction the ammonium ion behaves as:
   (A) a reducing agent
   (B) an acid
   (C) a base
   (D) an oxidizing agent

3. The number of metal–metal bonds in $[Mo(\eta^5\text{-}Cp)(CO)_3]_2$ is:

   (A) zero
   (B) one
   (C) two
   (D) three

4. The number of d-d transitions in the electronic spectrum of a high-spin Fe(III) octahedral complex is:

   (A) zero
   (B) two
   (C) three
   (D) one

5. In all of the following reactions carbon monoxide serves as a reducing agent, EXCEPT in:

   (A) $2CO(g) + O_2(g) = 2CO_2(g)$
   (B) $CO(g) + H_2O(g) = CO_2(g) + H_2(g)$
   (C) $3CO(g) + Fe_2O_3(s) = 3CO_2(g) + 3Fe(s)$
   (D) $4CO(g) + Ni(s) = Ni(CO)_4(g)$

6. Which of the following has the smallest bond enthalpy?

   (A) Si-H
   (B) C-H
   (C) Ge-H
   (D) Pb-H

7. Of the complexes shown below, the complex that is most kinetically labile towards ligand substitution is:

(A) $[Co(en)_3]^{3+}$
(B) $[Cr(H_2O)_6]^{2+}$
(C) $[Fe(CN)_6]^{4-}$
(D) $[Cr(H_2O)_6]^{3+}$

8. The number of geometrical isomers possible for $[IrCl_3(PPh_3)_3]$ is:

(A) one
(B) two
(C) four
(D) six

9. A trigonal planar geometry is exhibited by:

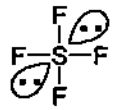
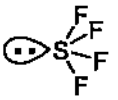
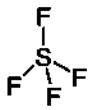
(A) SO_3
(B) NH_3
(C) PCl_3
(D) NI_3

10. Of the following complexes, chirality will be exhibited by: (en – ethylenediamine; ox - oxalate)
(A) $[Cr(ox)_3]^{3-}$
(B) $[Pt(en)Cl_2]$
(C) $[Ni(CO)_4]$
(D) $[Fe(CN)_6]^{4-}$

11. The metal ions required for nitrogen fixation by the enzyme nitrogenase are:

(A) copper and zinc
(B) iron and zinc
(C) iron and molybdenum
(D) copper and vanadium

12. The correct structure for SF_4 molecule is:

(A) 
(B) 
(C) 
(D) 

13. The bright yellow color of $[Cu(phen)_2]^+$ (phen = 1,10-phenanthroline) is due to:

(A) d-d transitions
(B) Metal to ligand charge transfer
(C) Ligand to metal charge transfer
(D) π to π^* charge transfer in the phenanthroline ligand

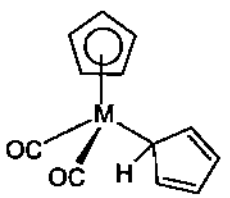
14. The reaction of $[PtCl_4]^{2-}$ with NH_3 gives product A while its reaction with $[NO_2]^-$ followed by NH_3 gives product B. The products A and B, respectively, are:

(A) *trans*-$[PtCl_2(NH_3)_2]$ and *trans*-$[PtCl_2(NH_3)(NO_2)]^-$
(B) *cis*-$[PtCl_2(NH_3)_2]$ and *trans*-$[PtCl_2(NH_3)(NO_2)]^-$
(C) *cis*-$[PtCl_2(NH_3)_2]$ and *cis*-$[PtCl_2(NH_3)(NO_2)]^-$
(D) *trans*-$[PtCl_2(NH_3)_2]$ and *cis*-$[PtCl_2(NH_3)(NO_2)]^-$

15. One of the products of the reaction between H_2O_2 and OCl^- in ethanol is:

(A) H_2
(B) Singlet O_2
(C) Triplet O_2
(D) Cl_2

16. In the complex shown below,



the metal which will satisfy the above structural requirement is:

(A) Co
(B) Mn
(C) Fe
(D) Cr

17. In the $[Ni(NH_3)_6]^{2+}$ ion,

(A) the Ni–N bond lengths are all equal
(B) the Ni–N bond lengths are all unequal
(C) equatorial Ni–N bonds are longer than the axial ones
(D) axial Ni–N bonds are longer than the equatorial ones

18. Of the pairs of diatomics given below, the one where the anion has a higher bond order than the neutral species is:

(A) B_2 and B_2^-
(B) N_2 and N_2^-
(C) O_2 and O_2^-
(D) F_2 and F_2^-

19. The type of force that holds the layers of carbon atoms together in graphite is:

(A) ionic
(B) hydrogen-bonding
(C) van der Waals
(D) covalent

20. The number of isomers possible for octahedral $[CrCl_2(H_2O)_4]^+$ and octahedral $[CoCl_2(en)_2]^+$ are:

(A) two isomers for $[CrCl_2(H_2O)_4]^+$; two isomers for $[CoCl_2(en)_2]^+$
(B) two isomers for $[CrCl_2(H_2O)_4]^+$; three isomers for $[CoCl_2(en)_2]^+$
(C) three for $[CrCl_2(H_2O)_4]^+$; three for $[CoCl_2(en)_2]^+$
(D) three for $[CrCl_2(H_2O)_4]^+$; two for $[CoCl_2(en)_2]^+$

21. In an inner-sphere electron transfer reaction, the ligand that cannot act as a bridging one is:

(A) 1,10-phenanthroline
(B) 4,4'-bipyridine
(C) pyrazine
(D) bis(4-pyridyl)methane

22. The product obtained from the reaction of SF_4 with CsF is:

(A) $[SF_5]^-$
(B) S_2F_2
(C) SF_6
(D) $[SF_3]^+$

23. Which set of elements contains a metalloid?

(A) K, Mn, As, Ar
(B) Ba, Ag, Sn, Xe
(C) Li, Mg, Ca, Kr
(D) Fr, F, O, Rn

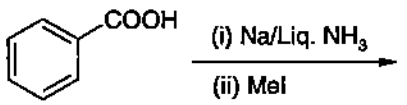
24. The first step in the catalytic cycle for the hydrogenation of alkenes by Wilkinson's catalyst is:

(A) alkene coordination
(B) oxidative addition of H_2
(C) loss of PPh_3
(D) loss of Cl^-

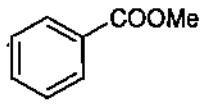
25. The solubility of LiF in water is the lowest among the Group I metal halides, primarily, because:

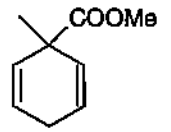
(A) LiF is non-polar
(B) the lattice energy of LiF is very large
(C) LiF is covalent
(D) the hydration energy of LiF is very large

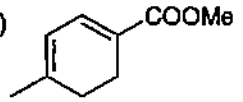
26. The major product in the following reaction

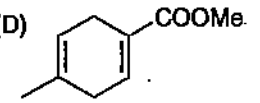


will be:

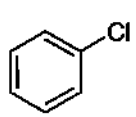
(A) 

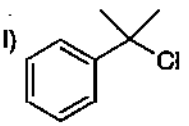
(B) 

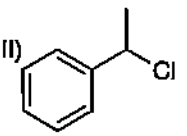
(C) 

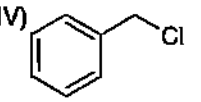
(D) 

27. The correct order of solvolysis of the following compounds

(I) 

(II) 

(III) 

(IV) 

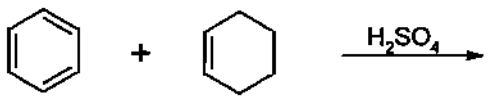
is:

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

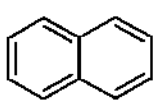
28. Reaction of benzamide with NaOBr in the presence of NaOH yields:

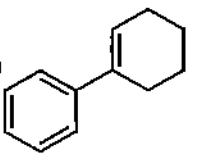
(A) Aniline
(B) Benzoic acid
(C) Benzoyl bromide
(D) Bromobenzene

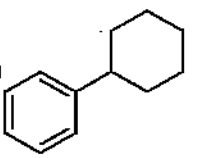
29. The major product of the following reaction,

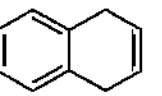


is:

(A) 

(B) 

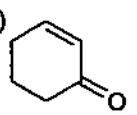
(C) 

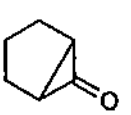
(D) 

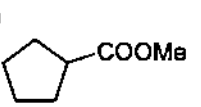
30. The conversion of bromobenzene to benzoic acid is best achieved by:

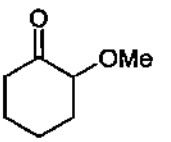
(A) heating with NaOH and CO_2 under pressure
(B) heating with formic acid
(C) reaction with (i) Mg/dry ether, then (ii) CO_2
(D) reaction with (i) Mg/dry ether, then (ii) formaldehyde

31. The major product obtained by reaction of 2-chlorocyclohexanone with sodium methoxide is:

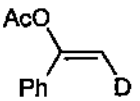
(A) 

(B) 

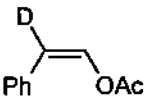
(C) 

(D) 

32. Reaction of phenylacetylene with methylmagnesium bromide in THF, followed by quenching with CH_3COOD yields:

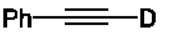


(A)



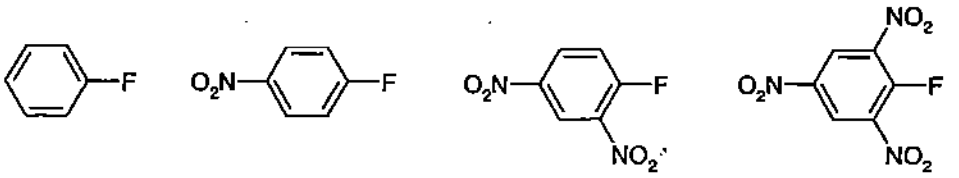
(B)

(C)



(D)

33. The order of reactivity of the following compounds,

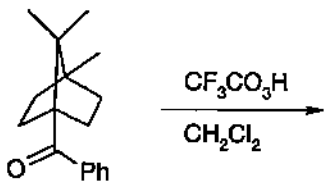


I II III IV

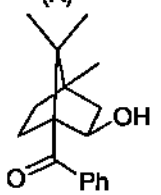
towards displacement by methyl amine is:

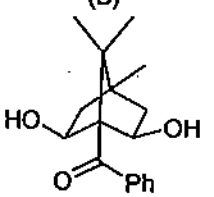
(A) I > II > III > IV
(B) IV > III > II > I
(C) II > III > IV > I
(D) IV > II > III > I

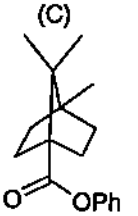
34. The major product of the following reaction



is:

(A)


(B)


(C)


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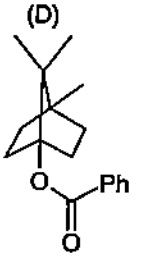


35. A solution of aniline in aqueous HCl at 0 °C was first mixed with acetic anhydride. Upon adding an aqueous solution of sodium acetate a white precipitate formed. This product is likely to be:

(A) acetanilide
(B) benzamide
(C) phenyl isocyanide
(D) phenyldiazonium acetate

36. Hydrazine is used as one of the reagents in which of the following name reactions?

(A) Cannizzaro
(B) Wolff-Kishner
(C) Claisen
(D) Reformatsky

37. The most suitable reagent for the conversion of octanoic acid to 1-octanol is:

(A) Pd-C/H_2
(B) $LiAlH_4$
(C) N_2H_4
(D) $RhCl(PPh_3)_3/H_2$

38. The reaction of 1,3-dimethylbenzene with $POCl_3$ in DMF yields:

(A) 4-chloro-1,3-dimethylbenzene
(B) 3-methylbenzyl chloride
(C) 3,5-dimethylbenzaldehyde
(D) 2,4-dimethylbenzaldehyde

39. Upon treatment with strong acid, cyclohexyl methyl ether yields:

(A) cyclohexene
(B) 1,3-cyclohexadiene
(C) cyclohexanone
(D) dicyclohexyl ether

40. Ethyl acetate is dissolved in excess methanol containing a *catalytic* amount of sodium methoxide. The major product of the reaction is:

(A) methyl acetate
(B) sodium acetate
(C) ethyl acetoacetate
(D) ethyl (2-methoxy)acetate

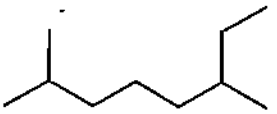
41. Which of the following compounds is non-aromatic?

(A) Anthracene
(B) Furan
(C) Azulene
(D) Cycloheptatriene

42. The reaction of *R*-2-bromobutane with sodium cyanide in dimethyl sulfoxide will produce:

(A) *S*-2-cyanobutane
(B) *R*-2-cyanobutane
(C) *cis*-2-butene
(D) *trans*-2-butene

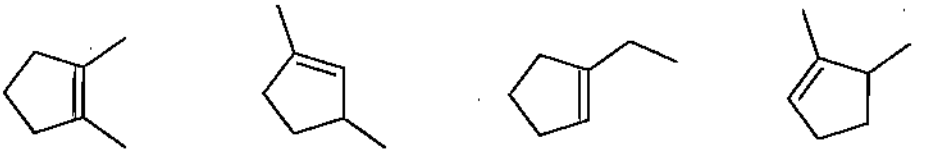
43. The IUPAC name for the following compound



is:

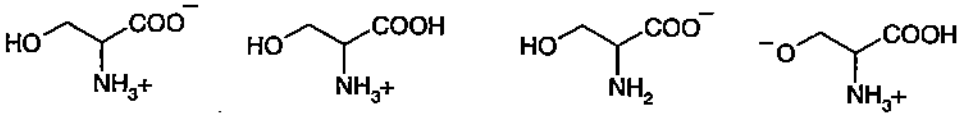
(A) 1,2,6-triethylheptane
(B) 2-ethyl-6-methylheptane
(C) 2,6-dimethyloctane
(D) 2-ethyl-5-isopropylpentane

44. Which of the following compounds will yield 2,6-heptanedione upon ozonolysis?



A B C D

45. At pH 2, serine will exist as:

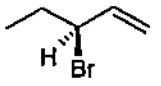


A B C D

46. Which one of the following reagents is best suited for the oxidation of toluene to benzoic acid?

(A) m-CPBA
(B) Hydrogen peroxide
(C) Potassium permanganate
(D) Pyridinium chlorochromate

47. Compound I, upon exposure to light for prolonged periods,



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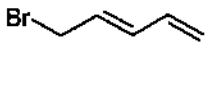
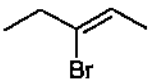
loses its optical activity due to the formation of:



A



B

C

D

48. 4-Aminophenol on reaction with acetic anhydride (1 equiv.) at room temperature yields:

(A) 4-acetamidophenol
(B) 4-acetoxyaniline
(C) 4-aminoacetophenone
(D) 2-acetyl-4-aminophenol

49. Which of the following reagents is useful for the conversion of phenol to salicylaldehyde?

(A) formaldehyde/NaOH
(B) chloroform/NaOH
(C) N,N-dimethylaniline/formaldehyde
(D) formaldehyde/H_2SO_4

50. Which of the following offers the best combination of reactants to give the highest yield of *tert*-butyl methyl ether?

(A) $(CH_3)_2C{=}CH_2$ + $NaOCH_3$
(B) $(CH_3)_2CHCH_2I$ + $NaOCH_3$
(C) $(CH_3)_3COK$ + CH_3I
(D) $(CH_3)_3CBr$ + $KOCH_3$

51. In a simple extraction of a monomeric organic compound from water with an immiscible organic solvent, the relative distribution ratio, D_r, is defined as the concentration of the solute in the organic phase to that in water. The D_r value is 50. How many milligrams of the solute will remain in 200 mL of water if after extraction there are 10 mg of the solute in the 100 mL of the organic phase?

(A) 0.05 mg
(B) 0.10 mg
(C) 0.40 mg
(D) 0.20 mg

52. Ten liters of an ideal gas at 3 bar and 300 K is expanded to 20 liters and the temperature is increased to 475 K. The final pressure is approximately:

(A) 7.2 bar
(B) 6.0 bar
(C) 1.5 bar
(D) 2.4 bar

53. Dissolution of ammonium chloride in water follows the equilibrium:

$NH_4Cl(s) \rightleftharpoons NH_4^+(aq) + Cl^-(aq) \quad \Delta H = +3.5$ kcal/mol

The equilibrium will shift to the right upon:

(A) increasing the temperature
(B) decreasing the temperature
(C) dissolving NaCl in the solution
(D) dissolving ammonium perchlorate in the solution

54. A Carnot engine produces 3.5 kJ of work for every 20 kJ of heat supplied during an isothermal expansion stroke. If the compression stroke of the engine is executed at 300 K, the temperature during the isothermal expansion stroke is:

(A) 440 K
(B) 364 K
(C) 160 K
(D) 236 K

55. A spontaneous process at a constant temperature and volume will always proceed with (A – Helmholtz Free energy, G – Gibbs Free energy, S – Entropy, H - Enthalpy):

(A) $\Delta H < 0$
(B) $\Delta A < 0$
(C) $\Delta S > 0$
(D) $\Delta G < 0$

56. A solution has an absorbance of 0.12 in a 2.0-centimeter cell. If the absorption coefficient of the species is 2.0 liter.cm^{-1}.$gram^{-1}$, the concentration is:

(A) 0.030 gram/liter
(B) 0.060 gram/liter
(C) 0.030 mole/liter
(D) 0.060 mole/liter

57. For a monoatomic gas, the ratio of the molar heat capacities, Cp/Cv is equal to:

(A) 1
(B) 7/5
(C) 3/2
(D) 5/3

58. The vibrational transition from v =1 to v =2 in HCl gives rise to a line that is much less intense than the line arising from v =0 to v =1 at 20°C. The main reason for this is that the:

(A) v =1 to v =2 transition is forbidden
(B) v =1 state has a much smaller dipole moment
(C) v =0 state is more populated than the v =1 state
(D) v =1 to v =2 transition requires more energy

59. Which of the following carbonate species would be present in significant concentrations in a solution of carbonic acid at pH 10? (For carbonic acid, $pKa_1 = 6.64$, $pKa_2 = 10.16$)

(A) H_2CO_3
(B) HCO_3^-
(C) HCO_3^- and CO_3^{2-}
(D) CO_3^{2-}

60. The osmotic pressure of a solution containing 0.5 g of a nonvolatile solid (molar mass 344 g mol^{-1}) in 100 g water at 300 K is approximately:

(A) 0.25 atm
(B) 0.35 atm
(C) 3.50 atm
(D) 0.025 atm

61. An electron moving at a speed of 2.27×10^6 m s^{-1} will have an wavelength close to:

(A) 3.2 Å
(B) 13.2 Å
(C) 132.0 Å
(D) 6.4 Å

62. Assuming "a" to be the edge length of a cube, the inter-planar spacing d_{hkl} for a cubic system between (220) sets of planes is given by:

(A) $a/(2\sqrt{2})$
(B) $a/\sqrt{2}$
(C) 2a
(D) a/2

63. A reaction proceeds via a two-step mechanism:

$A_2 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2A$ fast reaction

$A + B \xrightarrow{k_2}$ products slow reaction

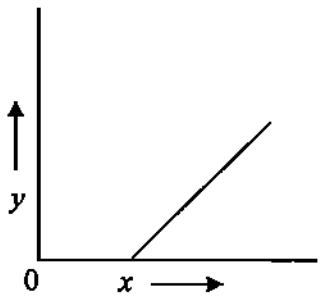
The rate law for the overall reaction is:

(A) Rate = $k[A_2][B]$
(B) Rate = $k[A_2]^2[B]$
(C) Rate = $k[A_2]^{1/2}[B]^2$
(D) Rate = $k[A_2]^{1/2}[B]$

64. The period of molecular vibration is typically of the order of:

(A) 10^{-14} sec
(B) 10^{-6} sec
(C) 10^{-4} sec
(D) 10^{-2} sec

65.



A graph of y plotted against x is a straight line which has the slope shown above and does not pass through the origin. This could be a graph in which y is the:

(A) volume of an ideal gas and x is the absolute temperature
(B) pressure of an ideal gas and x is the reciprocal of volume
(C) energy of the most energetic electrons emitted during illumination and x is the frequency of the light
(D) specific heat of a solid element and x is the absolute temperature

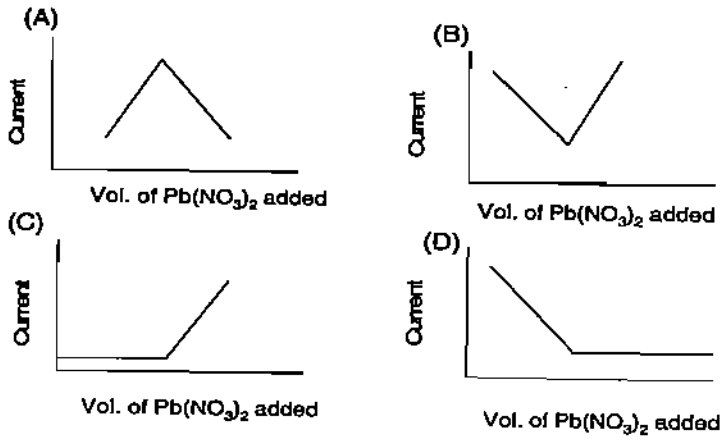
66. A 1 M solution of which of the following salts has the highest pH?

(A) $NaNO_3$
(B) Na_2CO_3
(C) NH_4Cl
(D) $NaHSO_4$

67. The process in which a molecule in an excited singlet state converts to the lowest lying triplet state is known as:

(A) internal conversion
(B) intersystem crossing
(C) a Frank-Condon transition
(D) phosphorescence

68. When potassium sulphate (aq.) solution is titrated with lead nitrate (aq.) solution (titrant) at a moderately negative potential of -0.6 V, which of the following amperometric curve will represent the data?



69. The heats of vapourization and boiling points of four compounds are given in the table below.

Compound	Boiling point (°C)	ΔH_{vap} (cal/g)	Molecular weight
Acetone	56.1	124.5	58
Benzene	80.2	94.3	78
Chloroform	61.5	59	120
Methane	-159	138	16

Of the above compounds, the one that will show the greatest elevation of boiling point upon addition of a fixed molality of a solute is:

(A) acetone
(B) benzene
(C) chloroform
(D) methane

70. Given the following standard electrode potentials,

$AgCl + e = Ag + Cl^-$, $E° = 0.2223$ V ---- (1)
$Ag^+ + e = Ag$, $E° = 0.799$ V ---- (2)

the solubility product of AgCl is:

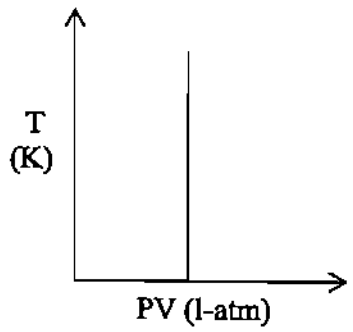
(A) 1.8×10^{-10}
(B) 1.8×10^{-20}
(C) 18×10^{-10}
(D) 2.8×10^{-10}

71. The number of unpaired electrons in a molecule in a doublet state is:

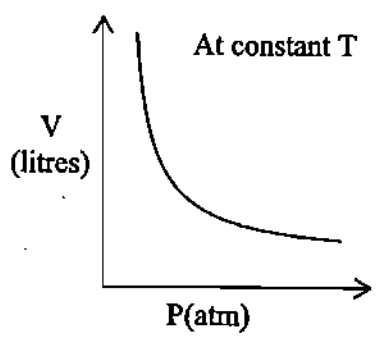
(A) 0
(B) 1
(C) 2
(D) 3

72. Which of the following graphs does NOT accurately characterize ideal gas behaviour? (P = pressure, V = volume and T = temperature)

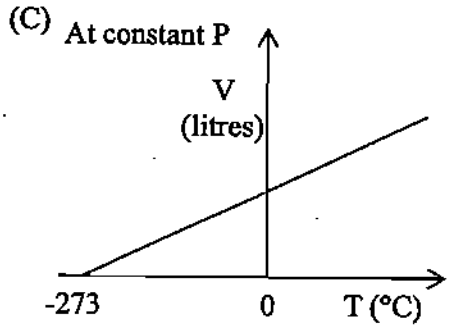
(A)



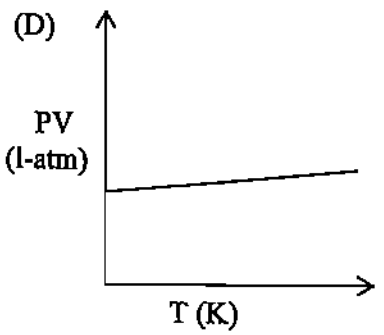
(B)



(C)



(D)



73. Assume benzene and toluene form an ideal solution. At a certain temperature, the vapour pressure of pure benzene is 200 torr and that of pure toluene is 70 torr. The mole fraction of benzene in the solution is 0.4. What is the mole fraction of benzene in the vapour in equilibrium with the solution?

(A) 0.19
(B) 0.66
(C) 0.40
(D) 0.33

74. Resistance of 0.02 $mol.dm^{-3}$ solution of acetic acid in a cell with cell constant = 0.2 cm^{-1} was found to be 800 Ω. What is the degree of ionization of the acid at this concentration? (Given Λ_m^0 for acetic acid =0.04 S $mol^{-1}m^2$)

(A) 0.003
(B) 0.03
(C) 0.3
(D) 3

75. If the temperature of one mole of monoatomic ideal gas changes from 273 K to 303 K, how much is the change in its kinetic energy?

(A) 102 Joules
(B) 42 Joules
(C) 84 Joules
(D) 125 Joules

76. The dimensions of a rectangular box, measured with calipers having a least count of 0.1 mm, are 5mm x 10mm x 5mm. The maximum percentage of error in the measure of its volume is:

(A) 5 %
(B) 10 %
(C) 15 %
(D) 20 %

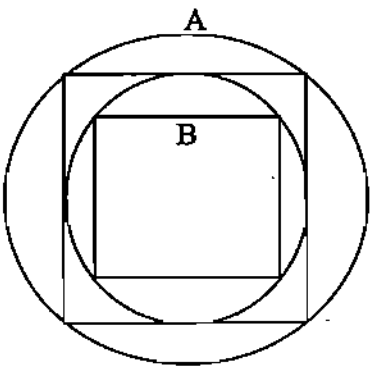
77. The slope of a function y = f(x) varies as x^2. Which of the following best defines the function? (m and c are constants)

(A) $y = x^2 + c$
(B) $y = 2x$
(C) $y = 1/12x^4 + c$
(D) $y = mx^3 + c$

78. The function $y = x^2 + x$, best characterizes

(A) a circle
(B) a straight line intersecting a circle
(C) a parabola
(D) none of the above

79. If the radius of the innermost circle is 'a', what is the difference in the area between outermost circle marked as 'A' and the innermost square marked as 'B' in the figure (π = 3.14):



(A) $2a^2(\pi - 1)$
(B) $2a^2(\pi - 2)$
(C) $2a^2(\pi - \sqrt{2})$
(D) $2a^2(\pi - 1/2)$

80. The sum of the infinite series $2 + 1 + 1/2 + 1/4 + 1/8 + \cdots$ is:

(A) 3.9
(B) 4.0
(C) 4.1
(D) 5.0

81. Given that the value of $\tan(\theta)$ is 1, the values of θ in the interval $(0, 2\pi)$ are:

(A) $\pi/4$ and $5\pi/4$
(B) $\pi/4$ and $3\pi/4$
(C) $\pi/4$ and $7\pi/4$
(D) $\pi/4$ and $6\pi/4$

82. If sinα and cosα are two roots of $25x^2 + 5x - 12 = 0.0$, then the value of sin 2α is:

(A) 12/25
(B) -12/25
(C) -24/25
(D) 4/5

83. The coordinates of the two corners of an equilateral triangle are (-2,0) and (2,0). The coordinate of the third corner could be:

(A) $(2\sqrt{3},0)$
(B) $(0,2\sqrt{3})$
(C) $(-2\sqrt{3},0)$
(D) (0, -2)

84. The value of a function f(x) at x=2 is 8 and the value of the first derivative of the same function at x=2 is 8. The value of f(x) at x=2.1 is closest to:

(A) 7.2
(B) 9.4
(C) 8.6
(D) 8.8

85. The speed of an object, s, depends on time, t, as $s=3t^2-2t$. The speed is:

(A) maximum at t=1/3
(B) minimum at t=2/3
(C) minimum at t=1/2
(D) minimum at t=1/3

86. Which of the following is NOT a unit of Planck constant?

(A) m.Kg/s
(B) J.s
(C) eV.s
(D) m^2.Kg/s

87. There are two roads in a plane area, which can be described by the two equations $y = 4x^2$ and $y = x$. Which one of the following statements is correct?

(A) The two roads are parallel to one another.
(B) The two roads intersect at only one point.
(C) The two roads do not intersect.
(D) The two roads intersect at two points.

88. A car traveling at 30 m/s sends out a sound wave of frequency 1 kHz to a stationary observer in front of the car's path. Assuming that the velocity of sound is 300 m/s, the frequency perceived by the observer is approximately:

(A) 1.1 KHz
(B) 0.9 KHz
(C) 1.2 KHz
(D) 0.8KHz

89. Which of the following is NOT a fermion?

(A) Electron
(B) Proton
(C) Deuteron
(D) Neutron

90. Which of the following will increase the magnitude of the force acting on a charged particle moving in a magnetic field?

(A) Keeping the direction of moving particle perpendicular to the direction of the magnetic field
(B) Keeping the direction of moving particle parallel and in the same direction as that of the magnetic field
(C) Keeping the magnetic field at an angle of 45° with respect to the direction of the particle
(D) Keeping the direction of moving particle parallel and in the opposite direction to that of the magnetic field

91. The percentage increase in the time period of a pendulum when its length is doubled is:

(A) 82.8 %
(B) 41.4 %
(C) 100 %
(D) 0 %

92. Which of the following is correct regarding the Energy (E) radiated per second (Stefan-Boltzmann Law) by an object at temparature, T, with emissivity, ε and surface area, A?

(A) $E \propto \varepsilon A^2 T^4$
(B) $E \propto \varepsilon A^2 T^3$
(C) $E \propto \varepsilon A T^2$
(D) $E \propto \varepsilon A T^4$

93. The energy of the ground state of the hydrogen atom is -13.6 eV. The energy of the first excited state of the hydrogen atom is:

(A) -27.2 eV
(B) -6.8 eV
(C) -3.4 eV
(D) -1.3 eV

94. In a class of 40 students, 25 are girls and 15 are boys. You need to pick three representatives, two from girls and one from boys. The number of different ways in which this can be done is:

(A) 9880
(B) 2660
(C) 3800
(D) 4500

95. An electric motor fitted at the ground floor of a house takes 10 minutes to fill the overhead tank with water. The tank has a capacity of 30 m^3. If the tank is 60 m above the ground and the efficiency of the pump is 30%, how much of electric power is consumed by the pump for filling the tank completely? (Take g = 10 m/s^2)

(A) 100 kW
(B) 150 kW
(C) 200 kW
(D) 250 kW

96. In a surface tension experiment with a capillary tube 1 m long, water rises up to 0.1 m. If the same experiment is repeated in an artificial satellite revolving around the earth, the rise of water level in the capillary tube is:

(A) 0.1 m
(B) 0.5 m
(C) 0.98 m
(D) 1 m

97. A man is carrying a block of a certain material (whose density is 1000 kg/m^3) weighing 1 kg in his left hand and a bucket full of water weighing 10 kg in right hand. Later he puts the block into the bucket. Then the load he carries in his right hand would be:

(A) 9 Kg
(B) 10 Kg
(C) 11 Kg
(D) 12 Kg

98. The threshold of wavelength for emission of photoelectrons from a metal is 2300 Å. The energy of the electrons ejected from the surface by light of wavelength 1900 Å is:

(A) 0.116 eV
(B) 5.38 eV
(C) 1.16 eV
(D) 6.54 eV

99. If the radius of Earth is 6400 Km and the Escape velocity on the surface of the earth is 11.2 km/s, what is the approximate escape velocity at an altitude of 9000 m above the surface of the earth?

(A) 8.0 km/s
(B) 17.4 km/s
(C) 7.2 km/s
(D) 15.7 km/s

100. The potential energy of a diatomic molecule V is a function of the internuclear distance R. Its functional form is $V(x) = A\,[1 - \exp(-a\,x)]^2$, where $x = R - b$. A, a and b are constants. At the equilibrium inter-nuclear distance, the potential energy has the least value. With the above functional form, the equilibrium inter-nuclear distance is equal to:

(A) $1/a$
(B) b
(C) ∞
(D) 0