PHYSICS

1. (C) The image formed by lens will be at centre of curvature of the mirror

For lens

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

$$\frac{1}{v}-\frac{1}{(-20)}=-\frac{1}{5}$$

$$\frac{1}{v}=-\frac{1}{20}-\frac{1}{5}$$

$$v=-4cm$$

Hence distance b/n the lens and the mirror will be 5cm

2. (A) For observer in air

$$\frac{n_2}{v}-\frac{n_1}{u}=\frac{(n_2-n_1)}{R}$$

$$\frac{1}{v}-\frac{3}{2(-5)}=\frac{1-15}{(-5)}$$

$$\frac{1}{v}+\frac{3}{10}=\frac{1}{10}$$

$$\frac{1}{v} \quad \frac{-2}{10}$$

$$v=-5cm$$

For observer in water

$$\frac{n_2}{v}-\frac{n_1}{u}=\frac{(n_2-n_1)}{R}$$

$$\frac{4}{3v}-\frac{3}{2(-9)}=\frac{\left(\frac{4}{3}-\frac{3}{2}\right)}{\infty}$$

$$\frac{4}{3v} \quad \frac{-1}{6} \qquad\qquad \Rightarrow v=-8cm$$

Distance between the image = 14 - (8+5) = 1 cm

3. (B) $V = \frac{kq}{d} - \frac{kq}{R_1} + \frac{kq}{R_2}$

$= kq\left[\frac{1}{R_2} - \frac{1}{R_1} + \frac{1}{d}\right]$

4. (D) $P_1V_1 \quad P_2V_2$

$(P_0)(2V_0) = (P_0 + pgh)V_0$

$2P_0 = P_0 + pgh$

$P_0 \quad pgh$

$10^5 \quad (1000)(10)h$

$h \quad 10m$

5. (C) $I = \frac{I_0}{2}\cos^2\theta\sin^2\theta$

$I = \frac{I_0}{8}\sin^2 2\theta$

6. (D) Conceptual

7. (D) $\frac{dv}{dt} \quad \frac{v^2}{R}$

$\int_{v_0}^{2V_0}\frac{dv}{v^2} \quad \int_O^t dt$

$\left[\left(-\frac{1}{v}\right)\right]_{V_0}^{2v_0} = \frac{t}{R}$

$+\left(\frac{1}{v_0} - \frac{1}{2v_0}\right) = \frac{t}{R}$

$\frac{1}{2v_0} \quad \frac{t}{R}$

$t \quad \frac{R}{2v_0}$

8. (B) $x = \frac{u^2\sin^2\theta}{g} = \frac{(3)^2\sin 30°}{10}$

$\frac{9}{20}$ m

9. (D) $n_1 \sin\theta_1 = n_2 \sin\theta_2$ — (1)

$n_1 \cos\theta_1 w_1 = n_2 \cos\theta_2 w_2$ — (2)

Solving (1) & (2) w = 6 rad/s

10. (B) Conceptual

11. (A) $v_x = 50\cos 53°$

$= 50\left(\frac{3}{5}\right) = 30\,m/s$

$v_y = 50\sin 53° = 40\,m/s$

Momentum conservation

$(5)[30\hat{i} + 20\hat{j}] = (2.5)(\vec{v}) + (2.5)(40)\hat{j}$

$150\hat{i} + 100\hat{j} = 2.5\vec{v} + 100\hat{j}$

$\vec{v} \quad 60\hat{i}$

$v \quad 60\,m/s$

12. (B) $\left(\frac{hc}{\lambda}\right) = \left(\frac{8\times10^{-3}}{5\times10^{15}}\right) = 1.6\times10^{-18}\,J$

$10eV$

$eV_0 = K_{max} = \frac{hc}{\lambda} - \phi$

$\phi = \frac{hc}{\lambda} - eV_0$

$= 10eV - 3eV$

$7eV$

13. (C) $v = \sqrt{2g(5-h)}$

$x = \sqrt{2g(5-4)}\sqrt{\frac{2h}{g}}$

$$x = 2\sqrt{4(5-h)}$$

$$9 = 4(h)(5-h)$$

$$h \quad \frac{1}{2}m, 4\frac{1}{2}m$$

14. (A) (150 - 60) = 25 a

$$a \quad \frac{90}{25}m/s^2$$

$$\frac{18}{5}m/s^2$$

$$150 - T_1 = (15)\left(\frac{18}{5}\right)$$

$$T_1 \quad 96N$$

$$T_2 - 50 = 5a$$

$$T_2 - 50 = (5)\left(\frac{18}{5}\right)$$

$$T_2 \quad 68$$

$$\frac{T_1}{T_2} = \frac{6x}{17} = \frac{96}{68}$$

x = 4

15. (A) $_{z}P^{A} \longrightarrow {}_{(z-2)}Q^{(A-4)} + {}_{2}He^{4}$

$$_{(z-2)}Q^{(A-4)} \longrightarrow {}_{(z-1)}R^{(A-4)} + e^{-}$$

$$_{(z-1)}P^{(A-4)} \longrightarrow {}_{z}S^{A-4} + e^{-}$$

P & S are isotopes

16. (B) $N \quad N_0 e^{-\lambda t}$

$$\left.\frac{dN}{dt}\right|_{t \;\; 0} = -\lambda N_0$$

$$(\lambda N_0)T = N_0$$

$$T = \frac{1}{\lambda} = t_{avg}$$

17. (C) $dI \quad (dm)x^2$

$$dm = \sigma dA$$

$$dI = \int_0^R (kx)(2\pi x)dx\,x^2$$

$$M = \int_0^R (kx)(2\pi x)dx$$

$$I = \int_0^R (2\pi x)x^4 dx$$

$$I = 2\pi k \frac{R^5}{5}$$

$$I_d \quad \frac{I}{2}$$

$$\left(\frac{\pi k R^5}{5}\right)$$

$$M = 2\pi \frac{kx^3}{3}\bigg]_0^R = (2\pi K)\frac{R^3}{3}$$

$$\pi k = \frac{3}{2}\frac{M}{R^3}$$

$$I_d = \left(\frac{3}{2}\right)\frac{M}{R_3} - \frac{R^5}{5}$$

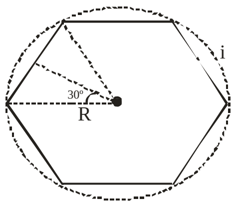
$$\frac{3}{10}MR^2$$

18. (B) $\frac{1}{2}mv^2 - \frac{1}{2}(4m)\left(\frac{v}{4}\right)^2 = x\left(\frac{1}{2}mv^2\right)$

$$\left(1 - \frac{1}{4}\right) = x$$

$$x \quad \frac{3}{4}$$

19. (C)



$$B = 6\left[\frac{\mu_0}{4\pi}\left(\frac{i}{R\cos 30^\circ}\right)(\sin 30^\circ + \sin 30^\circ)\right]$$

$$= \frac{3\mu_0 i}{2\pi R}\frac{1}{\left(\sqrt{\frac{3}{2}}\right)} = \frac{\sqrt{3}\mu_0 i}{\pi R}$$

20. (C) i – V characterstics of solar cell

21. (A) $\eta \le 1 - \frac{T_L}{T_H}$

$$\left(\frac{1}{4}\right) \le 1 - \frac{T_L}{T_H}$$

$$\left(\frac{T_L}{T_H}\right) \le \left(\frac{3}{4}\right)$$

$$(T_L)\frac{4}{3} \le T_H$$

$$T_H \ge 200^\circ C$$

22. (C) $3\left(\frac{\lambda}{2}\right) \quad L$

$$\lambda = \frac{2L}{3}$$

$$v = v\,\lambda$$

$$v\left(\frac{2L}{3}\right)$$

23. (B) $2T\left[\frac{1}{r_1} - \frac{1}{r_2}\right] = pgh$

$$h \quad 10\, mm$$

24. (A) Conceptual

25. (A) Conceptual

26. (C)

Balanced Wheatstone bridge

$$C_{eq} = \frac{18 \times 6}{18+6} + \frac{6 \times 2}{6+2}$$

$$= 4.5 + 1.5$$

$$= 6\mu F$$

27. (D) Volume of cavity will also expand on heating

28. (A) $\varepsilon = \int_{l/2}^{3l/2} Bvdx$

$$\int \frac{\mu_0}{2\pi} \frac{i}{x} vdx$$

$$\frac{\mu_0}{2\pi} iv \ln 3$$

29. (C) $i = \sqrt{i_1^2 + i_2^2}\sin(wt + \phi)$

$$i_{rms} \quad \frac{10}{\sqrt{2}}$$

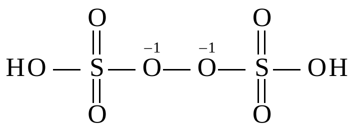
$$\frac{\sqrt{i_1^2 + i_2^2}}{\sqrt{2}}$$

30. (A) Conceptual

Chemistry

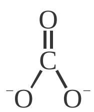
31 (C) Volume increase with rise in temperature

32 (C) Marshall's acid; $H_2S_2O_8$



33 (D)

$C\equiv O$ BO = 3



BO = $\frac{4}{3}$ $\qquad BO \, \alpha \frac{1}{\text{Bond length}}$

O=C=O BO = 2

34 (D) $\Delta G = \Delta H - T\Delta S \Rightarrow +\Delta H - T(-\Delta S) \Rightarrow +\Delta H + T(\Delta S)$

35 (A) $NaHCO_3$ has an acidic hydrogen which reacts with basic NaOH.

36 (B) N_2O_4(1 Mole) $\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow \frac{1}{300} = \frac{P_2}{600} \Rightarrow P_2 = 2atm$

	N_2O_4	$\rightleftharpoons$	$2NO_2$	
Initial;	1mole		0	
Final	0.8		0.4	Total Moles = 1.2

37 (C) $MO_x + H_2 \longrightarrow H + H_2O$ Equivalent of metal = equivalent of oxygen

$$\frac{1.05}{E} \quad \frac{3.15-1.05}{8}$$

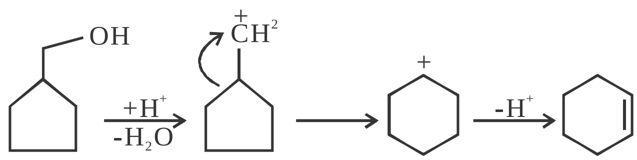
38 (D) M_{eq} of Ag = 200 X 0.1 = 20 $\qquad M_{eq}$ of Ag to be deposited = $\frac{20}{2} \quad 10$

M_{eq} of Ag = $\frac{i\times t}{96500}\times 1000 \Rightarrow t = 9650\sec$

39 (A) Smaller is the size of particle, faster is motion.

40 (D) Conceptual

41 (C) Ring expansion



42 (C) $M_1V_1X_1=M_2V_2X_2$ $0.02 \times V_1 \times 5 = 0.1 \times 30 \times 1$ $V_1 = 30$ mL

43 (D) $\Delta H - \Delta U = \Delta n_g RT \Rightarrow 3 \times 8.314 \times 298 \times 10^{-3} KJ$ = +7.43 KJ

44 (B) Conceptual

45 (B) $CH_3 - C \equiv H \xrightarrow[HgSO_4(dil.)]{H_2SO_4(dil.)} CH_3 - \underset{OH}{\overset{OH}{C}} - \underset{H}{\overset{H}{C}} \xrightarrow{-H_2O} CH_3 - \overset{OH}{\overset{\|}{C}} - CH_3$

46 (A)

$$A \rightarrow B + C + D$$

Initial	P_0	0	0	0
Dis.	x	x	x	x
Left at t	$P_0 - x$	x	x	x

$$P_0 - x + x + x + x = P$$

$$P_0 + 2x = P$$

$$x = \frac{P - P_0}{2} \qquad P_x = P_0 - \left(\frac{P - P_0}{2}\right) = \frac{3P_0 - P}{2}$$

$$K \quad \frac{2.303}{t} \log \frac{(P_0)}{P_0 - x}$$

$$K \quad \frac{2.303}{t} \log \frac{P_0}{\frac{3P_0 - P}{2}}$$

$$K \quad \frac{2.303}{t} \log \left(\frac{2P_0}{3P_0 - P}\right)$$

47 (D) 3^o Carbo Cation are more stable, React faster

48 (B) $CH_3-CH_2-O-CH_2CH_3$ ($C_4H_{10}O$) $\quad CH_3-\overset{\overset{\Large O}{||}}{C}-CH_2-CH_3$ (C_4H_8O)

49 (D) Grignard's Reagent reacts easily with carbonyl group

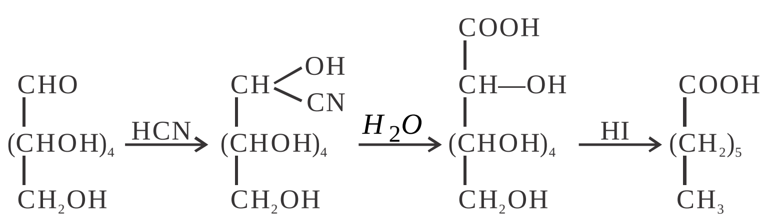
50 (C) $X_B = \dfrac{n_B}{n_A+n_B} = \dfrac{1}{1+\dfrac{1000}{18}}$ Molality = 1 molal, n_B=1, W_A=1 kg = 1000 g,

$n_A \quad \dfrac{1000}{18}$

51 (C) Less electronegative element will easily donate.

52 (B) Bordeaux = CaO + $CuSO_4$ (Insecticide for grapes)

53 (B) Fluorescein is prepared from phthalic anhydride and resorcinol.

54 (B) 

55 (D) All these are the test of protein

(A). Biuret Test (B). Ninhydrin Test (C). Xanthoprotein test

56 (B) $n(\underset{\underset{CN}{|}}{CH_2=CH}) \xrightarrow{\text{Polymerise}} -(\underset{\underset{CN}{|}}{CH_2=CH})_n^-$

Polyacrylonitrile = (PAN) Orlon

57 (D) AgCl is soluble in NH_3 due to complex formation.

$AgCl + 2NH_3 \longrightarrow [Ag(NH_3)_2]Cl$

58 (C)

59 (C) IV is least basic because lone pair of hydrogen is in resonance and hence less available for donation.

60 (A) An Experimental fact depending upon the ability of the ligand to cause crystal field splitting.

MATHEMATICS

61. (A) Given; $\left(\vec{a}+3\vec{b}\right).\left(7\vec{a}-5\vec{b}\right)=0 \Rightarrow 7\vec{a}^2-15\vec{b}^2+16\vec{a}.\vec{b}=0 \rightarrow (1)$

Also, $7\vec{a}^2+8\vec{b}^2-30\vec{a}.\vec{b}=0 \rightarrow (2)$, From (1) & (2), $\vec{a}.\vec{b}=\dfrac{\vec{b}^2}{2} \rightarrow (3)$

Putting in (1), $|\vec{a}|$ $|\vec{b}|$, so $\vec{a}.\vec{b}=ab\cos\theta \Rightarrow \theta=60^\circ$

62. (B) $e=\sqrt{1+\dfrac{a^2}{b^2}} \Rightarrow \sqrt{1+\dfrac{1}{4}} \Rightarrow \dfrac{\sqrt{5}}{2}$

63. (A) $\dfrac{ds}{dt}=(6t+3)m/s$

$$d_1=\int_0^1 (6t+3).dt=6 \Rightarrow \tan\theta_1=\frac{6}{\sqrt{3}} \Rightarrow \theta_1=30^\circ$$

$$d_2=\int_0^2 (6t+3).dt \Rightarrow \tan\theta_2=\frac{18}{6\sqrt{3}} \Rightarrow \theta=60^\circ \quad \Rightarrow \theta=\theta_2-\theta_1=30^\circ$$

64. (D) 184

65. (C) Use direct formula for equation of plane

66. (C)

67. (A) $\alpha\beta=\dfrac{c}{a} \Rightarrow$ Length of tangent $\sqrt{\dfrac{c}{a}}$

68. (B) multiply numerator and denominator by $(1-\cos 2x)$

69. (A) Calculate unit vector and then find distance

70. (C) Use $a^{\frac{1}{2}}$ p then apply binomial expansion

71. (C) $T_n = \left(n^2 - n + 1\right)n! \Rightarrow \left(n^2 - 1\right)n! - (n-2)n!$

$= (n-1)(n+1)! - (n-2)n!$

$\Rightarrow sum = (n-1)(n+1)!$, here n=20, so sum=19(21!)

72. (B) The area of the region bounded by curve is $\dfrac{8a^2}{3m^3}$

Here a=3, So, $\dfrac{3}{8} = \dfrac{8(3)^2}{3(m)^3} \Rightarrow m = 4$

73. (D) Pre-multiply both sides with $\begin{pmatrix} 5 & 0 \\ -k & 5 \end{pmatrix}$, So that $\dfrac{-2k}{5} + 25a = 0 \Rightarrow a = \dfrac{2k}{125}$

74. (C) Here $\dfrac{|z_1|}{2} = \dfrac{|z_2|}{3} = \dfrac{|z_3|}{4} = k = \dfrac{|z_1| + |z_2| + |z_3|}{2+3+4}$

75. (A) $e^2x^2 - 2\pi e^2 x + \pi^2 e^2 + \pi^2 y^2 - 2\pi^2 ey + e^2\pi^2 = e^2\pi^2$

$\Rightarrow \dfrac{\left(x-\pi\right)^2}{\pi^2} + \dfrac{\left(y-e\right)^2}{e^2} = 1$, ellipse, $a = \pi, b = e,$ So, $AS_1 + AS_2 = 2\pi$

76. (D) No of five digit numbers having at least one digit repeated = $10^5 - 30240 = 69760$

77. (B) Solving the asymptotes, the centre is x=1 and y=0, since $e \quad \sqrt{2}$

$\dfrac{(x-1)^2}{a^2} - \dfrac{(y-0)^2}{a^2} = 1 \Rightarrow (x-1) - y.\dfrac{dy}{dx} = 0$ Or, $yy^1 = (x-1)$

78. (A) $f\left(f\left(x\right)\right) \quad x$ So, $g(x) = f\left(\dfrac{x^2}{x}\right) = f\left(x\right)$

$\dfrac{dg}{dx} = \dfrac{df}{dx} = -\left(\pi - x^n\right)^{\frac{1-n}{n}} x^{n-1}$

79.(A) $\dfrac{b}{a} = \dfrac{c}{b} \Rightarrow \dfrac{b^2}{a} = c$ and $a + b + c = mb$

Combining above, $\left(\dfrac{b}{a}\right)^2 + (1-m)\left(\dfrac{b}{a}\right) + 1 = 0$

Since, $\dfrac{b}{a}$ is real, $\left(1-m\right)^2 - 4(1)(1) > 0 \quad \Rightarrow m < -1$ or $m > 3 \Rightarrow m_{\min} = 4$

80. (C) $\sim\left(\sim sv\left(\sim r\wedge s\right)\right)\Rightarrow s\wedge\left(\sim\left(\sim r\wedge s\right)\right)\Rightarrow s\wedge\left(rv\sim s\right)\Rightarrow\left(s\wedge r\right)v\left(s\wedge\sim s\right)$

$\left(s\wedge r\right)vf\Rightarrow s\wedge r$

81.(B) Put $x \quad \cos^2\theta$ or $dx=-2\cos\theta\sin\theta.d\theta$

$\Rightarrow f\left(x\right)=\sqrt{x}$ and $k=-4 \quad \Rightarrow f\left(-k\right)=\sqrt{4}=2$

82. (A) On the left of x=99

83. (B) Use $\sin^{-1}x=y\Rightarrow 2y^2-y-6=0$

$\Rightarrow y=2$ or $y \quad \frac{-3}{2} \Rightarrow \sin^{-1}x\neq 2>\frac{\pi}{2}$ So, $x \quad \sin^{-1}\left(\frac{-3}{2}\right)\Rightarrow$ one solution

84. (D)

85. (A) Let the number be 1,2,3,........ 9, 10, a, b

Then $\frac{1+2+3+.....+10+a+b}{12}=12\Rightarrow 55+a+b=144 \Rightarrow a+b=89\Rightarrow a=45\,\&\,b=44$ Possible

86. (C) $I=\int_{-\pi}^{\pi}\frac{\cos^2 x}{1+a^x}.dx\Rightarrow 2I=\int_{-\pi}^{\pi}\cos^2 x.dx$

$$2I=\frac{1}{2}\int_{-\pi}^{\pi}\left(1+\cos^2 x\right).dx\Rightarrow 2I=\frac{1}{2}\left[x+\frac{\sin^2 x}{2}\right]_{-\pi}^{\pi}\Rightarrow I=\frac{\pi}{2}$$

87. (C) We observe that, $\left[\frac{x}{39}\right]=\left[\frac{x}{41}\right]=0$ if $x\in\{1,2.....38\}$

$\left[\frac{x}{39}\right]=\left[\frac{x}{41}\right]=1$ if $x\in\{41.....77\}$, $\left[\frac{x}{39}\right]=\left[\frac{x}{41}\right]=2$ if $x\in\{82.....116\}$

$\left[\frac{x}{39}\right]=\left[\frac{x}{41}\right]=3$ if $x\in\{123,.....,155\}$, $\left[\frac{x}{39}\right]=\left[\frac{x}{41}\right]=19$ if $x\in\{779\}$

$$Total=38+\left(1+3+.....+37\right)\Rightarrow 38+\sum_{n\ 1}^{19}\left(2n-1\right)=38+\left(19\right)^2=399$$

88. (A) $\lim_{x\to\frac{1}{2}}\left(\sin^2 \pi x\right)^{\frac{\alpha\sin^2 \pi x}{\beta\cos^2 \pi x}}$ e^{2016} $\Rightarrow e^{\lim_{x\to\frac{1}{2}}\left[\frac{\alpha\sin^2 \pi x)}{\beta\left(1-\sin^2 \pi x\right)}\right]\left\{-\left(1-\sin^2 \pi x\right)\right\}} = e^{2016}$

$\frac{-\alpha}{\beta} = 2016 \Rightarrow \alpha + 2016\beta = 0$

89. (A) Using section formula, we get, $\left(h, \frac{-b}{3}\right)$ on the circle

Therefore, $h^2 + \left(\frac{-b}{3}\right)^2 - ah - b\left(\frac{-b}{3}\right) = 0 \Rightarrow h^2 - ah + \frac{4b^2}{9} = 0$

Must get distinct real roots, $D > 0 \Rightarrow a^2 - 4.4.\frac{b^2}{9} > 0 \Rightarrow 9a^2 > 16b^2$

90. (B) n(s) = No of ways of selecting 3 tickets out of (2n+1) tickets consecutively numbered =

${}^{2n+1}C_3$ $\frac{n(4n^2-1)}{3}$, n(E)=1+3+....+(2n-1)=n^2

Required Probability = $\frac{n(E)}{n(S)} = \frac{n^2}{n(4n^2-1)}3 = \frac{3n}{4n^2-1}$