2.4 Momentum & Impulse

Question Paper

Course	DP IB Physics
Section	2. Mechanics
Topic	2.4 Momentum & Impulse
Difficulty	Hard

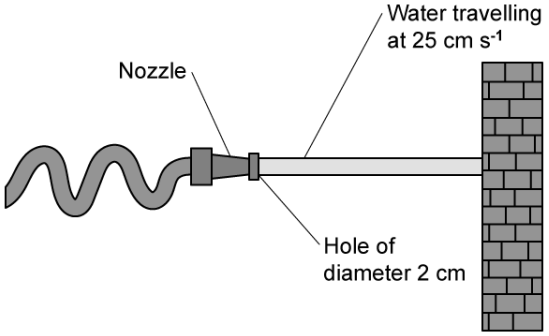
Time allowed: 20

Score: /10

Percentage: /100

Question 1

Water is ejected from the nozzle of a hose through a hole of a diameter 2 cm. The water leaves the nozzle of the hose with a velocity of 25 cm s^{-1} and travels horizontally towards a wall, as shown below.



After colliding with the wall the water has zero velocity. Water has a density of 1 g cm^{-3}.

What is the force exerted by the water on the wall?

A. 625π N

B. 25π N

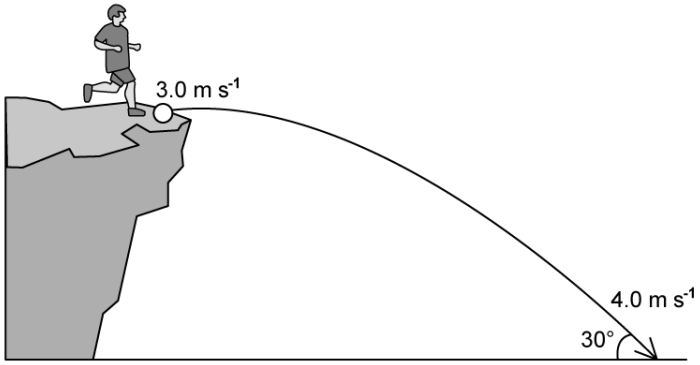
C. $\frac{625\pi}{4}$ N

D. 2500π N

[1 mark]

Question 2

A ball of mass 0.60 kg is kicked off a cliff with a horizontal velocity of 3.0 m s^{-1}. It follows the path of a projectile shown below and lands with a velocity of 4.0 m s^{-1} at an angle of 30° to the ground. Air resistance is negligible during the flight.



What is the magnitude of the change in momentum of the ball between the top of the cliff and the ground below?

You may need to use the following trigonometric values to help you:

$$\cos(30) = \frac{\sqrt{3}}{2}$$

$$\sin(30) = \frac{1}{2}$$

A. $1.2\sqrt{3}$ N s

B. 0.6 N s

C. 2 N s

D. 1.2 N s

[1 mark]

Question 3

A BB gun fires 4 g ball bearings at a rate of 100 balls per minute. The balls leave the BB gun at a velocity of 20 m s^{-1} and strike a fixed steel block. The balls rebound off the block with the same velocity as they were fired.

What is the average force exerted on the steel container?

A. 16 N

B. $\frac{0.16}{60}$ N

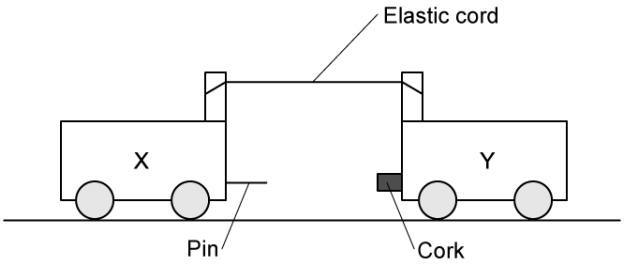
C. $\frac{16}{60}$ N

D. $\frac{1600}{60}$ N

[1 mark]

Question 4

Two trolleys, X and Y, are connected by an elastic cord, of negligible mass, as shown below. Trolley X is twice the mass of trolley Y.



The two trolleys are pulled apart so that the elastic cord is stretched. The trolleys are then released at the same time and move towards each other. The trolleys stick together on impact.

Just before the trolleys collide, the speed of trolley X is 20 cm s^{-1}.

What is the speed of the trolleys after they collide?

A. 20 cm s^{-1}

B. 0 cm s^{-1}

C. 10 cm s^{-1}

D. 30 cm s^{-1}

[1 mark]

Question 5

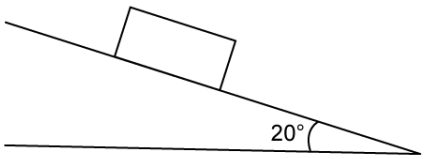
The diagram below shows a block of mass 2 kg sliding down a rough slope from rest against a constant friction force of 2.5 N.

Use the following assumptions to help you:

Acceleration due to free fall is 10 m s^{-2}

cos(20) = 0.9

sin(20) = 0.3



What is the momentum of the block along the slope after 5 seconds?

A. 7.75 kg m s^{-1}

B. 38.75 kg m s^{-1}

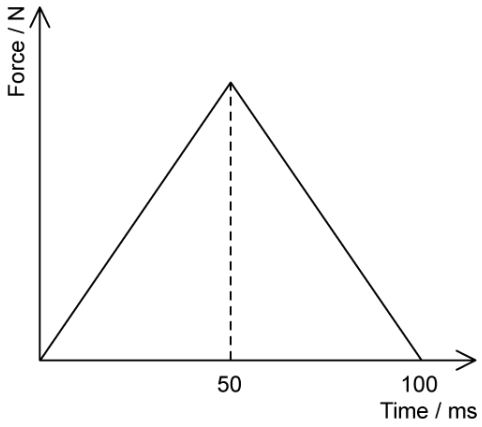
C. 77.5 kg m s^{-1}

D. 17.5 kg m s^{-1}

[1 mark]

Question 6

A car of mass 3000 kg is travelling at 5 m s^{-1} when it collides with a wall and is brought to rest. The force-time graph of the impact is shown below.



What is the maximum force exerted on the car?

A. 15 000 N

B. 300 000 N

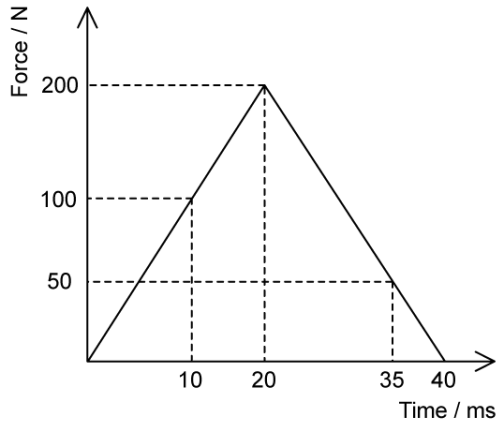
C. 75 N

D. 3000 N

[1 mark]

Question 7

The variation of the force, *F*, with time, *t*, acting on a mass of 160 g is shown on the graph below.



The velocity of the body at *t* = 10 ms is 5 m s^{-1}.

What is the velocity of the body at *t* = 35 ms?

A. 30 m s^{-1}

B. $\frac{835}{32}$ m s^{-1}

C. $\frac{27}{8}$ m s^{-1}

D. $\frac{675}{32}$ m s^{-1}

[1 mark]

Question 8

Particle P has a mass *m* and is moving towards a stationary particle, Q, of mass *M*. P is travelling with a velocity of *u* before colliding head on with particle Q. The collision between the particles is elastic.

What is the velocity of particle Q after the collision?

A. $\frac{2mu}{M + m}$

B. $\frac{(M - m)u}{M}$

C. *u*

D. 2*mu*

[1 mark]

Question 9

An object of mass 25 g travelling at 4.0 m s^{-1} collides head-on with a mass of 15 g travelling in the opposite direction at $\frac{20}{3}$ m s^{-1}. The collision between the masses is inelastic.

How much kinetic energy is lost after the collision?

A. $\frac{31}{30}$ J

B. $\frac{8}{15}$ J

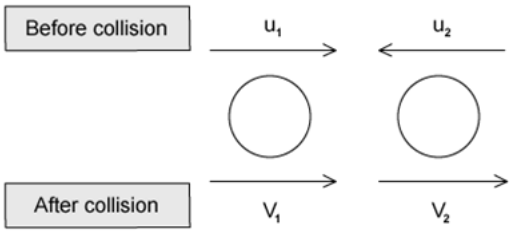
C. $\frac{1}{30}$ J

D. $\frac{31}{80}$ J

[1 mark]

Question 10

Two spheres approach each other along the same straight line. Their speeds are u_1 and u_2 before collision, and v_1 and v_2 after collision, in the directions shown below



Which equation is correct if the collision is perfectly elastic?

A. $u_1 - u_2 = v_2 - v_1$

B. $u_1 - u_2 = v_2 + v_1$

C. $u_1 + u_2 = v_2 + v_1$

D. $u_1 + u_2 = v_2 - v_1$

[1 mark]