INSTITUTE OF ENGINEERING

MODEL ENTRANCE EXAM

(SET – 2)
Solutions

Instructions:

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

Date : 2081/02/19
(June 01)

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

1) b
2) c
3) b
4) b
5) d
6) c
7) c
8) b
9) a
10) c
11) d
12) b
13) b On increasing the temperature, volume of solution increases. Hence, molarity decreases.
14) b Electrons flow from cathode to anode through internal supply. In the solution, ions flow and not the electrons.
15) c $N_2H_4 \rightarrow -2$
$N_3H \rightarrow -\frac{1}{3}$
$NH_3 \rightarrow -3$
$NH_2OH \rightarrow -1$
16) a Electonic configuration of 'K' → $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$
$n = 4, l = 0, m = 0, s = \frac{1}{2}$
17) b
18) d ${O_2}^-$ has one unpaired electron and hence is paramagnetic.
19) c MgO → Basic oxide
20) b Due to highest electronegativity of Fluorine.
21) b Calcination is a process in which an ore is heated, generally, in absence of air to expel water from a hydrated oxide of CO_2 from a carbonate at temperature below their melting point.
22) d AgCl is soluble in dilute solution of NH_4OH.
AgI is insoluble in NH_4OH solution.
23) d Tendency to knock follows the order:
Straight chain alkanes > Branched alkanes > olefins > cycloalkanes > aromatic hydrocarbons
24) a For aldol condensation, aldehyde or ketone must contains α-H.
25)
26) d Reactivity towards ESR follows:
$-NH_2 > -OH > -OCH_3 > -H > -X > -CHO > -COOH > -CN > -NO_2$
27) b $r_1 = \frac{\Delta}{s-a}$
$s = \frac{13+14+15}{2} = 21$ and $\Delta = \sqrt{21(21-13)(21-14)(21-15)} = 84$
So, $r_1 = \frac{84}{21-13} = 10.5$
28) b Here, $A = \tan^{-1} x \Rightarrow \tan A = x$
$\sin 2A = \frac{2\tan A}{1+tan^2 A} = \frac{2x}{1+x^2}$
29) a On squaring, we get,
$1 + 2\sin\theta . \cos\theta = 1 + 2\sin 2\theta . \cos 2\theta$
$\sin 2\theta = \sin 4\theta$
$\theta = \frac{\pi}{6}$
30) c Given expression is : $3\cos\theta + 4\sin\theta$
Here, $a = 3, b = 4$

The interval is : $\left[-\sqrt{a^2+b^2}, \sqrt{a^2+b^2}\right] = [-5,5]$

31) b $\lim_{x\to 0}\left(\frac{\sin x - x}{x}\right)\sin\frac{1}{x} = \lim_{x\to 0}\left(\frac{\sin x}{x} - 1\right).\lim_{x\to 0}\sin\frac{1}{x} = (1-1)\times(\text{a finite quantity}) = 0$

32) b $\frac{d}{dx}\cos^{-1}(\sin x) = \frac{d\cos^{-1}(\sin x)}{d(sinx)}.\frac{d(sinx)}{dx} = -\frac{1}{\sqrt{1-sin^2x}}.\cos x = -\frac{\cos x}{\cos x} = -1$

33) d $\int_0^{\frac{1}{\sqrt{2}}}\frac{dx}{\sqrt{1-x^2}} = [\sin^{-1}x]_0^{\frac{1}{\sqrt{2}}} = \sin^{-1}\left(\frac{1}{\sqrt{2}}\right) - \sin^{-1}(0) = \frac{\pi}{4}$

34) c Area of equilateral triangle (A) $= \frac{\sqrt{3}}{4}a^2$

$\frac{dA}{dt} = \frac{\sqrt{3}}{4}.2a.\frac{da}{dt} = \frac{\sqrt{3}}{2}ak \qquad \left[\because \frac{da}{dt} = k\ unit/sec\right]$

35) a $\sqrt{a+ib} + \sqrt{a-ib} = \sqrt{2|z|+2a}$

$\therefore \sqrt{7+24i} + \sqrt{7-24i} = \sqrt{2\times 25 + 2\times 7} = 8$

36) a Let, $y = x^2 - 6x + 13 = x^2 - 2.x.3 + 3^2 - 3^2 + 13 = (x-3)^2 + 4$

The least value of y is 4, when $x - 3 = 0$.

37) b Mean $(\bar{x}) = \frac{-1+0+4}{3} = 1$

M.D. from mean $= \frac{\sum|x_i - \bar{x}|}{n} = \frac{2+1+3}{3} = 2$

38) b $A - (B\cap C) = (A-B)\cup(A-C)$

39) a $y = x - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{2} + \cdots + \infty$

$y = log_e(1+x)$

$e^y = 1 + x$

$x = e^y - 1$

40) c $f(x) = \frac{x}{2+x^2}$ is defined for any value of x in R.

So, Domain = (-∞, ∞)

41) a Projection of $\vec{b}$ on $\vec{a} = \frac{\vec{a}.\vec{b}}{|\vec{a}|} = \frac{5.2+(-3).1+1.2}{\sqrt{2^2+2^2+1}} = \frac{10-3+2}{3} = \frac{9}{3} = 3$

42) a Given, $a = 3b$

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

$\frac{x}{3b} + \frac{y}{b} = 1$

$x + 3y = 3b$ --- (1)

The point (1,2) lies in (1)

$1 + 6 = 3b$

$b = \frac{7}{3}$

So, the required equation is:

$x + 3y = 7$

43) c Centre of the circle $x^2 + y^2 - 6x - 4y - 3 = 0$ is (3,2)

Centre of concentric circle = (3,2)

Radius (r) = 5

The equation of the concentric circle is:

$(x-3)^2 + (y-2)^2 = 25$

$x^2 - 6x + 9 + y^2 - 4y + 4 = 25$

$x^2 + y^2 - 6x - 4y - 12 = 0$

44) b $(x+3)^2 + y^2 = (x-3)^2$

$y^2 = (x-3)^2 - (x+3)^2 = -12x$

45) d $x^2 - y^2 = 0$

$(x-y)(x+y) = 0$

$x - y = 0, x + y = 0$

It represents a pair of lines.

46) c $(a_1, b_1, c_1) = (1,2,3)$

$(a_2, b_2, c_2) = (3, -3, 1)$

$\cos\theta = \frac{a_1a_2 + b_1b_2 + c_1c_2}{\sqrt{a_1{}^2 + b_1{}^2 + c_1{}^2}\sqrt{a_2{}^2 + b_2{}^2 + c_2{}^2}} = \frac{1.3 + 2(-3) + 3.1}{\sqrt{1^2+2^2+3^2}\sqrt{3^2+(-3)^2+1^2}} = 0$

$\theta = 90^\circ$

47) c

48) c

49) b $E = mc^2 = mc.c = pc$

$E^2 = p^2c^2$

50) c For a perfectly rigid body, both Young's modulus and bulk modulus is infinite.

51) b In SHM, total energy is: $E = \frac{1}{2}m\omega^2A^2$

$E \propto A^2$

52) a

53) c Sound waves are longitudinal waves that is why in air they cannot be polarized.

54) a The net charge enclosed by the sphere is zero.

55) b

56) d Above Curie temperature, ferromagnetic material become paramagnetic.

57) c

58) c Image formed is complete but has decreased intensity.

59) d Photoelectric current depends upon :

(i) the intensity of incident light

(ii) the potential difference applied between the two electrodes

(iii) the nature of the emitter material

60) a

61) d

62) c

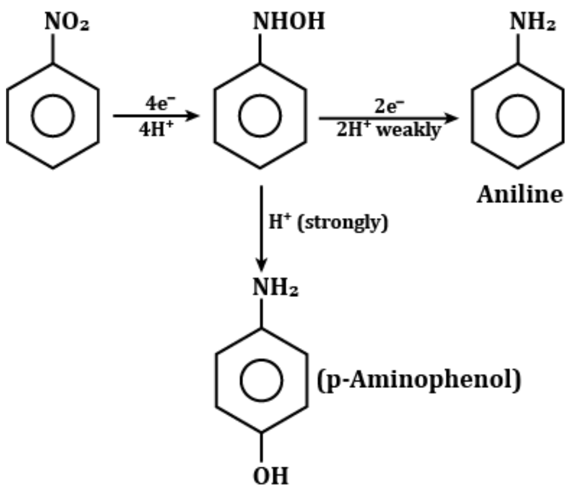
63) b

64) a

65) b 1° alcohol which gives positive Iodoform test is Ethanol. So, A is ethanol.

$CH_3CH_2OH \xrightarrow{PCl_5} CH_3CH_2Cl \xrightarrow{alc.KCN} CH_3CH_2CN \xrightarrow{H_2O/\,H^+} CH_3CH_2COOH$

66) c



67) d $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

$K_p = K_c(RT)^{\Delta n_g}$
$\Delta n_g = (2) - (3+1) = -2$
$K_p = K_c(RT)^{-2}$

68) d (a) $\frac{5}{22.4} \times N_A$ (b) $\frac{0.5}{2} \times N_A$ (c) $\frac{10}{32} \times N_A$ (d) $\frac{15}{22.4} \times N_A$
(d) contains maximum number of atoms.

69) d For zero order reaction,
$k = \frac{1}{t}[[A]_0 - [A]]$
or, $[A] = [A]_0 - kt$
Thus, plot of [A] vs t is straight line with negative slope.

70) d $E^0{}_{cell} = E^0{}_{ox}(Mg) + E^0{}_{red}(Cu)$
or, $2.7 = E^0{}_{ox}(Mg) + 0.34$
$E^0{}_{ox}(Mg) = 2.36\ V$
$\therefore E^0{}_{red}(Mg) = -2.36\ V$

71) c For isoelectronic species, ionic radii decrease with increase in effective (relative) charge. Also, Ar, K and Ca belong to the same period (3rd period).
Thus, the order is: $Ca^{2+} < K^+ < Ar$

72) b $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$
X Residue
$CaO + H_2O \rightarrow Ca(OH)_2$
Y
$Ca(OH)_2 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$
Z
$Ca(HCO_3)_2 \xrightarrow{\Delta} CaCO_3 + CO_2 + H_2O$
X

73) b Here, $r = 12\ cm$, frequency, $v = \frac{7}{100} rps$
The angular speed of the insect is:
$\omega = 2\pi v = 2\pi \times \frac{7}{100} = 0.44\ rads^{-1}$
The linear speed of insect is: $v = \omega r = 0.44 \times 12 = 5.3\ cms^{-1}$

74) b Limiting friction, $f = \mu mg = 0.6 \times 1 \times 9.8 = 5.88\ N$
Applied force, $F = ma = 1 \times 5 = 5\ N$
As, $F < f$, so force of friction = 5 N

75) b According to the law of conservation of angular momentum, we get,
$L_i = L_f$
or, $I_i\omega_i = I_f\omega_f$
or, $\omega_f = \frac{I_i\omega_i}{I_f} = \left(\frac{I_i}{3I_i}\right)\omega_0 = \frac{\omega_0}{3}$

76) c $h = \frac{2S\cos\theta}{r\rho g}$
Mass of water in the first tube,
$m = \pi r^2 h\rho = \pi r^2 \times \left(\frac{2S\cos\theta}{r\rho g}\right) \times \rho = \frac{2\pi r S\cos\theta}{g}$
$m \propto r$
Hence, $\frac{m'}{m} = \frac{2r}{r} = 2$
or, $m' = 2m = 2 \times 5 = 10\ g$

77) c $T_i = 90^\circ C$ (Initial Temperature)
$T_f = 80^\circ C$ (Final Temperature)

$T_0 = 20^{\circ}C$ (Room Temperature)
Let time taken be t minutes.
According to Newton's law of cooling,
Rate of cooling $\frac{dT}{dt} = K\left[\frac{(T_i+T_f)}{2} - T_0\right]$
or, $\frac{90-80}{t} = K\left[\frac{(90+80)}{2} - 20\right]$
$K = \frac{10}{65\,t}$
In 2nd condition,
$T_i = 80^{\circ}C$ (Initial Temperature)
$T_f = 60^{\circ}C$ (Final Temperature)
Let time taken be t' minutes.
$\frac{80-60}{t'} = \frac{10}{65\,t}\left[\frac{(80+60)}{2} - 20\right]$
$\frac{20}{t'} = \frac{10}{65\,t}(50)$
$t' = \frac{13}{5}t$

78) d $P_1V_1^{\gamma} = P_2V_2^{\gamma}$
or, $PV^{\gamma} = P_2\left(\frac{V}{4}\right)^{\gamma}$
or, $P_2 = 4^{\gamma}P$
Now, for monatomic gases,
$\gamma = \frac{5}{3}$
$\therefore P_2 = 4^{5/3}$ P = 10.08 P

79) c Let L be the length of the pipe.
Fundamental frequency of closed pipe is:
$v_c = \frac{v}{4L}$
Where, v is the speed of sound in air.
Fundamental frequency of open pipe of same length is
$v_o = \frac{v}{2L}$
Divide (ii) by (i), we get,
$\frac{v_0}{v_c} = 2$
or, $v_0 = 2v_c = 2v$

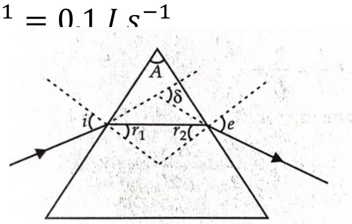
80) c Initial energy of the combined system,
$U_1 = \frac{1}{2}CV_1^2 + \frac{1}{2}CV_2^2 = \frac{C}{2}\left(V_1^2 + V_2^2\right)$
On joining the two condensers in parallel, common potential
$V = \frac{CV_1+CV_2}{C+C} = \frac{V_1+V_2}{2}$
Final energy of the combined system
$U_2 = \frac{1}{2}(C+C)\left(\frac{V_1+V_2}{2}\right)^2$
Decrease in energy
$\Delta U = U_1 - U_2 = \frac{1}{2}C\left(V_1^2 + V_2^2\right) - \frac{1}{2}(2C)\left(\frac{V_1+V_2}{2}\right)^2 = \frac{C}{4}[2\left(V_1^2 + V_2^2\right) - (V_1+V_2)^2] =$
$\frac{C}{4}(V_1 - V_2)^2$

81) c Potential of 20 V will be same across each resistance.
$I_1 = \frac{V}{R_1} = \frac{20}{2} = 10\ A$
$I_2 = \frac{V}{R_2} = \frac{20}{4} = 5\ A$

$I_3 = \frac{V}{R_3} = \frac{20}{5} = 4\ A$
Total current drawn from the circuit,
$I = I_1 + I_2 + I_3 = 10 + 5 + 4 = 19\ A$

82) c The energy stored in the inductor is:
$U = \frac{1}{2} L i^2$
The energy stored in the inductor per second is:
$\frac{dU}{dt} = Li\frac{di}{dt} = 200 \times 10^{-3}\ H \times 1\ A \times 0.5\ A\ s^{-1} = 0.1\ J\ s^{-1}$

83) a Here, $i = 60°, A = 30°, \delta = 30°$
As, $i + e = A + \delta$
$e = A + \delta - i = 30° + 30° - 60° = 0°$
Hence, emergent ray is normal to the surface.
$e = 0° \Rightarrow r_2 = 0°$
As, $r_1 + r_2 = A$
$r_1 = 30° - 0 = 30°$
$\mu = \frac{\sin i}{\sin r_1} = \frac{\sqrt{3}}{2} \times \frac{2}{1} = \sqrt{3} = 1.732$



84) b $\beta = \frac{D\lambda}{d} \propto \lambda$
or, $\frac{\beta_2}{\beta_2} = \frac{\lambda_2}{\lambda_1}$
or, $\beta_2 = \frac{\lambda_2}{\lambda_1} \times \beta_1 = \frac{5}{8} \times 2.4 \times 10^{-4} = 1.5 \times 10^{-4}\ m$
Decrease in fringe width $= \beta_1 - \beta_2 = (2.4 - 1.5) \times 10^{-4} = 0.9 \times 10^{-4}\ m$

85) a According to Einstein's photoelectric equation
$K_{max} = \frac{hc}{\lambda} - \emptyset_0$ --- (1)
$2K_{max} = \frac{hc}{\lambda'} - \emptyset_0$ --- (2)
Dividing (2) by (1), we get,
$2 = \frac{\frac{hc}{\lambda'} - \emptyset_0}{\frac{hc}{\lambda} - \emptyset_0}$
$2\frac{hc}{\lambda} - 2\emptyset_0 = \frac{hc}{\lambda'} - \emptyset_0$
$hc\left(\frac{2}{\lambda} - \frac{1}{\lambda'}\right) = \emptyset_0$
$\emptyset_0 = 1240\ \left(\frac{2}{600} - \frac{1}{400}\right) = 1.03\ eV$ [Take hc=1240 eV nm]

86) d Probability that no ball is green $= \frac{C_1^{10} \times C_1^{9}}{15 \times 14} = \frac{90}{15 \times 7} = \frac{3}{7}$
$\therefore$ Required probability $= 1 - \frac{3}{7} = \frac{4}{7}$

87) a $\cot^{-1} x + \cot^{-1} y = \frac{\pi}{2}$
$\cot^{-1} x = \frac{\pi}{2} - \cot^{-1} y$
$x = \cot\left(\frac{\pi}{2} - \cot^{-1} y\right) = \cot(\tan^{-1} y) = \cot\left(\cot^{-1}\frac{1}{y}\right)$
$x = \frac{1}{y}$
$xy = 1$

88) d $\lim_{x \to 0} \frac{1 - \cos x}{x^2} = \lim_{x \to 0} \frac{2\, sin^2\frac{x}{2}}{x^2} = \lim_{x \to 0} \frac{2\left(\sin\frac{x}{2}\right)^2}{\left(\frac{x}{2}\right)^2 \times 2^2} = \frac{2}{4} \times 1 = \frac{1}{2}$

89) b

90) d $\int \frac{dx}{\tan x+\cot x} = \int \frac{dx}{\frac{\sin x}{\cos x}+\frac{\cos x}{\sin x}} dx = \int \frac{1}{2}.\frac{\sin 2x}{1} dx = \frac{1}{2}\left[\frac{-\cos 2x}{2}\right] + c = \frac{-\cos 2x}{4} + c$

91) c Given, $\frac{dr}{dt} = 0.25\ cm/sec$

$\frac{dA}{dt} = \frac{d}{dt}(\pi r^2) = \pi \times 2r.\frac{dr}{dt} = \pi \times 2 \times 7 \times 0.25 = 11\ cm^2/sec$

92) a In X-axis, $y = 0$

i.e., $x(1-x)^2 = 0$

$x = 0,1$

Area bounded (A) $= \int_0^1 y\, dx = \int_0^1 x(x^2-2x+1)dx = \left[\frac{x^4}{4} - \frac{2x^3}{3} + \frac{x^2}{2}\right]_0^1 = \frac{1}{4} - \frac{2}{3} + \frac{1}{2} = \frac{1}{12}$

93) b First series is:

$a + ar + ar^2 + \cdots + \infty$

$\frac{a}{1-r} = 3$ --- (1)

Second series is:

$a^2 + a^2r^2 + a^2r^4 + \cdots + \infty$

$\frac{a^2}{1-r^2} = 3$

$\frac{a.a}{(1-r)(1+r)} = 3$

$\frac{3a}{1+r} = 3$ (from (1))

$\frac{a}{1+r} = 3$ --- (2)

Dividing (1) by (2),

$\frac{1+r}{1-r} = 3$

$r = \frac{1}{2}$

94) d $\begin{vmatrix} x & x^2 & 1+x^3 \\ y & y^2 & 1+y^3 \\ z & z^2 & 1+z^3 \end{vmatrix} = \begin{vmatrix} x & x^2 & 1 \\ y & y^2 & 1 \\ z & z^2 & 1 \end{vmatrix} + \begin{vmatrix} x & x^2 & x^3 \\ y & y^2 & y^3 \\ z & z^2 & z^3 \end{vmatrix} = \begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix} + xyz\begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix}$

$= (1+xyz)\begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix}$

$= 0 \times \begin{vmatrix} 1 & x & x^2 \\ 1 & y & y^2 \\ 1 & z & z^2 \end{vmatrix} = 0$

95) c $t_{r+1} = {}^6C_r\,(2x)^{6-r}\left(\frac{1}{3x}\right)^r = {}^6C_r\,.\frac{1}{3^r}\,.\,2^{6-r}\,.\,x^{6-2r}$

For term independent of x,

$6 - 2r = 0$

$r = 3$

Required term = ${}^6C_3\,.\frac{2^{6-3}}{3^3} = \frac{160}{27}$

96) a A person can go from A to B and B to C in 5 × 4 = 20 ways

A person can return from C to B and B to A in 3 × 4 = 12 ways (excluding previous ways)

Total number of ways $= 20 \times 12 = 240$

97) a $ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0$, meets y-axis, where $x = 0$,

i.e., $by^2 + 2fy + c = 0$

If y_1 and y_2 are roots of this equation,

$y_1 + y_2 = -\frac{2f}{b}$, $y_1y_2 = \frac{c}{b}$

Length of intercept on y-axis

$= |y_1 - y_2| = \sqrt{(y_1 + y_2)^2 - 4y_{1y_2}}$

or, $0 = \sqrt{\frac{4f^2}{b^2} - \frac{4c}{b}}$

or, $0 = \frac{2\sqrt{f^2 - bc}}{b}$

$\therefore f^2 = bc$

98) d Given equations of the circles are:

$S_1 : x^2 + y^2 + 4x = 0$

$S_2 : x^2 + y^2 + 2\lambda y = 0$

Equation of the common chord is:

$S_1 - S_2 = 0$

$x^2 + y^2 + 4x - x^2 - y^2 - 2\lambda y = 0$

$2x - \lambda y = 0$ --- (1)

But the equation of the common chord is

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

(1) and (2) must be identical.

Hence, $\lambda = 3$

99) a distance between the foci, $2ae = 8$

Distance between the directrices, $\frac{2a}{e} = 18$

or, $2ae \times \frac{2a}{e} = 8 \times 18$

$a^2 = 36$

$a = \pm 6$

And $e = \frac{8}{2a} = \frac{8}{2.6} = \frac{2}{3}$

We have : $b^2 = a^2(1 - e^2) = a^2 - a^2e^2 = 36 - 16 = 20$

Required equation is:

$\frac{x^2}{36} + \frac{y^2}{20} = 1$

100) b $QR = \sqrt{(3+1)^2 + (5-3)^2 + (-2-2)^2} = 6$

D.c's of QR are $\frac{3+1}{6}, \frac{5-3}{6}, \frac{-2-2}{6}$ i.e., $\frac{2}{3}, \frac{1}{3}, -\frac{2}{3}$

❖❖❖❖ Thank You!!! ❖❖❖❖