ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	3	2	2	3	4	1	2	1	4	1	4	4	2	2	2	3	2	2	4	2
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	1	1	1	2	2	4	1	3	4	1	2	2	2	4	3	1	3	2	2	3
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	1	2	2	1	3	1	4	2	4	4	2	2	1	3	2	2	3	3	4
Que.	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
Ans.	1	3	2	3	1	4	4	1	3	4	3	2	3	4	3	2	1	1	2	1
Que.	81	82	83	84	85	86	87	88	89	90										
Ans.	1	3	3	3	3	2	2	4	3	4										

HINT – SHEET

3. Energy stored in inductor $\frac{1}{2}LI^2$

$$=\frac{1}{2}\times(2)\times(1)^2=1J$$

Energy developed in resistance
$= I^2RT = I^2 \times 10 \times 10 = 100J$

Hence the required ratio is $\frac{1}{100}$

4. $\oint E.d\ell = -\frac{d\phi}{dt}$

$E \times 2\pi R = \pi R^2 \frac{dB}{dt}$

$E = \frac{R}{2}\times 8t = R8$

$(qE)R = (\mu mg)R$

$\mu = \frac{8qR}{mg}$

5. The induced current in upper semicircular and lower semicircular will cancel each other in diameter (AB)

6. $q = \frac{\Delta\phi}{R}$ $\quad \therefore \Delta\phi = qR =$ area of it graph $\times$ R.

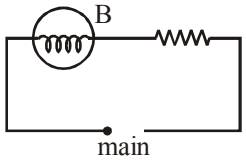
7. Since the tube is very long the force on magnet due to induced current will continue to oppose its motion till it acquires a constant speed.

8. $R = \frac{(220)^2}{100}$

$$R_{eq} = \frac{R}{3}+R = \frac{4R}{3} = \frac{4(220)^2}{300}$$

$$P = \frac{V^2}{R_{eq}} = \frac{V^2}{R_{eq}} = \frac{(220)^2\times 300}{4(220)^2} = \frac{300}{4} = 75\ W$$

9.



For power across heater is maximum resistance of bulb should be minimum.

$$P_{heater} = \left(\frac{V}{R_H + R_b}\right)^2 R_H$$

R_{bulb} is minimum for 200 W.

10. Assume M cells are connected correct and N cells connected wrong.

$M + N = 12$ ....(1)

$(M + 2)\,E - NE = 3R \Rightarrow M - N + 2 = \frac{3R}{E}$

.....(2)

$ME - (N+2)E = 2R \Rightarrow M - N - 2 = \frac{2R}{E}$ ..... (3)

from eq (1) and (2)

$-M + N + 10 = 0 \Rightarrow M - N = 10$ .....(4)

$M = 11,\ N = 1$

11. $i = \frac{2}{10 + R}$

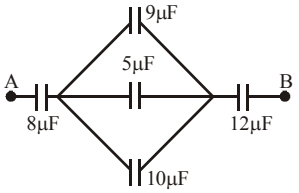
$$x = \frac{V}{\ell} = \frac{2\times 10}{(R+10)} \cdot \frac{1}{100}$$

$$V_1 = x\ell \quad \Rightarrow \quad 10 \times 10^{-3} = \frac{2\times 10}{(R+10)} \times \frac{40}{100}$$

$$R + 10 = \frac{8}{10\times 10^{-3}}$$

$$\Rightarrow \quad R + 10 = 800 \quad \Rightarrow \quad R = 790\Omega$$

12. $\frac{1}{C_{eq}} = \frac{1}{8} + \frac{1}{24} + \frac{1}{12} \Rightarrow C_{eq} = 4\mu F$



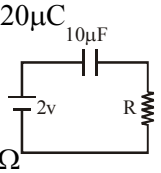
$V_A - V_B = 60$ V

13. Charge at steady steady state $q_0 = 20\mu C$

$q = q_0\,(1 - e^{t/\tau})$

$q = 12.6 = 20\,(1 - e^{-50\times 10^{-3}/\tau})$

and $\tau = RC = 50 \times 10^{-3} \Rightarrow R = 5\ K\Omega$



14. When switch is open = $C_{eq} = \frac{15}{2}\mu F$

$$q_i = C_{eq}\,V = \frac{15}{2} \times 200 = 1500\ \mu C$$

When switch is closed

$C_{eq} = 30\ \mu F$

$q_f = 30 \times 200 = 6000\ \mu C$

$= 4.5 \times 10^{-3} C$

15. The electric force between the plates will be balanced by the additional weight

hence $mg = \frac{Q^2}{2A\in_0} = \frac{C^2V^2}{2A\in_0}$

$$mg = \frac{\in_0 AV^2}{2d^2}$$

$$m = \frac{\in_0 AV^2}{2d^2 g} = \frac{\in_0 \times 100 \times 10^{-4}(5000)^2}{2(5\times 10^{-3})^2 \times 10}$$

$m = 4.425$ g

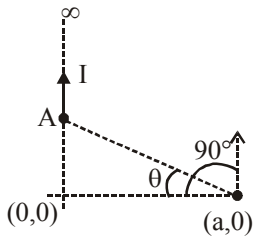
17. In a conductor, potential is same everywhere

$\therefore$ Potential at A = potential at centre

$= V_{due\ to\ p} + V_{due\ to\ induced\ charges}$

$$= \frac{kp}{(r\sec\phi)^2} + 0 = \frac{kp\cos^2\phi}{r^2}$$

18.

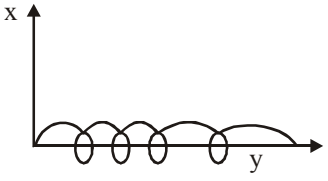


$$B = \frac{\mu_0}{4\pi}\frac{i}{a}\,(\sin 90 + \sin(-\theta))$$

$$= \frac{\mu_0}{4\pi}\frac{i}{a}(1 - \sin\theta) = \frac{\mu_0}{4\pi}\frac{i}{a}\left(1 - \frac{b}{\sqrt{a^2+b^2}}\right)$$

19. The particle will move in a non-uniform helical path with increasing pitch as shown below:

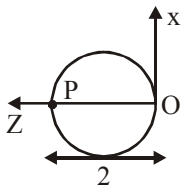
Its time period will be:



Changing the view, the particle is seemed to move in a circular path in (x – z)plane as below

Its time period will be $T = \frac{2\pi m}{qB} = 2\pi$ sec

Changing the view the particle is seemed to move in a circular path in (x – z) plane as below



After π-seconds the particle will be at point 'P', hence x coordinate will be 0
For linear motion along y-direction.

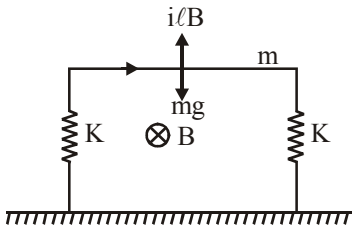
$y(\pi) = 0(\pi)+\frac{1}{2}\frac{Eq}{m}(\pi)^2$

$y(\pi)=\frac{\pi^2}{2}$ and OP = 2 Hence the coordinate

$\left(0,\frac{\pi^2}{2},2\right)$

20. The force on the rod due to magnetic field and gravity is

$i\ell B$–mg(upwards)



Hence the extension in the springs is $\frac{i\ell B - mg}{2k}$ (Note that effective spring constant is 2k)
Therefore the length of the spring is $\ell_0+\frac{i\ell B - mg}{2k}$

21. Vector sum $\overrightarrow{PQ}+\overrightarrow{QR}+\overrightarrow{RP}=0$
Thus force on PQR = 0.

22. $\tau = \vec{m}\times\vec{B}$

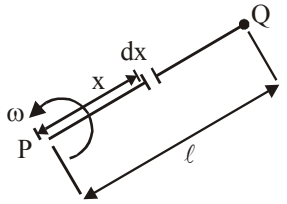
$= I_0L^2\hat{k}\times\left(\frac{B}{\sqrt{2}}\hat{i}+\frac{B}{\sqrt{2}}\hat{j}\right) = \frac{I_0L^2B}{\sqrt{2}}(\hat{j}-\hat{i})$

23. Loss in potential energy = gain in kinetic energy
(–MB cos90°) – (–MBcos0°) = KE
= MB = KE
= πR^2IB = KE.

24. Charge on the differential element dx, $dq = \frac{Q}{\ell}.dx$

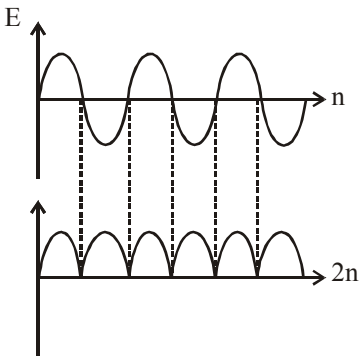
equivalent current di = f dq
∴ magnetic moment of this element dμ =(di)NA (N=1)

$= \left(\pi x^2\right)f\frac{Q}{\ell}dx$



$\Rightarrow m = \int_0^{\mu} d\mu = \frac{\pi fQ}{\ell}\int_0^{\ell} x^2$; $\mu = \frac{1}{3}\pi fQ\ell^2$.....

25.



AC source with R, L, C connected in series

26. When all (L, C, R) are connected then net phase difference = 60 – 60 = 0. So, there will be resonance.

$I = \frac{V}{R} = 2a$

& $P = I^2R$ = 400 watt.

27. $I_{rms} = \frac{60}{120} = \frac{1}{2}$Amp

$V_L = I_{rms}\times(\omega L)$

$40 = \frac{1}{2}\times(40\times10^3)\times L$

At resonance $V_C = I_{rms}\left(\frac{1}{\omega c}\right) = V_L$

$$C = \frac{1}{2}\times\frac{1}{4\times10^3}\times\frac{1}{40}$$

$$C = \frac{25}{8}\mu F$$

28. $\eta\% = \frac{E_2I_2}{E_1I_1}\times 100 = \frac{140}{240\times0.7}\times100 = 83.3\%$

29. general equation of V

$$V = \frac{V_0}{T/2}t - V_0 = \frac{2V_0}{T}t - V_0$$

$$V_{rms} = \left[\frac{\int_0^T V^2dt}{T}\right]^{\frac{1}{2}} = \left[\frac{\int_0^T\left(\frac{2V_0}{T}t - V_0\right)^2dt}{T}\right]^{\frac{1}{2}} = \frac{V_0}{\sqrt{3}}$$

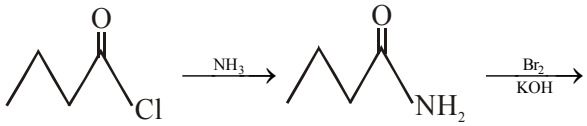
30. B & C are equipotential and field is conservative, therefore:

$$\therefore\ W_{CA} = W_{BA} = -\int_{2a}^{a}\frac{\lambda}{2\pi\varepsilon_0 r}q\ dr = \frac{q\lambda}{2\pi\varepsilon_0}\ln 2.$$

31. 1° amine can give carbyl amine reaction.

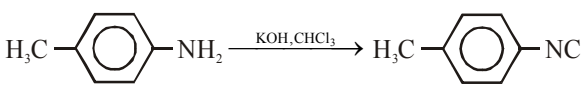
32. H–C(=O)–OH part therefore it can give tollen's test

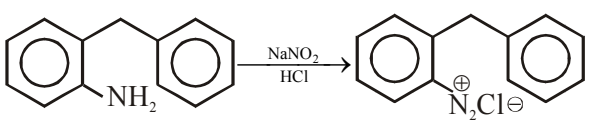
33. Rate of N_4 attack α electrophilicity of $>C=O$ group

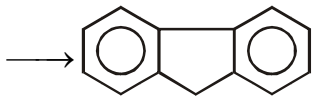
36. 

$CH_3–CH_2–CH_2–NH_2$

37. It's Beckmann rearrangement only antigroup will migrate

38. 

39. 

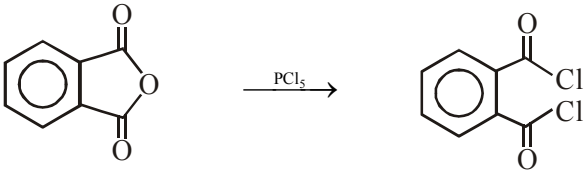


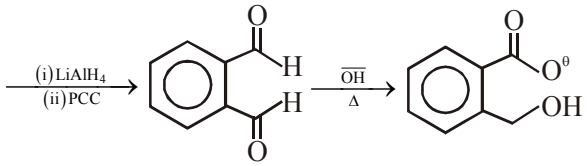
40. (A) $Ph–C(=O)–CH_3 \xrightarrow[H_3O^+]{LiAlH_4} Ph–CH(OH)–CH_3$

(B) $Ph–C(=O)–NH_2 \xrightarrow[Br_2]{KOH} Ph–NH_2$

(C) $Ph–C(=O)–NH_2 \xrightarrow[P_4O_{10}]{} PhCN$

(D) $Ph–C(=O)–OH \xrightarrow[SOCl_2]{} Ph–C(=O)–Cl \xrightarrow{NH_3} Ph–C(=O)–NH_2$

41. 



cannizeroo reaction

42. Hoffmann Bromamid reaction has total retention of configuration

43. $pH = pK_a + \log\frac{1/3}{2/3}$

44. Add H^+

45. $C = C_0e^{-kt}$

$k_f = 2.1\times10^{-3}$

$k_b = 4.2\times10^{-4}$

$$K_c = \frac{k_f}{k_b} = 5.0$$

46. $Q_c = \frac{1\times1}{1\times1} = 1$

$\because\ Q_c > K_c$ so reaction will proceed in backward direction

$$A_2(g) + B_2(g) \rightleftharpoons C_2(g) + D_2(g)$$

conc. eqm $\frac{1+x}{10}\ \frac{1+x}{10}\ \frac{1-x}{10}\ \frac{1-x}{10}$

$$0.25 = \frac{\left(\frac{1-x}{10}\right)^2}{\left(\frac{1+x}{10}\right)^2} \Rightarrow x = 0.333$$

$$[A_2(g)] = \frac{1+x}{10} = \frac{1.333}{10} = 0.133$$

47. $x(\text{product}) \propto \left(\frac{1}{P}\right)^{\Delta n_g/2}$

$\propto (V)^{\Delta n_g/2}$

	Δn_g	x
(a)	1	$\alpha\sqrt{V}$
(b)	0	no effect
(c)	–5	$\alpha(V)^{-5/2}$
(d)	–1	$\alpha(V)^{-1/2}$

61. $f(xy) = \frac{f(x)}{y}$

Put y = 3 & x = 10

$f(30) = \frac{f(10)}{3} \Rightarrow f(10) = 3 \times f(30) = 3 \times 20 = 60$

Now put y = 4 & x = 10

$f(40) = \frac{f(10)}{3} \Rightarrow f(40) = \frac{60}{4} = 15$

62. $f(x) = \sin^2x + \cos^4x + 2$
$= \sin^2x + (1 - \sin^2x)^2 + 2$
$= -\sin^2x + \sin^4x + 3$
$= -\sin^2x \cdot \cos^2x + 3$

$f(x) = -\frac{1}{4}(\sin^2 2x) + 3$

$\therefore$ Period of f(x) is $T_1 = \frac{\pi}{2}$

& $g(x) = \cos(\cos x) + \cos(\sin x)$
$g(x + \pi/2) = \cos(\sin x) + \cos(\cos x)$
$= g(x)$

$\therefore$ $T_2 = \pi/2$

63. Domain of f(x) = [2, 4]
But given functiuon is injective as well as surjective
$\therefore$ x = [3, 4] or [2, 3]
& $y = [\sqrt{2}, 2]$

64. $\cos^{-1}(x) + \cos^{-1}(2x) + \cos^{-1}(3x) = \pi$
$\Rightarrow \cos^{-1}(2x) + \cos^{-1}(3x) = \pi - \cos^{-1}(x)$

$\Rightarrow \cos^{-1}\left(2x \cdot 3x - \sqrt{1-4x^2}\sqrt{1-9x^2}\right) = \cos^{-1}(-x)$

$\Rightarrow 6x^2 - \sqrt{1-4x^2}\sqrt{1-9x^2} = -x$

$\Rightarrow (6x^2 + x) = \sqrt{1-4x^2}\sqrt{1-9x^2}$
$\Rightarrow 36x^4 + x^2 + 12x^3 = (1 - 4x^2)(1 - 9x^2)$
$\Rightarrow 36x^4 + x^2 + 12x^3 = 1 - 13x^2 + 36x^4$
$\Rightarrow 12x^3 + 14x^2 - 1 = 0$
$\therefore$ a = 12, b = 14, c = 0

65. $\sum_{n=1}^{\infty} \tan^{-1}\left(\frac{\frac{n}{n+2} - \frac{n-1}{n+1}}{1 + \frac{n}{n+2} \times \frac{n-1}{n+1}}\right)$

$\sum_{n=1}^{\infty} \tan^{-1}\left(\frac{1}{n^2+n+1}\right)$

$\sum_{n=1}^{\infty} (\tan^{-1}(n+1) - \tan^{-1} n)$

$= \tan^{-1}(2) - \tan^{-1}(1) + \tan^{-1}(3) - \tan^{-1}(2) + ...+...+\tan^{-1}(\infty)$
$= \tan^{-1}(\infty) - \tan^{-1}(1)$
$= \frac{\pi}{2} - \frac{\pi}{4} = \frac{\pi}{4}$

66. $x = \sin(2\tan^{-1}2) : y = \sin\left(\frac{1}{2}\tan^{-1}\frac{4}{3}\right)$

Let $\tan^{-1} 2 = \theta$
$2 = \tan\theta$
$x = \sin 2\theta$
$x = 2\sin\theta\cos\theta$

$x = 2\frac{2}{\sqrt{5}} \times \frac{1}{\sqrt{5}} = \frac{4}{5}$

$\because$ $1 - x = 1/5$

& $\because$ $y^2 = \frac{1}{5}$

$\tan^{-1} 4/3 = \alpha$
$4/3 = \tan\alpha$

$y = \sin\frac{\alpha}{2}$

$y = \sqrt{\frac{1-\cos\alpha}{2}} = \sqrt{\frac{1-3/5}{2}}$

$y = \frac{1}{\sqrt{5}}$ $\therefore$ $y^2 = 1 - x$

67. $f : R \to R$

$f(x) = 3^{-|x|} - 3^x + \text{Sgn}(e^{-x}) + 2$

$f(x) = 3^{-|x|} - 3^x + 1 + 2$; ($\because e^{-x} = +ive$)

$f(x) = 3^{-|x|} - 3^x + 3$

when $x < 0$; $f(x) = 3^x - 3^x + 3 = 3$ $\therefore$ many one not one one.

when $x > 0$; $f(x) = 3^{-x} - 3^x + 3$

$\because$ Range $\neq R$ $\therefore$ Not on to.

69. $f'(x) = \lim\limits_{h\to 0}\dfrac{f(x+h)-f(x)}{h}$

$= \lim\limits_{h\to 0}\dfrac{f(x)-3xh+f(h)-f(x)}{h}$

$= \lim\limits_{h\to 0}\left(-3x+7+\dfrac{f(h)}{h}\right)$

$= -3x + 7$

70. $a = \min.\ \{x^2 + 2x + 3;\ x\in R\}$

$a = -\dfrac{D}{4a} = \dfrac{-(4-4.1.3)}{4.1} = 2$

$b = \lim\limits_{x\to 0}\dfrac{\sin x\cos x}{e^x - e^{-x}}(\%form)$

$b = \lim\limits_{x\to 0}\left(\dfrac{\cos x\cdot\cos x - \sin^2 x}{e^x + e^{-x}}\right) = \dfrac{1}{2}$

$\sum\limits_{r=0}^{n} a^r b^{n-r} = a^0.b^n + a^1.b^{n-1} + a^2.b^{n-2} + ... + a^n.b^0$

$= b^n + \dfrac{a}{b}\cdot b^n + \left(\dfrac{a}{b}\right)^2\cdot b^n + ... + \dfrac{a^n}{b^n}\cdot b^n$

$= \dfrac{b^n.\left(1-(a/b)^{n+1}\right)}{(1-a/b)}$

$= 2^n\left(\dfrac{1-4^{n+1}}{1-4}\right) = \dfrac{4^{n+1}-1}{3.2^n}$

71. $\lim\limits_{x\to 0}(\cos ax)^{\text{cosec}^2 bx}\ (1^\infty \text{form})$

$= e^{\lim\limits_{x\to 0}(\cos ax - 1)\times\dfrac{1}{\sin^2 bx}}$

$= e^{\lim\limits_{x\to 0} -\dfrac{1-\cos ax}{(ax)^2}\times\dfrac{(ax)^2}{\left(\dfrac{\sin bx}{bx}\times bx\right)^2}}$

$= e^{-\frac{1}{2}\frac{a^2}{b^2}}$

75. $y = \dfrac{x^3}{(x-1)(x-2)(x-3)}$

$\ell ny = 3\ell nx - \ell n(x-1) - \ell n(x-2) - \ell n(x-3)$

$\dfrac{y'}{y} = \dfrac{3}{x} - \dfrac{1}{x-1} - \dfrac{1}{x-2} - \dfrac{1}{x-3}$

$= \left(\dfrac{1}{x} - \dfrac{1}{x-1}\right) + \left(\dfrac{1}{x} - \dfrac{1}{x-2}\right) + \left(\dfrac{1}{x} - \dfrac{1}{x-3}\right)$

$\Rightarrow \dfrac{xy'}{y} = \dfrac{1}{1-x} + \dfrac{2}{2-x} + \dfrac{3}{3-x}$

76. $y^2 = \sec x + y$

$(2y-1)\dfrac{dy}{dx} = \sec x\tan x$

$I = \int\limits_0^{\pi/3}(\sec x\tan x)dx = (\sec x)_0^{\pi/3} = 2 - 1 = 1$

77. $e^{xy}.1 + xe^{xy}\left(y + x\dfrac{dy}{dx}\right) = \dfrac{dy}{dx} + e^{\sin 2x}.\cos 2x$

at $x = 0$

$1 + 0 = \left(\dfrac{dy}{dx}\right)_{x=0} + 2 \Rightarrow \left(\dfrac{dy}{dx}\right)_{x=0} = -1$

78. $\because$ $g(x) = f^{-1}(x)$

$gf(x) = x$

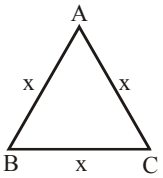
$g^1 f(x)\ f^1(x) = 1$

($\because$ $f(1) = -7/6$)

$\therefore$ $g^1(f(1)) = \dfrac{1}{f^1(1)}$

$g^1(-7/6) = \dfrac{1}{5}$

79.



$\dfrac{dx}{dt} = 2\text{cm/sec.}$

त्रिभुज का क्षेत्र. $S = \dfrac{\sqrt{3}}{4}x^2$

$$\frac{ds}{dt}=\frac{\sqrt{3}}{4}2x\frac{dx}{dt}$$

When x = 10 cm.

$$\frac{ds}{dt}=\frac{\sqrt{3}}{2}10\times 2$$

$$= 10\sqrt{3}\ cm^2/sec.$$

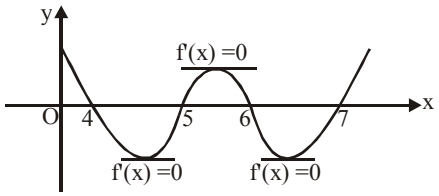
81. $f'(x) > 0 \therefore$ f is $\uparrow$ ing

$g'(x) < 0 \therefore$ g is $\downarrow$ ing.

$\because \quad g(x) > g(x+1)$

$\therefore \quad f(g(x)) > f(g(x+1))$

86. $f(x) = (x-4)(x-5)(x-6)(x-7)$



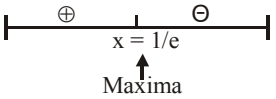
87. $f(x) = \left(\frac{1}{x}\right)^x$

$\ell ny = x\ln(1/x) = -x\ell nx$

$$\frac{1}{y}\left(\frac{dy}{dx}\right)=-(1+\ell n\,x)$$

$$\frac{dy}{dx}=-\left(\frac{1}{x}\right)^x(1+\ell n\,x)=0\left(\because\left(\frac{1}{x}\right)^x\neq 0\right)$$

$1 + \ell n\, x = 0 \Rightarrow x = 1/e$



$f(x)_{max} = e^{1/e}$