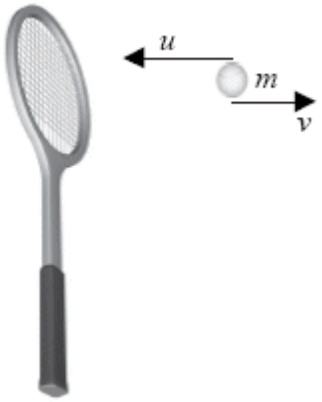
1. A tennis ball of mass m moving horizontally with speed u strikes a vertical tennis racket. The ball bounces back with a horizontal speed v.



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.

(Total 1 mark)

2. A force F is applied to a body moving along a straight line. A resistive force f acts on the body. Both forces act along the same straight line as the motion of the body. The rate of change of momentum of the body is equal to

A. $F - f$.

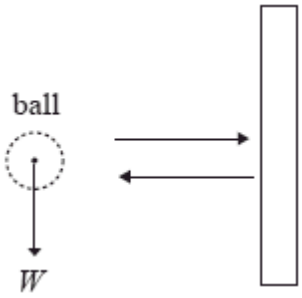
B. F.

C. $F + f$.

D. f.

(Total 1 mark)

3. A ball of weight W is travelling horizontally towards a vertical wall. It strikes the wall and rebounds horizontally. The change in the magnitude of the momentum of the ball is Δp. Which of the following is the magnitude of the impulse that the ball imparts to the wall?



A. $W + \Delta p$

B. $W - \Delta p$

C. W

D. Δp

(Total 1 mark)

4. Two objects undergo an inelastic collision. Which of the following is correct in respect of both the conservation of momentum and the conservation of total energy of the system?

	Momentum	**Total energy**
A.	conserved	not conserved
B.	conserved	conserved
C.	not conserved	not conserved
D.	not conserved	conserved

(Total 1 mark)

5. A constant force of magnitude F is applied to a mass m for a time interval Δt. The magnitude of the impulse given to the mass equals

A. $\frac{F}{m}$.

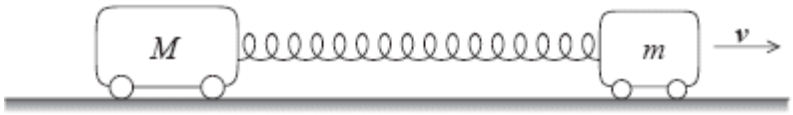
B. $\frac{F}{\Delta t}$.

C. $F\Delta t$.

D. $\frac{F\Delta t}{m}$.

(Total 1 mark)

6. 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. $m\boldsymbol{v}$.

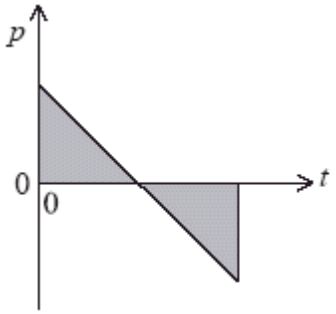
B. $-m\boldsymbol{v}$.

C. $M\boldsymbol{v}$.

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

(Total 1 mark)

7. A rubber ball, travelling in a horizontal direction, strikes a vertical wall. It rebounds at right angles to the wall. The graph below illustrates the variation of the ball's momentum p with time t when the ball is in contact with the wall.



Which of the following statements is true?

A. The shaded area is equal to the force exerted by the wall on the ball.

B. The shaded area is equal to the force exerted by the ball on the wall.

C. The gradient is equal to the force exerted by the wall on the ball.

D. The gradient is equal to the force exerted by the ball on the wall.

(Total 1 mark)

8. A general expression for Newton's second law of motion is

$$F = \frac{\Delta p}{\Delta t}.$$

What condition is applied so that the law may be expressed in the form $F = ma$?

A. The mass m is constant.

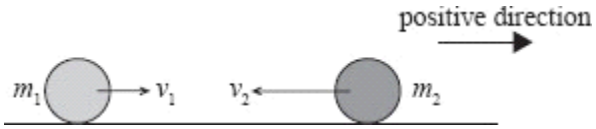
B. The acceleration a is constant.

C. The force F is constant.

D. The direction of the force F is constant.

(Total 1 mark)

9. Two spheres of masses m_1 and m_2 are moving towards each other along the same straight-line with speeds v_1 and v_2 as shown.



The spheres collide. Which of the following gives the total change in linear momentum of the spheres as a result of the collision?

A. 0

B. $m_1v_1 + m_2v_2$

C. $m_1v_1 - m_2v_2$

D. $m_2v_2 - m_1v_1$

(Total 1 mark)

10. This question is about impulse.

(a) A net force of magnitude F acts on a body. Define the *impulse I* of the force.

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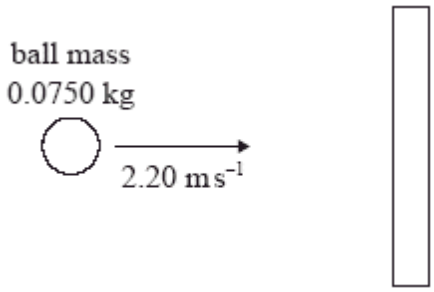
(1)

(b) A ball of mass 0.0750 kg is travelling horizontally with a speed of 2.20 m s^{-1}. It strikes a vertical wall and rebounds horizontally.



Due to the collision with the wall, 20 % of the ball's initial kinetic energy is dissipated.

(i) Show that the ball rebounds from the wall with a speed of 1.97 m s^{-1}.

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(2)

(ii) Show that the impulse given to the ball by the wall is 0.313 N s.

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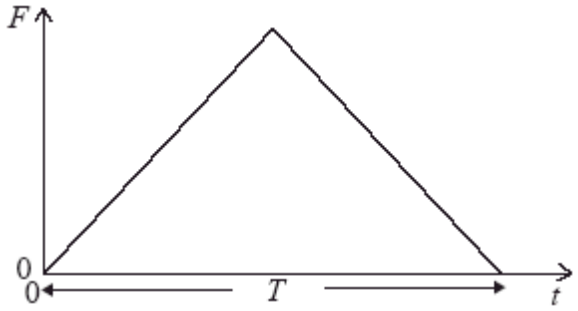
(2)

(c) The ball strikes the wall at time $t = 0$ and leaves the wall at time $t = T$.

The sketch graph shows how the force F that the wall exerts on the ball is assumed to vary with time t.



The time T is measured electronically to equal 0.0894 s.

Use the impulse given in (b)(ii) to estimate the average value of F.

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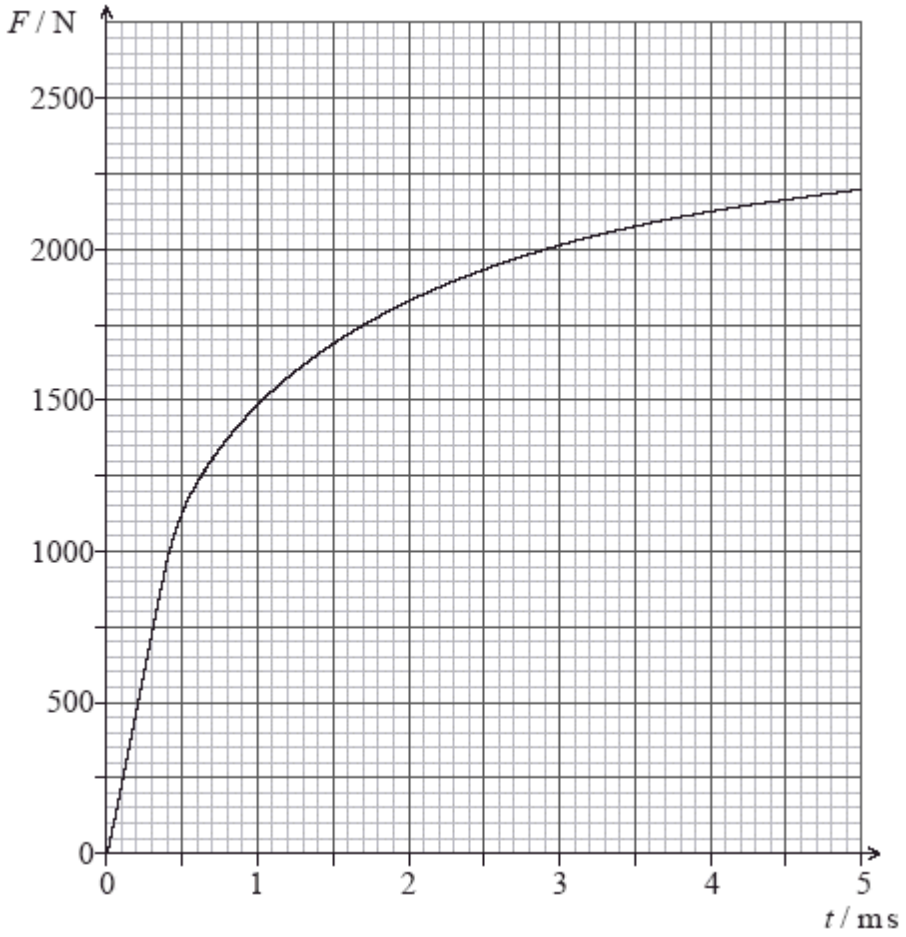
(4)
(Total 9 marks)

11. This question is about dynamics and energy.

A bullet of mass 32 g is fired from a gun. The graph shows the variation of the force F on the bullet with time t as it travels along the barrel of the gun.



The bullet is fired at time $t = 0$ and the length of the barrel is 0.70 m.

(a) State and explain why it is inappropriate to use the equation $s = ut + \frac{1}{2}at^2$ to calculate the acceleration of the bullet.

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(2)

(b) Use the graph to

(i) determine the average acceleration of the bullet during the final 2.0 ms of the graph.

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(2)

(ii) show that the change in momentum of the bullet, as the bullet travels along the length of the barrel, is approximately 9 N s.

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(3)

(c) Use the answer in (b)(ii) to calculate the

(i) speed of the bullet as it leaves the barrel.

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(2)

(ii) average power delivered to the bullet.

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(3)

(d) Use Newton's third law to explain why a gun will recoil when a bullet is fired.

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(3)
(Total 15 marks)

12. This question is about collisions.

(a) State the principle of conservation of momentum.

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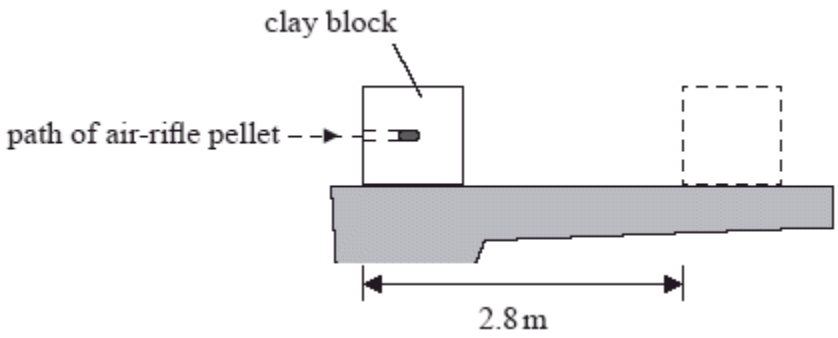
(2)

(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}.

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(2)

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

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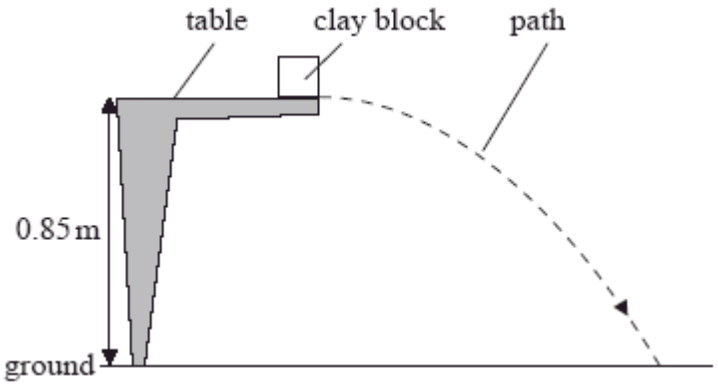
(4)

(c) The experiment is repeated with the clay block placed at the edge of the table so that it is fired away from the table. The initial speed of the clay block is 4.3 m s^{-1} horizontally. The table surface is 0.85 m above the ground.



(not to scale)

(i) Ignoring air resistance, calculate the horizontal distance travelled by the clay block before it strikes the ground.

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(4)

(ii) The diagram in (c) shows the path of the clay block neglecting air resistance. On the diagram, draw the approximate shape of the path that the clay block will take assuming that air resistance acts on the clay block.

(3)
(Total 15 marks)