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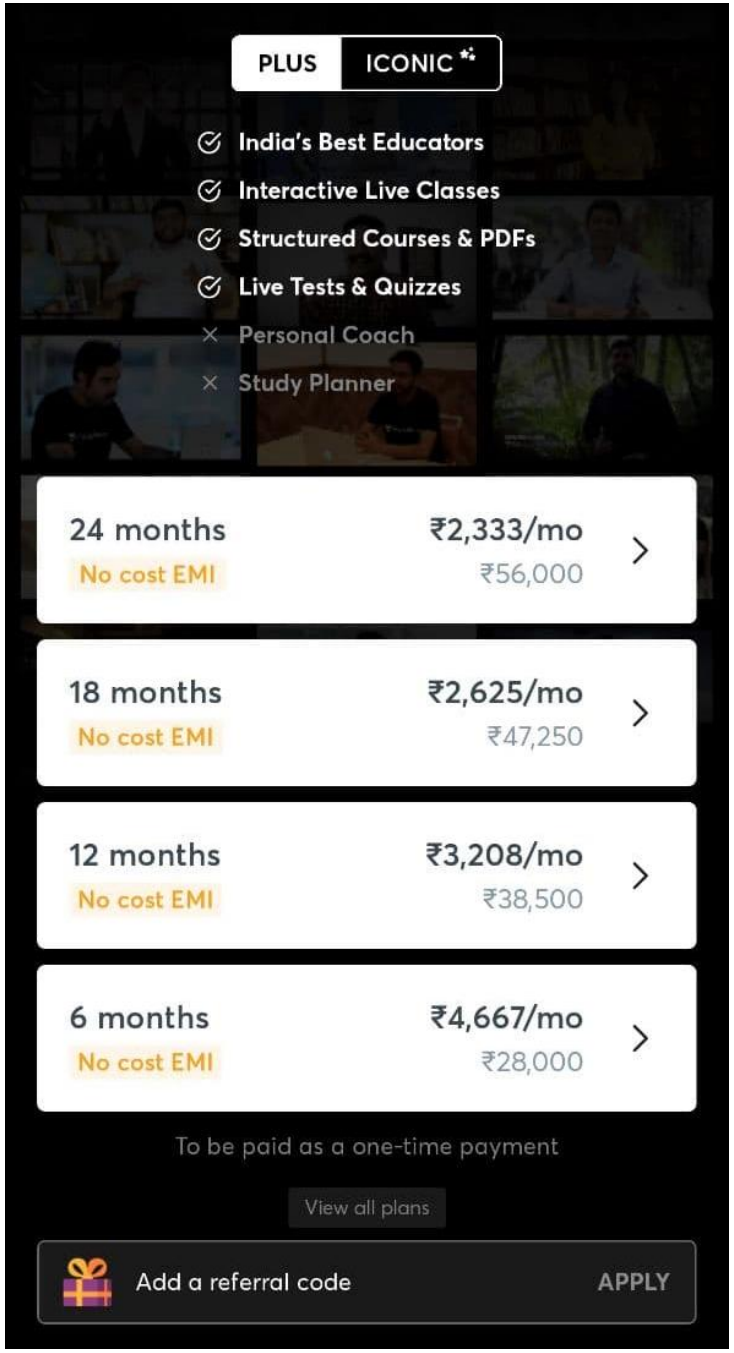

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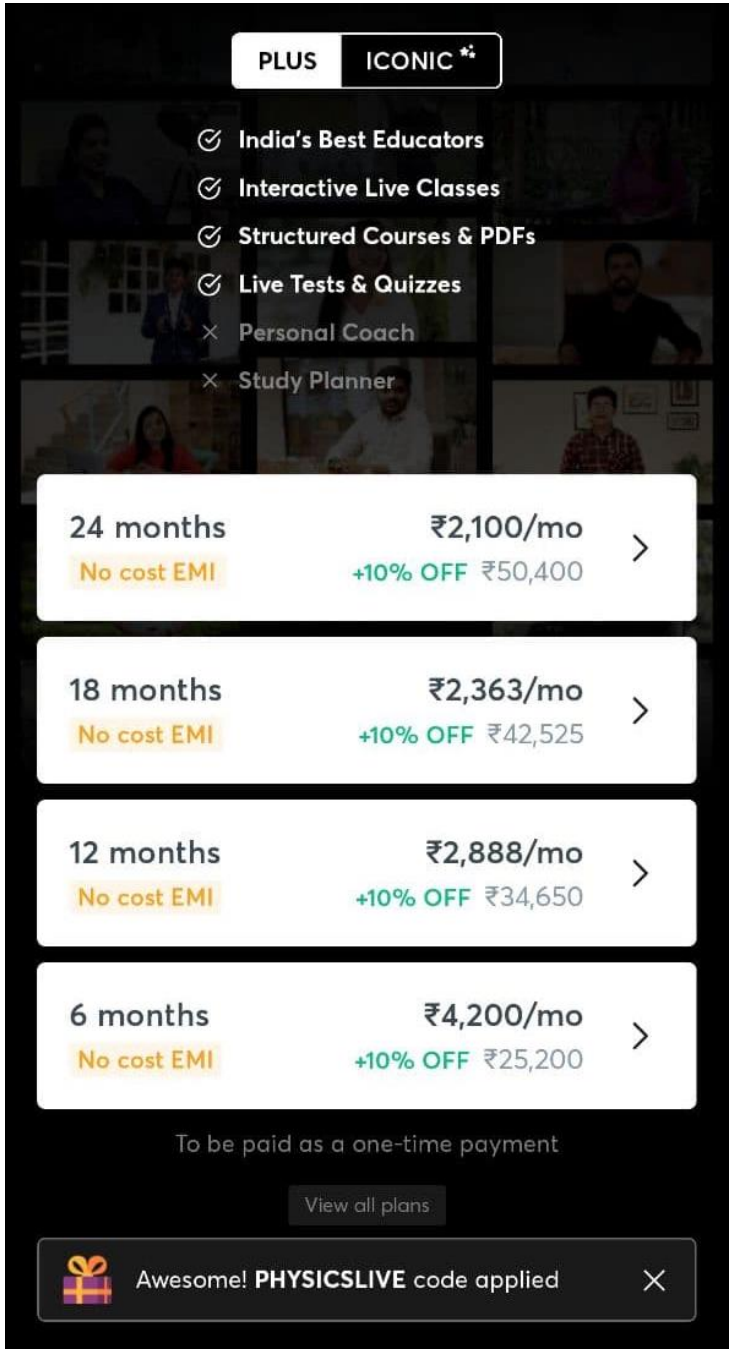

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H.C. Verma Physics

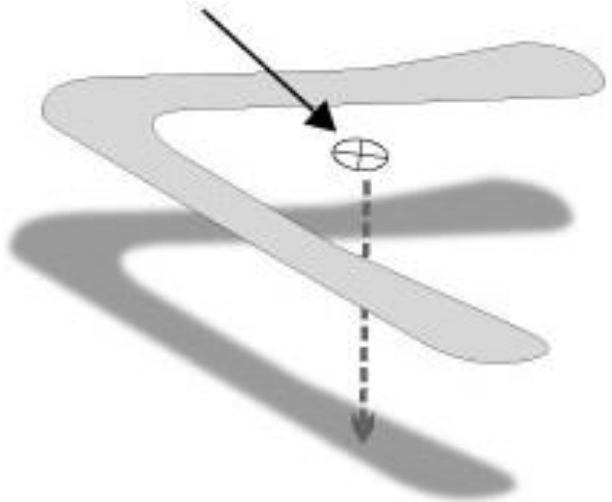
Questions for Short Answers

C-9 Centre of Mass

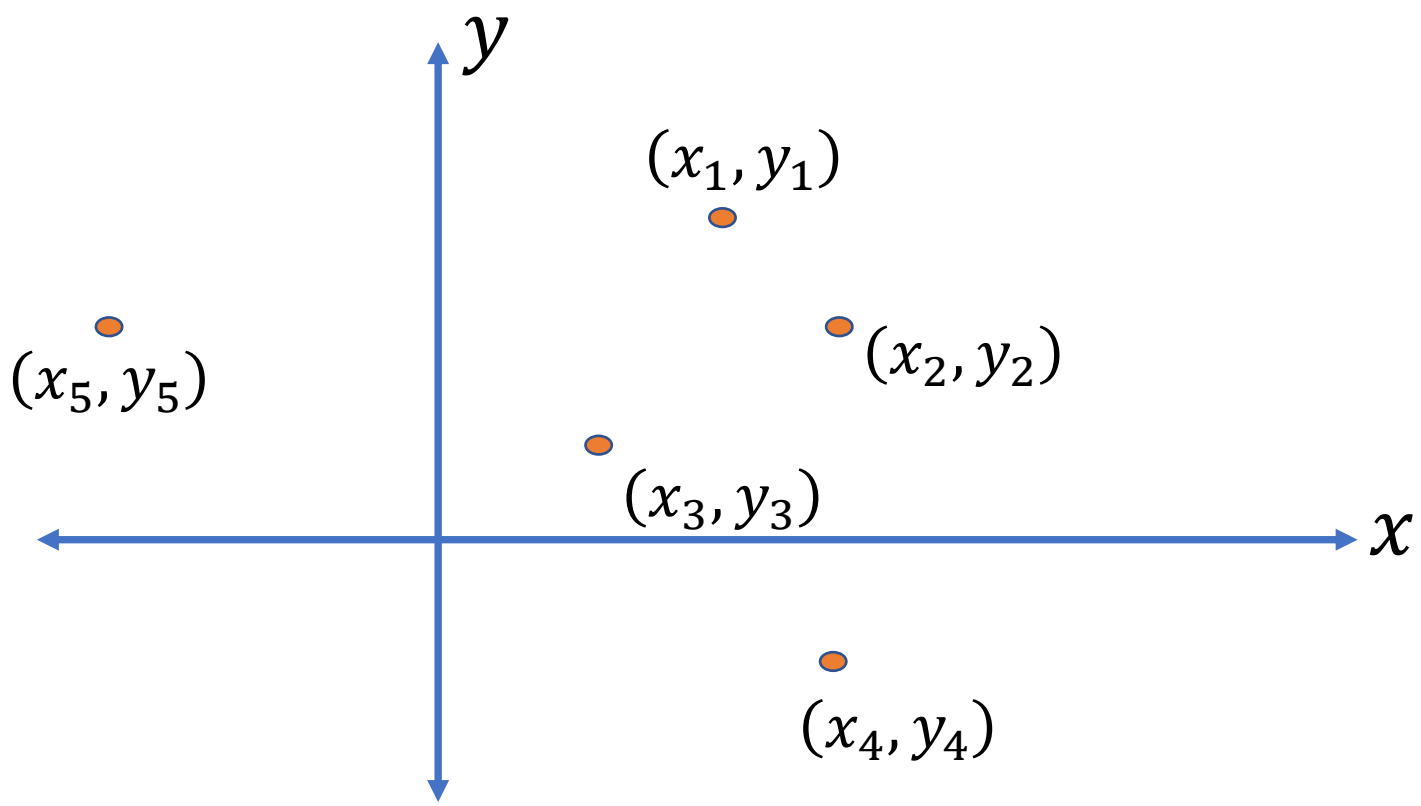
By PRATEEK JAIN SIR

Q) Can the centre of mass of a body be at a point outside the body?

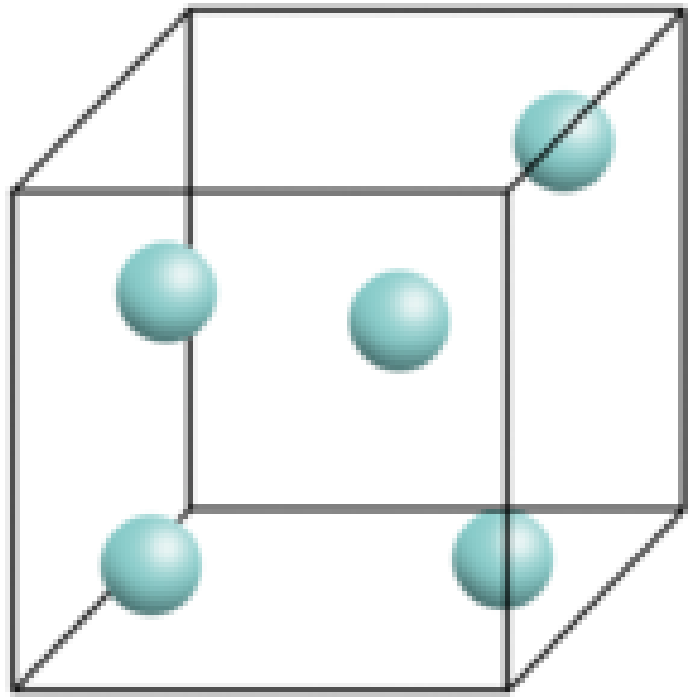
Centre of mass



Q) If all the particles of a system lie in X-Y plane, is it necessary that the centre of mass be in X-Y plane?



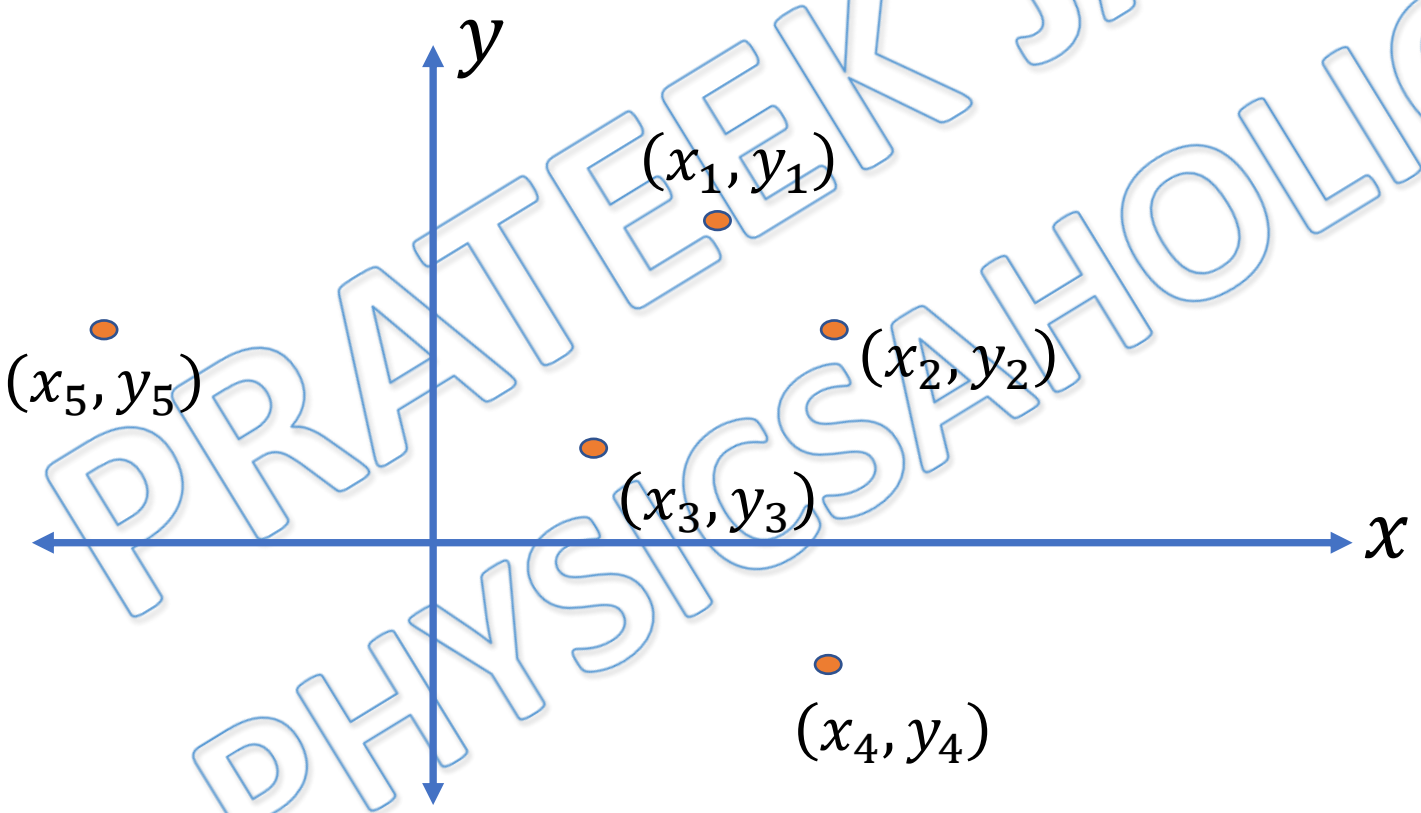
Q) If all the particle of a System lie in a cube, is it necessary that the centre of mass be in the cube?



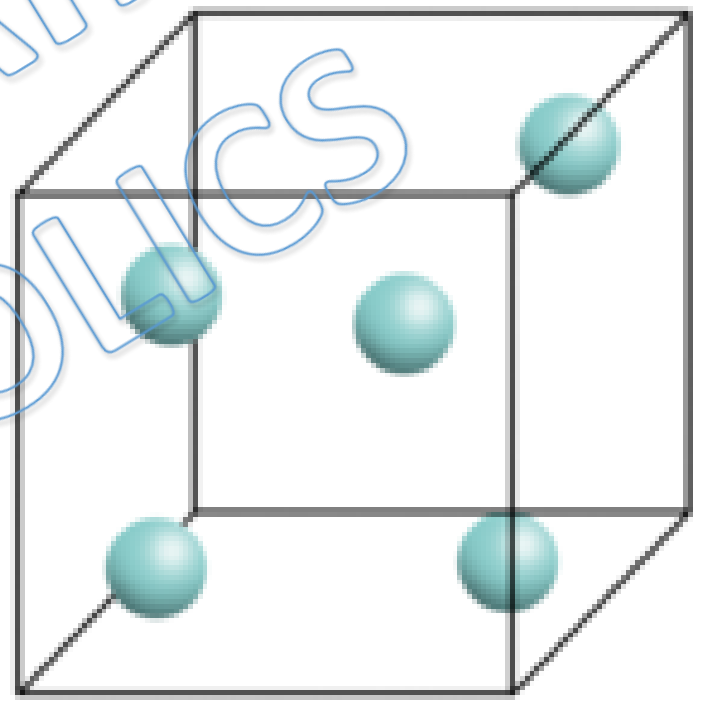
Q) The centre of mass is defined as $\vec{R} = \frac{1}{M}\sum_i m_i \vec{r}_i$ Suppose we define "centre of charge" as $\vec{R}_c = \frac{1}{Q}\sum_i q_i \vec{r}_i$ where represents the ith charge placed at $\vec{r}_i$ and Q is the total charge of the system.

(a) can the centre of charge of a two-charge system be outside the line segment joining the charges.

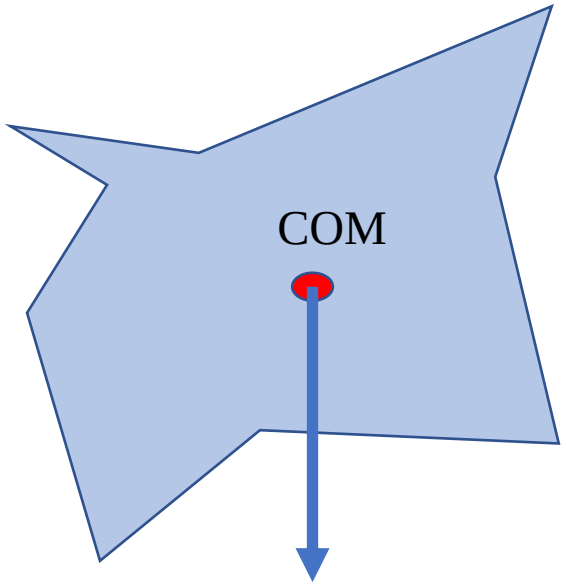
Q) (b) If all the charges of a system are in X.Y plane, is it necessary that the centre of charge be in X-Y plane?



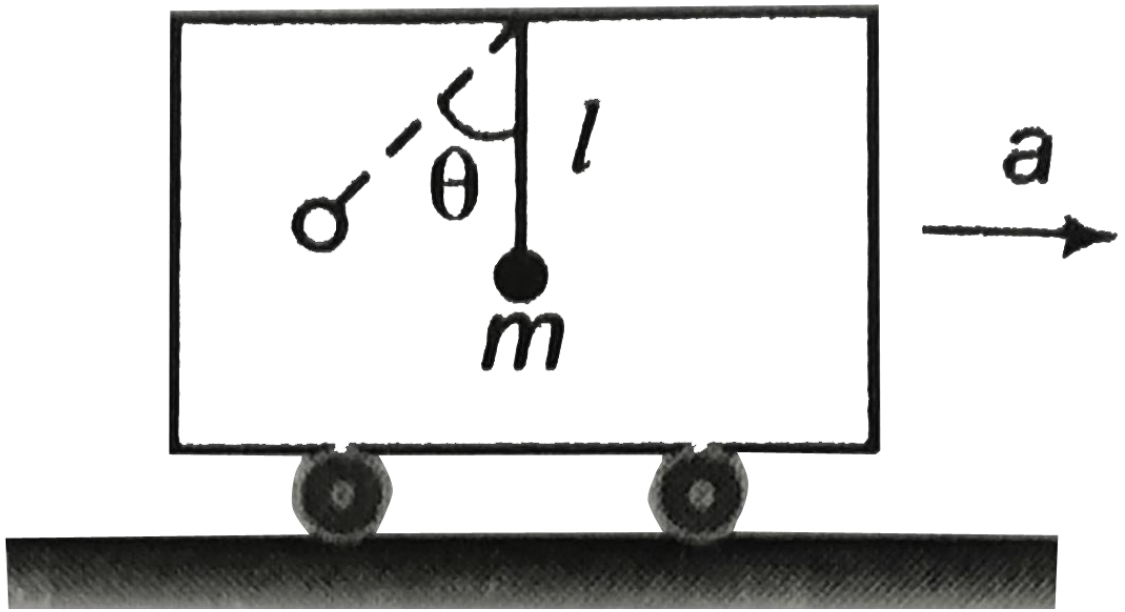
Q) (c) If all the charges of a system lie in a cube, is it necessary that the centre of charge be' in the cube?



Q) The weight Mg of an extended body is generally shown in a diagram to act through the centre of mass. Does it mean that the earth does not attract other particles?

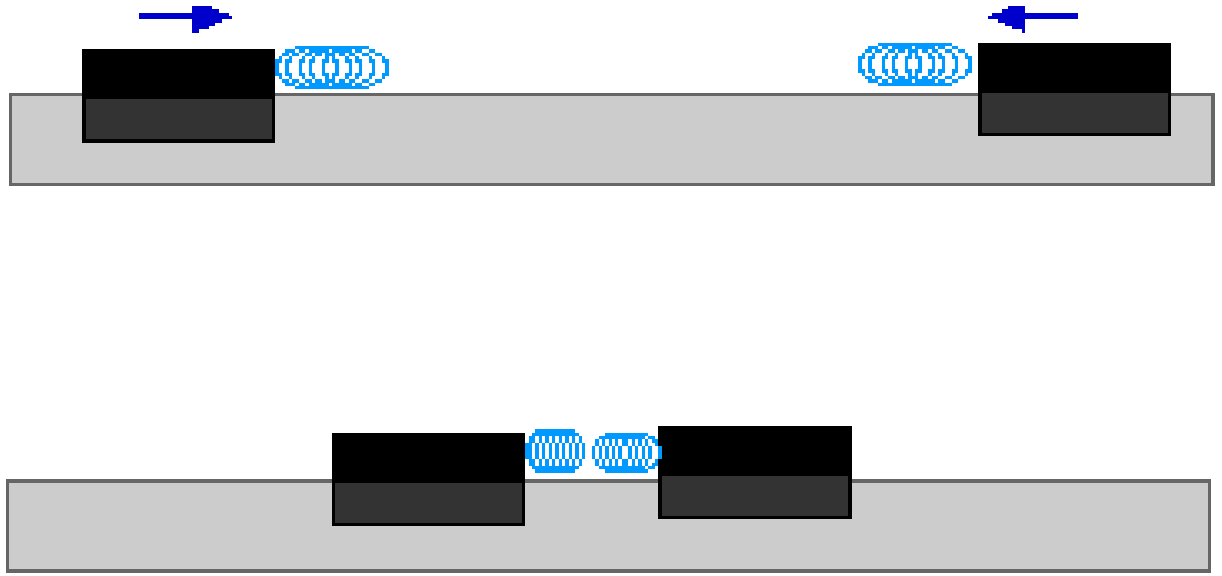


Q) A bob suspended from the ceiling of a car which is accelerating on a horizontal road. The bob stays at rest with respect to the car with the string making an angle θ with the vertical. The linear momentum of the bob as seen from the road is increasing with time. Is it a violation of conservation of linear momentum? If not, where is the external force which changes the linear momentum?



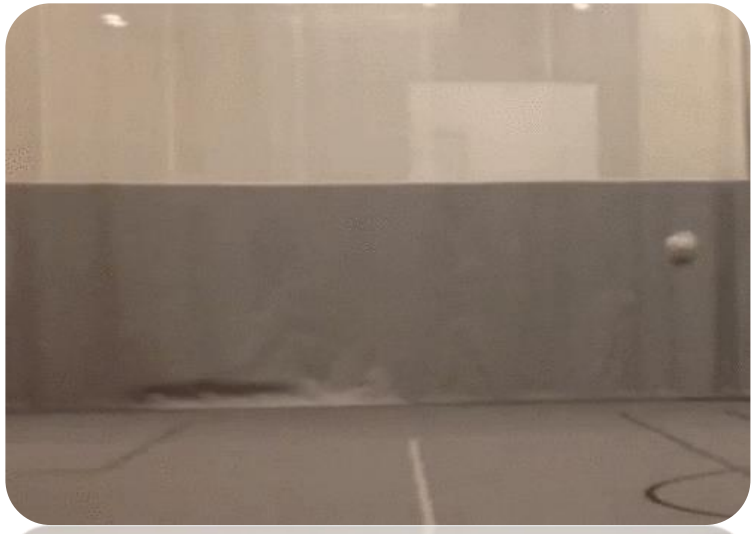
Q) You are waiting for a train on a railway platform. Your three year old niece is standing on your iron trunk containing the luggage. Why does the trunk not recoil as she jumps off on the platform?

Q) In a head-on collision between two particles, is it necessary that the particles will acquire a common velocity at least for one instant?



Q) A collision experiment is done on a horizontal table kept in an elevator. Do you expect a change in the results if the elevator is accelerated up or down because of the non-inertial character of the frame?

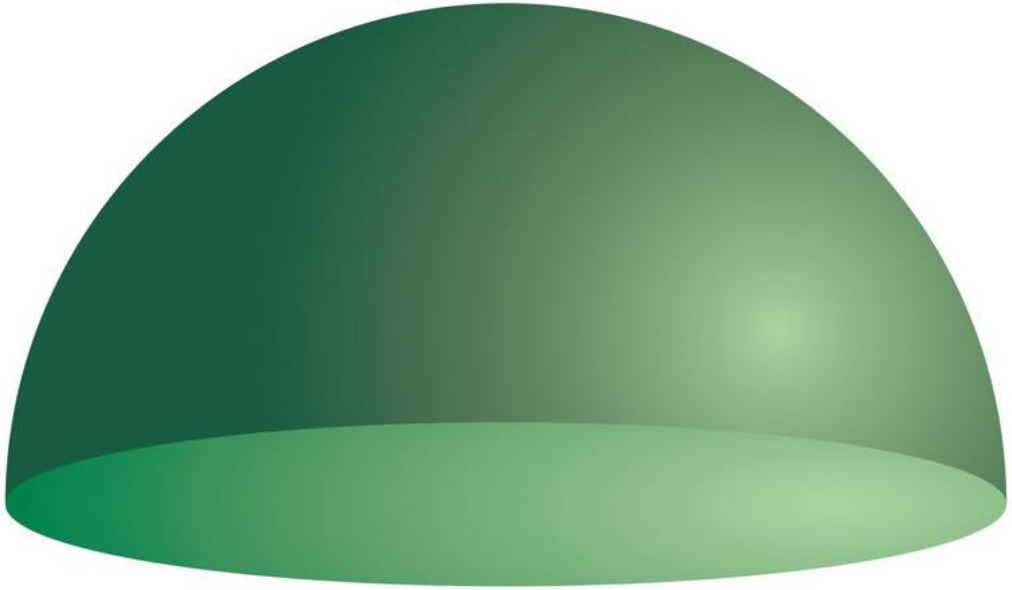
Q) Two bodies make an elastic head-on collision on a smooth horizontal table kept in a car. Do you expect a change in the result if the car is accelerated on a horizontal road because of the non-inertial character of the frame? Does the equation "Velocity of separation = Velocity of approach" remain valid in an accelerating car? Does the equation "final momentum = initial momentum" remain valid in the accelerating car?

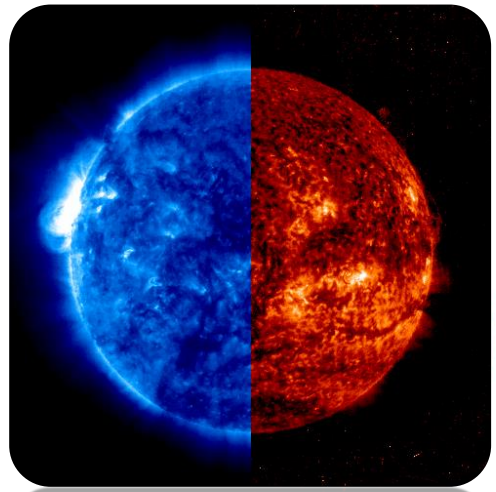


Q) If the total mechanical energy of a particle is zero, is its linear momentum necessarily zero? Is it necessarily nonzero?

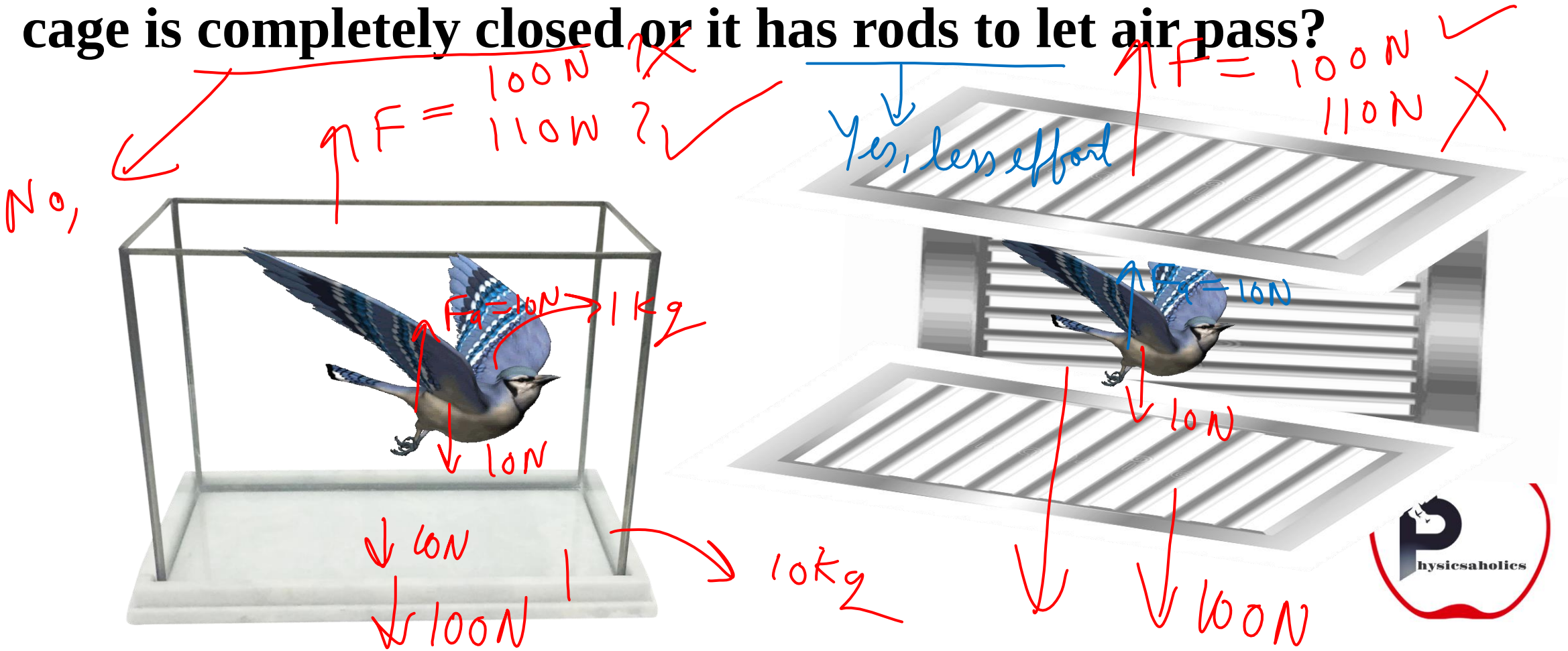
Q) If the linear momentum of a particle is known, can you find its kinetic energy? If the kinetic energy of a particle is known can you find its linear momentum?

Q) What can be said about the centre of mass of a uniform hemisphere without making any calculation? Will its distance from the centre be more than r/2 or less than r/2?

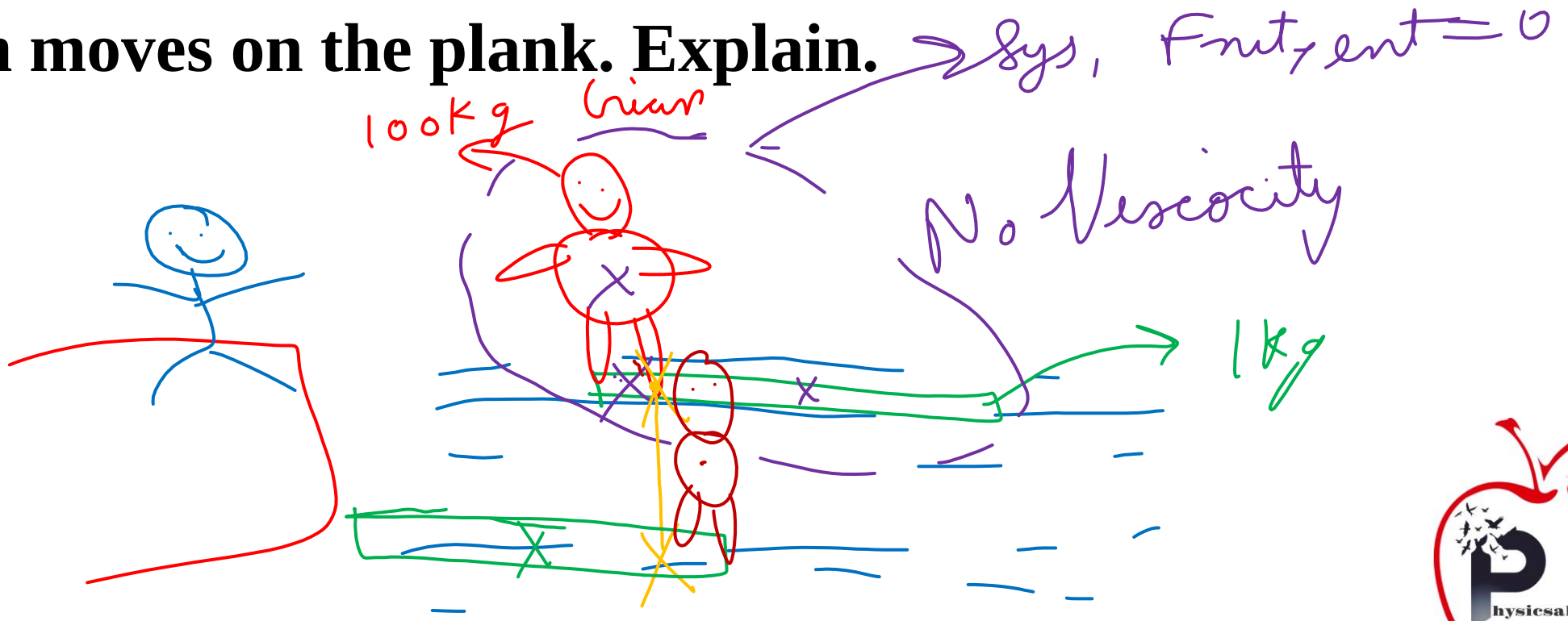




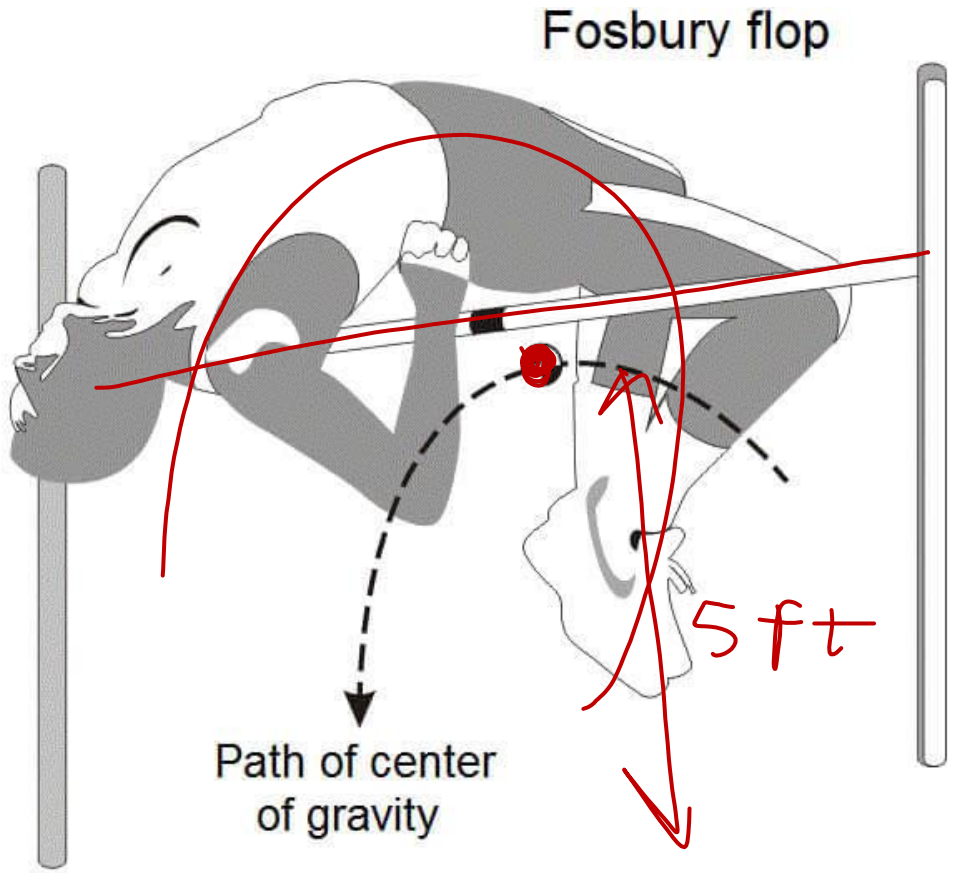
Q) You are holding a cage containing a bird. Do you have to make less effort if the bird flies from its position in the cage and manages to stay in the middle without touching the walls of the cage? Does it make a difference whether the cage is completely closed or it has rods to let air pass?



Q) A fat person is standing on a light plank floating on a calm lake. The person walks from -one end to the other on the plank. His friend sitting on the shore watches him and finds that the person hardly moves any distance because the plank moves backward about the same distance as the person moves on the plank. Explain.



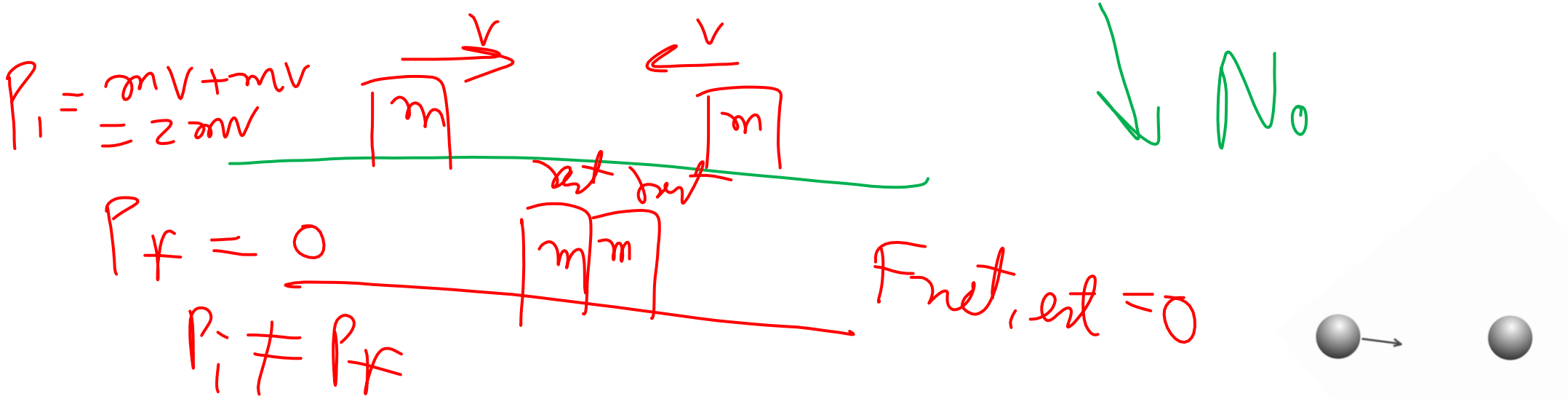
Q) A high-jumper successfully clears the bar. Is it possible that his centre of mass crossed the bar from below it. Try it with appropriate figures



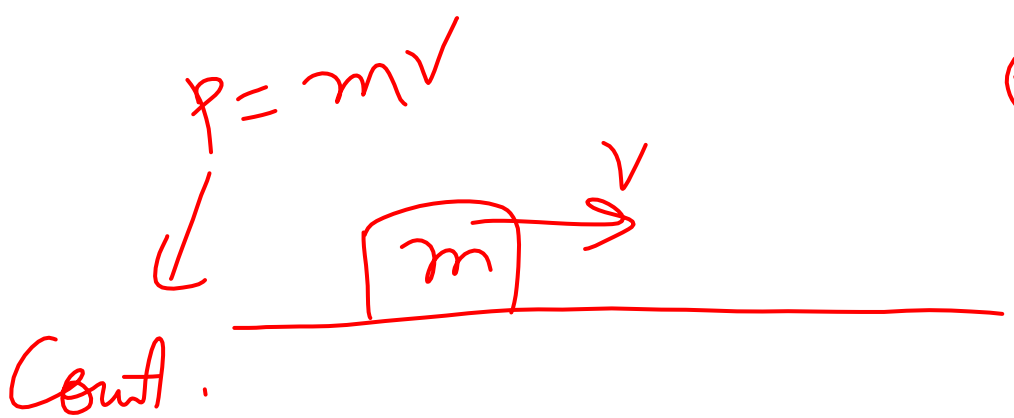
Q) Which of the two persons shown in figure is more likely to fall down? Which external force is responsible for his falling down?

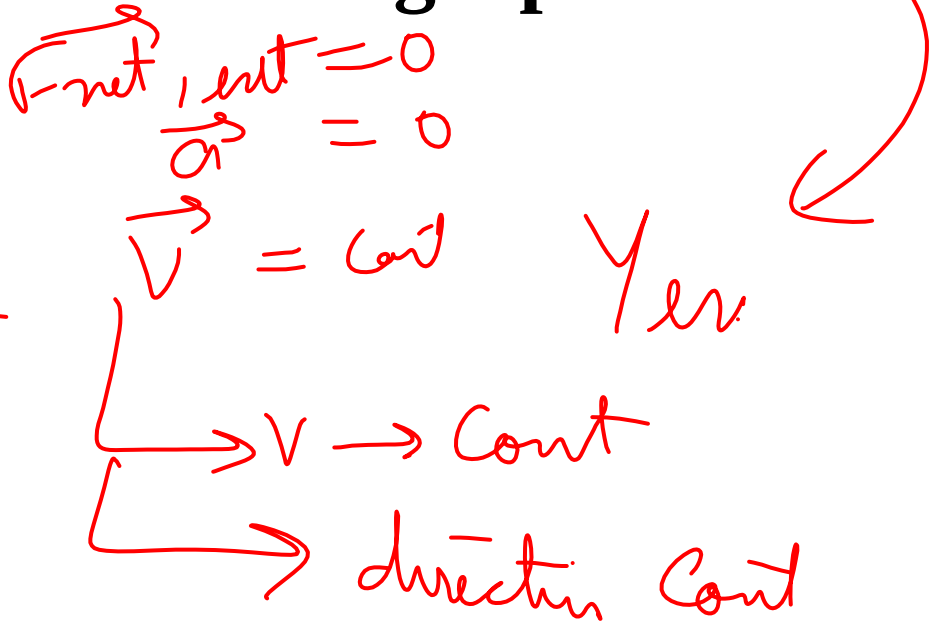
$\vec{p} = m\vec{v}$

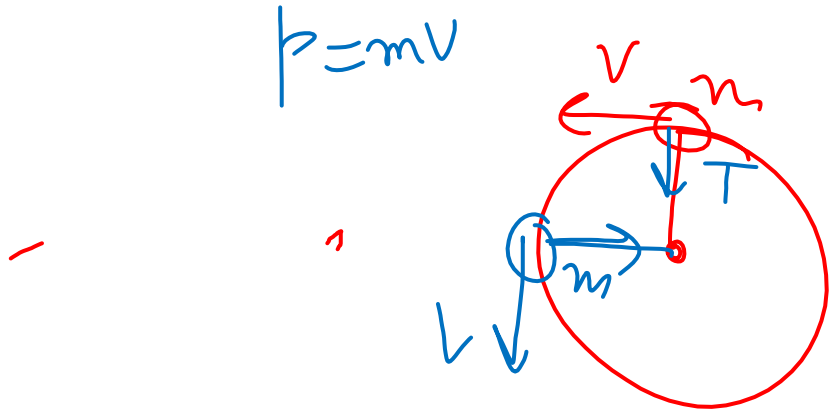
Q) Suppose we define a quantity 'Linear Momentum' as linear momentum = mass × speed. The linear momentum of a system of particles is the sum of linear momenta of the individual particles. Can we state a principle of conservation of linear momentum as "linear momentum of a system remains constant if no external force acts on it"?



Q) Use the definition of linear momentum from the previous question. Can we state the principle of conservation of linear momentum for a single particle?





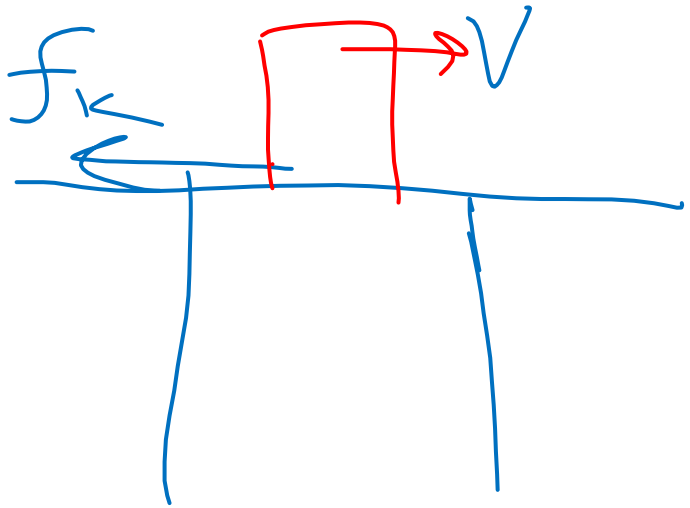


Q) To accelerate a car we ignite petrol in the engine of the car. Since only an external force can accelerate the centre of mass, is it proper to say that "the force generated by the engine accelerates the car"?

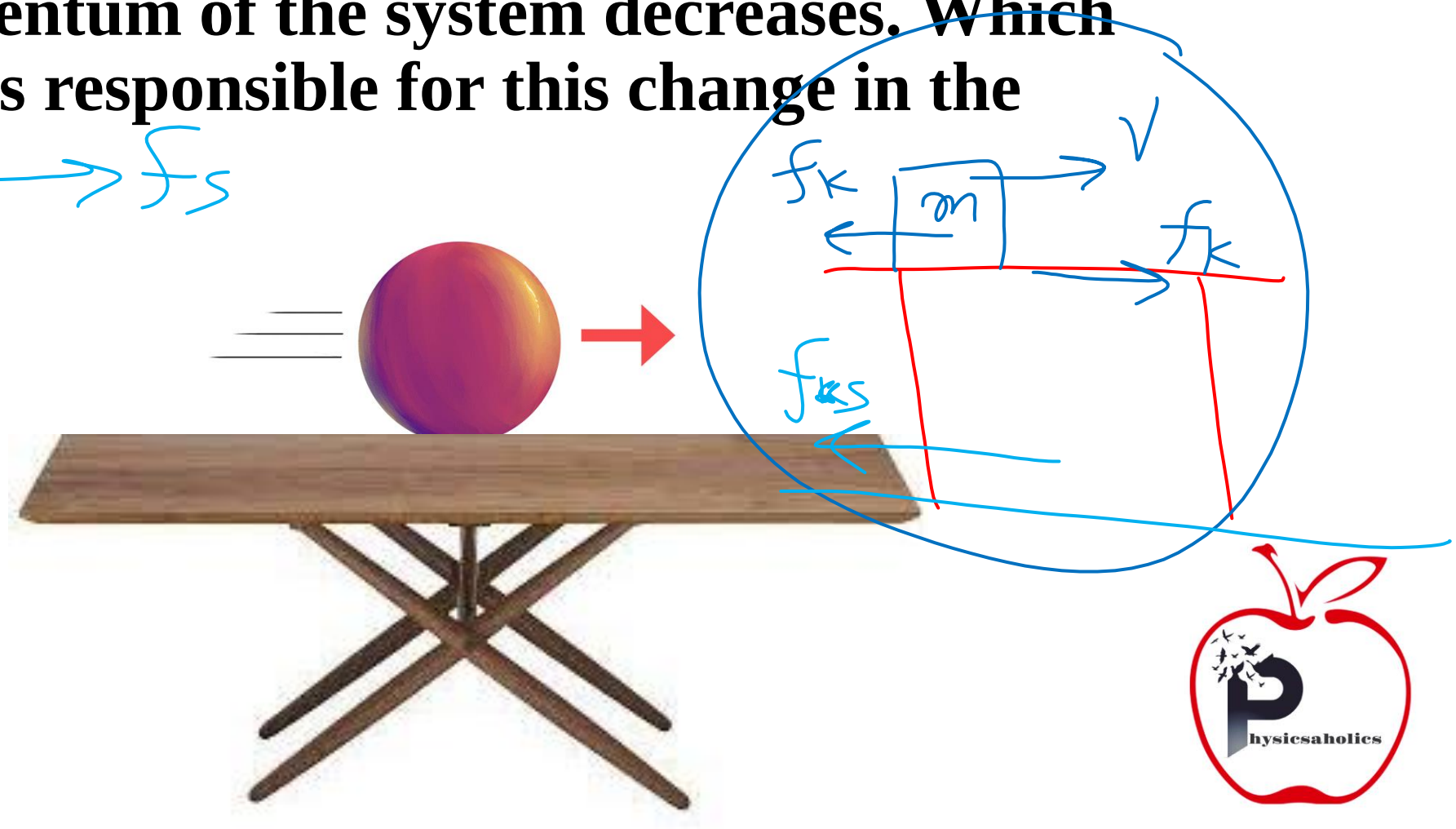
No

$$\vec{F}_{net,ext} = M\vec{a}_{cm}$$

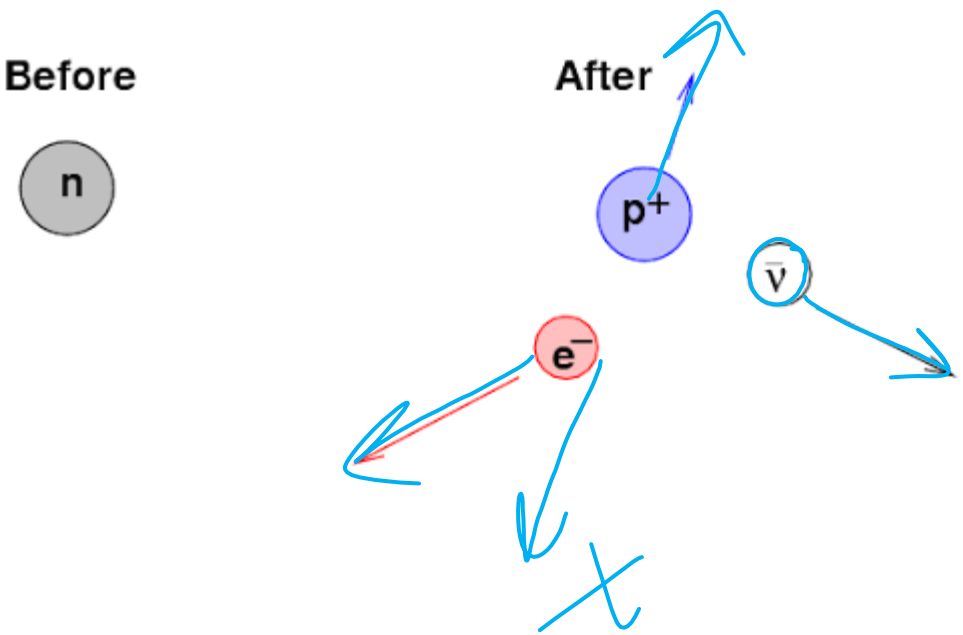
Q) A ball is moved on a horizontal table with some velocity. The ~~ball~~ block stops after moving some distance. Which external force is responsible for the change in the momentum of the ball?

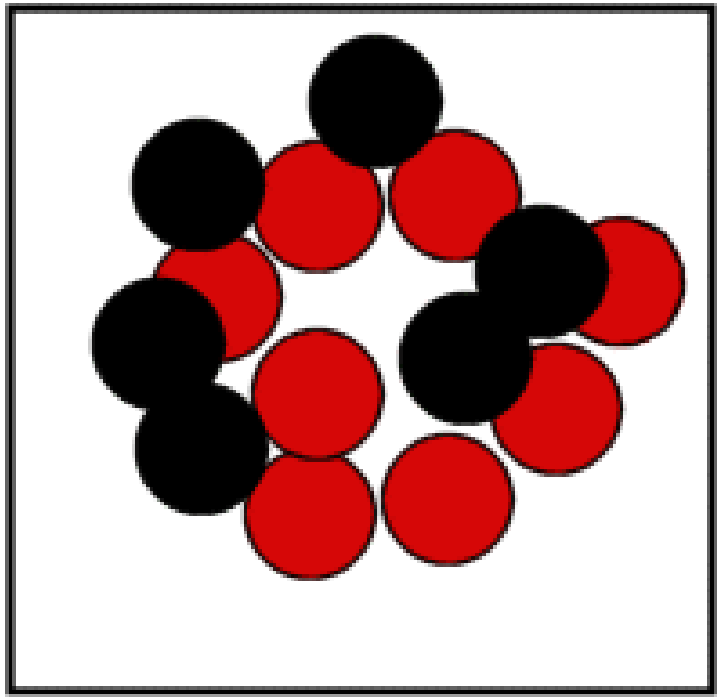


Q) Consider the situation of the previous problem. Take "the table plus the ball" as the system. Friction between the table and the ball is then an internal force. As the ball slows down the momentum of the system decreases. Which external force is responsible for this change in the momentum?



Q) When a nucleus at rest emits a beta particle, it is found that the velocities of the recoiling nucleus and the beta particle are not along the same straight line. How can this be possible in view of the principle of conservation of momentum?





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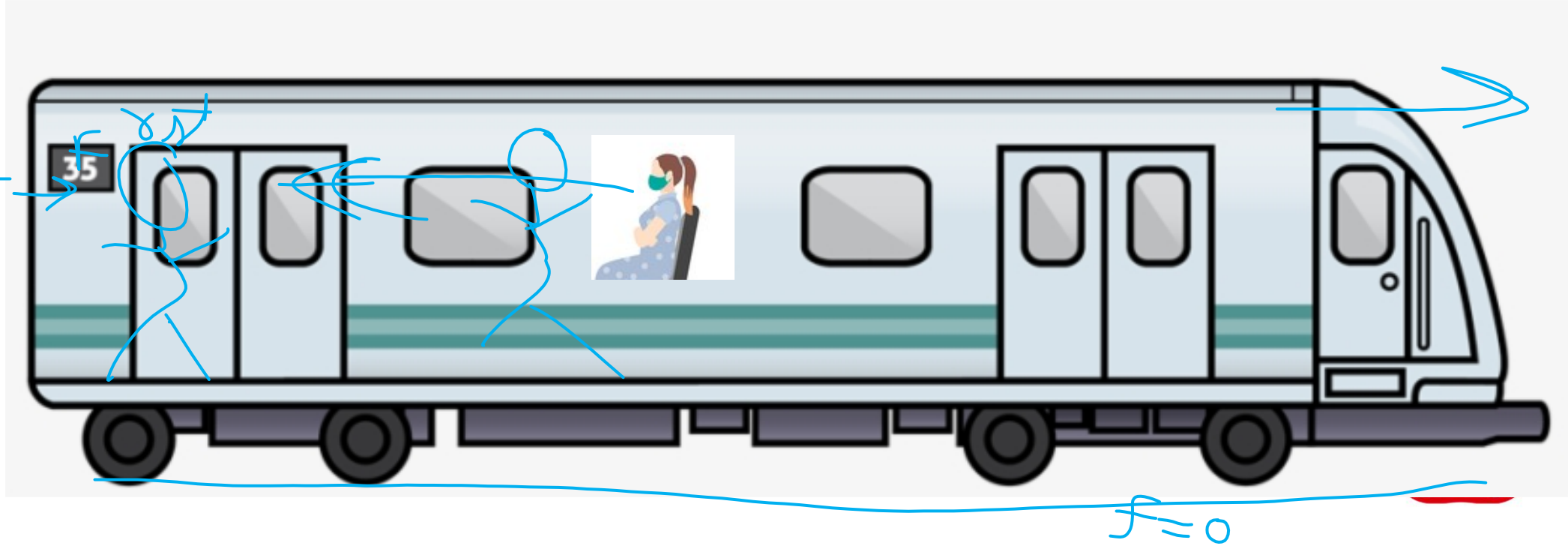
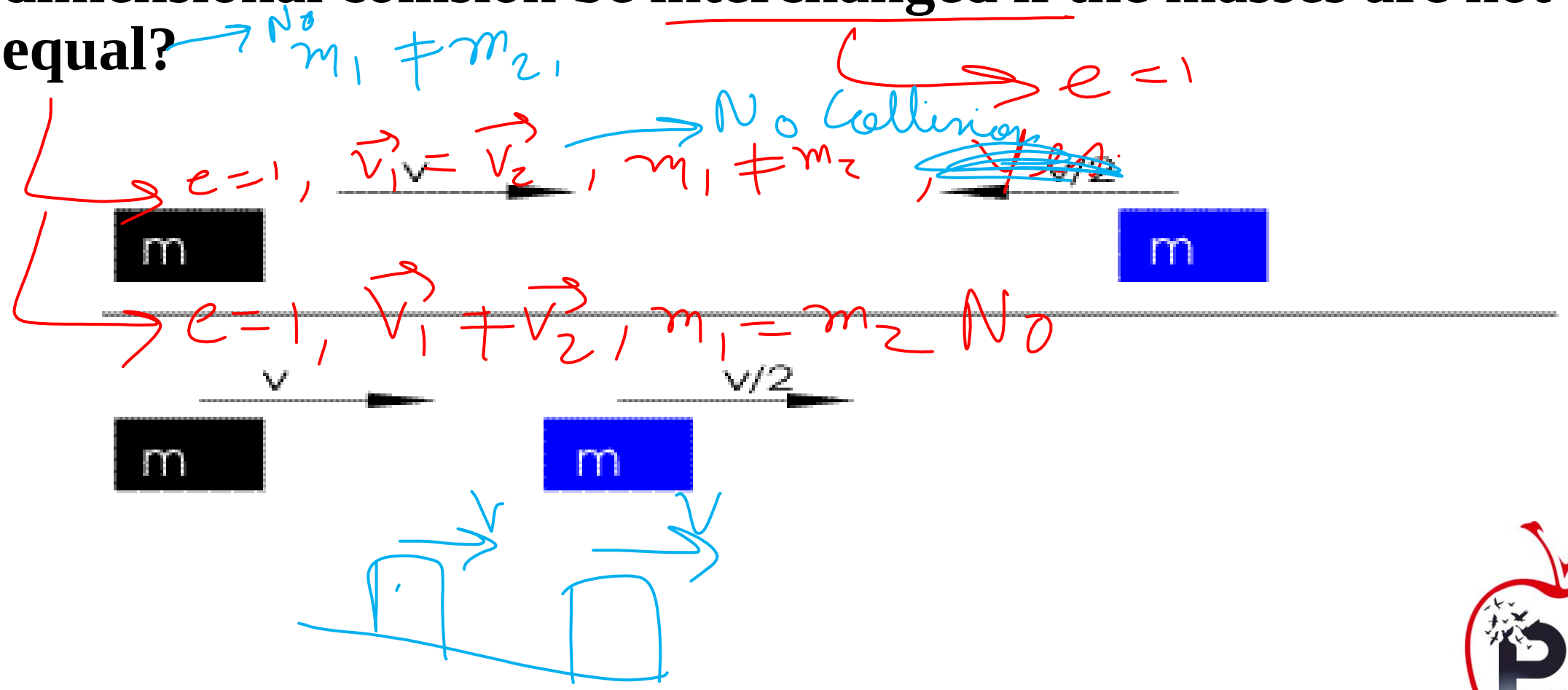
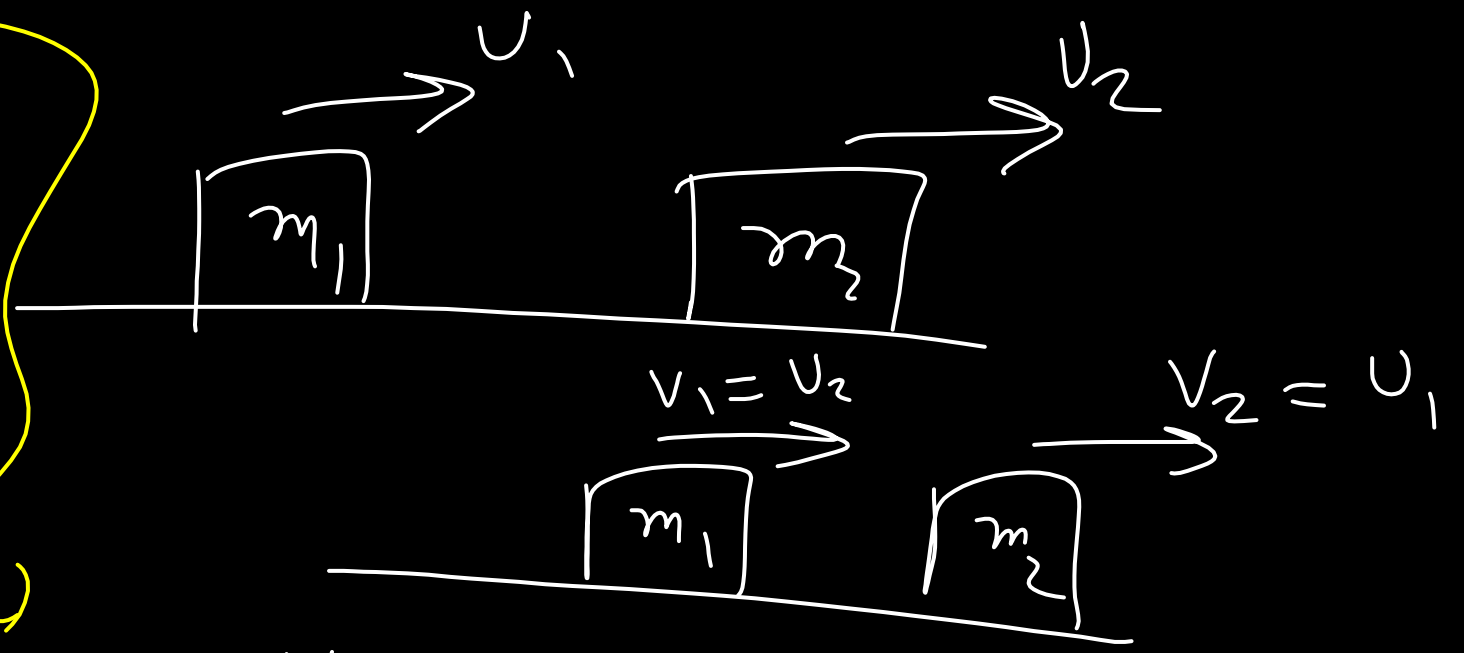
Q) A van is standing on a frictionless portion of a horizontal road. To start the engine, the vehicle must be set in motion in the forward direction. How can the persons sitting inside the van do it without coming out and pushing from behind?



Q) In one-dimensional elastic collision of equal masses, the velocities are interchanged. Can velocities in a one-dimensional collision be interchanged if the masses are not equal?



Source: Wikipedia



$e = 1$

$p_i = p_f$

$m_1 u_1 + m_2 u_2 =$

$= m_1 v_2 + m_2 v_1$

$m_1 (u_1 - u_2) = m_2 (u_1 - u_2)$

$(m_1 - m_2)(u_1 - u_2) = 0$

$\rightarrow u_1 = u_2$

$\rightarrow m_1 = m_2$

$$e = \frac{v_2 - v_1}{u_1 - u_2} = \frac{u_1 - u_2}{u_1 - u_2} = 1$$

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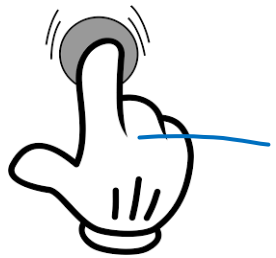

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