1.6 Momentum

01. 0625_w23_qp_42 Q: 3

(a) A balloon of mass 15 g is glued to a straw. The straw is threaded onto a horizontal string, as shown in Fig. 3.1.
The balloon is filled with air and then the air is released.

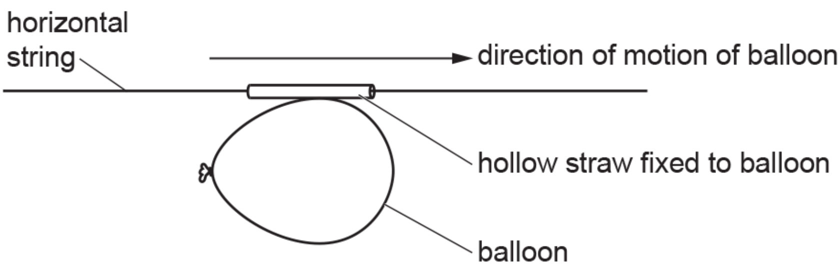

Fig. 3.1

As the air leaves the balloon, the balloon experiences a force.
The balloon accelerates from rest until it reaches a constant speed. It then travels 0.67 m in 0.18 s at this constant speed.

(i) Explain in words what is meant by the term impulse.

....

.... [1]

(ii) Calculate the resultant impulse on the balloon while it is accelerating.

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impulse = ... [3]

(iii) Explain how momentum is conserved as the balloon accelerates.

....

....

.... [2]

(b) Fig. 3.2 shows the directions of two forces acting on a different balloon as it moves.

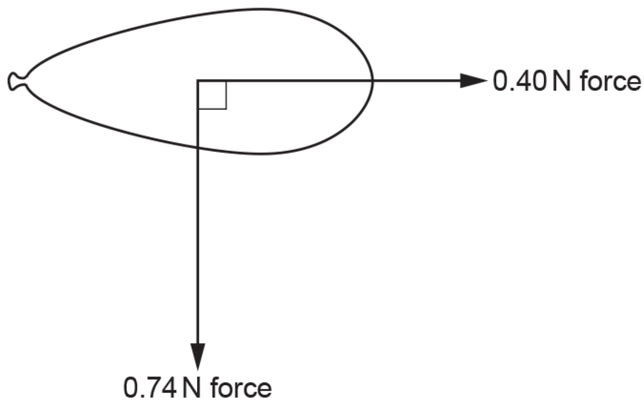

Fig. 3.2 (not to scale)

Determine the magnitude and direction of the resultant force on the balloon.

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magnitude ....

direction relative to horizontal force ....
[4]

02. 0625_w21_qp_42 Q: 3

Fig. 3.1 shows a collision at very slow speed between two cars travelling along a straight road.

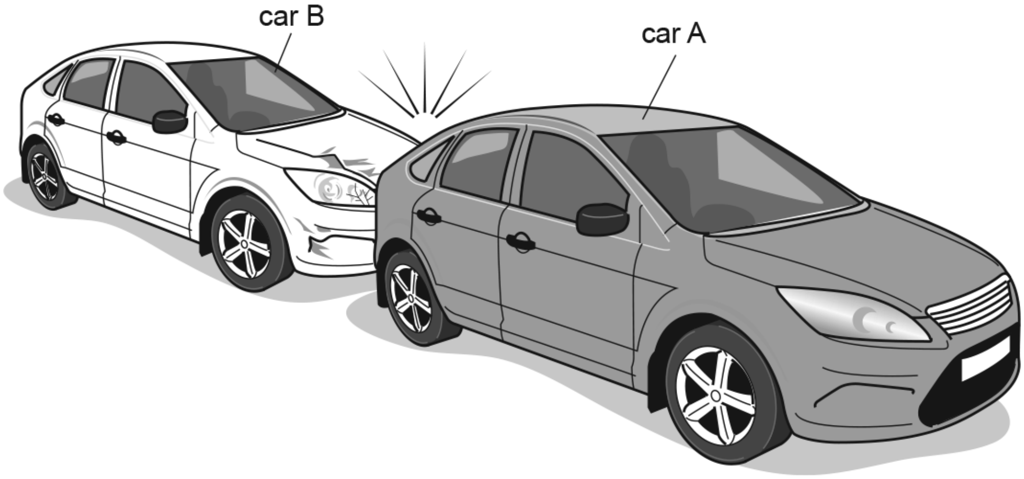

Fig. 3.1

Car B, of mass 800 kg, is moving at 2.0 m/s and collides with car A, of mass 1000 kg, which is stationary. After the collision, both cars travel in the same direction as the initial direction of car B.

(a) After the collision, car A moves at 1.3 m/s.

Show that the speed of car B after the collision is approximately 0.4 m/s.

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[3]

(b) **(i)** Calculate the impulse exerted by car A on car B.

impulse = ... [2]

(ii) State the impulse exerted by car B on car A.

impulse = ... [1]

03. 0625_m20_qp_42 Q: 2

Fig. 2.1 shows an athlete crossing the finishing line in a race. As she crosses the finishing line, her speed is 10.0 m/s. She slows down to a speed of 4.0 m/s.

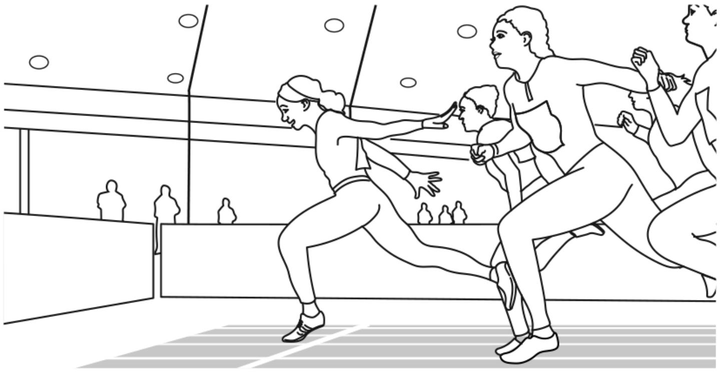

Fig. 2.1

(a) The mass of the athlete is 71 kg. Calculate the impulse applied to her as she slows down.

impulse = ... [3]

(b) (i) Define *impulse* in terms of *force* and *time*.

....

.... [1]

(ii) The athlete takes 1.2 s to slow down from a speed of 10.0 m/s to a speed of 4.0 m/s.

Calculate the average resultant force applied to the athlete as she slows down.

force = ... [2]

(c) Calculate the force required to give a mass of 71 kg an acceleration of 6.4 m/s^2.

force = ... [2]

[Total: 8]

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04. 0625_s20_qp_42 Q: 2

Fig. 2.1 shows a train.

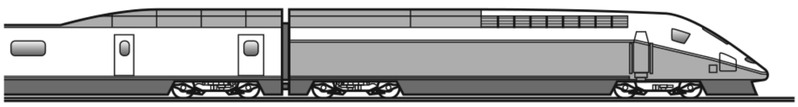

Fig. 2.1

The total mass of the train and its passengers is 750 000 kg. The train is travelling at a speed of 84 m/s. The driver applies the brakes and the train takes 80 s to slow down to a speed of 42 m/s.

(a) Calculate the impulse applied to the train as it slows down.

impulse = ... [3]

(b) Calculate the average resultant force applied to the train as it slows down.

force = ... [2]

(c) Suggest how the shape of the train helps it to travel at high speeds.

....

.... [1]

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(d) The train took 80 s to reduce its speed from 84 m/s to 42 m/s. Explain why, with the same braking force, the train takes more than 80 s to reduce its speed from 42 m/s to zero.

....

.... [1]

(e) On a wet day, the train travels a greater distance before it stops along the same track. The train has the same speed of 84 m/s before the brakes are applied.

Suggest a reason for this.

....

.... [1]

[Total: 8]

05. 0625_w20_qp_41 Q: 1

Fig. 1.1 shows an ice-hockey player moving on ice. He is preparing to hit the solid disc called a puck.

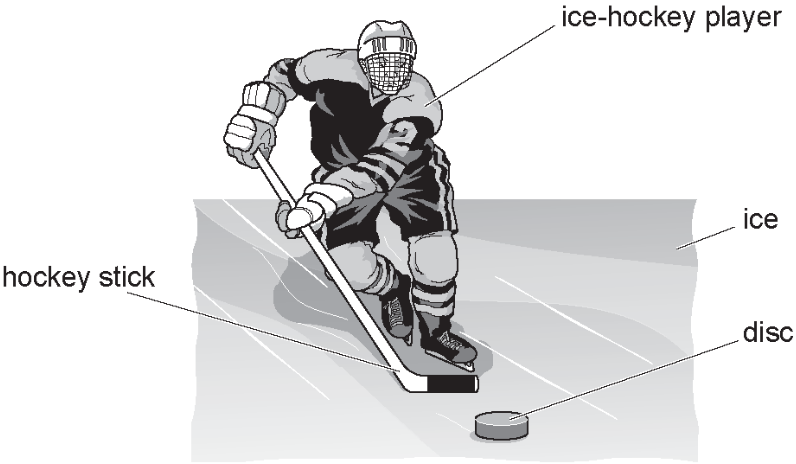

Fig. 1.1

The disc of mass 0.16 kg is moving horizontally across the surface of the ice at a speed of 15 m/s.

(a) Calculate the magnitude of the momentum of the disc.

magnitude of momentum = ... [2]

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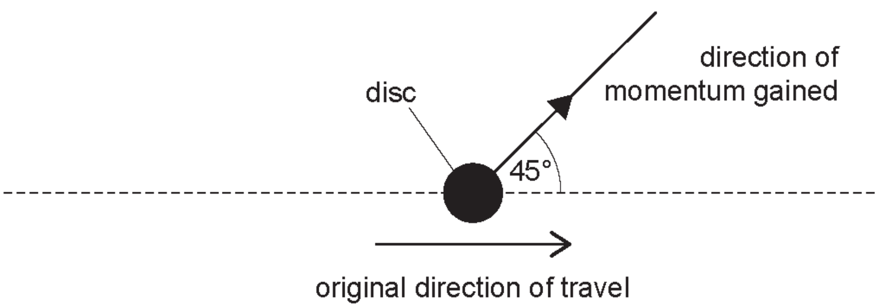
(b) The hockey player strikes the disc with his hockey stick and the momentum of the disc changes. The disc gains momentum of 3.0 kg m/s at 45° to the original direction of travel of the disc, as shown in Fig. 1.2.



(i) State the magnitude of the impulse exerted on the disc and the direction, in degrees, of the impulse relative to the original direction of travel.

magnitude of impulse = ...

direction of impulse: .... ° to original direction
[1]

(ii) Determine the magnitude of the new momentum of the disc and its new direction relative to the original direction of travel by drawing a scale diagram.

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06. 0625_s19_qp_41 Q: 1

A rocket is stationary on the launchpad. At time t = 0, the rocket engines are switched on and exhaust gases are ejected from the nozzles of the engines. The rocket accelerates upwards.

Fig. 1.1 shows how the acceleration of the rocket varies between time t = 0 and time $t = t_f$.

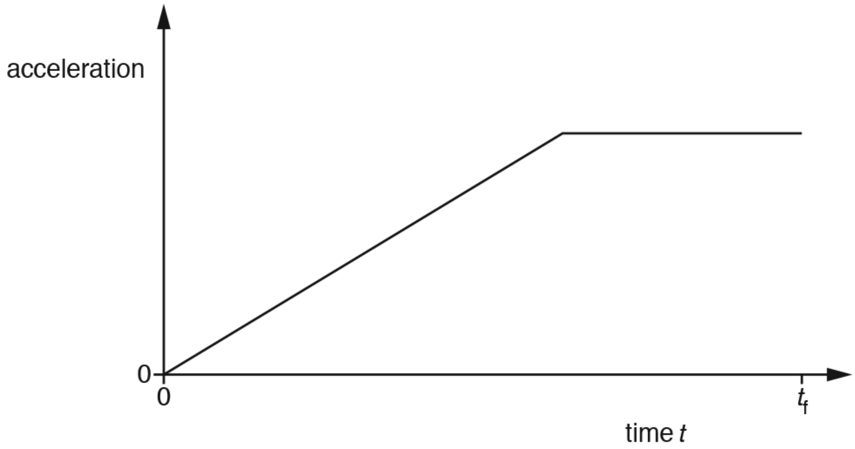

Fig. 1.1

(a) Define *acceleration*.

....

.... [1]

(b) On Fig. 1.2, sketch a graph to show how the speed of the rocket varies between time t = 0 and time $t = t_f$.

Fig. 1.2

[3]

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(c) Some time later, the rocket is far from the Earth. The effect of the Earth's gravity on the motion of the rocket is insignificant. As the rocket accelerates, its momentum increases.

(i) State the principle of the conservation of momentum.

....

....

.... [2]

(ii) Explain how the principle of the conservation of momentum applies to the accelerating rocket and the exhaust gases.

....

....

....

.... [2]

[Total: 8]

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07. 0625_s19_qp_42 Q: 2

Fig. 2.1 shows a model fire engine. Its brakes are applied.

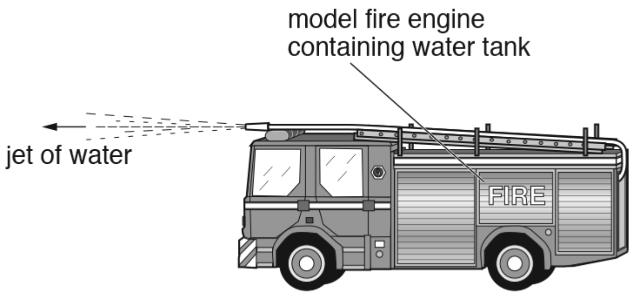

Fig. 2.1

0.80 kg of water is emitted in the jet every 6.0 s at a velocity of 0.72 m/s relative to the model.

(a) Calculate the change in momentum of the water that is ejected in 6.0 s.

momentum = ... [2]

(b) Calculate the magnitude of the force acting on the model because of the jet of water.

force = ... [2]

(c) The brakes of the model are released.

State and explain the direction of the acceleration of the model.

Statement ....

Explanation ....

....
[2]

(d) In **(c)** the model contains a water tank, which is initially full.

State and explain any change in the magnitude of the initial acceleration if the brakes are first released when the tank is nearly empty.

Statement ....

Explanation ....

....

....
[3]

[Total: 9]

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