1.2 Forces & Momentum

MCQ

Medium

1

1 mark

A person is pushing a trolley at a constant velocity.

The floor exerts a force *P* on the person, the person exerts a force Q on the trolley.

The trolley exerts a force *R* on the person and the total drag force on the trolley is *S*.

(Source: Andy Dossett/Alamy Stock Photo)

Which pair of forces is a Newton's Third Law pair?

A. *P* and *R*

B. Q and *R*

C. Q and *S*

D. *P* and *S*

2

1 mark

Which row of the table contains two units that are **not** equivalent?

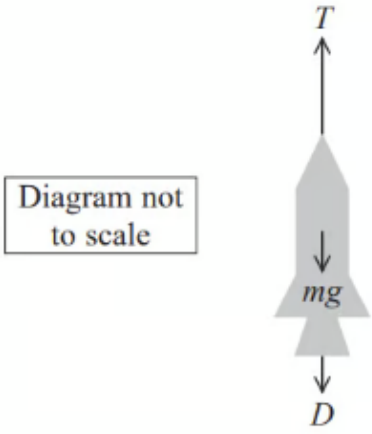
	Unit 1	Unit 2
A	$J\,s^{-1}$	W
B	$kg\,m\,s^{-2}$	N s
C	$N\,kg^{-1}$	$m\,s^{-2}$
D	N m	J

3

1 mark

The diagram shows a rocket of mass *m* accelerating upwards with acceleration *a*.

The diagram represents the forces acting on the rocket.



Which of the following equations gives the value of *D*?

A. $D = T + m(g - a)$

B. $D = T + m(a + g)$

C. $D = T - m(g - a)$

D. $D = T - m(g + a)$

4

1 mark

A van travels along a straight, horizontal road at a constant velocity.

Which of the following statements is correct?

A. The frictional force of the road on the tyres can be ignored.

B. The frictional force of the road on the tyres is equal to the resultant force on the van.

C. The frictional force of the road on the tyres is in the direction of motion of the van.

D. The frictional force of the road on the tyres is in the opposite direction to the motion of the van.

5

1 mark

A massive star exerts a gravitational force F_{star} on a small distant planet. The planet exerts a gravitational force F_{planet} on the star.

Which row of the table is correct?

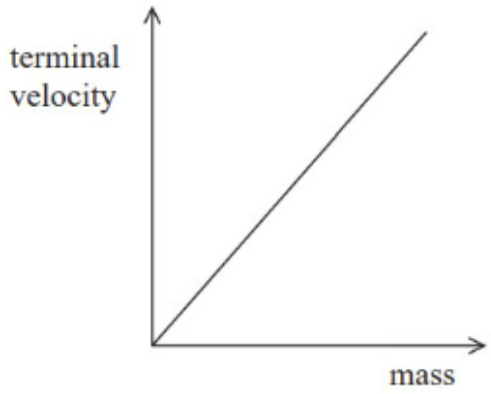
	Magnitude of forces	Direction of forces
☐ A	$F_{planet} < F_{star}$	opposite
☐ B	$F_{planet} < F_{star}$	the same
☐ C	$F_{planet} = F_{star}$	opposite
☐ D	$F_{planet} = F_{star}$	the same

Hard

1

1 mark

The graph shows how terminal velocity varies with mass for small spheres of equal diameter falling through a viscous liquid.



Which of the following describes the gradient of the graph for a liquid of greater viscosity?

A. a greater gradient

B. a smaller gradient

C. a variable gradient

D. the same gradient

Structured Questions

Medium

1a

2 marks

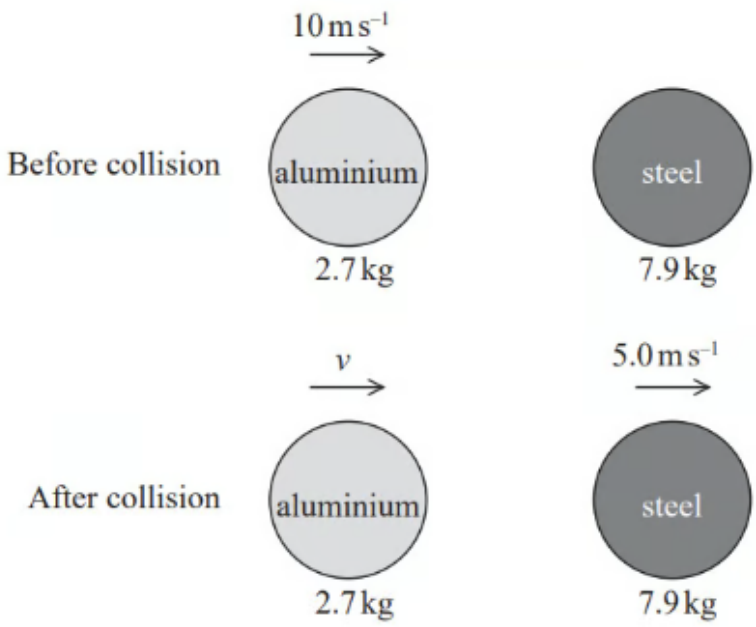
An aluminium sphere collides head-on with a stationary steel sphere. The two spheres move off separately after the collision.

State the principle of conservation of momentum.

1b

3 marks

The aluminium sphere has an initial velocity of 10.0 m s^{-1}. Immediately after the collision the velocity of the steel sphere is 5.0 m s^{-1}.



Calculate the velocity v of the aluminium sphere immediately after the collision.

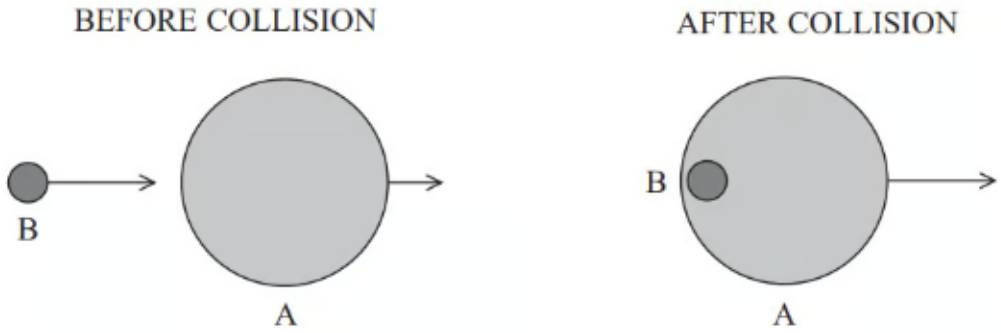
mass of aluminium sphere = 2.7 kg
mass of steel sphere = 7.9 kg

v = ...

2a

2 marks

A slow moving asteroid A was hit by a faster asteroid B. Asteroid B was absorbed by asteroid A as shown.



State the principle of conservation of linear momentum.

2b

5 marks

Before the collision, asteroid A had a velocity of 2.19×10^3 m s^{-1} and a momentum of 1.80×10^{17} kg m s^{-1}.

(i) Show that the mass of asteroid A was about 8.2×10^{13} kg. (2)

ii) Calculate the velocity of the asteroids after the collision.

mass of asteroid B = 5.90×10^{12} kg
velocity of asteroid B before the collision = 15.0×10^3 m s^{-1} **(3)**

Velocity of asteroids = ...

3a

2 marks

A railway carriage of mass 7.15×10^4 kg moving at 4.50 m s^{-1} collides with a second railway carriage of mass 5.35×10^4 kg moving in the same direction.

The carriages join together. Immediately after the collision they move at a speed of 3.62 m s^{-1}.

Show that the total momentum of the carriages immediately after the collision was approximately 4.5×10^5 kg m s^{-1}.

3b

2 marks

Calculate the velocity of the second carriage before the collision.

Velocity of second carriage = ...

3c

2 marks

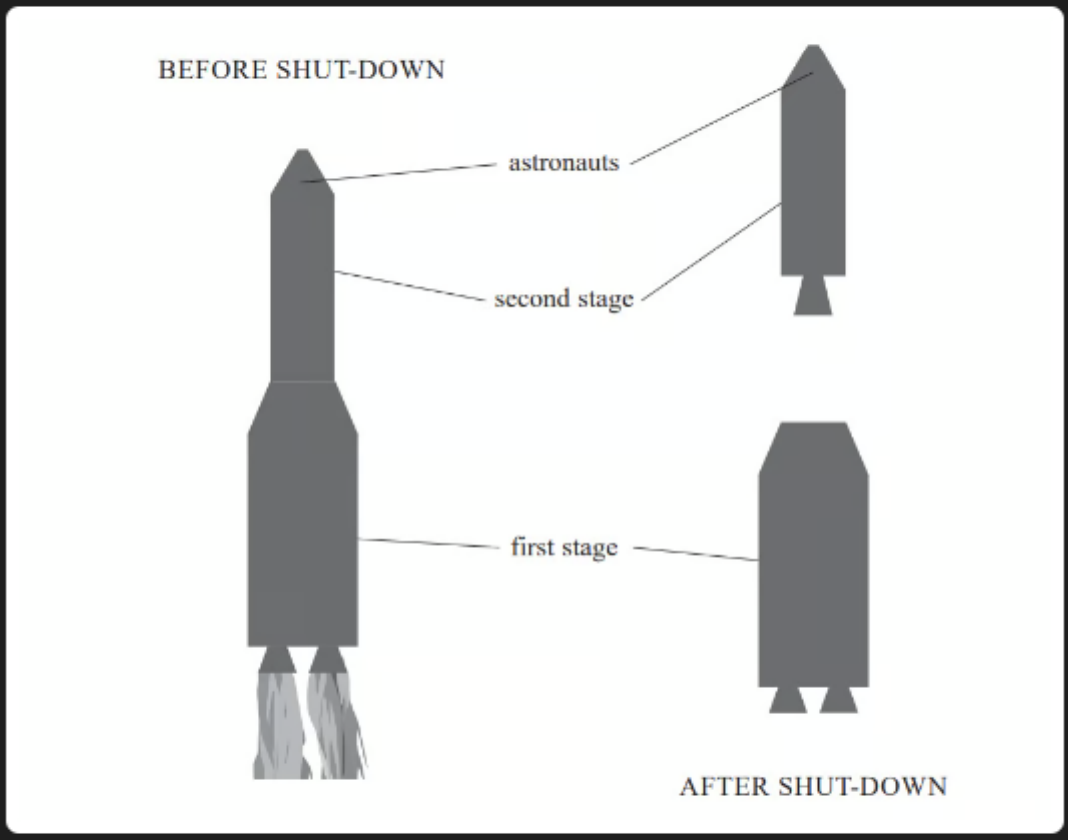
Calculate the change in total kinetic energy during the collision.

Change in total kinetic energy = ...

4

6 marks

*A large spacecraft is made up of several 'stages'. Each stage consists of a rocket motor and a fuel tank. Once a stage has used all its fuel, the rocket motor in that stage shuts down. The stage then disconnects from the spacecraft and falls back to Earth.



As the rocket is rising due to the upward force of the first stage, an astronaut feels himself pushed further and further back, compressing the back of his seat.

When the first stage shuts down, the astronaut is suddenly projected forwards by the seat. The astronaut is held in place by a safety strap.

Explain the effects experienced by the astronaut. You may assume that the force provided by the first stage rocket motor is constant until the moment it shuts down.

5

4 marks

A helicopter can hover in a fixed position as shown.

(Source: Ascent Xmedia/Getty Images)

The helicopter blades move air vertically downwards.

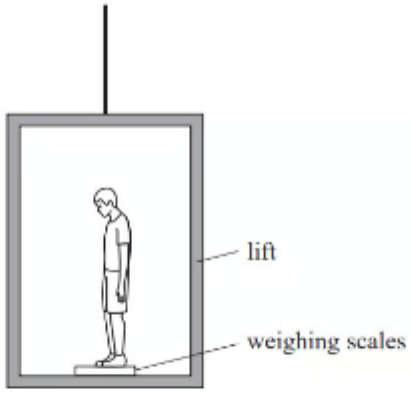
Explain how this enables the helicopter to maintain a constant height above the ground.

Hard

1

6 marks

*A student of weight 600 N is standing on weighing scales in a lift. The scales are calibrated to give readings in newtons.



The lift moves upwards at constant velocity, then decelerates to rest. As the lift moves, the student looks at the readings on the scales.

Explain the readings on the scales.