NAME: _____ **DATE:** _____ PHYSICS

PAPER 1 REVISION

2.2 Forces and Dynamics (Momentum)

1. A rocket is fired vertically. At its highest point, it explodes. Which **one** of the following describes what happens to its total momentum and total kinetic energy as a result of the explosion?

	Total momentum	Total kinetic energy
A.	unchanged	increased
B.	unchanged	unchanged
C.	increased	increased
D.	increased	unchanged

(1)

2. Joe is standing on the surface of a frozen pond and he throws a ball horizontally. Considering Joe and the ball together, which **one** of the following correctly describes the change in the magnitude of the momentum and the change in the kinetic energy of Joe and the ball immediately after the ball is thrown?

	Magnitude of momentum of Joe and ball	Kinetic energy of Joe and ball
A.	No change	Increases
B.	Increases	Increases
C.	No change	No change
D.	Increases	No change

(1)

3. A ball of mass m, travelling in a direction at right angles to a vertical wall, strikes the wall with a speed v_1. It rebounds at right angles to the wall with a speed v_2. The ball is in contact with the wall for a time Δt. The magnitude of the force that the ball exerts on the wall is

A. $\dfrac{m(v_1 + v_2)}{\Delta t}$.

B. $m(v_1 + v_2)\Delta t$.

C. $\dfrac{m(v_1 - v_2)}{\Delta t}$.

D. $m(v_1 - v_2)\Delta t$.

(1)

4. Two spheres X and Y are moving towards each other along the same straight line with momenta of magnitude P_X and P_Y respectively. The spheres collide and move off with momenta p_X and p_Y respectively, as illustrated below.

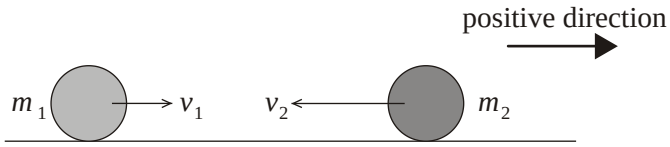
Which **one** of the following is a correct statement of the law of conservation of momentum for this collision?

A. $P_X + P_Y = p_X + p_Y$ B. $P_X - P_Y = p_X + p_Y$

C. $P_X - P_Y = p_X - p_Y$ D. $P_X + P_Y = p_X - p_Y$

(1)

5. 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. $m_2v_2 - m_1v_1$

(1)

6. An object of mass m is initially at rest. An impulse I acts on the object. The change in kinetic energy of the object is

A. $\frac{I^2}{2m}$. B. $\frac{I^2}{m}$. C. I^2m. D. $2I^2m$.

(1)

7. Two objects collide inelastically. For this system of two objects

A. only momentum is conserved.
B. only kinetic energy is conserved.
C. both momentum and kinetic energy are conserved.
D. neither momentum nor kinetic energy are conserved.

(1)

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.

(1)

9. The net force acting on a body is zero. Which of the following quantities must also have zero magnitude for this body?

A. Momentum B. Velocity C. Speed D. Acceleration

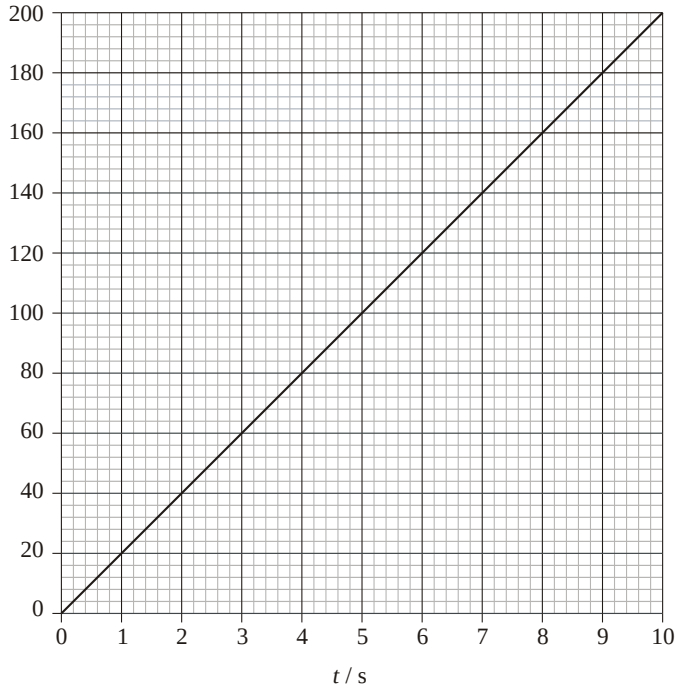
(1)

10. A net force of magnitude F acts on a body for a time Δt producing an impulse of magnitude Y. Which of the following is the magnitude of the rate of change of momentum of the body?

A. F B. $F\Delta t$ C. Y D. $Y\Delta t$

(1)

11. A constant force of magnitude F acts on a body. The graph shows the variation with time t of the momentum p of the body.



The magnitude of the force F is

A. 1000 N.

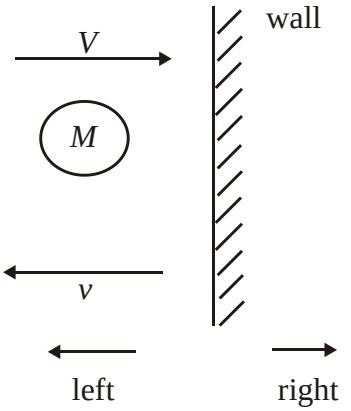
B. 200 N.

C. 20 N.

D. 0.05 N.

(1)

12. A ball of mass M hits a wall at speed V normal to the wall. It rebounds with speed v normal to the wall as shown below.

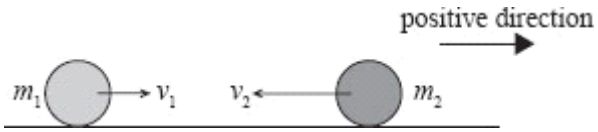


What is the magnitude of the change in momentum of the ball and the direction of the force that the wall exerts on the ball?

	change in momentum	direction of force
A.	$M(V - v)$	to the right
B.	$M(V - v)$	to the left
C.	$M(V + v)$	to the right
D.	$M(V + v)$	to the left

(1)

13. 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. $m_2v_2 - m_1v_1$

(1)

PAPER 2 REVISION

2.2 Forces and Dynamics (Momentum)

14. Momentum

(a) State the law of conservation of momentum.

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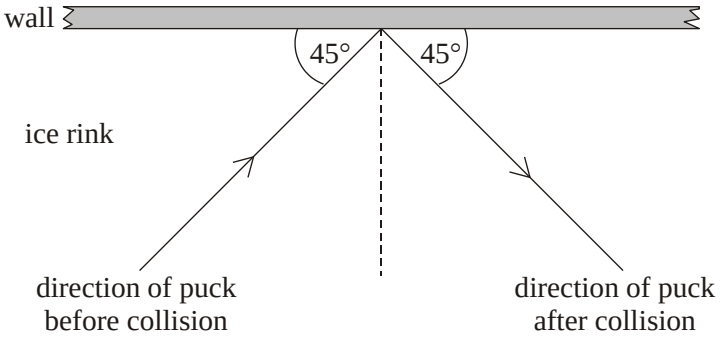
(2)

(b) An ice hockey puck collides with the wall of an ice rink. The puck is sliding along a line that makes an angle of 45° to the wall.



The collision between the wall and the puck is perfectly elastic.

(i) State what is meant by an *elastic collision*.

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(1)

(ii) Discuss how the law of conservation of momentum applies to this situation.

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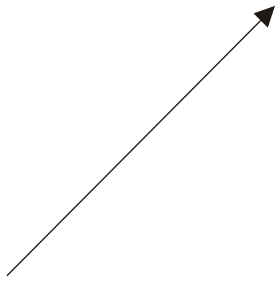
(c) The diagram below is a scale diagram that shows the vector representing the momentum of the puck before collision.

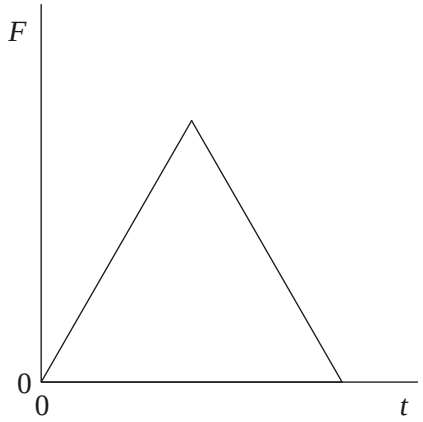
Scale: 1.0 cm = 0.10 N s



By adding appropriate vectors to the diagram, deduce that the magnitude of the change in momentum of the puck as a result of the collision is 0.71 N s.

(4)

(d) The sketch-graph below shows the variation with time *t* of the force *F* exerted by the wall on the puck.



The total contact time is 12 ms. Estimate, explaining your reasoning, the maximum force exerted by the wall on the puck.

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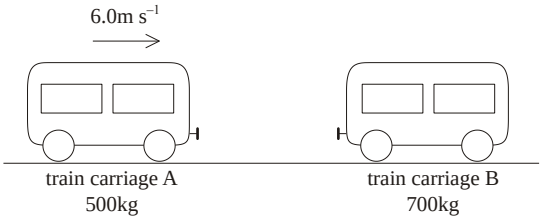
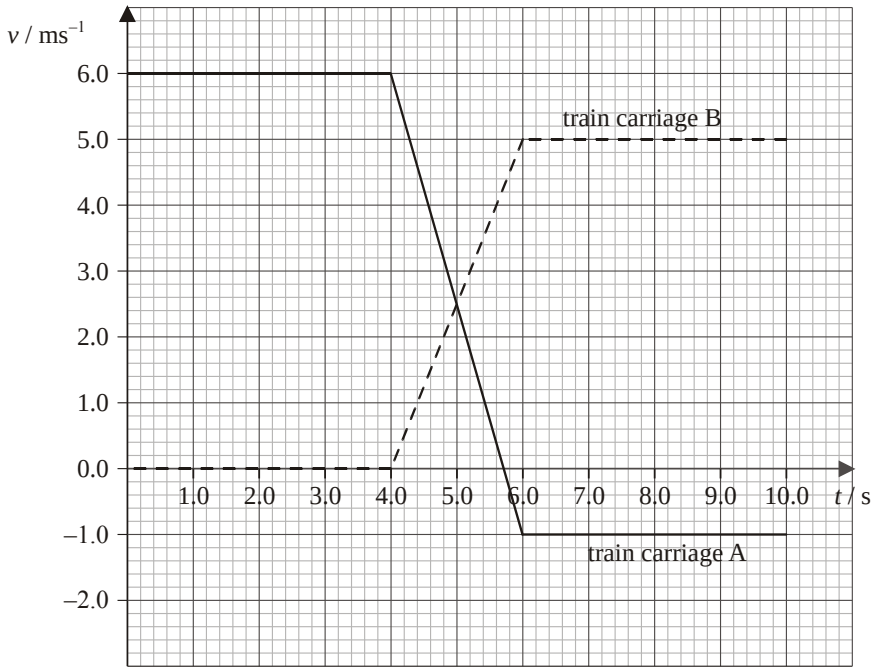
(3)
(Total 12 marks)

15. This question is about energy and momentum.

A train carriage A of mass 500 kg is moving horizontally at 6.0 m s^{-1}. It collides with another train carriage B of mass 700 kg that is initially at rest, as shown in the diagram.



The graph below shows the variation with time *t* of the velocities of the two train carriages before, during and after the collision.



(a) Use the graph to deduce that

(i) the total momentum of the system is conserved in the collision;

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(2)

(ii) the collision is elastic.

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(2)

(b) Calculate the magnitude of the average force experienced by train carriage B.

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(3)

(Total 7 marks)

16. This question is about momentum and energy.

(a) Define *impulse of a force* and state the relation between impulse and momentum.

definition:

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relation:

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(2)

(b) By applying Newton's laws of motion to the collision of two particles, deduce that momentum is conserved in the collision.

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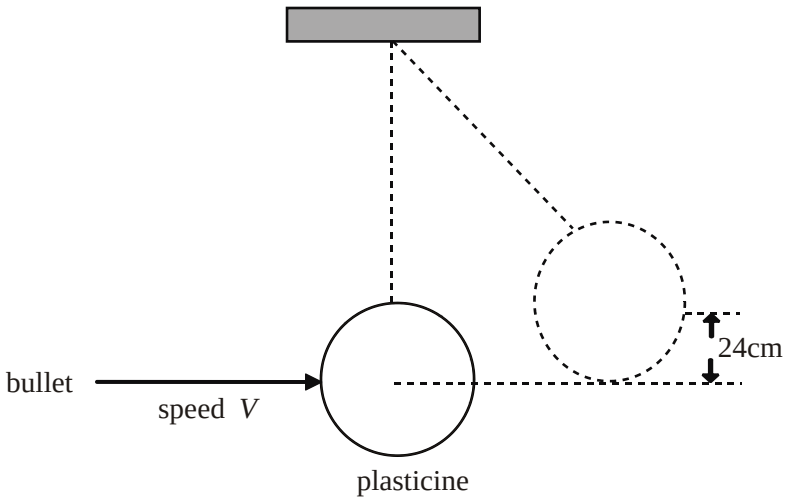
(5)

(c) In an experiment to measure the speed of a bullet, the bullet is fired into a piece of plasticine suspended from a rigid support by a light thread.



The speed of the bullet on impact with the plasticine is V. As a result of the impact, the bullet embeds itself in the plasticine and the plasticine is displaced vertically through a height of 24 cm. The mass of the bullet is 5.2×10^{-3} kg and the mass of the plasticine is 0.38 kg.

(i) Ignoring the mass of the bullet, calculate the speed of the plasticine immediately after the impact.

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(ii) Deduce that the speed V with which the bullet strikes the plasticine is about 160 m s^{-1}.

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(2)

(Total 11 marks)

16. This question is about momentum and the kinematics of a proposed journey to Jupiter.

(a) State the law of conservation of momentum.

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(2)

A solar propulsion engine uses solar power to ionize atoms of xenon and to accelerate them. As a result of the acceleration process, the ions are ejected from the spaceship with a speed of 3.0×10^4 m s^{-1}.

(b) The mass (nucleon) number of the xenon used is 131. Deduce that the mass of one ion of xenon is 2.2×10^{-25} kg.

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(2)

(c) The original mass of the fuel is 81 kg. Deduce that, if the engine ejects 77×10^{18} xenon ions every second, the fuel will last for 1.5 years. (1 year = 3.2×10^7 s)

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(2)

(d) The mass of the spaceship is 5.4×10^2 kg. Deduce that the initial acceleration of the spaceship is 8.2×10^{-5} m s^{-2}.

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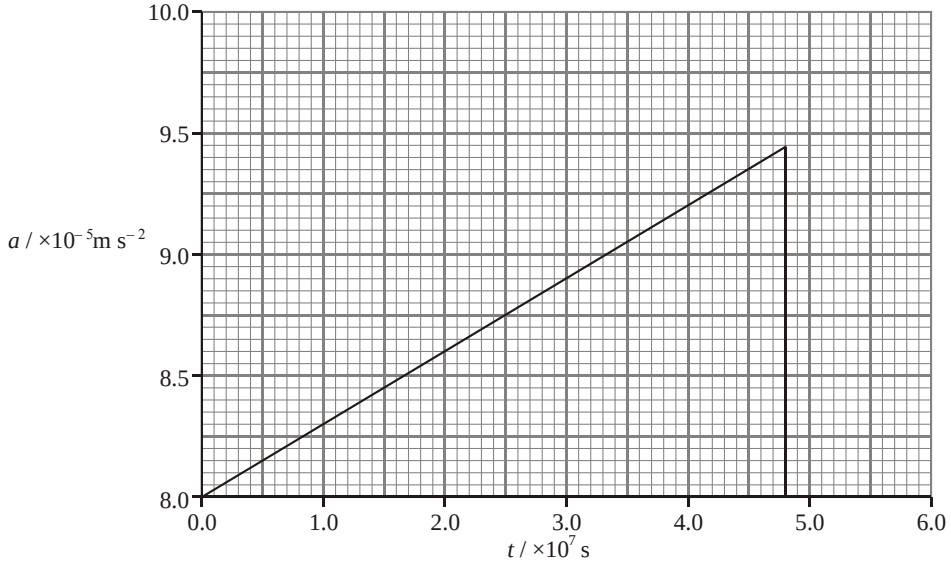
(5)

The graph shows the variation with time t of the acceleration a of the spaceship. The solar propulsion engine is switched on at time $t = 0$ when the speed of the spaceship is 1.2×103 m s^{-1}.



(e) Explain why the acceleration of the spaceship is increasing with time.

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(2)

(f) Using data from the graph, calculate the speed of the spaceship at the time when the xenon fuel has all been used.

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(4)

(g) The distance of the spaceship from Earth when the solar propulsion engine is switched on is very small compared to the distance from Earth to Jupiter. The fuel runs out when the spaceship is a distance of 4.7×10^{-11} m from Jupiter. Estimate the total time that it would take the spaceship to travel from Earth to Jupiter.

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(2)

(Total 19 marks)