Linear Momentum

Definitions

Linear momentum is the product of the mass and velocity of an object. It is a vector quantity, possessing a magnitude and a direction.

Conservation of momentum: If a closed system is not affected by external forces, its total linear momentum does not change. Momentum is conserved in a collision.

Momentum before = momentum after

Impulse: Impulse is force multiplied by the time for which it acts. (AKA **change in momentum**). Impulse is a vector. It is not usually given its own symbol. It is measured in Ns.

Two-dimensional analysis

Momentum is also conserved in a collision where the objects are moving in two dimensions. As momentum is a vector quantity the sum must be considered as a vector sum. Split the momentum up into two components, usually the x and y directions. The total momentum in each of these directions must be conserved.

Equations

$p = m\ v$	Momentum	p	kg m s^{-1}
	mass	m	kg
	velocity	v	m s^{-1}
$\Delta p = F\ \Delta t$	Change in Momentum	Δp	kg m s^{-1}
	Force	F	N
	Change in time	Δt	s

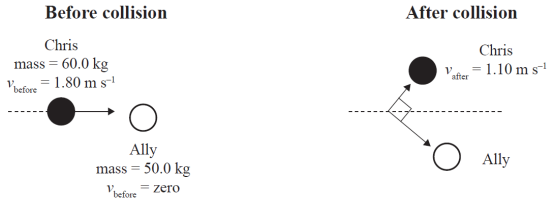
Questions

QUESTION ONE (2019;1)

Ally and Chris are rollerblading. Assuming friction is negligible, the system of Ally and Chris can be considered an isolated system in the horizontal direction.

(a) State a relevant physical quantity that is conserved during a collision between Chris and Ally.

(b) At one instant, Ally stops, and Chris collides with her. They move off at right angles to each other, as shown in the diagram below. Show that Ally's speed after the collision is 1.71 m s^{-1}.

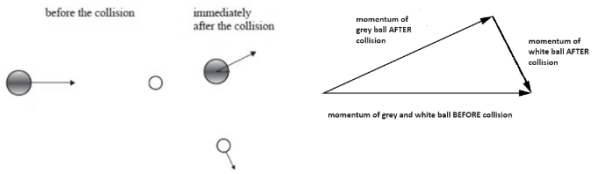


Terms

Inertia: The tendency of objects in motion to stay in motion, and objects at rest to stay at rest, unless another force causes its speed or direction to change

Tips

- Memorise the definition for the conservation of the momentum
- Trigonometry (SOHCAHTOA and $c^2 = a^2 + b^2$ should be sufficient to solve any physics problems at NCEA Level 3 but – if required – you could always draw a scale diagram or use the sine/cosine rule or split into horizontal components)



The analysis involves the drawing of a vector diagram (as above)

Answers

(a) Linear momentum, velocity of Centre of Mass, total energy.

(b) Total *p* before = 60 *x* 1.8 = 108 kg m s^{-1} = total *p* after (conservation of momentum law)

$$p_{Ally} = \sqrt{108^2 - 66^2} = 85.486 \text{ kg m s}^{-1}$$

$$v_{Ally} = \frac{p}{m} = \frac{85.486}{50} = 1.70972 = 1.71 \text{ m s}^{-1}$$