MAHESH TUTORIALS SCIENCE

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Hints & Solutions

PART A - PHYSICS

1. **a) Gravitational**

Gravitation is the weakest interaction.

2. **d) $10\sqrt{10}$: 1**

$$\frac{T_1^2}{T_2^2} = \left(\frac{10^{13}}{10^{12}}\right)^3 = (10)^3 = 1000$$

$$\therefore \frac{T_1}{T_2} = \sqrt{1000} = 10\sqrt{10}$$

3. **c) 57600 km**

$$\frac{mg'}{mg} = \frac{1}{100} \text{ or } \frac{g'}{g} = \frac{1}{100} = \frac{(R)^2}{(R+h)^2} \text{ or}$$

$$\frac{R}{R+h} = \frac{1}{10} \text{ or } 9R = h \text{ or}$$

h = 6400 × 9 = 57600 km

4. **b) 40 kg**

Here $mg_e = 90 \text{ kg} = \frac{GM_e m}{R^2_e}$. At Mars

$$W = \frac{GM_e m}{R^2_m} \qquad \therefore \frac{W}{90} = \frac{M_m}{R^2_m} \times \frac{R^2_e}{M_e}$$

$$\text{or } \frac{W}{90} = \frac{\frac{1}{9}M_e}{\left(\frac{1}{2}R_e\right)^2} \times \frac{M^2_e}{M_e} = \frac{4}{9}$$

∴ W = 40 kg

5. **b) 1 : 2**

Gravitational force $F = \frac{G(M-m)m}{r^2}$

For 'F' to be max. $\frac{dF}{dm} = 0$

$$\text{or } \frac{d}{dm}\left[\frac{G}{r^2}(Mm - m^2)\right] = 0$$

or M – 2m = 0 or M = 2m

6. **c) $\frac{1}{2}$ mg R**

$$\text{P.E. change} = \int_R^{2R} \frac{GMm}{r^2}\, dr$$

$$= GMm\left[\frac{1}{R} - \frac{1}{2R}\right] = \frac{GMm}{2R} = \frac{gR^2m}{2R}$$

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

7. **c) $\frac{1}{800}$ rad s^{-1}**

Here $mg - mR\omega^2 = 0$ or $R\omega^2 = g$

$$\text{or } \omega = \sqrt{\frac{g}{R}} = \frac{1}{800} \text{ rad s}^{-1}$$

8. **b) 22 km/sec**

$\upsilon^2_e = 2G\frac{4}{3}\pi R^2_e \rho$ and $\upsilon^2_p = 2G\ \frac{4}{3}\ \pi R^2_p$

$$\therefore \frac{\upsilon^2_p}{\upsilon^2_e} = \frac{R^2_p}{R^2_e} = 4 \text{ or } \upsilon_p = 2\upsilon_e$$

9. **a) It will continue moving along with the satellite in the same orbit with same velocity**

10. **b) 2 : 1**

Here $E_e = \frac{1}{2}m\upsilon^2_e$ and $E_0 = \frac{1}{2}m\upsilon^2_0$

$$\therefore \frac{E_e}{E_0} = \frac{\upsilon^2_e}{\upsilon^2_0} = \left(\sqrt{2}\right)^2 = \frac{2}{1}$$

11. **b)** $\sqrt{2GM\left(\frac{1}{R}-\frac{1}{R_0}\right)}$

Here W = $\int_{R_0}^{R} \frac{-GMm}{r^2}dr$

$= -GMm\left(\frac{1}{R_0}-\frac{1}{R}\right) = GMm\left(\frac{1}{R}-\frac{1}{R_0}\right)$

Equate it to K.E. to find the velocity.

12. **a)** $(GMm^2r)^{1/2}$

Here L = $m\upsilon r$. Also $\frac{GMm}{r^2} = \frac{m\upsilon^2}{r}$

or $m\upsilon^2 = \frac{GMm}{r^2}$.

Multiplying by 'mr^2' both sides, $m^2\upsilon^2r^2 = GMm^2r$ or $m\upsilon r = (GMm^2r)^{1/2}$.

13. **c)** $\frac{GMm}{8R}$

Here $E_f - E_i$ = Energy required where E_f and E_i are the final and initial P.E. of the satellite.

Thus $E_f - E_i = \frac{1}{2}\left[\frac{GMm}{R}-\frac{GMm}{4R}\right]$

or Energy = $\frac{1}{4}.\frac{GMm}{R}\left[1-\frac{1}{2}\right] = \frac{GMM}{8R}$

14. **a)** $\frac{\upsilon r}{R}$

Here angular momentum is conserved.

∴ $I_1\omega_1 = I_2\omega_2$ or $MR^1{}_2\omega_1 = MR_2{}^2\omega_2$

Now $\omega_1 = \frac{\upsilon}{r}$ and $\omega_2 = \frac{V}{R}$

∴ $r^2 \times \frac{\upsilon}{r} = R^2 \times \frac{V}{R}$ or $\upsilon r = V.R$

or $V = \frac{\upsilon r}{R}$.

15. **d)** **zero**

As the centripetal force is provided by gravitational force and acts perpendicular. So, the work done is zero.

16. **b)** **zero**

17. **b)** $\left[\frac{2G(m_1+m_2)}{r}\right]^{1/2}$

When masses are at infinite distance P.E.= 0 and K.E = 0 total energy = zero. If υ is the relative velocity of approach, then by law of conservation of energy

$\frac{1}{2}\left(\frac{m_1m_2}{m_1+m_2}\right)\upsilon^2 - \frac{Gm_1m_2}{r} = 0$

or $\upsilon = \left[2G\frac{(m_1+m_2}{r}\right]^{1/2}$

18. **a)** $\frac{GM_emx}{R^3}$

Here $g' = g\left(1-\frac{d}{R}\right)$ at depth d = R – x

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

Force on mass

'm' = $mg' = mg\frac{x}{R} = m \times \frac{GM_e}{R^2} \times \frac{x}{R}$

$= \frac{GM_emx}{R^3}$

19. **b)** $\sqrt{\frac{2g}{R}}$

Here $mg' = mg - mR\omega^2\cos^2 45^0 = 0$

or $mg = mR\omega^2 \times \frac{1}{2}$ or $\omega^2 = \frac{2g}{R}$

$\omega = \sqrt{\frac{2g}{R}}$

20. **c)** $\frac{50}{6}$ **m**

Here $50 = 0 + \frac{1}{2}g_e(60)^2$ and

$S = 0 + \frac{1}{2}g_m(60)^2$

∴ $\frac{S}{50} = \frac{g_m}{g_e} = \frac{1}{6}$

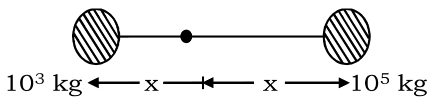
∴ $S = \frac{50}{6}$ m.

21. **a)** $\left[\frac{4G(M_1 + M_2)}{d}\right]^{1/2}$

Here applying law of conservation of energy $\frac{1}{2}m\upsilon^2 - \frac{GM_1m}{\left(\frac{d}{2}\right)} - \frac{GM_2m}{\left(\frac{d}{2}\right)} = 0$

or $\upsilon = \left[\frac{4G(M_1 + M_2)}{d}\right]^{1/2}$

22. **b)** $\frac{2}{11}$ **m**



$$\frac{G \times 10^3}{x^2} = \frac{G \times 10^5}{(2-x)^2}$$

$\frac{(2-x)^2}{x^2} = 100$ or $\frac{2-x}{x} = 10$

or $10x = 2 - x$

or $x = \frac{2}{11}$ m

23. **b)** $\mathbf{2.5 \times 10^4}$ **km**

By conservation of energy, we have :

$$\frac{1}{2}m\upsilon^2 = -\frac{GMm}{R+h} - \left(-\frac{GMm}{R}\right) = \frac{GMmh}{R(R+h)}$$

$$\upsilon^2 = \frac{2GMh}{R^2 + Rh}$$

$$\Rightarrow \quad R^2 + Rh = \frac{2GMh}{\upsilon^2 R}$$

$$R^2 = \frac{2GMh}{\upsilon^2} - Rh$$

$$\Rightarrow \quad R = \frac{2GMh}{\upsilon^2 R} - h$$

$$R = h\left[\frac{2GM}{\upsilon^2 R} - 1\right]$$

$$\Rightarrow \quad h = \frac{\upsilon^2 R^2}{2GM - \upsilon^2 R} = \frac{\upsilon^2 R^2}{2gR^2 - \upsilon^2 R}$$

$$h = \frac{(10^4)^2 \times (6.4 \times 10^6)^2}{2 \times 9.8(6.4 \times 10^6)^2 - (10^4)^2 \times 6.4 \times 10^6}$$

$= 2.5 \times 10^7$m $= 2.5 \times 10^4$ km

24. **b)** **7/9**

Gravitational force due to solid sphere,

$$F_1 = \frac{GMm}{(2R)^2}$$

where M and m are mass of the solid sphere and particle respectively and R is the radius of the sphere. The gravitational force on particle due to shpere with cavity = force due to solid sphere creating cavity assumed to be present above at that position.

i.e. $F_2 = \frac{GMm}{4R^2} - \frac{G(M/8)m}{(3R/2)^2}$

$= \frac{7}{36}\frac{GMm}{R^2}$

So, $\frac{F_2}{F_1} = \frac{7GMm}{36R^2} \Big/ \left(\frac{GMm}{4R^2}\right)$

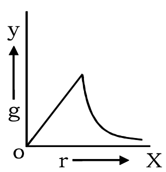
$= \frac{7}{9}$

25. **a)** **the equator**

26. **c)** **5**

First we weight 16 in each pan; then heavier 16 are weighed 8 in each of the pans; the heavier 8 are divided 4 each in a pan; heavier 4 are divided 2 each and heavier two one each in the pan. In all 5 weighings are made.

27. **d)**



28. **c)** $\mathbf{10^6}$

Now $g = \frac{GM}{R^2} = \frac{4/3\pi R^3 \rho G}{R^2}$

$= 4/3\pi R\rho$

$g_1 \propto R_1\rho_1$ and $g_2 \propto R_2\rho_2$

$\therefore \quad \frac{g_2}{g_1} = \frac{R_2\rho_2}{R_1\rho_1}$

Now $\frac{4}{3}\pi R_1^3 = 10^9 \times \frac{4}{3}\pi R_2^3$

or $R_2 = 10^{-3} R_1$

Hence $g_2 = g_1\left(\frac{10^{-3} R_1 \times 10^9 \rho_1}{R_1\rho_1}\right)$

29. **c)** **1 : 2 : 4**

By energy conservation

$$\frac{1}{2}mv^2 - \frac{GMem}{R} = -\frac{GMem}{R+h}$$

$$\Rightarrow h = \frac{v^2R}{2gR - v^2}$$

Putting the values of v the get

$h_1 : h_2 : h_3$ as 1: 2 : 4

30. **a)** **488**

Here m(g + a) = 608 and m(g – a) = 368.

Solving a = 2.4 m s^{-2} and m = 49.8 kg

The real weight = 49.8 × 9.8 = 488 N.

31. **c)** **7.5 R**

If x_1 and x_2 be the distance covered by two bodies then $x_1 + x_2 = 9R$.

Also $Mx_1 = 5\ Mx_2$

$\Rightarrow \quad x_2 = \frac{x_1}{5}$

$x_1 + \frac{x_1}{5} = 9R$

$\Rightarrow \quad x_1 = 7.5\ R$

32. **b)** $\left(\frac{\mathbf{gR^2}}{\mathbf{R+X}}\right)^{1/2}$

$$\upsilon_0 = \sqrt{\frac{GM}{R+x}} = \sqrt{\frac{gR^2}{R+x}}$$

33. **c)** **is directly proportional to g**

$$\mathbf{g} = \frac{GM}{R^2} = \frac{G}{R^2} \times \frac{4}{3}\pi R^3.\rho$$

$$g = \frac{4}{3}\pi R \rho G$$

$\Rightarrow \quad \rho \propto g.$

34. **d)** **1/8 times**

$$\frac{T_2}{T_1} = \left(\frac{r_1}{r_2}\right)^{3/2} = \left(\frac{R/4}{R}\right)^{3/2} = \frac{1}{8}$$

$\Rightarrow \quad T_2 = \frac{T_1}{8}$

35. **c)** $\mathbf{k/x^2}$

$dV = -Edx$

or $V = -\int_{\infty}^{x/\sqrt{2}} Edx$

$= -\int_{\infty}^{x/\sqrt{2}} kx^{-3}dx = k/x^2$

36. **d)** **Depends upon the height from which it is projected**

Escape velocity to the body depends upon the height from which it is projected.

37. **c)** $-\frac{4Gm}{R}$

Gravitational potential on the surface of the shell is V = Gravitational potential due to particle (V_1) + Gravitational potential due to shell particle (V_2)

$$= -\frac{Gm}{R} + \left(-\frac{G3m}{R}\right) = -\frac{4Gm}{R}$$

38. **b)** **2h : R**

The energy required to raise a satellite to height r above the centre of earth from the surface of earth is

$$E_1 = \frac{GMm}{r} - \left(-\frac{GMm}{R}\right)$$

$$= \frac{GMm(r-R)}{rR} = \frac{GMmh}{rR}$$

Energy required to put the satellite into orbit is

$$E_2 = \frac{1}{2}m\upsilon_0^2 = \frac{1}{2}m.\frac{GM}{r}$$

$$\therefore \quad \frac{E_1}{E_2} = \frac{GMmh}{rR} \times \frac{2r}{GMm} = \frac{2h}{R}$$

39. **c)** **conservative**
The force of gravitation is a conservation force

40. **c)** **F**
Gravitational force is indenpendent of nature of medium between the masses.

41. **a)** **$W_1 = W_2 = W_3$**
As gravitational force is a conservative force, so work done is indendent of path followed.

42. **c)** **decrease**
Gravitational potential energy of a body in the gravitational field,

$$E = \frac{-GMm}{r}.$$

When, r decreases negative value of E increases i.e., E decreases.

43. **c)** **The kinetic energies of two satellites are equal**

Orbital speed $\upsilon = \sqrt{\frac{GM}{r}}$ is indenpendent of mass of the satellise.
So, S_1 and S_2 are moving with same speed.

44. **b)** **r_2/r_1**
Gravitational force provides necessary centripetal force.

$$\therefore \quad \frac{m\upsilon_1^2}{r} = \frac{GMm}{r_1^2} \text{ and } \frac{m\upsilon_2^2}{r} = \frac{GMm}{r_2^2}$$

$$\therefore \quad \upsilon_1^2 r_1^2 = \upsilon_2^2 r_2^2$$

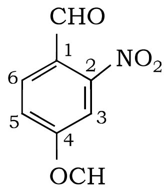
$$\therefore \quad \frac{\upsilon_1}{\upsilon_2} = \frac{r_2}{r_1}$$

45. **b)** **$4\ G\ M_p/D_p^2$**

$$g = \frac{GM_p}{R^2} = \frac{4GM_p}{D^2_P}$$

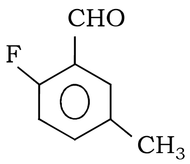
PART B - CHEMISTRY

46. **a)** **4–methoxy–2–nitrobenzaldehyde**



4–methoxy–2–nitrobenzaldehyde

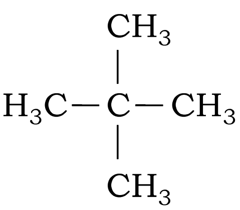
47. **a)** **1–fluoro–4–methyl–2–nitrobenzene**



1–fluoro–4–methyl–2–nitrobenzene

48. **c)** **4, 0, 0 and 1**

The structure of neopentane is

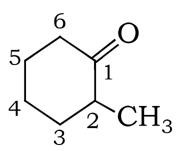


It has 1 quatemary and 4 primary carbons.

49. **d)** $-COOH, -SO_3H, -CONH_2, -CHO$

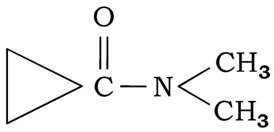
50. **b)** **5,6–diethyl–3–methyl dec–4–ene**

51. **b)** **2–methyl cyclohexanone**



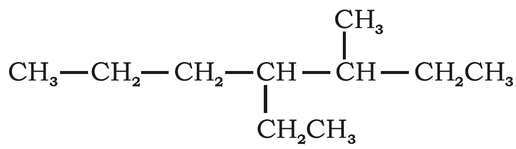
2–methyl cyclohexanone

52. **a)** **N,N–dimethylcyclopropanecarboxamide**



N,N–dimethylcyclopropanecarboxamide

53. **d)**



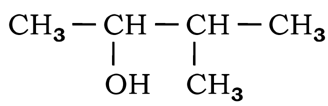
3-Methyl-4-ethyl heptane

Ethyl should come before methyl.

54. **b)** **Ethanoic anhydrid**

55. **c)** **C_nH_{2n-1} and C_nH_{2n}**

56. **c)**



→ 2-methyl-3-butanol

57. **c)** **2-methyl-2, 4-pentanediol**

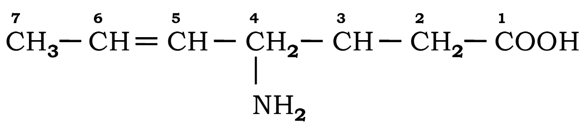
58. **a)** **3-methyl cyclohexene**

59. **d)** **3,4,5-trimethylnonane**

60. **c)** **3-methyl-2-butenoic acid**

61. **b)** **$CH_3 - CH_2 - C \equiv C - CH_2 - COOH$**

62. **c)** **3-amino-5-heptenoic acid**

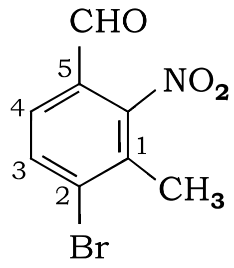


3-amino-5-heptenoic acid

63. **c)** **2-methyl pent-2-ene-1-01**

64. **b)** **2-ethyl-3-methyl but -1-ene**

65. **b)** **2-bromo-5-hydroxybenzonitrile**



2-bromo-5-hydroxybenzonitrile (–CN group gets higher priority over –OH and – Br

66. **b)** **3-methyl-1-butene**

67. **b)** **2-bromopropanol**

68. **c)** **Concentration of OH^- decreases**
Due to common ion effect.

69. **a)** $\mathbf{4x^3}$
$Mg(OH)_2 \rightleftharpoons Mg^{++} + 2OH^-$
(X) $(2x)^2$
$K_{sp} = 4X^2$

70. **a)** $\mathbf{2.7 \times 10^{-21}}$
$AB_3 \rightleftharpoons A^+ + 2B^-$
1×10^{-5} 2×10^{-5}
$k_{SP} = [1 \times 10^{-5}]\ [2 \times 10^{-5}]^2 = 4 \times 10^{-15}$

71. **d)** $\mathbf{3.2 \times 10^{-11}}$
K_{sp} for $CaF^2 = 4s^3 = 4 \times [2 \times 10^{-4}]^3$
$= 3.2 \times 10^{-11}$

72. **b)** $\mathbf{NH_4Cl}$
NH_4Cl is hydrolysed and give]H^+]
$NH_4Cl + H.OH \rightleftharpoons NH_4OH + HCl$
$NH_4^+ + H.OH \rightleftharpoons NH_4OH + H^+$

73. **c)** **Hydrolysis**
$FeCl_3$ is a salt of weak base ($Fe(OH)_3$) and strong acid (HCl)

74. **b)** $\dfrac{K_w}{K_a \times K_b}$
NH_3CN is a salt of weak acid and weak base.

75. **a)** **Increase with increase in temperature**

76. **c)** **0.01M $CaCl_2$**
0.01M $CaCl_2$ gives maximum Cl^- ions to keep K_{sp} of AgCl constant, decrease in $[Ag^+]$ will be maximum.

77. **d)** **Concentration of S^{2-} increases**
In IV[th] group the S^{2-} concentration increase when added the NH_4OH because
$NH_4OH \rightleftharpoons NH_4^+ + OH^-$
$H_2S \rightleftharpoons 2H^+ + S^{2-}$
$OH^- + H^+ \rightleftharpoons H_2O$. So that S^{2-} is increased

78. **c)** $\mathbf{CH_3COOK}$
Because it is a salt of weak acid and strong base.

79. **a)** $\mathbf{108 \times 10^{-25}}$
$Sb_2S_3 \rightarrow 2Sb^{+2} + 3S^{--}$; $K_{sp} = (2x)^2.(3x)^3$
2x 3x
$K_{sp} = 108\ x^5$; $K_{sp} = 108 \times (1 \times 10^{-5})^5$
$= 108 \times 10^{-25}$

80. **a)** $\mathbf{10^{-4}}$ **M Ag^+ and 10^{-4} M Cl^-**
After mixing $[Ag^+][Cl^-] > K_{sp}$.

81. **d)** $\mathbf{10^{-9}}$
pH = 5 means$[H^+] = 10^{-5}$
pOH = 14 – pH = 14 – 5 = 9
$[OH^-] = 10^{-pOH} = 10^{-9}$

82. **a)** **Ammonium acetate and acetic acid**
An acid buffer solution consists of solution of weak acid with strong base of its salt.

83. **b)** **Na_2CO_3**
Na_2CO_3 when react with water form strong base and weak acid. So its aqueous solution is basic.

84. **c)** **$HCl + NH_4Cl$**
A strong acid is not used to make a buffer.

85. **d)** **Between 7 and 8**
$[OH^-]$ of 10^{-6}M NaOH = 10^{-6}
When 100 times diluted,

$$[OH^-] = \frac{10^{-6}}{10^2} = 10^{-8}$$

As it is weak base, but proteolysis of water will also take place. So, the contribution of OH^- ions from water must also be considered.

∴ Total $[OH^-] = 10^{-8} + 10^{-7}$

86. **b)** **The conjugate base of $H_2PO^-_4$ is HPO^{2-}_4**
pH > 7 = Basic
It means contain more hydroxide ions than carbonate ions.

87. **a)** **4×10^{-8} mol^{2}L^{-2}**

$$CuBr \rightleftharpoons Cu^+ + Br^-$$

K_{sp} (S) (S)

$$K_{sp} = S^2 = (2 \times 10^{-4})^2 = 4 \times 10^{-8} \frac{mol^2}{l^2}$$

88. **a)** **2.22×10^{-5}**

$$h = \frac{k_w}{k_a} = \frac{1 \times 10^{-14}}{4.5 \times 10^{-10}} = 2.22 \times 10^{-5}$$

89. **d)** **$s = (K_{sp}/256)^{1/5}$**
$MX_4 \rightarrow M + 4X$; $K_{sp} = (4s)^4$ s; $K_{sp} = 256s^5$
s 4s

$$s = \left(\frac{k_{sp}}{256}\right)^{1/5}$$

90. **c)** **6.1**
$K = Ka_1 \times Ka_2 = 4.5 \times 10^{-3} \times 1.7 \times 10^{-10}$
$H+ = \sqrt{Kc} = \sqrt{4.5 \times 10 - 3 \times 1.7 \times 10^{-10}}$
$pH = -\log[H^+] = -\log[8.7 \times 10^{-7}]$
$pH = 7 - \log 8.7 = 7 - 0.9395 = 0.6$
$= 7 - \log 8.7 = 7 - 0.9395 = 6.06$