بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِيْمِ

বিস্‌মিল্লাহির রাহ্‌মানির রাহীম

উদ্ভাস

একাডেমিক এন্ড এডমিশন কেয়ার

Class Nine: **Physics** 1st Paper (Chapter-03)

Force

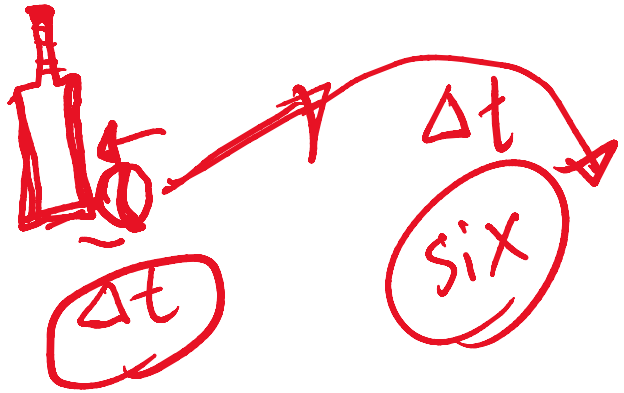
Lecture P-06

* Momentum
* Collision
* C.M.& E
* Mathem - -

Impulse of Force

Impulsive force
* huge amount of force
* little duration time

**(Multiplication of Force and Time is known as Impulse of Force.)



In this case,

Impulse of force,

$J = F \times t$

$= ma \times t$ [Newton's 2nd law]

$= m\left(\frac{v-u}{t}\right) \times t$

$= mv - mu$

So,

$$\boldsymbol{F \times t = mv - mu = J}$$

$a = \frac{v-u}{t}$

F= ma

$= kgms^{-2}$ [$m = kg$, $a = ms^{-2}$]

Unit: Ns/kgms^{-1}

Dimension: $Ns \Rightarrow kgms^{-2} \times s$

$\Rightarrow kgms^{-1}$

$\therefore [J] = [MLT^{-1}]$

Pole-01

Velocity Vector

$J = F \times \Delta t = m(v - u)$

$= 2(3 - (-5))$

Q. The girl kicks the 2kg mass football at a velocity of 5m/s and it hits the goal post. Then, it returns at a speed of 3 m/s. What is the impulse of force?

Ans.

a) -4 Ns b) 10 Ns c) 16 Ns d) None

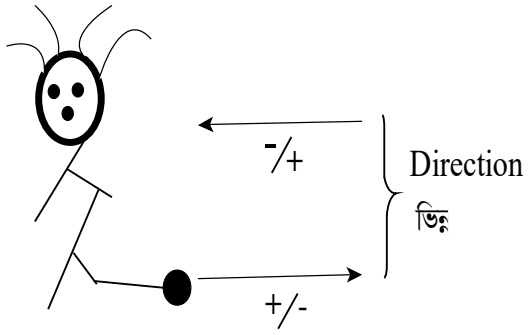
$= 2 \times (3+5) = 16\,Ns$

Here is the Solve:

Given,

$$v = 3ms^{-1}$$
$$u = -5ms^{-1}$$

$\because$



$$\therefore J = mv - mu$$
$$= 2 \times 3 - 2 \times (-5)$$
$$= 6 + 10$$
$$= \frac{16Ns}{-16Ns} \left[if \ \frac{+/-}{change} \right]$$

Momentum = mv

(Multiplication of Mass & Velocity is known as Momentum! → Vector)

P = mass × velocity

ভর ও বেগ (×) হবে!!

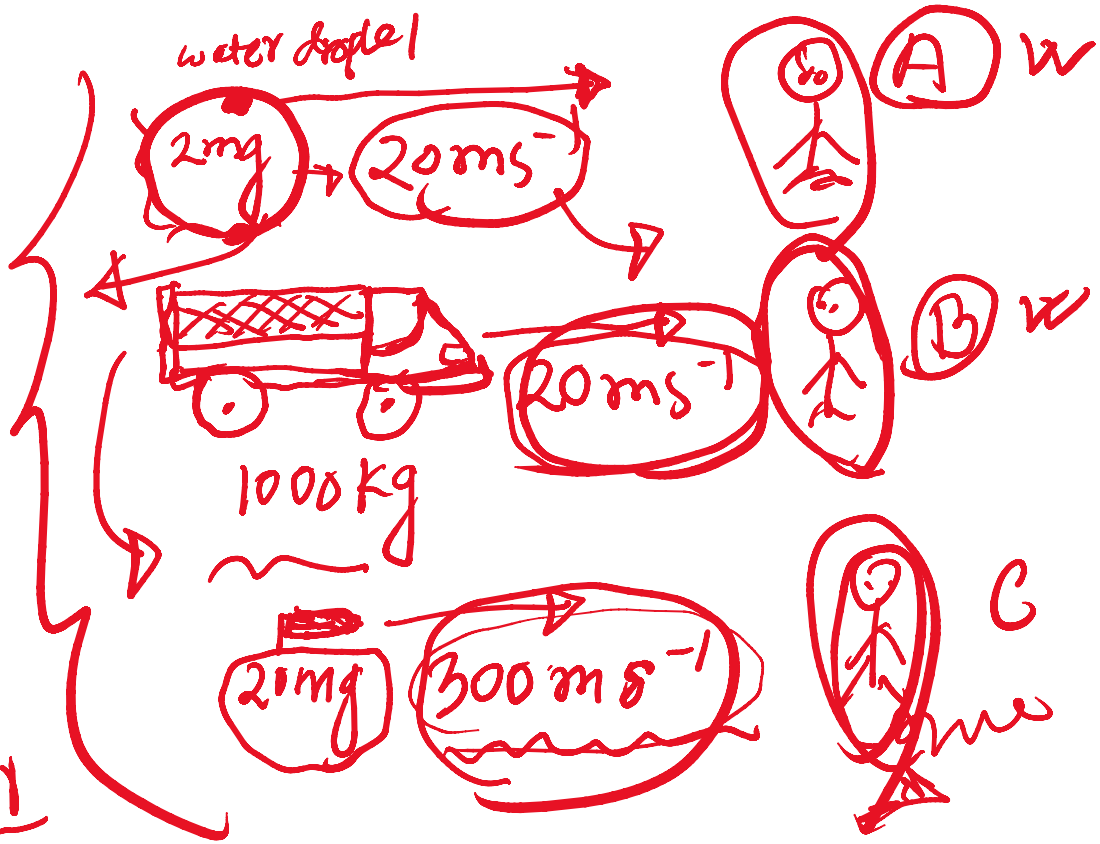
m v = m × v

unit: $kgms^{-1}$ = Kg × ms^{-1}

Dimension: = MLT^{-1}

$[P] = [MLT^{-1}]$

Scalar × Vector ⇒ Vector



Pole-02

Q. 2kg mass football is thrown at a velocity of 10m/s & it returns from wall at same velocity! What will be the change in momentum?)

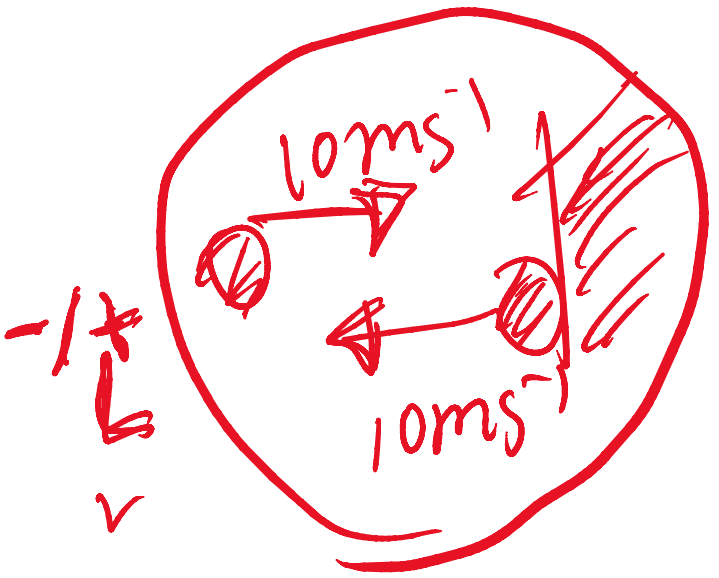
Ans: a) 40 N/s^2 b) 40 Ns c) 20 $kgms^{-2}$ d) 0 $kgms^{-1}$

$2kg \times (10 - (-10))$ $m(v-u)$

$= 2kg \times 20\ ms^{-1}$

$= 40\ kgms^{-1}$

$= 40\ Ns$



Solution

$mv - mu$

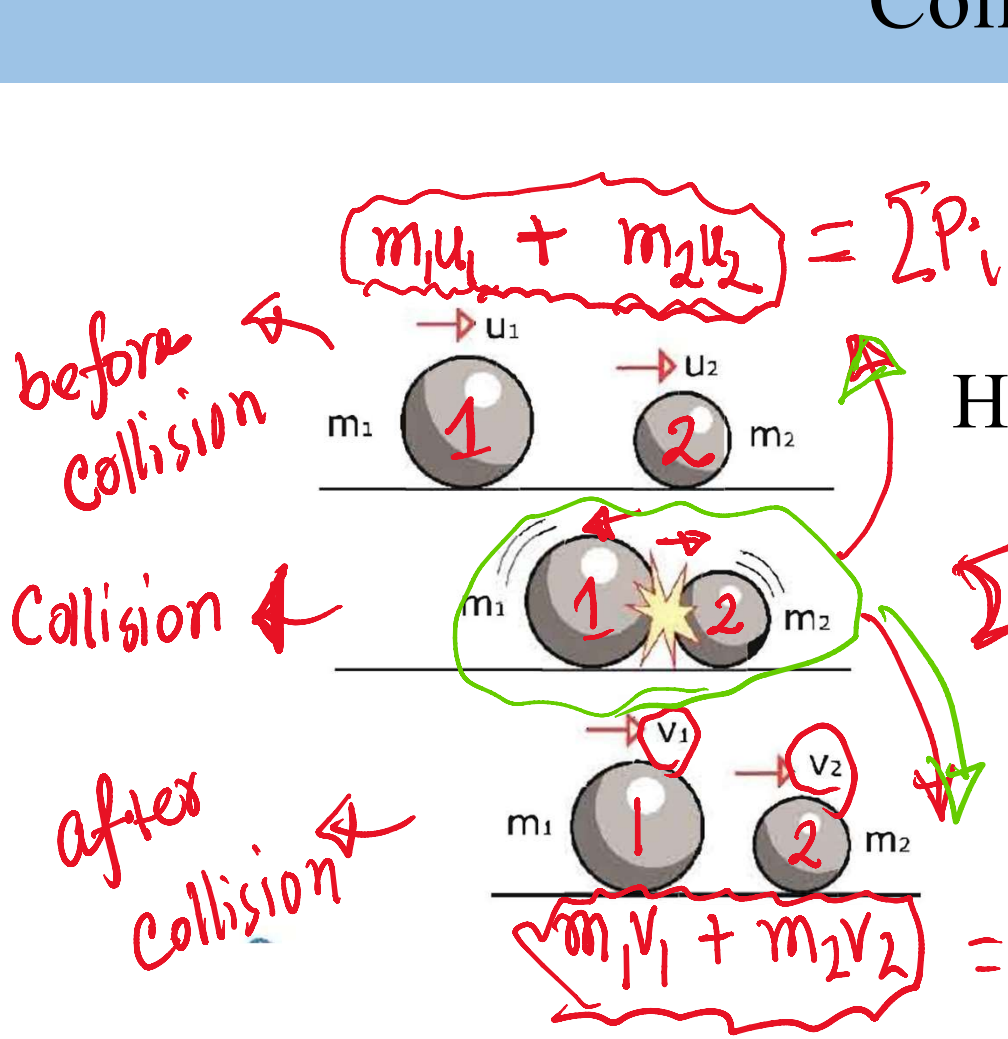
$= m \times 10 - m\,(-10)$

$= 2m \times 10$

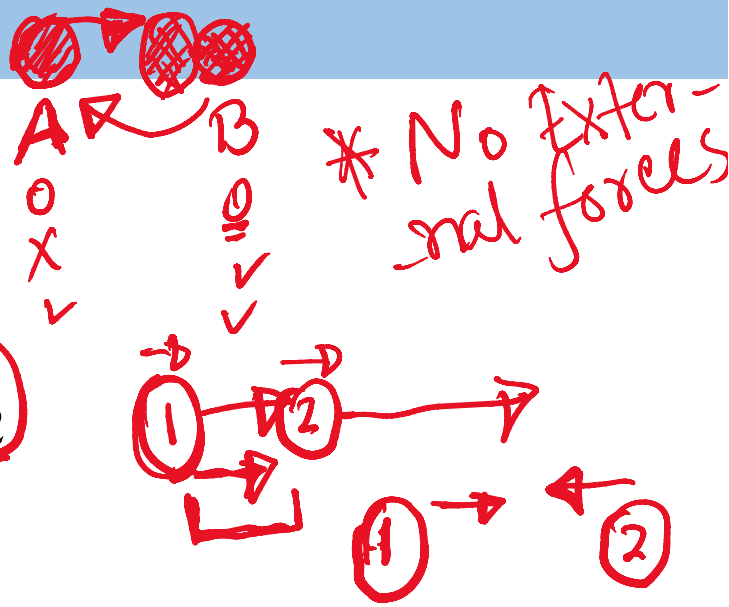
$= (2 \times 2 \times 10) kgms^{-1}$

$= 40\ kgms^{-1}$ (Ans.)

Collision



Here, $u_1 > u_2$



$\sum$ Summation

$\sum P_i = \sum P_f$

Conservation of momentum

Collision

So,

Combined Momentum before Collision $= m_1u_1 + m_2u_2$

Combined Momentum after Collision $= m_1v_1 + m_2v_2$

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2 \quad (*)$$

As, no force is applied from outside, according to Law of conservation of momentum,

$$\Rightarrow m_1u_1 + m_2u_2 + \ldots = m_1v_1 + m_2v_2 + \ldots\ldots$$

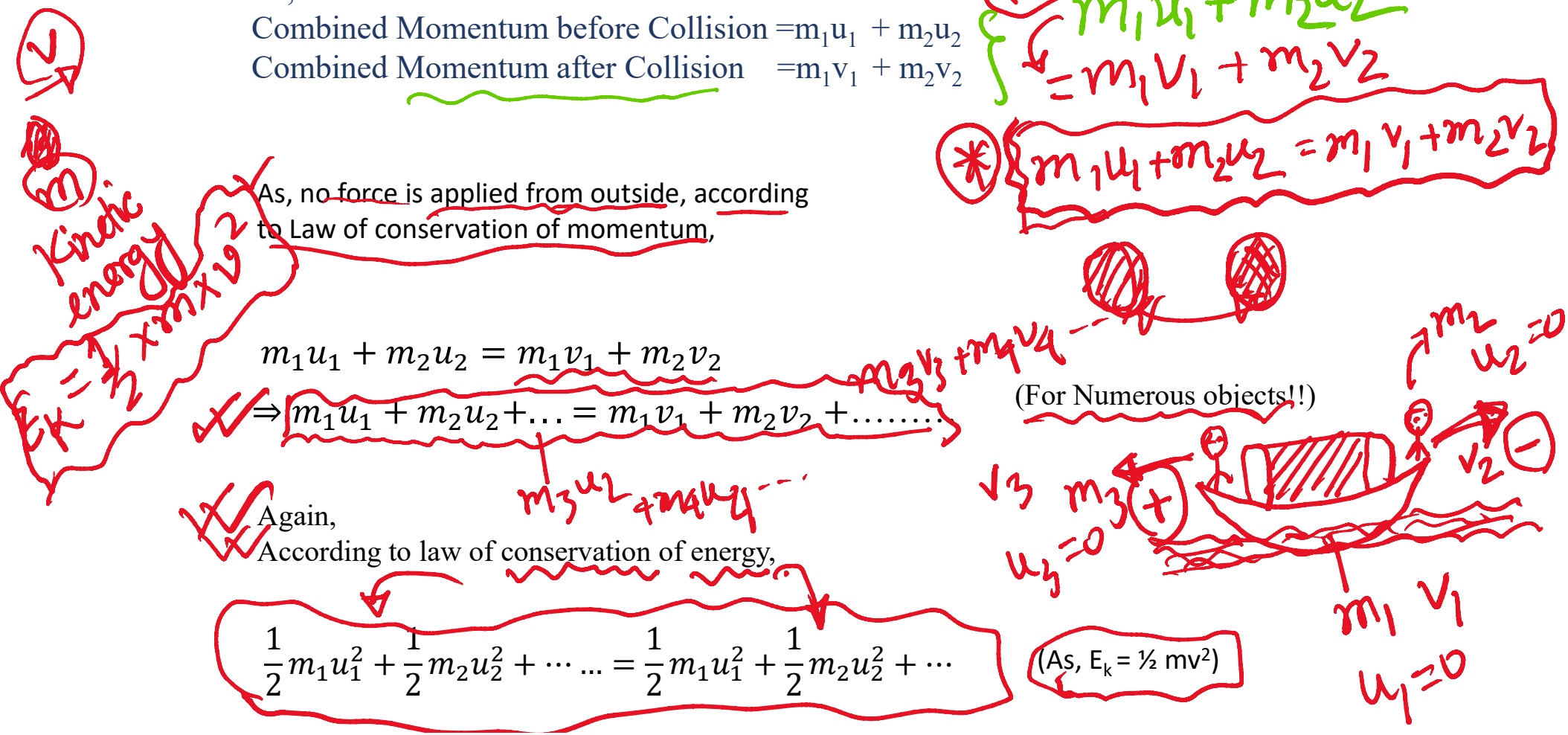
(For Numerous objects!!)

Again,

According to law of conservation of energy,

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 + \cdots \ldots = \frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 + \cdots$$

(As, $E_k = \frac{1}{2}mv^2$)



Laws of Conservation of momentum & energy:

Safe Jouney: ** Seat Belt must
** Driving Speed Slower

From Laws of Conservation of momentum & energy, we can denote v_1 & v_2→

$$v_1 = \frac{(m_1 - m_2)u_1 + 2m_2u_2}{m_1 + m_2}$$

$$v_2 = \frac{(m_2 - m_1)u_2 + 2m_1u_1}{m_1 + m_2}$$

**Practise a lil bit!

Pole-03

Q. A and B objects are approaching towards each other. They will have collision if:

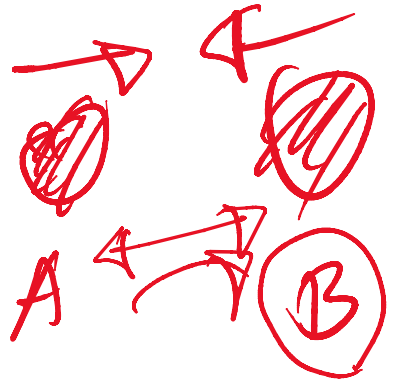
Ans:

a) $|U_a| = |U_b|$

b) $|U_a| < |U_b|$

c) $|U_a| > |U_b|$

d) All

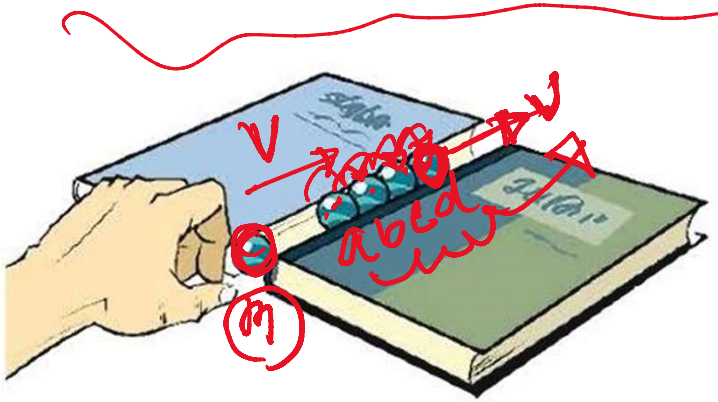


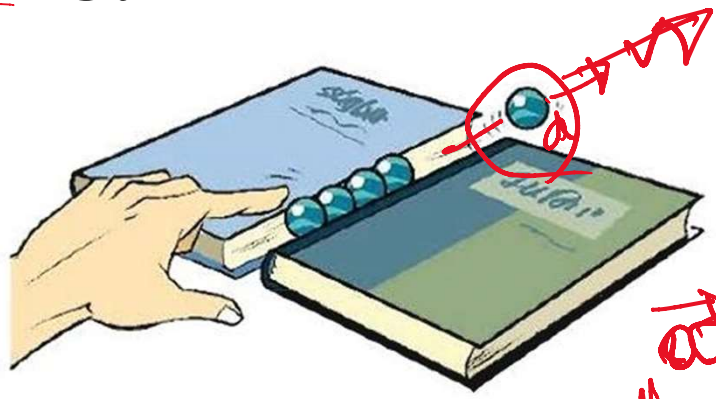
$5ms^{-1} = 5ms^{-1}$

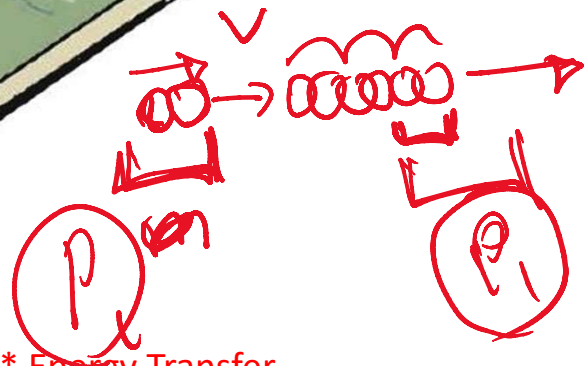
$6ms^{-1} > 5$

$5 < 6$

Conservation of Energy & Momentum:







Here,

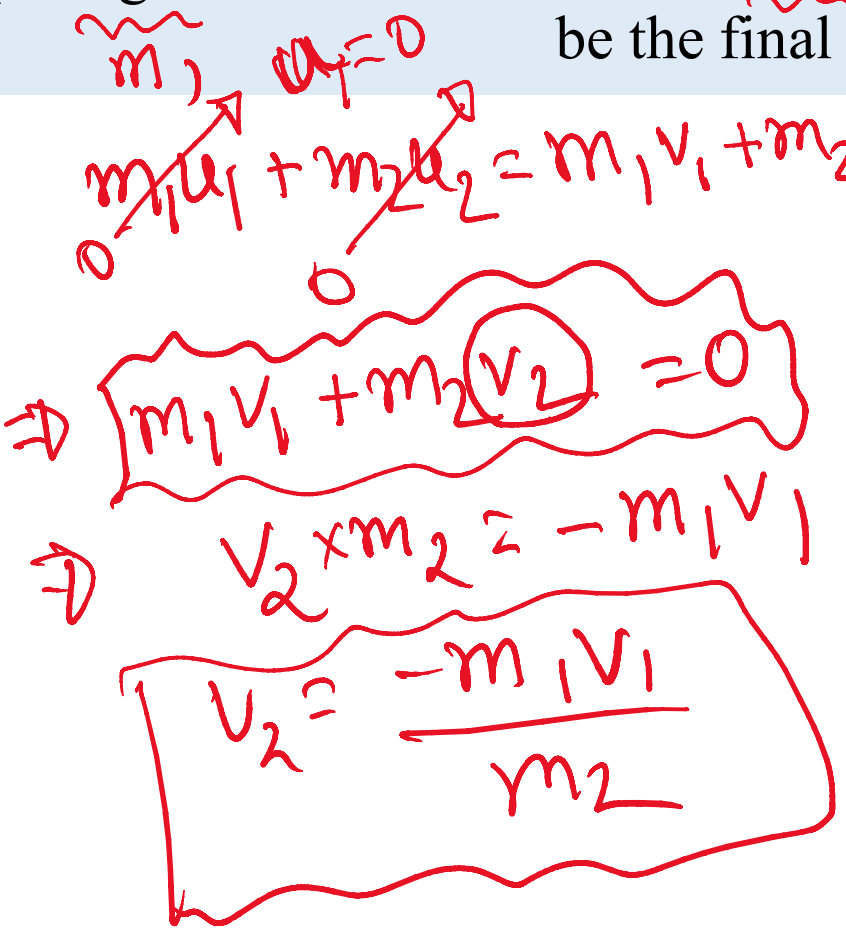
** Energy Transfer

1 ● Strike ⟶ 1 ● out

2 ● Strike ⟶ 2 ● out

Mathematical Problems

(Q. A 2gm mass bullet is fired at 500 m/s velocity from a 2kg mass rifle! What will be the final velocity of the rifle?)

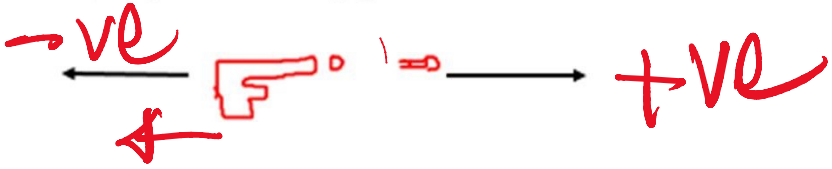


Solution:

Given, Mass of Rifle = 2 kg.
Mass of bullet = $2g = 2\times10^{-3}$
initial Velocity of Rifle = $0ms^{-1}$
initial Velocity of bullet = $0\ ms^{-1}$
Final velocity of bullet = $500\ ms^{-1}$
Final velocity of Rifle = ?
Now,

$$m_1u_1 + m_2v_2 = m_1v_1 + m_2v_2$$
$$\Rightarrow 0 = m_1v_1 + m_2v_2$$
$$\Rightarrow m_1v_1 = -m_2v_2$$
$$\Rightarrow v_1 = -\frac{m_2v_2}{m_1} = \frac{(2\times10^{-3}\times500)}{2}\ ms^{-1} = -0.5ms^{-1}$$

Here, (-) means opposite direction!!



Pole-04

Q. If you start to fire from a gun while sitting on a frictionless floor, then:

Ans:

a) The bullet will go faster than before

b) You will move backward

c) i+ ii

d) None

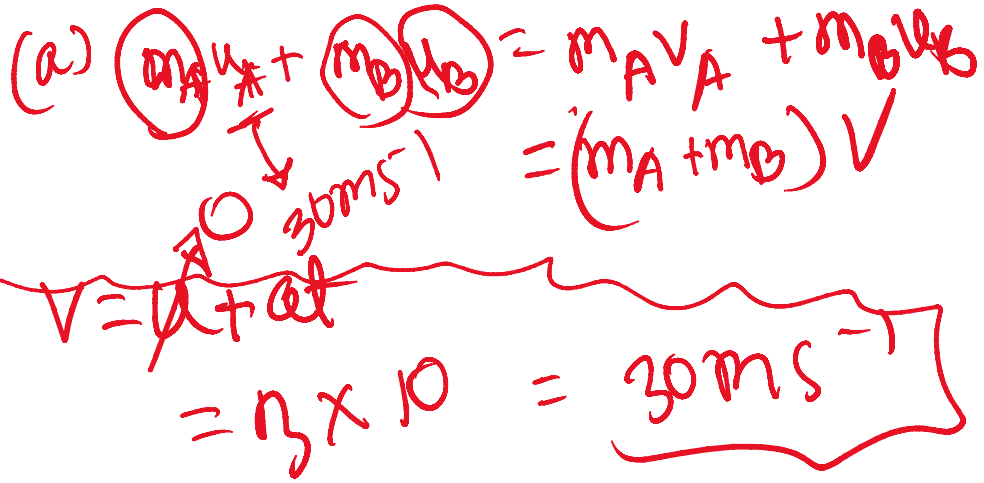
Mathematical Problems

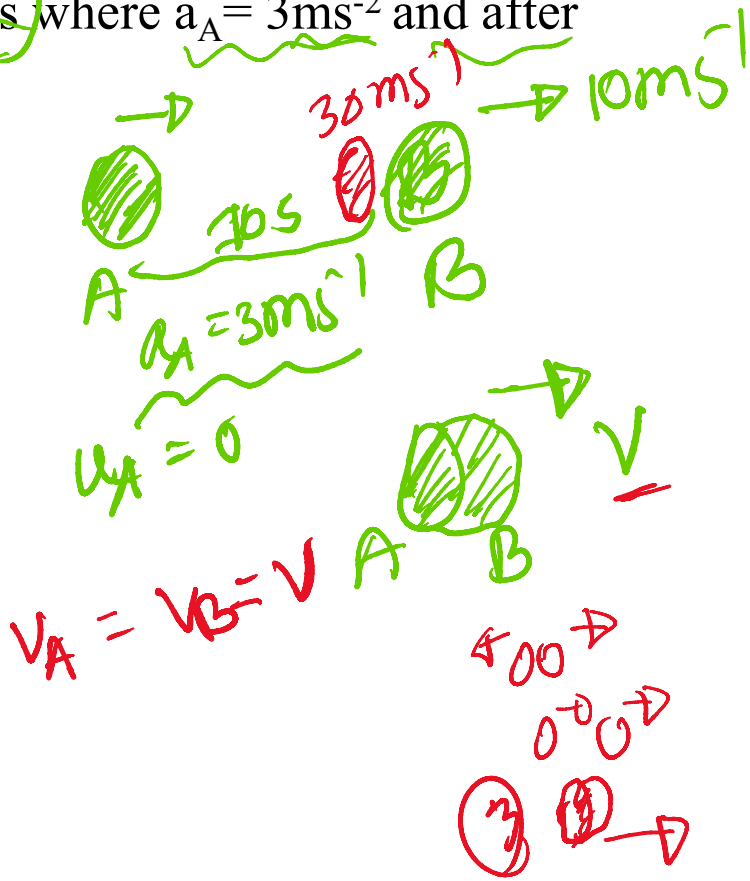
(Q.Mass of A = 20kg & mass of B = 30kg. B is moving with a constant velocity 10m/s. $u_A = 0$ and A makes a collision with B after movement of 10s where $a_A = 3ms^{-2}$ and after collision, they become a combined object.

(a) Velocity of Combined Object=?

(b) Does it follow law of conservation of momentum?

(c) Does it follow law of conservation of energy?





Solution:

(a) Given, $m_A = 20\ kg$

$m_B = 30\ kg$

$v_B = 10ms^{-1}$

$v_A = 0ms^{-1}$

$a_A = 3ms^{-2}$

$t = 10\ sec$

So, After t time, $V_A = u_A + a_A t$

$= (0 + 3 \times 10)ms^1 = 30\ ms^1$

Now, combined velocity = V [let]

So, $m_1u_1 + m_2u_2 = (m_1 + m_2) \times v$

$\Rightarrow m_AV_A + m_BV_B = (m_A + m_B) \times v$

$\Rightarrow 20 \times 30 + 30 \times 10 = (20 + 30) \times v$

$\Rightarrow v = 18\ ms^{-1}$ (Ans.)

Solution:

(b) Given, $m_A = 20kg$

$m_B = 30kg$

Before Collision, $v_A = 30ms^{-1}$

$v_B = 10ms^{-1}$

After Collision, v = $18\ ms^{-1}$

Before Collision total momentums,

$= m_A v_A + m_B v_B$

$= (20 \times 30 + 30 \times 10)kgms^{-1}$

$= 900\ kgms^{-1}$

After Collision total momentums,

$= (m_A + m_B) \times v$

$= (20 + 30) \times 18kgms^{-1}$

$= 900\ kgms^{-1}$.

SO,

$m_A u_A + m_B u_B = 900\ kgms^{-1}$

$(m_A + m_B)\ v = 900\ kg\ ms^{-1}$

Conserved

Solution:

(c) Given, $m_A = 20kg$

$m_B = 30kg$

$v_A = 30m/s$

$v_B = 10m/s$

$v = 18m/s$

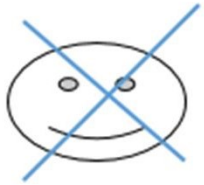
∴ Before Collision total kinetic energy,

$= \frac{1}{2}m_A v_A^2 + \frac{1}{2}m_B v_B^2 = 0.5 \times 20 \times (30)^2 + 0.5 \times 30 \times (10)^2 = 10{,}500\ J$

∴ After Collision total kinetic energy,

$= \frac{1}{2}m_A v^2 + \frac{1}{2}m_B v^2 = 0.5 \times 20 \times (18)^2 + 0.5 \times 30 \times (18)^2 = 8100\ J$

SO,



Pole-05

Q. After the collision of a truck and a marble:

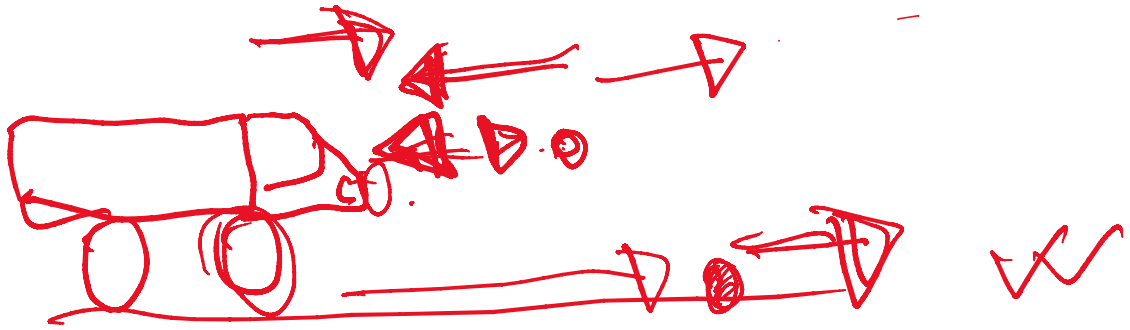
Ans:

a) The velocity of the truck is unchanged.

b) The direction of the velocity of the marvel is unchanged.

c) i + ii

d) None.



লেগে থাকো সৎভাবে,

স্বপ্ন জয় তোমারই হবে

উদ্ভাস-উন্মেষ শিক্ষা পরিবার

THANK YOU