INSTITUTE OF ENGINEERING

MODEL ENTRANCE EXAM

(SET – 4)
Solutions

Instructions:

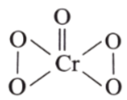
There are 100 multiple-choice questions, each having four choices of which only one choice is correct.

Date : 2081/03/01
(June 15)

Duration : 2 hours
Time : 8 A.M. – 10 A.M.

SECTION – A (**1 marks**) (1*60 = 60)

1) c
2) b
3) b
4) b
5) b
6) c
7) b
8) a
9) b
10) a
11) a
12) a
13) c Isomers which have different arrangement of alkyl group present on either side of polyvalent functional groups are metamers.
14) a If double and triple bond are present on same position, then priority goes to double bond.
15) b Characteristic reaction of Benzene is Electrophilic Substitution Reaction.
16) b For aldol condensation, aldehyde or ketone must have α-H.
17) d IF_3 → sp^3d hybridization (2 lone pair + 3 bond pair) → bent-T geometry
PCl_3 → sp^3 hybridization (1 lone pair + 3 bond pair) → pyramidal geometry
NH_3 → sp^3 hybridization (1 lone pair + 3 bond pair) → pyramidal geometry
BF_3 → sp^2 hybridization (0 lone pair + 3 bond pair) → trigonal planar geometry
18) b Number of atoms = number of moles × N_A × atomicity $= 0.1 \times 6.023 \times 10^{23} \times 3$
$= 1.806 \times 10^{23}$ atoms
19) c The highest pH refers to the basic solution containing OH^- ions. Therefore, the basic salt releasing more OH^- ions on hydrolysis will give highest pH in water.
Only the salt of strong base and weak acid would release more OH^- ion on hydrolysis. Among the given salts, Na_2CO_3 corresponds to the basic salt as it is formed by the neutralization of NaOH [strong base] and H_2CO_3 [weak acid].
$CO_3{}^{2-} + H_2O \rightleftharpoons HCO_3{}^- + OH^-$
20) c The electronic configuration $1s^2, 2s^2 2p^5, 3s^1$ shows lowest ionization energy because this configuration is unstable due to the presence of one electron in s-orbital. Hence, less energy is required to remove the electron.
21) c The structure of CrO_5 is:



Oxidation state of Cr is +6 due to the presence of two peroxide linkages which can be calculated as:
$x + 4(-1) + (-2) = 0$
$x - 6 = 0$
$x = +6$
22) c Each of the Na^+ and Cl^- ions has coordination number of 6.
23) d Hydrometallurgy involves both leaching and precipitation of the metal from its solution by adding a precipitating agent.
24) d White phosphorous (most reactive phosphorous) produce phosphorescence.

25) b

26) c Mercury in presence of ozone is oxidized to suboxide. It starts sticking to glass and loses mobility. Hence, mercury loses its meniscus in contact with ozone. This is termed as the tailing of mercury and is used as a test for ozone.
$2Hg + O_3 \rightarrow Hg_2O + O_2$

27) d The relation $A \cup \phi = A$ is true for any set A, not just the null set. ϕ is the identity element for the union operation, meaning any set unioned with the empty set remains unchanged.

28) a For a complex number z, -z is the reflection of z about the origin. Reflecting about the origin adds π radians to the argument of z.
So, if $\arg(z) = \theta$, then $\arg(-z) = \theta + \pi$
$\arg(-z) - \arg(z) = \theta + \pi - \theta = \pi$

29) d If a matrix A is scaled by a scalar k, the determinant of the resulting matrix is scaled by k^n, where n is the order of the matrix.
$\det(kA) = k^n \det(A)$
For a 3×3 matrix, $n = 3$
$\det(-2A) = (-2)^3 \det A = -8\Delta$

30) a

31) b

32) a

33) b

34) b

35) a

36) c

37) d

38) b

39) c

40) b

41) c

42) a

43) a

44) a

45) a

46) a

47) d For a particle performing uniform circular motion, magnitude of the acceleration remains constant.

48) a

49) c The breaking stress of the wire depends upon the nature of material of the wire.

50) a After terminal velocity is reached, the net acceleration of the body falling through a fluid is zero because the body after attaining terminal velocity will continue moving with same velocity through the viscous medium.

51) d In a cyclic process, the system returns to its initial state. Since internal energy is a state variable, $\Delta U = 0$, for a cyclic process.

52) d No medium is required in radiations, such as radiations from the sun travel through vacuum and reaches us.

53) a Speed of sound wave in a fluid is:
$v = \sqrt{\frac{B}{\rho}}$
Where, B is the bulk modulus and ρ is the density of the medium.

54) a The material suitable for using as a dielectric must have high dielectric strength X and large dielectric constant K.

55) b Semiconductors having negative temperature coefficient of resistivity whereas metals are having positive temperature coefficient of resistivity. With increase in temperature, the resistivity of metal increases whereas resistivity of semiconductor decreases.

56) d Under the influence of electric force, the particle moves along electric field. As we know,
Magnetic force $\vec{F} = q(\vec{v} \times \vec{B})$
Here, $\vec{v} \parallel \vec{B}$, so, $\vec{F} = 0$.
Hence, the particle moves along a straight line in the direction of electric field.

57) c As, $\varepsilon = L\frac{dI}{dt}$
When $\frac{dI}{dt} = 1, \varepsilon = L$

58) d

59) c When Young's double slit experiment is repeated in water, instead of air
$\lambda' = \frac{\lambda}{\mu}$, i.e., wavelength decreases.
$\beta = \frac{\lambda' D}{d}$, i.e., fringe width decreases.
Therefore, fringe becomes narrower.

60) c

<u>SECTION – B (2 marks)</u> (2*40=80)

61) d

62) b

63) b

64) a

65) a A is ethanol. Ethanol can give positive Iodoform test.
$CH_3CH_2OH \xrightarrow{PCl_5} CH_3CH_2Cl \xrightarrow{alc.KOH,\Delta} CH_2 = CH_2 \xrightarrow{H_2O/H^+} CH_3CH_2OH$

66) b For methyl group, the order will be $2^\circ > 1^\circ > 3^\circ > NH_3$

67) d For the reaction,
$Ca(OH)_2(s) \rightleftharpoons Ca^{2+}(aq) + 2OH^-(aq)$
S 2S
$K_{sp} = [Ca^{2+}][OH^-]^2 = S(2S)^2$ --- (i)
Given, $p^H = 9$
$p^{OH} = 14 - -9 = 5$
$[OH^-] = 10^{-5}$
From (i), $[OH^-] = 2S = 10^{-5}$
$S = \frac{10^{-5}}{2}$
$K_{sp} = 4S^3 = 4\left(\frac{10^{-5}}{2}\right) = 0.5 \times 10^{-15}$

68) b $E^0{}_X = -1.2\ V$
$E^0{}_Y = +0.5\ V$
$E^0{}_Z = -3.0\ V$
Higher the reduction potential, lesser is the reducing power.

$\therefore Z > X > Y$

69) a $\frac{r_{CH_4}}{r_X} = 2 = \sqrt{\frac{M_X}{M_{CH_4}}} = \sqrt{\frac{M_X}{16}}$

$\frac{M_X}{16} = 4$

$M_X = 64$

70) b $k = \frac{1}{40}\ln\frac{0.1}{0.025} = \frac{1}{40}\ln 4$

$R = k[A]^1 = \frac{1}{40}\ln 4 \times 0.01 = 3.47 \times 10^{-4}$ M/min

71) c

72) c

73) b

74) a

75) a

76) c

77) b

78) b

79) a

80) c

81) b

82) c

83) a

84) d

85) b

86) c

87) a

88) a $r = 100\ cm = 1\ m$

Frequency, $f = \frac{14}{22}$ rps

$\omega = 2\pi f = 2 \times \frac{22}{7} \times \frac{14}{22} = 4\ rads^{-1}$

The acceleration of the stone is: $a_c = \omega^2 r = (4)^2 \times 1 = 16\ m/s^2$

89) b Here, $m = 0.2$ kg, $v = 5\ m/s$, h = length of elevator $= 5$ m

As relative velocity of the bolt w.r.t. elevator is zero, therefore, in the impact, only potential energy of the bolt is converted into heat energy.

Amount of heat produced = Potential energy lost by the bolt = $mgh = 0.2 \times 10 \times 5 = 10$ J

90) c As Young's modulus, $Y = \frac{(F/A)}{(\Delta L/L)}$

As applied force and extension ΔL are same for steel and copper wires,

$\frac{F}{\Delta L} = \frac{YA}{L}$

So, $\frac{Y_S A_S}{L_S} = \frac{Y_C A_C}{L_C}$

or, $\frac{Y_S}{Y_L} = \frac{L_S}{L_C} \times \frac{A_C}{A_S} = \frac{4.5}{3.5} \times \frac{4\times10^{-5}}{3\times10^{-5}} = 1.7$

91) b Volume of bubble, $V = \frac{4}{3}\pi R^3$

$R = \left(\frac{3V}{4\pi}\right)^{1/3}$

Work done, $W = S \times 8\pi R^2 = S \times 8\pi\left(\frac{3V}{4\pi}\right)^{2/3}$

$W \propto V^{2/3}$

$\therefore \frac{W_2}{W_1} = \left(\frac{V_2}{V_1}\right)^{2/3} = \left(\frac{2V}{V}\right)^{2/3} 2^{2/3}$

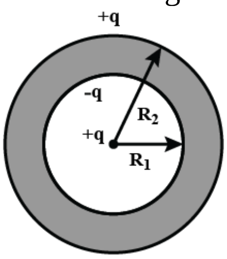
$W_2 = 2^{2/3} W_1$

92) d If m is the mass of ice melted, then
Heat spent in melting = Heat supplied by the ball
$mL = Ms\Delta T$
$m \times 80 = (80 \times 1000) \times 0.2 \times 100$
$m = 2 \times 10^4$ g

93) d The coefficient of performance of a refrigerator is given by:
$\beta = \frac{Q_2}{W} = \frac{Q_2}{Q_1 - Q_2}$
$\frac{1}{3} = \frac{Q_2}{200 - Q_2}$
$Q_2 = \frac{200}{4} = 50$ J
$\therefore W = Q_1 - Q_2 = 200 - 50 = 150$ J

94) d The given transverse harmonic wave equation is:
$y = 3\sin\left(36t + 0.018x + \frac{\pi}{4}\right)$ --- (i)
As there is positive sign between t and x terms, therefore the given wave is travelling in the negative x-direction.
The standard transverse harmonic wave equation is:
$y = a\sin(\omega t + kx + \phi)$ --- (ii)
Comparing (i) and (ii), we get,
$a = 3\ cm, \omega = 36\ rad\ s^{-1}, k = 0.018\ rad\ cm^{-1}$
Amplitude of the wave, $a = 3\ cm$
Frequency of the wave, $f = \frac{\omega}{2\pi} = \frac{36}{2\pi} = \frac{18}{\pi}$ Hz
Velocity of the wave, $v = \frac{\omega}{k} = \frac{36}{0.018} = 2000\ cms^{-1} = 20\ ms^{-1}$

95) b When a charge +q is placed at the centre of spherical cavity as shown in the figure,



Charge induced on the inner surface of shell $= -q$
Charge induced on the outer surface of shell $= +q$
$\therefore$ Surface charge density on the inner surface $= \frac{-q}{4\pi {R_1}^2}$
Note:
Surface charge density on the outer surface $= \frac{+q}{4\pi {R_2}^2}$

96) a Applying Kirchhoff's first law at the junction P,
$6 = i_1 + i_2$ --- (1)
Applying Kirchhoff's second law to the closed loop PQRP,
$-2i_1 - 2i_1 + 2i_2 = 0$
$4i_1 - 2i_2 = 0$ --- (2)
Solving (1) and (2), we get
$i_1 = 2A, i_2 = 4A$

97) c For six layers of windings, total number of turns, $N = 6 \times 450 = 2700$

Number of turns per unit length, $n = \frac{N}{l} = \frac{2700}{90\times10^{-2}} = 3000$

The field inside the solenoid near the centre, $B = \mu_0 nI = 4\pi \times 10^{-7} \times 3000 \times 6$

$= 72\pi \times 10^{-4}$ T

98) b $\frac{1}{f} = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

Here, $f = 20\ cm, \mu = 1.55, R_1 = R$ and $R_2 = -R$

$\frac{1}{20} = (1.55 - 1)\left(\frac{1}{R} - \frac{1}{(-R)}\right)$

$\frac{1}{20} = 0.55 \times \frac{2}{R}$

$\therefore R = 0.55 \times 2 \times 20 = 22\ cm$

99) b Distance of 2^{nd} order maximum from the centre of the screen

$x = \frac{5}{2}\frac{D\lambda}{d}$

$d = \frac{5}{2}\frac{D\lambda}{x} = \frac{5}{2} \times \frac{0.8\times600\times10^{-9}}{15\times10^{-3}} = 80\ \mu m$

100) a Current gain, $\alpha = \frac{Power\ gain}{Voltage\ gain} = \frac{800}{840} = \frac{20}{21}$

$\beta = \frac{\alpha}{1-\alpha} = \frac{\frac{20}{21}}{1-\frac{20}{21}} = 20$

As, $\beta = \frac{I_C}{I_B}$

$I_C = \beta I_B = 20 \times 1.2 = 24\ mA$

❖❖❖❖ Thank You!!! ❖❖❖❖