DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 13

SYLLABUS : Work, Energy and Power-2 (Conservation of momentum and energy, collision, rocket case)

Max. Marks : 112 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 28 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.20) : There are 20 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 A rifle man, who together with his rifle has a mass of 100 kg, stands on a smooth surface fires 10 shots horizontally. Each bullet has a mass 10 gm and a muzzle velocity of 800 m/s. What velocity does rifle man acquire at the end of 10 shots

(a) 0.8 m/s (b) 0.5 m/s (c) 0.3 m/s (d) 1.2 m/s

Q.2 A bullet of mass 10 g travelling horizontally with a velocity of 300 m/s strikes a block of wood of mass 290 g which rests on a rough horizontal floor. After impact the block and the bullet move together and come to rest when the block has travelled a distance of 15 m. The coefficient of friction between the block and the floor will be - (Duration of impact is very short)

(a) $\frac{1}{2}$ (b) $\frac{2}{3}$ (c) $\frac{1}{3}$ (d) $\frac{3}{4}$

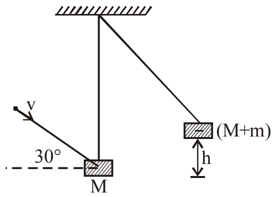
Q.3 A 20 g bullet pierces through a plate of mass m_1 = 1 kg and then comes to rest inside a second plate of mass m_2 = 2.98 kg. It is found that the two plates, initially at rest, now move with equal velocities. The percentage loss in the initial velocity of bullet when it is between m_1 and m_2. (Neglect any loss of material of the bodies, due to action of bullet.) will be -

(a) 20% (b) 25%
(c) 30% (d) 45%

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ

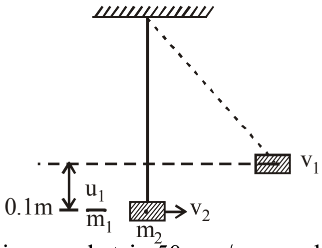
Space for Rough Work

Q.4 A bullet of mass 20 g hits a block of mass 1.98 kg suspended from a massless string of length 100 cm and sticks to it. The bullet flies down at an angle of 30º to the horizontal with a velocity of 200 m/s. Through what height the block will rise-



(a) 0.15 m
(b) 0.30 m
(c) 0.45 m
(d) 0.75 m

Q.5 A bullet of mass 0.01 kg travelling at a speed of 500 m/s strikes a block of mass 2 kg, which is suspended by a string of length 5 m. The centre of gravity of the block is found to rise a vertical distance of 0.1 m. The speed of the bullet after it emerges from the block will be -



(a) 1.4 m/s
(b) 110 m/s
(c) 220 m/s
(d) 14 m/s

Q.6 The rate of burning of fuel in a rocket is 50 gm/sec. and comes out with and velocity 4×10^3 m/s. The force exerted by gas on rocket will be -

(a) 200 N (b) 250 N
(c) 2.5×10^6 N (d) 2.5×10^4 N

Q.7 A body of mass 1 kg strikes elastically with another body at rest and continues to move in the same direction with one fourth of its initial velocity. The mass of the other body is -

(a) 0.6 kg (b) 2.4 kg (c) 3 kg (d) 4 kg

Q.8 A ball moving with a speed of 9 m/s strikes with an identical stationary ball such that after the collision the direction of each ball makes an angle of 30° with the original line of motion. Find the speeds of the two balls after the collision. Is the kinetic energy conserved in this collision process ?

(a) $3\sqrt{3}$ m/s, no (b) $3\sqrt{3}$ m/s, no
(c) $6\sqrt{3}$ m/s, yes (d) 0, yes

Q.9 The mass of a rocket is 500 kg and the relative velocity of the gases ejecting from it is 250 m/s with respect to the rocket. The rate of burning of the fuel in order to give the rocket an initial acceleration 20 m/s^2 in the vertically upward direction (g = 10 m/s^2), will be -

(a) 30 kg/s (b) 60 kg/s
(c) 45 kg/s (d) 10 kg/s

Q.10 A slow moving electron collides elastically with a hydrogen atom at rest. The initial and final motions are along the same straight line. What fraction of electron's kinetic energy is transferred to the hydrogen atom? The mass of hydrogen atom is 1850 times the mass of electron.

(a) 0.217 % (b) 2.17 % (c) 0.0217 % (d) 21.7 %

Q.11 A particle of mass 4 m which is at rest explodes into three fragments, two of the fragments each of mass m are found to move each with a speed v making an angle 90º with each other. The total energy relased in this explosion is -

(a) $\frac{1}{2}mv^2$ (b) mv^2
(c) $\frac{3}{2}mv^2$ (d) $2\,mv^2$

Q.12 A body of mass M splits into two parts αM and (1 – α) M by an internal explosion, which generates kinetic energy T. After explosion if the two parts move in the same direction as before, their relative speed will be -

(a) $\sqrt{\frac{T}{(1-\alpha)M}}$ (b) $\sqrt{\frac{2T}{\alpha(1-\alpha)M}}$
(c) $\sqrt{\frac{T}{2(1-\alpha)M}}$ (d) $\sqrt{\frac{2T}{(1-\alpha)M}}$

Q.13 A body of mass 1 kg initially at rest explodes and breaks into three fragments of masses in the ratio 1 : 1 : 3. The two pieces of equal mass fly off perpendicular to each other with a speed of 30 m/sec each. What is the velocity of the heavier fragment ?

(a) $10\sqrt{2}$ m/s (b) $15\sqrt{2}$ m/s
(c) $5\sqrt{2}$ m/s (d) $20\sqrt{2}$ m/s

RESPONSE GRID					
	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ
	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ

Space for Rough Work

Q.14 A body of mass m moving with a velocity v_1 in the X-direction collides with another body of mass M moving in Y-direction with a velocity v_2. They coalasce into one body during collision. The magnitude and direction of the momentum of the final body, will be-

(a) $\sqrt{(mv_1)+(Mv_2)}$, $\tan^{-1}\left(\frac{Mv_2}{mv_1}\right)$

(b) $\sqrt{(mv_1)+(Mv_2)}$, $\tan^{-1}\left(\frac{Mv_1}{mv_2}\right)$

(c) $\sqrt{(mv_1)^2+(Mv_2)^2}$, $\tan^{-1}\left(\frac{Mv_2}{mv_1}\right)$

(d) $\sqrt{(mv_1)^2+(Mv_2)^2}$, $\tan^{-1}\left(\frac{Mv_1}{mv_2}\right)$

Q.15 A ball of mass m hits a wall with a speed v making an angle θ with the normal. If the coefficient of restitution is e, the direction and magnitude of the velocity of ball after reflection from the wall will respectively be -

(a) $\tan^{-1}\left(\frac{\tan\theta}{e}\right)$, $v\sqrt{\sin^2\theta+e^2\cos^2\theta}$

(b) $\tan^{-1}\left(\frac{e}{\tan\theta}\right)$, $\frac{1}{v}\sqrt{e^2\sin^2\theta+\cos^2\theta}$

(c) $\tan^{-1}(e\tan\theta)$, $\frac{v}{e}\tan\theta$

(d) $\tan^{-1}(e\tan\theta)$, $v\sqrt{\sin^2\theta+e^2}$

Q.16 A tennis ball dropped from a height of 2 m rebounds only 1.5 metre after hitting the ground. What fraction of energy is lost in the impact?

(a) 1/2 (b) 1/4 (c) 1/8 (d) 1/16

Q.17 A bullet is fired from the gun. The gun recoils, the kinetic energy of the recoil shall be-

(a) equal to the kinetic energy of the bullet
(b) less than the kinetic energy of the bullet
(c) greater than the kinetic energy of the bullet
(d) double that of the kinetic energy of the bullet

Q.18 Conservation of linear momentum is equivalent to-

(a) Newton's second law of motion
(b) Newton's first law of motion
(c) Newton's third law of motion
(d) Conservation of angular momentum.

Q.19 In an inelastic collision-

(a) momentum is conserved but kinetic energy is not conserved
(b) momentum is not conserved but kinetic energy is conserved
(c) neither momentum nor kinetic energy is conserved
(d) both the momentum and kinetic energy are conserved

Q.20 Inelastic collision is the-

(a) collision of ideal gas molecules with the walls of the container
(b) collision of electron and positron to an inhilate each other.
(c) collision of two rigid solid spheres lying on a frictionless table
(d) scattering of α-particles with the nucleus of gold atom

DIRECTIONS (Q.21-Q.23) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct
(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.21 Which of the following statements is false for collisions-

(1) Momentum is conserved in elastic collisions but not in inelastic collisions.
(2) Total-kinetic energy is conserved in elastic collisions but momentum is not conserved.
(3) Total kinetic energy and momentum both are conserved in all types of collisions
(4) Total kinetic energy is not conserved in inelastic collisions but momentum is conserved

Q.22 Which of the following hold when two particles of masses m_1 and m_2 undergo elastic collision?

(1) When $m_1 = m_2$ and m_2 is stationary, there is maximum transfer of kinetic energy in head on collision
(2) When $m_1 = m_2$ and m_2 is stationary, there is maximum transfer of momentum in head on collision
(3) When $m_1 >> m_2$ and m_2 is stationary, after head on collision m_2 moves with twice the velocity of m_1.
(4) When the collision is oblique and $m_1 = m_2$ with m_2 stationary, after the collision the particle move in opposite directions.

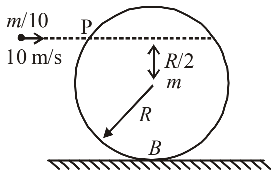
RESPONSE GRID					
	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ
	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	

Space for Rough Work

Q.23 Two balls at the same temperature collide inelastically. Which of the following is not conserved?
(1) Kinetic energy (2) Velocity
(3) Temperature (4) Momentum

DIRECTIONS (Q.24-Q.26) : Read the passage given below and answer the questions that follows :

A small particle of mass m/10 is moving horizontally at a height of $3R/2$ from ground with velocity 10 m/s. A perfectly inelastic collision occurs at point P of sphere of mass m placed on smooth horizontal surface. The radius of sphere is R. (m = 10 kg and R = 0.1 m) (Assume all surfaces to be smooth).



Q.24 Speed of particle just after collision is
(a) approx 5.0 m/s (b) approx 10 m/s
(c) approx. 15.0 m/s (d) approx 20.0 m/s

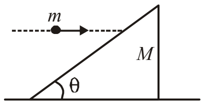
Q.25 Speed of sphere just after collision is
(a) 27/43 m/s (b) 30/43 m/s
(c) 35/43 m/s (d) 40/43 m/s

Q.26 Angular speed of sphere just after collision is
(a) zero (b) 2 rad/sec
(c) 2.5 rad/sec (d) 3 rad/sec

DIRECTIONS (Q. 27-Q.28) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(c) Statement -1 is False, Statement-2 is True.
(d) Statement -1 is True, Statement-2 is False.

Q.27 A particle of mass m strikes a wedge of mass M horizontally as shown in the figure.



Statement - 1 : If collision is perfectly inelastic then, it can be concluded that the particle sticks to the wedge.
Statement - 2 : In perfectly inelastic collision velocity of both bodies is same along common normal just after collision.

Q.28 Statement - 1 : In an elastic collision in one dimension between two bodies, total momentum remains the same before, during and after the collision.
Statement - 2 : In an elastic collision in one dimension between two bodies, total kinetic energy remains the same before, during and after the collision.
[Assume external forces are absent in both the above statements].

RESPONSE GRID	
	23.ⓐⓑⓒⓓ 24.ⓐⓑⓒⓓ 25.ⓐⓑⓒⓓ 26.ⓐⓑⓒⓓ 27.ⓐⓑⓒⓓ 28.ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 13 - PHYSICS			
Total Questions	28	Total Marks	112
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	44
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS 13

(1) **(a)** Let m_1 and m_2 be the masses of bullet and the rifleman and v_1 and v_2 their respective velocities after the first shot. Initially the rifleman and bullet are at rest, therefore initial momentum of system = 0.
As external force is zero, momentum of system is constant i.e. initial momentum = final momentum

$$= m_1v_1 + m_2v_2$$

or $v_2 = \frac{m_1v_1}{m_2} = -\frac{(10\times10^{-3}\text{kg})(800\text{m/s})}{100\text{kg}} = -0.08$ m/s

Velocity acquired after 10 shots

$$= 10\ v_2 = 10 \times (-0.08) = -0.8 \text{ m/s}$$

i.e, the velocity of rifle man is 0.8 m/s in a direction opposite to that of bullet.

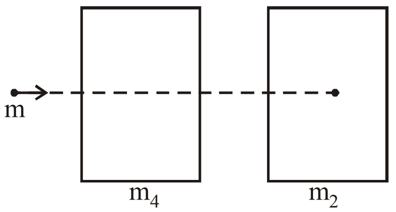
(2) **(c)** Let the mass of block and bullet be M and m respectively If v is the velocity of bullet and V is the velocity of block with bullet embedded in it,
Now according to conservation of momentum ,
$mv = (M + m)V$
$(10\times10^{-3})(300) = (290\times10^{-3} + 10\times10^{-3})$ V or V = 10 m/s

The kinetic energy just after impact is $\frac{1}{2}(M + m)V^2$, which is lost due to work done on it by the force of friction F. Since force of friction F = μ (M+m)g and the work done is given by Fd, we have

$$\frac{1}{2}(M + m)V^2 = \mu(M + m)gd$$

or $\mu = \frac{1}{2}\frac{V^2}{gd} = \frac{1}{2}\times\frac{10^2}{(10)(15)} = \frac{1}{3}$

(3) **(a)** Let the initial velocity of the bullet of mass m = 20 g = 0.020 kg be u and v the velocity with which each plate moves.
The initial momentum of system (bullet + plate) = mu



Final momentum of system = $m_1v + (m_2 + m)v$
(Since bullet remains in 2nd plate)
∴ According to principle of conservation of momentum
i.e. $mu = m_1v + (m_2 + m)v$,
i.e. 0.02u = 4v

or $u = \frac{4}{.02} = 200$ v ....(1)

Let v_1 be the velocity of the bullet as it comes out of plate m_1. Applying conservation of linear momentum for the collision of bullet with plate m_2.
i.e. $mv_1 = (m_2 + m)v$
$0.02\ v_1 = (2.98 + 0.02)$ v

i.e. $v_1 = \frac{3}{.02}v = 150$ v ....(2)

Required percentage loss in initial velocity of bullet

$$\frac{u - v_1}{u}\times100\% = \frac{200v - 150v}{200v}\times100 = 25\%$$

(4) **(a)** Part (I) - The horizontal component of the momentum of the bullet is equal to the momentum of the block with the bullet
$mu\cos\alpha = (M + m)V$ ....(1)
Where V is the velocity of the block plus bullet embedded in it.
Part (II) - As the block can move as a pendulum, the block rises till its kinetic energy is converted into potential energy. So, if the block rises upto a height h,

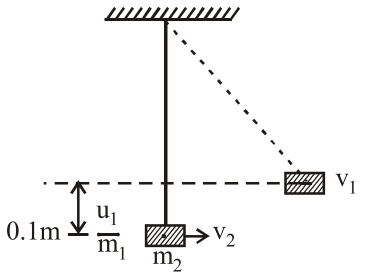
$\frac{1}{2}(M + m)V^2 = (M + m)gh$ ....(2)

From (1) & (2)

$$h = \left(\frac{m}{M + m}\right)^2 \cdot \frac{u^2\cos^2\alpha}{2g}$$

$$= \left(\frac{20\times10^{-3}}{2}\right)^2 .(200)^2 \cdot \frac{\cos^2 30^\circ}{(2)\ (10)} = 0.15 \text{ m}$$

(5) **(c)** Initial velocity of bullet, $u_1 = 500$ m/s
Let v_1 and v_2 be the speeds of bullet and block after collision



respectively then, $\frac{1}{2}mv_2^2 = mgh$

$\Rightarrow v_2 = \sqrt{2gh} = \sqrt{2\times9.8\times0.1} = 1.4$ m/s

According to principle of conservation of linear momentum, We have
$m_1u_1 + 0 = m_1v_1 + m_2v_2$
or $0.01\times500 = 0.01\ v_1 + 2\times1.4 \Rightarrow v_1 = 220$ m/s

(6) **(a)** The rate of change of momentum is equal to force

$$F = \frac{dp}{dt} = v\frac{dm}{dt} \quad \text{(Here v is constant)}$$

Here $v = 4 \times 10^3$ m/s & $\frac{dm}{dt} = 50 \times 10^{-3}$ kg/s

$\therefore F = 4 \times 10^3 \times 50 \times 10^{-3} = 200$ N

(7) **(a)** Given that, Initial velocity = u

Final velocity $= \frac{u}{4}$

So by conservation of momentum, we have

$$1 \times u + 0 = 1 \times \frac{u}{4} + m \times v_2 \Rightarrow mv_2 = \frac{3u}{4} \quad \text{....... (1)}$$

and by conservation of energy, we have

$$\frac{1}{2} \times 1 \times u^2 + 0 = \frac{1}{2} \times 1\left(\frac{u}{4}\right)^2 + \frac{1}{2} m v_2^2$$

$$\text{or } v_2^2 = \frac{15}{16}u^2 \quad \text{....... (2)}$$

From equation (1) and (3),

$$\frac{(mv_2)^2}{mv_2^2} = \frac{(9/16)u^2}{(15/16)u^2} \text{ or } m = 0.6\,\text{kg}$$

(8) **(a)** Initial momentum of the balls

$= m \times 9 + m \times 0 = 9\,m$ ....(1)

where m is the mass of each ball.

Let after collision their velocities are v_1 and v_2 respectively.

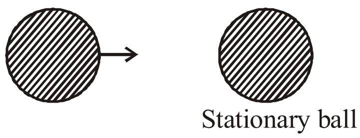
Final momentum of the balls after collision along the same line $= mv_1 \cos 30° + mv_2 \cos 30°$

$$= \frac{mv_1\sqrt{3}}{2} + \frac{mv_2\sqrt{3}}{2} \quad \text{........(2)}$$

According to law of conservation of momentum

$$9\,m = \frac{mv_1\sqrt{3}}{2} + \frac{mv_2\sqrt{3}}{2}$$

$$\frac{9 \times 2}{\sqrt{3}} = v_1 + v_2 \quad \text{.......(3)}$$



(a) Before collision

The initial momentum of the balls along perpendicular direction = 0.

Final momentum of balls along the perpendicular direction

$$= mv_1 \sin 30° - mv_2 \sin 30° = \frac{m}{2}(v_1 - v_2)$$

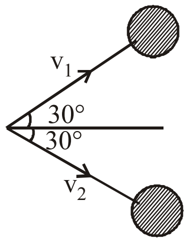
Again by the law of conservation of momentum

$(m/2)(v_1 - v_2) = 0$

$\therefore (v_1 - v_2) = 0$ ......(4)

Solving equations (3) and (4), we have

$v_1 = 3\sqrt{3}$ m/s and $v_2 = 3\sqrt{3}$ m/s



According to law of conservation of energy

Energy before collision = Energy after collision

$$\frac{1}{2}m u_1^2 + \frac{1}{2}m u_2^2 = \frac{1}{2}m v_1^2 + \frac{1}{2}m v_2^2$$

$$\frac{1}{2}m(9)^2 + 0 = \frac{1}{2}m(3\sqrt{3})^2 + \frac{1}{2}m(3\sqrt{3})^2$$

$$\frac{81\,m}{2} = \frac{54\,m}{2}$$

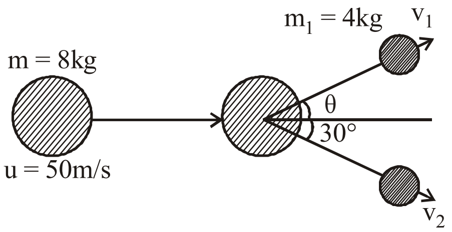
L.H.S. # R.H.S.

i.e., energy is not conserved in this collision or this is a case of inelastic collision.

(9) **(a)** The situation is shown in fig.

Let v_1 and v_2 be the velocities of two pieces after explosion.

Applying the law of conservation of energy, we have



$$\frac{1}{2}(8)(50)^2 + 15000 = \frac{1}{2}(D)\,v_1^2 + \frac{1}{2}(D)\,v_2^2$$

or $25000 = 2(v_1^2 + v_2^2)$ ......(1)

Applying the law of conservation of momentum along x-axis and y-axis respectively, we get

$8(50) = 4\,v_1 \cos\theta + v_2 \cos 30°$ ......(2)

and $0 = 4\,v_1 \sin\theta$

$= 4\,v_2 \sin 30° = 2\,v_2$ ......(3)

or $\sin\theta = \frac{v_2}{2v_1}$ ......(4)

From eq. (2)

$100 = v_1 \cos\theta + v_2 \cos 30°$

(10) **(a)** Let m be the mass of the rocket and v_r the relative velocity of the gas ejecting from the rocket. Suppose the fuel is burnt at a rate (dm/dt) to provide the rocket an acceleration a.

Then $a = \frac{v_r}{m}\left(\frac{dm}{dt}\right) - g$ ......(1)

Here $v_r = 250$ m/s, m = 500 kg, g = 10 m/s^2 and a = 20 m/s^2

Now from (1) $\frac{dm}{dt} = \frac{m}{v_r}(a+g)$

$$= \frac{500}{250}(20+10) = 60 \text{ kg/s}$$

(11) **(a)** Let m_1 and m_2 be the masses of electron and hydrogen atom respectively. If u_1 and v_1 be the initial and final velocities of electron, then initial kinetic energy of electron

$$K_i = \left(\frac{1}{2}\right) m u_1^2$$

Final kinetic energy of electron $K_f = \left(\frac{1}{2}\right) m v_1^2$

Fractional decrease in K.E.,

$$\frac{K_i - K_f}{K_i} = 1 - \frac{v_1^2}{u_1^2} \qquad ....(1)$$

For such a collision, we have

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

$$\therefore \frac{v_1}{u_1} = \left(\frac{m_1 - m_2}{m_1 + m_2}\right) \qquad ....(2)$$

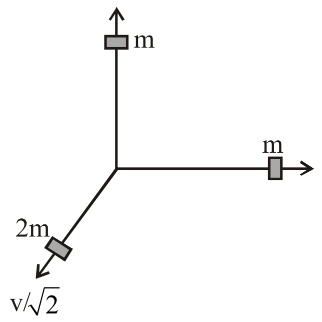
From eqs. (1) and (2) we have

$$\frac{K_i - K_f}{K_i} = 1 - \left(\frac{m_1 - m_2}{m_1 + m_2}\right)^2 = \frac{4m_1m_2}{(m_1+m_2)^2}$$

or $$\frac{K_i - K_f}{K_i} = \frac{4(m_2/m_1)}{(1+m_2/m_1)^2} = \frac{4 \times 1850}{(1+1850)^2}$$

$$= 0.00217 = 0.217\%$$

(12) **(c)**



Now the total energy released in the explosion

$$= \frac{1}{2}mv^2 + \frac{1}{2}mv^2 + \frac{1}{2}2m\left(\frac{v}{\sqrt{2}}\right)^2 = \frac{3}{2}mv^2$$

(13) **(a)** Let the speed of the body before explosion be u. After explosion, if the two parts move with velocities u_1 and u_2 in the same direction, then according to conservation of momentum,

$$\alpha M u_1 + (1-\alpha) M u_2 = Mu$$

The kinetic energy T liberated during explosion is given

by $T = \frac{1}{2}\alpha M u_1^2 + \frac{1}{2}(1-\alpha) M u_2^2 - \frac{1}{2} Mu^2$

$$= \frac{1}{2}\alpha M u_1^2 + \frac{1}{2}(1-\alpha) M u_2^2 - \frac{1}{2M}[\alpha Mu_1 + (1-\alpha) Mu_2]^2$$

$$= \frac{1}{2} M \alpha (1-\alpha)[u_1^2 + u_2^2 - 2u_1u_2]$$

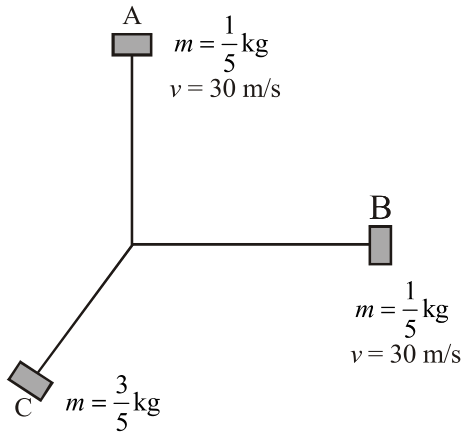
$$(u_1 - u_2)^2 = \frac{2T}{\alpha(1-\alpha)M}$$

$$\Rightarrow (u_1 - u_2) = \sqrt{\frac{2T}{\alpha(1-\alpha)M}}$$

(14) **(a)** The situation is shown in fig.

Let A and B be two pieces of equal mass (1/5 kg) which fly off perpendicular to a each other with equal velocity (30 m/sec)

Momentum of A or B = (1/5 × 30)



∴ Resultant momentum

$$= \sqrt{\{(1/5) \times 30\}^2 + \{(1/5) \times 30\}^2} = 6\sqrt{2} \text{ kg m/sec}$$

along the bisector of ∠ AOB

$(3/5) \times v = 6\sqrt{2} \Rightarrow v = 10\sqrt{2}$ m/sec

(15) **(c)** The situation is shown in fig.

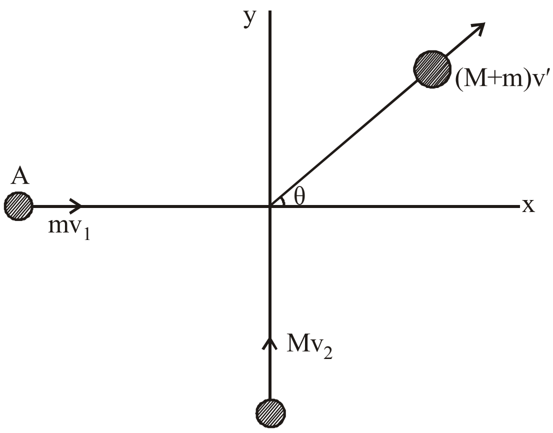
Equating the total initial and final momentum along each axis, we get

$mv_1 + 0 = (M+m)\, v' \cos\theta$ ....(A)

$0 + Mv_2 = (M+m)\, v' \sin\theta$ ....(B)

Squaring and adding eq. (A) and (B), we get

$(mv_1)^2 + (Mv_2)^2 = (M+m)^2 v'^2$ ....(C)



The final momentum

$$P = (M+m)\,v' = \sqrt{[(mv_1)^2 + (Mv_2)^2]}$$

[form eqn. (3)]

Dividing eqn. (2) by eqn. (1), we have

$$\tan\theta = \frac{Mv_2}{mv_1} \quad \text{or} \quad \theta = \tan^{-1}\left(\frac{Mv_2}{mv_1}\right)$$

(16) **(a)** Let the angle of reflection be θ' and the magnitude of velocity after collision be v'. As there is no force parallel to the wall, the component of velocity parallel to the surface remains unchanged.

Therefore, $v' \sin\theta' = v \sin\theta$ ......(1)

As the coefficient of restitution is e, for perpendicular component of velocity

Velocity of separation = e x velocity of approach

$-(v' \cos\theta' - 0) = -e\,(v\cos\theta - 0)$ ......(2)

From (1) and (2)

$$v' = v\sqrt{\sin^2\theta + e^2\cos^2\theta}$$

and $\tan\theta' = \tan\theta/e$

(17) **(a)** The fraction of energy lost is given by,

$$\frac{\Delta E}{E} = \frac{mg(h-h')}{mgh} = \frac{h-h'}{h}$$

given that, h = 2 meter and h' = 1.5 meter

$$\therefore \frac{\Delta E}{E} = \frac{2-1.5}{2} = \frac{1}{4}$$

(18) **(a)** A bullet is fired from the gun. The gun recoils, the kinetic energy of the recoil shall be less than the kinetic energy of the bullet.

(19) **(a)** Conservation of linear momentum is equivalent to Newton's second law of motion

(20) **(a)** In an inelastic collision momentum is conserved but kinetic energy is not.

(21) **(a)** Inelastic collision is the collision of electron and positron to an inhilate each other.

(22) **(a)** Total kinetic energy is not conserved in inelastic collisions but momentum is conserved

(23) **(a)** (1) when $m_1 = m_2$ and m_2 is stationary, there is maximum transfer of kinetic energy in head an collision

(2) when $m_1 = m_2$ and m_2 is stationary, there is maximum transfer of momentum in head on collision

(3) when $m_1 >> m_2$ and m_2 is stationary, after head on collision m_2 moves with twice the velocity of m_1.

(24) **(a)** Momentum remains conserved

(25) **(a)** Speed of particle after the collision

$$= \sqrt{\left(\frac{15}{43}\times\sqrt{3}\right)^2 + 25} = 5.036 \text{ m/s}$$

(26) **(b)** Speed of the sphere just after collision $= \frac{30}{43}$ m/s

(27) **(a)** Angular speed of sphere is zero as impulse due to collision passes through centre of sphere.

(28) **(c)** When e = 0, velocity of separation along common normal zero, but there may be relative velocity along common tangent.

(29) **(c)** Statement – 1 is false but statement – 2 is true.

(30) **(d)** Momentum remains constant before, during and after the collision but *KE* does not remain constant during the collision as the energy gets converted into elastic potential energy due to deformation.