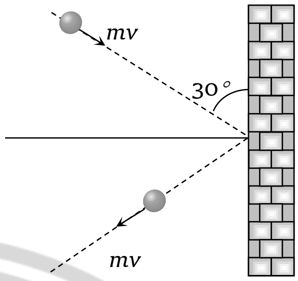
Elastic and Inelastic Collision

41. (b) F = Rate of change in momentum

$= \frac{2mv\sin\theta}{t}$

$= \frac{2\times10^{-1}\times10\sin30^{\circ}}{0.1}$

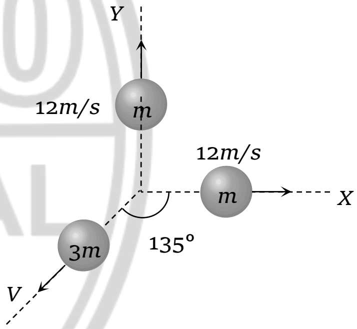
$\therefore F = 10N$



42. (d) By the conservation of momentum

$40\times10+(40)\times(-7)=80\times v \Rightarrow v=1.5m/s$

43. (d)



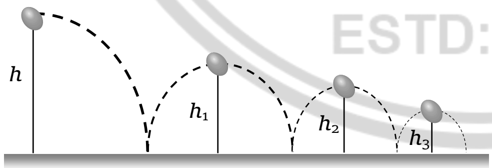
The momentum of third part will be equal and opposite to the resultant of momentum of rest two equal parts

let V is the velocity of third part.

By the conservation of linear momentum

$3m\times V = m\times12\sqrt{2} \Rightarrow V=4\sqrt{2}\ m/s$

44. (a)



Particle falls from height h then formula for height covered by it in nth rebound is given by

$$h_n = he^{2n}$$

where e = coefficient of restitution, n = No. of rebound

Total distance travelled by particle before rebounding has stopped

$$H = h+2h_1+2h_2+2h_3+2h_n+\ldots\ldots.$$

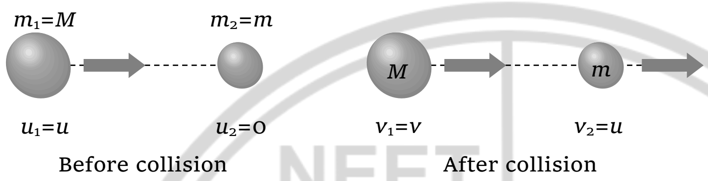
$$= h+2he^2+2he^4+2he^6+2he^8+\ldots\ldots.$$

$$= h + 2h(e^2 + e^4 + e^6 + e^8 + \ldots\ldots)$$

$$= h + 2h\left[\frac{e^2}{1-e^2}\right] = h\left[1 + \frac{2e^2}{1-e^2}\right] = h\left(\frac{1+e^2}{1-e^2}\right)$$

45. (d) Due to the same mass of *A* and *B* as well as due to elastic collision velocities of spheres get interchanged after the collision.

46. (a)



From the formulae $v_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right)\ u_1$

We get $v = \left(\frac{M-m}{M+m}\right)\ u$

47. (a) Momentum conservation

$5 \times 10 + 20 \times 0 = 5 \times 0 + 20 \times v \Rightarrow v = 2.5 m/s$

48. (d) Due to elastic collision of bodies having equal mass, their velocities get interchanged.

49. (c)

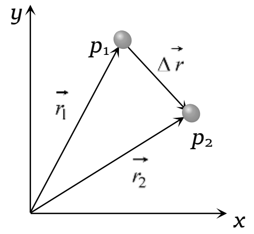
50. (b) $m_1 = 2kg$ and $v_1 = \left(\frac{m_1-m_2}{m_1+m_2}\right) u_1 = \frac{u_1}{4}$ (given)

By solving we get $m_2 = 1.2 kg$

51. (c)

52. (d) It is clear from figure that the displacement vector $\Delta \vec{r}$ between particles p_1 and p_2 is $\Delta \vec{r} = \vec{r_2} - \vec{r_1} = -8\hat{\imath} - 8\hat{\jmath}$

$|\Delta \vec{r}| = \sqrt{(-8)^2 + (-8)^2} = 8\sqrt{2}$ …..(i)



Now, as the particles are moving in same direction ($\because$ $\vec{v_1}$ and $\vec{v_2}$ are $+ve$), the relative velocity is given by

$$\vec{v}_{rel} = \vec{v_2} - \vec{v_1} = (\alpha - 4)\hat{\imath} + 4\hat{\jmath}$$

$\vec{v}_{rel} = \sqrt{(\alpha - 4)^2 + 16}$ …..(ii)

Now, we know $|\vec{v}_{rel}| = \frac{|\Delta \vec{r}|}{t}$

Substituting the values of $\vec{v}_{rel}$ and $|\Delta \vec{r}|$ from equation (i) and (ii) and $t = 2s$, then on solving we get $\alpha = 8$

53. (b) Fractional decrease in kinetic energy of neutron

$=1 - \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2$ [As m_1=1 and m_2 = 2]

$$= 1 - \left(\frac{1-2}{1+2}\right)^2 = 1 - \left(\frac{1}{3}\right)^2 = 1 - \frac{1}{9} = \frac{8}{9}$$

54. (a)

55. (b) When target is very light and at rest then after head on elastic collision it moves with double speed of projectile *i.e.* the velocity of body of mass *m* will be 2*v*.

56. (a) In head on elastic collision velocity get interchanged (if masses of particle are equal). *i.e.* the last ball will move with the velocity of first ball *i.e* 0.4 *m/s*

57. (a) By the principle of conservation of linear momentum,

$$Mv = mv_1 + mv_2 \Rightarrow Mv = 0 + (M - m)v_2 \Rightarrow v_2 = \frac{Mv}{M-m}$$

58. (a) Since bodies exchange their velocities, hence their masses are equal so that $\frac{m_A}{m_B} = 1$

59. (d) mgh = initial potential energy

mgh' = final potential energy after rebound

As 40% energy lost during impact $\therefore mgh'$=60% of mgh

$\Rightarrow h' = \frac{60}{100} \times h = \frac{60}{100} \times 10 = 6m$

60. (c)

61. (a) Fractional loss $= \frac{\Delta U}{U} = \frac{mg(h-h')}{mgh} = \frac{2-1.5}{2} = \frac{1}{4}$

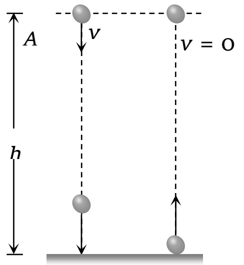
62. (c) $\frac{\Delta K}{K} = \left[1 - \left(\frac{m_1-m_2}{m_1+m_2}\right)^2\right] = \left[1 - \left(\frac{m-2m}{m+2m}\right)^2\right] = \frac{8}{9}$

$\Delta K = \frac{8}{9} K$ *i.e.* loss of kinetic energy of the colliding body is $\frac{8}{9}$ of its initial kinetic energy.

63. (d)

64. (a) $mgh = \frac{80}{100} \times mg \times 100 \Rightarrow h = 80m$

65. (a) Let ball is projected vertically downward with velocity *v* from height *h*



Total energy at point $A = \frac{1}{2}mv^2 + mgh$

During collision loss of energy is 50% and the ball rises up to same height. It means it possess only potential energy at same level.

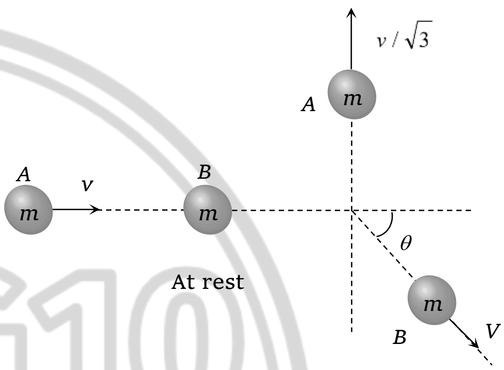
$50\%\left(\frac{1}{2}mv^2 + mgh\right) = mgh$

$$\frac{1}{2}\left(\frac{1}{2}mv^2 + mgh\right) = mgh$$
$$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20}$$
$$\therefore v = 20m/s$$

66. (a) $h_n = he^{2n}$ after third collision $h_3 = he^6$ [as n = 3]

67. (a) Let mass *A* moves with velocity *v* and collides inelastically with mass *B*, which is at rest.

According to problem mass *A* moves in a perpendicular direction and let the mass *B* moves at angle θ with the horizontal with velocity *v*.



Initial horizontal momentum of system (before collision) = *mv* ....(i)

Final horizontal momentum of system (after collision) = *mV* cosθ ....(ii)

From the conservation of horizontal linear momentum *mv* = *mV* cos$\theta \Rightarrow$ *v* = *V* cosθ ...(iii)

Initial vertical momentum of system (before collision) is zero.

Final vertical momentum of system $\frac{mv}{\sqrt{3}} - mV \sin\theta$

From the conservation of vertical linear momentum $\frac{mv}{\sqrt{3}} - mV\sin\theta = 0 \Rightarrow \frac{v}{\sqrt{3}} = V\sin\theta$ ...(iv)

By solving (iii) and (iv)

$$v^2 + \frac{v^2}{3} = V^2(\sin^2\theta + \cos^2\theta)$$

$$\Rightarrow \frac{4v^2}{3} = V^2 \;\Rightarrow V = \frac{2}{\sqrt{3}}v.$$

68. (d) Angle will be 90° if collision is perfectly elastic