BEATS ENGINEERING

INSTITUTE OF ENGINEERING

MODEL ENTRANCE EXAM

(SET – 11)
Solutions

Instructions:

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

Date : 2081/04/19
(August 03)

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

SECTION – A (1 marks) (1*60 = 60)

1) b Iω = constant. As the man stretch his arms, I increases. So, ω decreases.

2) d $F = \frac{YAl}{L} = kl$

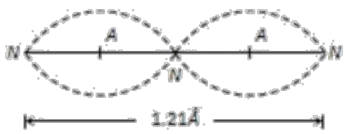
$F \propto l$. So, force constant is: $k = \frac{YA}{L}$

3) c $\gamma = \alpha_1 + 2\alpha_2$

4) c $\frac{\lambda_a}{\lambda_m} = \mu : 1$

$\frac{\lambda}{\lambda_m} = \mu : 1$

5) a



The given standing wave has 2 segments.

As length of one loop or segment is $\frac{\lambda}{2}$. So, length of two segments is $2\left(\frac{\lambda}{2}\right) = 2\left(\frac{1.21}{2}\right) = 1.21$ Å

6) d $S = \frac{iG}{ni-i} = \frac{G}{n-1}$

7) b $\lambda_e = \lambda_p$

$\frac{h}{P_e} = \frac{h}{P_p}$

$P_e = P_p$

8) a Barrier potential of a diode does not depends on diode design.

9) a T = mg, if lift is in uniform motion.

10) d $F = mr_1\omega_1{}^2 = mr_2\omega_2{}^2$

$9\omega^2 = r_2 \times (3\omega)^2$

$r_2 = 1$ cm

11) c $f_0 = \frac{v}{4l} = \frac{320}{4} = 80$ Hz

The frequencies obtained are 240, 320, 400, … etc.

12) a Potential difference across first cell, $V_1 = E - ir_1$

$0 = E - \frac{2E}{R+r_1+r_2}.r_1$

$R = r_1 - r_2$

13) b Vertical displacement $= d\left(1 - \frac{1}{\mu}\right) = \frac{(\mu-1)}{\mu}d$

14) c $KE_{max} = 2.6$ eV

$\phi = 4.2$ eV

$E = \phi + KE_{max} = 6.8$ eV

15) d

16) c The sum of mole fractions of all the components is unity (1).

17) d $Ag^+ + e^- \to Ag; Cu^{2+} + 2e^- \to Cu$

Thus, same quantity of electricity will deposit double the no. of Ag atoms than Cu,i.e., $x = 2y$.

18) c $2N_2O_5 \to 2N_2O_4 + O_2$ is bimolecular and of first order.

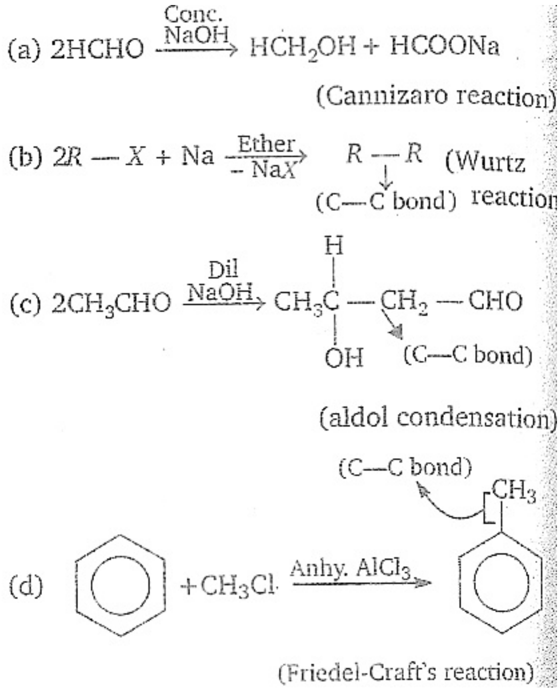
19) a Pine oil is used as a foaming agent in froth floatation process.

20) c When H_2S gas is passed through nitric acid, it produces amorphous sulphur.

21) b The bond energy will decrease down the group because, as we move down the group, the bond length increases. However, chlorine has greater energy than fluorine because of its extremely small size. The F-F bond length is so short that the lone pairs of electrons on the fluorine atoms repels the other and weakens the F-F bond.

22) a Isocyanide Reaction

23) a



24) c Hoffmann's method to separate amines in a mixture uses the reagent diethyl oxalate. Primary amine forms solid oxamide, the secondary amine forms a liquid oxamic ester and the tertiary amine does not react at all.

25) a Angular momentum $= \frac{nh}{2\pi}$

$\frac{1.5h}{\pi} = \frac{nh}{2\pi}$

$n = 3$

Therefore, the electron is present in third orbit.

26) b $SnCl_2$ is not isostrctural with CO_2 because $SnCl_2$ is in bent (angular) shape whereas CO_2 has linear shape.

27) d

28) a $CH_3CH = CH_2 + HCl \rightarrow CH_3CH(Cl)CH_3$

(Nucleophilic addition reaction)

29) b $\cos^{-1} x = \frac{\pi}{2} - \sin^{-1} x = \frac{\pi}{2} - \frac{\pi}{5} = \frac{3\pi}{10}$

30) c For $x > 0$, $\frac{x}{x} = 1$

For $x < 0$, $-\frac{x}{x} = -1$

For $x = 0$, 0

Range of f $= \{-1, 0, 1\}$

31) b α and β are the roots of $f(x) = 0$.

Then, the roots of $f\left(\frac{1}{x}\right) = 0$ are $\frac{1}{\alpha}$ and $\frac{1}{\beta}$.

32) a

33) a Integrating: $f(x) = e^x + \tan^{-1} x + c$

Putting $x = 0 : f(0) = e^0 + \tan^{-1} 0 + c$

$\Rightarrow c = 0$

34) a $\lim_{x\to 0} \frac{1-\cos x}{1+\cos x} = \frac{0}{2} = 0$

35) a $\frac{d}{dx}\cosh^{-1}\sec x = \frac{1}{\sqrt{sec^2 x - 1}}\frac{d}{dx}(\sec x) = \frac{1}{\tan x} \times \sec x \, . \tan x = \sec x$

36) b $x = 0, x - 2y = 0$
The angle between y-axis and $x = 2y$ is:
$\frac{\pi}{2} - \tan^{-1}\frac{1}{2} = \cot^{-1}\frac{1}{2}$

37) b Two planes are at right angles if:
$a_1 a_2 + b_1 b_2 + c_1 c_2 = 0$
$1.2 + 2.1 + k(-2) = 0k = 2$

38) a $\vec{a} + \vec{b} + \vec{c} = 0$
$\vec{b} + \vec{c} = -\vec{a}$
Squaring: $b^2 + c^2 + 2\vec{b}\vec{c} = a^2$
$2bc\cos\theta = a^2 - b^2 - c^2$
$\cos\theta = \frac{a^2 - b^2 - c^2}{2bc}$

39) d $\log_2(x^2 + 7) = 3$
$x^2 + 7 = 2^3 = 8$
$x^2 = 1$
$x = \pm 1$

40) d $(4k - 6) - (k + 2) = (3k - 2) - (4k - 6)$
$4k = 12$
$k = 3$

41) b $k = -2.1.2 - 1.2^3 = -12$

42) b $\sin^2\alpha + \sin^2\beta + \sin^2\gamma + 3 = 1 - \cos^2\alpha + 1 - \cos^2\beta + 1 - \cos^2\gamma + 3 = 6 - 1 = 5$

43) c $f'(x) = 3 > 0$. So, it is increasing for all $x \in R$.

44) c $f(x)$ is continuous at $x = 0$ if:
$\lim_{x\to 0} f(x) = f(0)$
$\lim_{x\to 0}\frac{\sin 5x}{3x} = k$
$\frac{5}{3} = k$

45) c $I = \int e^{\log\sec^2(2x+7)}dx = \int \sec^2(2x+7)\,dx = \frac{\tan(2x+7)}{2} + c$

46) c Multiplicative inverse of $z = \frac{1}{1+i} \times \frac{1-i}{1-i} = \frac{1-i}{2}$

47) b $\sec^{-1}(-x) = \pi - \sec^{-1} x$

48) c $y = \log(1 - x^3)$
$1 - x^3 = e^y$
$x^3 = 1 - e^y$
$x = (1 - e^y)^{1/3}$

49) c

50) d

51) d

52) a

53) a

54) d

55) a

56) c

57) b
58) a
59) b
60) c

SECTION – B (2 marks) (2*40=80)

61) c 100 g $CaCO_3$ = 6.023×10^{23} molecules
10 g $CaCO_3$ = 6.023×10^{22} molecules
1 molecule of $CaCO_3$ = 50 protons
6.023×10^{22} molecules = $50 \times 6.023 \times 10^{22} = 3.0115 \times 10^{24}$ protons

62) b Meq. Of H_2SO_4 should be equal to that of NaOH.
Meq. Of NaOH $= 0.2 \times 25 = 5$
Meq, of $H_2SO_4 = 2 \times \text{molarity} \times \text{vol (mL)} = 2 \times 0.1 \times 25 = 5$

63) b $MX_2(s) \overset{aq}{\rightleftharpoons} M^{2+} + 2X^-$
$K_{sp} = [M^{2+}][X^-]^2$
Let, $[M^{2+}] = x$
$[X^-] = 2x$
$K_{sp} = x \times (2x)^2$
$4 \times 10^{-12} = 4x^3$
$x = 1 \times 10^{-4}$ M

64) b Lower the value of standard enthalpy of formation, higher is stability. Thus the order of stability is:
$C(+24.94) < A(-46.19) < D(-296.9) < B(-393.4)$

65) a In the periodic table, on moving down, water solubility of alkaline earth metal decreases. Oxides and hydroxides of earth metal are basic except Be which is amphoteric.
Hence, the metal M is Be.

66) c $PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$

67) c

68) c $C_6H_5OCH_3 + HI \rightarrow CH_3I + C_6H_5OH$

69) d For vertical motion
$y = \frac{1}{2}gt^2$
$t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{2\times0.4}{9.8}} = 0.28$ sec
$v_s = \frac{d}{t} = \frac{200}{0.28} = 700$ m/s

70) c $mg - T = ma$
$T = mg - \frac{mg}{4} = \frac{3mg}{4}$
$W = T.d\cos 180^\circ = -\frac{3}{4}Mgd$

71) c $\Delta wt = mg - mg\left(1 - \frac{2h}{R}\right) = mg - mg + \frac{2mgh}{R} = 2m\frac{Gm}{R^2} \times \frac{h}{R}$
$= 2mG \times \frac{4}{3}\frac{R^3\rho h}{R^3} = \frac{8\pi G\rho mh}{3}$

72) d $P.A = 2\pi r.T$
$\rho gh \times \pi r^2 = 2\pi rT$
$\rho gh.r = 2T$

$\rho gh \times \frac{d}{2} = 2T$

$d = \frac{4T}{\rho gh} = \frac{4\times7\times10^{-2}}{10^3\times9.8\times0.4} = \frac{1}{14}\times10^{-3}\text{ m} = \frac{1}{14}\text{ mm}$

73) d $P \propto T^3$

$P = kT^3$ --- (i)

For adiabatic process

$T^\gamma \propto P^{\gamma-1}$

$P \propto T^{\frac{\gamma}{\gamma-1}}$

$P = kT^{\frac{\gamma}{\gamma-1}}$ --- (ii)

Comparing (i) and (ii)

$3 = \frac{\gamma}{\gamma-1}$

$\gamma = \frac{3}{2}$

74) a $\delta = i_1 + i_2 - A$

$55 = 15 + i_2 - 60$

$i_2 = 100^\circ$

75) b $\frac{I_{max}}{I_{min}} = \frac{4}{1} = \left(\frac{a_1+a_2}{a_1-a_2}\right)^2$

$\frac{a_1+a_2}{a_1-a_2} = \frac{2}{1}$

$a_1 + a_2 = 2a_1 - 2a_2$

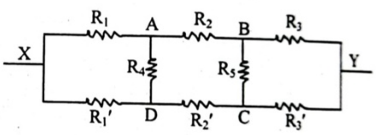
$3a_2 = a_1$

$\frac{a_1}{a_2} = 3:1$

76) b Minimum frequency is observed if whistle is moving away from person. So,

$f_{min} = \frac{v}{v+v_s}\times f = \frac{v}{v+r\omega}\times f = \frac{340}{340+0.5\times20}\times 385 = 374\text{ Hz}$

77) b



Here, $R_1 : R_2 : R_3 = R_1' : R_2' : R_3'$

or, $2:4:6 = 4:8:12$

or, $1:2:3 = 1:2:3$

So, AD and BC act as open circuit.

$R_{eq} = \frac{12\times24}{12+24} = 8\ \Omega$

78) a $F = BIl\sin\theta$

$\sin\theta = \frac{F}{Bil} = \frac{15}{2\times10\times1.5} = \frac{1}{2}$

$\theta = 30^\circ$

79) d $E = -L\frac{dI}{dt}$

$8 = -L\frac{(-2-2)}{0.05}$

$L = \frac{8\times0.05}{4} = 0.1\text{ Hz}$

80) b $\tan\phi = \frac{X_L}{R} = \frac{2\pi fL}{R}$

$\phi = \tan^{-1}\left(\frac{2\pi\times50\times0.5}{157}\right) = 45^\circ$

81) b For 1st

$qV = \frac{1}{2}mv_1^2$

$v_1 = \sqrt{\frac{2qV}{m}}$

For 2nd

$4qV = \frac{1}{2}mv_2^2$

$v_2 = \sqrt{\frac{8qV}{m}} = 2\sqrt{\frac{2qV}{m}} = 2v_1$

$\frac{v_1}{v_2} = \frac{1}{2}$

82) b $\frac{r_1}{(s-b)(s-c)} = \frac{\Delta}{(s-a)(s-b)(s-c)} \times \frac{s}{s} = \frac{\Delta s}{\Delta^2} = \frac{1}{r}$

$\frac{r_2}{(s-a)(s-c)} = \frac{1}{r}$ and $\frac{r_3}{(s-a)(s-b)} = \frac{1}{r}$

Adding all, $\sum \frac{r_1}{(s-b)(s-c)} = \frac{3}{r}$

83) c $a + (p-1)d = q$ (i)

$a + (q-1)d = p$ (ii)

(i) – (ii)

$d(p-q) = q-p$

$d = -1$

From (i), $a - p + 1 = q$

$a = p + q - 1$

$t_r = a + (r-1)d = p + q - 1 - r + 1 = p + q - r$

84) c $^nC_2 = 45$ $n(n-1) = 90$

Option 'c' satisfies the above relation.

85) a Coefficient of $x^n = {}^{2n+1}C_n = a = {}^{2n+1}C_{2n+1-n} = {}^{2n+1}C_{n+1}$

Coefficient of $x^{n+1} = {}^{2n+1}C_{n+1} = b$

$a = b$

86) c $x_1^2 + y_1^2 - 10 > 0$

$1 + k^2 - 10 > 0$

$k^2 > 9 \Rightarrow |k| > 3$

$\Rightarrow k > 3, k < -3$

Option 'c' is correct.

87) c $\int_0^1 \frac{dx}{\sqrt{1+x}-\sqrt{x}} = \int_0^1 \frac{dx}{\sqrt{1+x}-\sqrt{x}} \cdot \frac{\sqrt{1+x}+\sqrt{x}}{\sqrt{1+x}+\sqrt{x}} = \int_0^1 \frac{\sqrt{1+x}+\sqrt{x}}{1}\, dx = \left[\frac{(1+x)^{3/2}}{\frac{3}{2}} + \frac{x^{3/2}}{\frac{3}{2}}\right]_0^1 = \frac{4\sqrt{2}}{3}$

88) a $\frac{dx}{dt} = 2t, \frac{dy}{dt} = 2t - 1$

For perpendicular to x-axis

$\frac{dx}{dy} = 0 \Rightarrow \frac{2t}{2t-1} = 0$

$t = 0$

89) c $\sqrt{x} + \sqrt{y} = 1$

Differentiating wrt x,

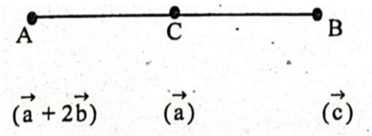
$\frac{1}{2\sqrt{x}} + \frac{1}{2\sqrt{y}}\frac{dy}{dx} = 0$

$\frac{dy}{dx} = -\frac{\sqrt{x}}{\sqrt{y}}$

At point $\left(\frac{1}{4}, \frac{1}{4}\right)$

$\frac{dy}{dx} = -\frac{\sqrt{\frac{1}{4}}}{\sqrt{\frac{1}{4}}} = -1$

90) b

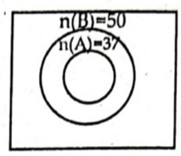


$\vec{a} = \frac{2\vec{c}-(\vec{a}+2\vec{b}).3}{2+3}$

$\vec{c} = \vec{a} - 3\vec{b}$

91) c $\tan^{-1}\left(\frac{1+\cos x}{\sin x}\right) = \tan^{-1}\left(\frac{2cos^2 x/2}{2\sin x/2\ \cos x/2}\right) = \tan^{-1}(\cot x/2) = \tan^{-1}\left(\tan\left(\frac{\pi}{2} - \frac{x}{2}\right)\right) = \frac{\pi}{2} - \frac{x}{2}$

92) c



From the venn-diagram, $A \subset B$. Then, $n(A - B) = 0$.

$n(B - A) = 50 - 37 = 13$

93) c Direction ratios of the line joining the points (1, 2, 0) and (4, 13, 5) is:

$4 - 1, 13 - 2, 5 - 0$ i.e., (3, 11, 5)

Direction ratios of the line = direction ratios of the normal to the plane.

94) c Putting $x = 0, 1, 2, ...$

$S = \sum_{n=0}^{\infty} \frac{(log_e x)^{2n}}{(2n)!} = 1 + \frac{(\log x)^2}{2!} + \frac{(\log x)^4}{4!} + \cdots + \infty = \frac{e^{log_e x} + e^{-log_e x}}{2} = \frac{x + x^{-1}}{2}$

95) a Area bounded $= \int_1^4 \sqrt{x}\, dx = \frac{14}{3}$ sq. units

96) c $\alpha = 2\omega, \beta = 2\omega^2$

$\frac{\alpha}{2} = \omega, \frac{\beta}{2} = \omega^2$

$\left(\frac{\alpha}{2}\right)^7 = \omega^7 = \omega$

The required equation is: $x^2 - (\omega + \omega^2)x + \omega^3 = 0$

i.e., $x^2 + x + 1 = 0$

97) a

98) c

99) b

100) a

❖❖❖❖ Thank You!!! ❖❖❖❖