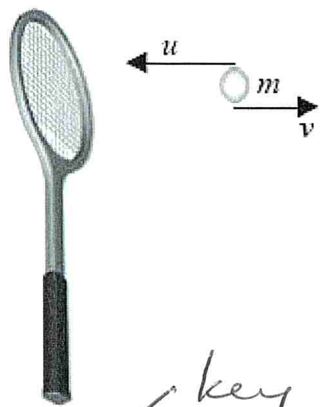
1. A tennis ball of mass m moving horizontally with speed u strikes a vertical tennis racket. The ball bounces back with a horizontal speed v.



key word

The magnitude of the change in momentum of the ball is

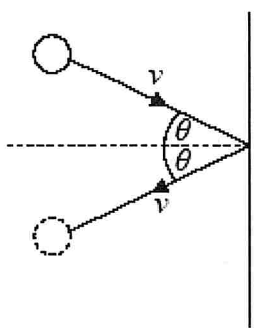
A. $m(u + v)$.

B. $m(u - v)$.

C. $m(v - u)$.

D. zero.

2. A gas atom strikes a wall with speed v at an angle θ to the normal to the wall. The atom rebounds at the same speed v and angle θ.



Which of the following gives the magnitude of the momentum change of the gas atom?

A. zero

B. $2mv \sin\theta$

C. $2mv$

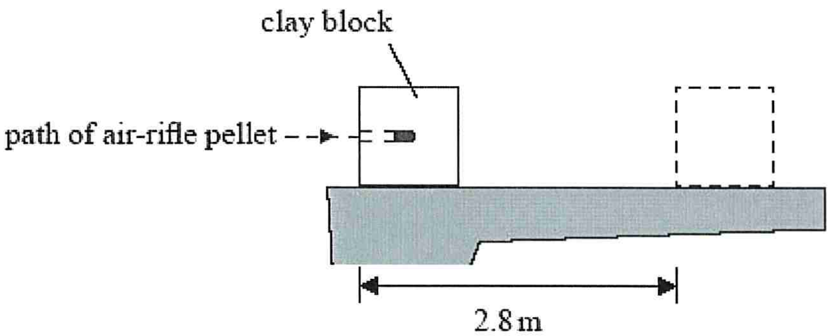
D. $2mv \cos\theta$

(a) State the principle of conservation of momentum.

In an isolated system the total momentum remains unchanged

(2)

(b) In an experiment, an air-rifle pellet is fired into a block of modelling clay that rests on a table.



(not to scale)

The air-rifle pellet remains inside the clay block after the impact.

As a result of the collision, the clay block slides along the table in a straight line and comes to rest. Further data relating to the experiment are given below.

Mass of air-rifle pellet	= 2.0 g
Mass of clay block	= 56 g
Velocity of impact of air-rifle pellet	= 140 m s^{-1}
Stopping distance of clay block	= 2.8 m

(i) Show that the initial speed of the clay block after the air-rifle pellet strikes it is 4.8 m s^{-1}.

$\vec{p}_{before} = \vec{p}_{after}$ $\quad (2\times10^{-3})(140) = (58\times10^{-3})v$

$v = 4.8 ms^{-1}$

(2)

(ii) Calculate the average frictional force that the surface of the table exerts on the clay block whilst the clay block is moving.

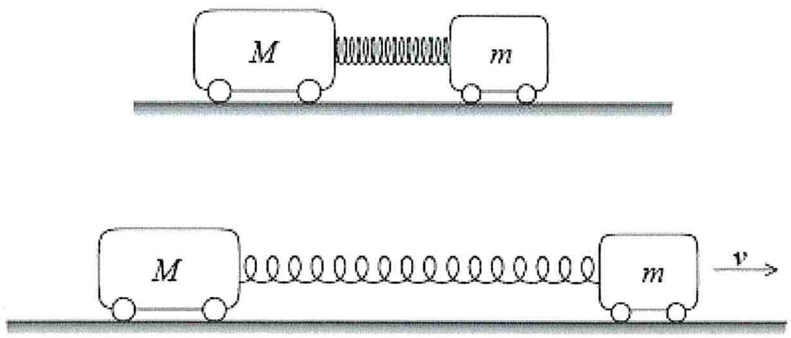
$W_f = \Delta E_k$

$\vec{F_f}\cdot\vec{s} = 0 - \frac{1}{2}mu^2$

$F_f = \dfrac{-\frac{1}{2}(58\times10^{-3})(4.8)^2}{2.8} = \underline{0.24 N}$

(4)

4. Two carts of different mass m and M are connected by a spring. They are pushed together such that the spring is compressed.



After the carts are released, the cart of mass m moves with velocity $\boldsymbol{v}$. The change in the momentum of mass M is

A. $m\boldsymbol{v}$.

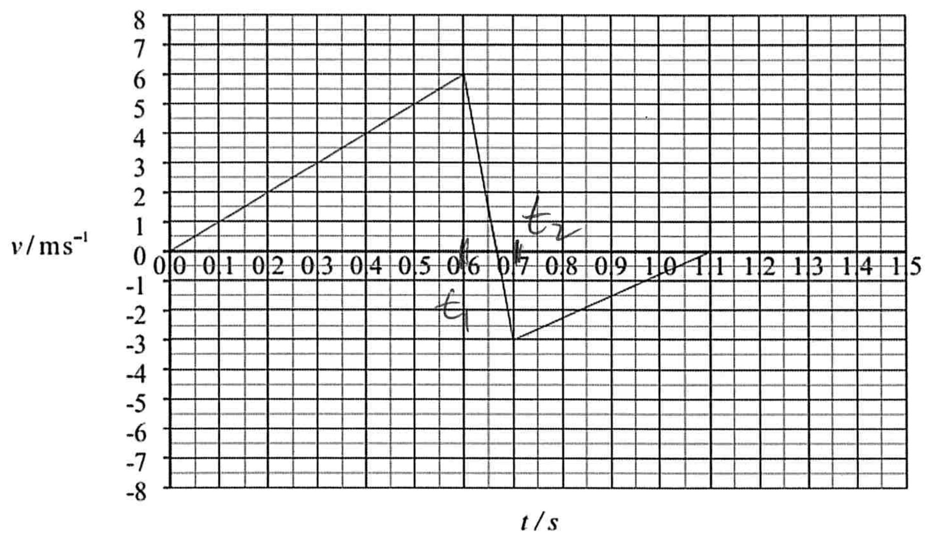
B. $-m\boldsymbol{v}$. ✓ this one!

C. $M\boldsymbol{v}$.

D. $-M\boldsymbol{v}$.

(Total 1 mark)

A soft rubber ball of mass 0.20 kg is dropped from rest on to a flat horizontal surface and it is caught at its maximum height of rebound. A sonic data logger is used to record the velocity of the ball as a function of time. The graph below shows how the velocity of the ball varies with time t from the instant it is released to the instant that it is caught.



(a) Mark on the graph above the time t_1 where the ball hits the surface and the time t_2 where it just loses contact with the surface. *[2]*

(b) Use data from the graph above to find the change in momentum of the ball between t_1 and t_2. *[3]*

$\vec{\Delta p} = \Delta\vec{V} \cdot m = (-3-6)(0\cdot2) = -1\cdot8 \text{ kgms}^{-1}$

(c) Determine the magnitude of the average force that the ball exerts on the surface. *[4]*

$\vec{F}_{Av} = \Delta p / \Delta t = \frac{-1\cdot8}{0\cdot1} = +18\text{ N}$

equal but opposite to what it receives.

(d) Explain how the collision between the ball and the surface is consistent with the principle of momentum conservation. *[2]*

change in momentum of the ball is equal but opposite to change in momentum of the earth. The earth's mass is so large that its Δv is very small.

(e) A hard rubber ball of the same mass as the soft rubber ball is dropped from the same height as that from which the soft rubber ball was dropped.

Given that the hard rubber ball exerts a greater force on the surface than the soft rubber ball, sketch on the graph opposite how you think the velocity of the hard rubber ball will vary with time. *(Note that this is a sketch graph; you do not need to add any values.)* *[5]*