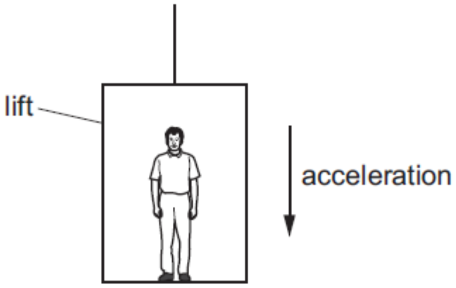
1. Nov/2023/Paper_ 9702/11/No.7

A man stands in a lift that is accelerating vertically downwards, as shown.



Which statement describes the force exerted by the man on the floor?

A It is equal to the weight of the man.

B It is greater than the force exerted by the floor on the man.

C It is less than the force exerted by the floor on the man.

D It is less than the weight of the man.

2. Nov/2023/Paper_ 9702/11/No.8

A ball of mass 200 g is thrown horizontally with a speed of $20\,m\,s^{-1}$ against a vertical wall.

The ball is in contact with the wall for a time of 0.10 s before rebounding back along its original path with a speed of $10\,m\,s^{-1}$.

What is the average force exerted by the wall on the ball during the collision?

A 20 N **B** 60 N **C** 20 kN **D** 60 kN

3. Nov/2023/Paper_ 9702/11/No.9

In an experiment, a metal ball is dropped into a viscous liquid. The terminal velocity of the ball in the liquid is measured.

The experiment is repeated four times. For each repeat, a change is made to one of the following.

1 the density of the metal of the ball

2 the height from which the ball is dropped

3 the density of the liquid

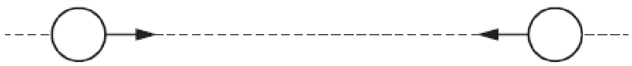
4 the depth of the liquid

Which two changes separately affect the terminal velocity of the ball in the liquid?

A 1 and 2 **B** 1 and 3 **C** 2 and 4 **D** 3 and 4

4. Nov/2023/Paper_ 9702/11/No.10

Two objects move towards each other along the same straight line.



After colliding, the two objects stick together and are stationary.

Which statement **must** be correct?

A The total kinetic energy of the two objects does not change during the collision.

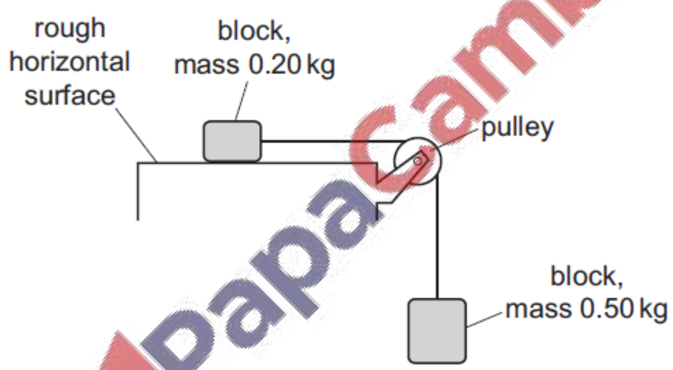
B The total momentum of the two objects before the collision is zero.

C The two objects have equal mass.

D The two objects have the same speed before the collision.

5. Nov/2023/Paper_ 9702/12/No.7

Two blocks, of mass 0.20 kg and 0.50 kg, are connected by a light inextensible string that passes over a frictionless pulley.



The blocks are initially held stationary. The block of mass 0.20 kg rests on a rough horizontal surface.

The block of mass 0.50 kg is suspended in air. Air resistance is negligible.

When the blocks are released, they have an acceleration of magnitude 2.0 $m\,s^{-2}$.

What is the magnitude of the frictional force between the block of mass 0.20 kg and the rough surface?

A 3.5 N **B** 3.9 N **C** 4.5 N **D** 6.3 N

6. Nov/2023/Paper_ 9702/12/No.8

A resultant force causes an object to accelerate.

What is equal to the resultant force?

A the acceleration of the object per unit mass

B the change in kinetic energy of the object per unit time

C the change in momentum of the object per unit time

D the change in velocity of the object per unit time

7. Nov/2023/Paper_ 9702/12/No.9

An object falls from a stationary helicopter and reaches terminal velocity.

What happens to the acceleration of the object between leaving the helicopter and reaching terminal velocity?

A It decreases to $9.81\,m\,s^{-2}$.

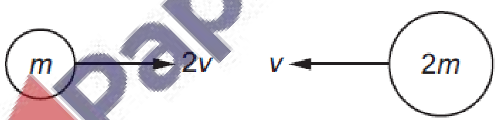
B It decreases to zero.

C It increases to $9.81\,m\,s^{-2}$.

D It remains constant at $9.81\,m\,s^{-2}$.

8. Nov/2023/Paper_ 9702/12/No.10

Two balls, of masses m and $2m$, travelling in a vacuum with initial velocities $2v$ and v respectively, collide with each other head-on, as shown.



After the collision, the ball of mass m rebounds to the left with velocity v.

What is the loss of kinetic energy in the collision?

A $\frac{3}{4}mv^2$ **B** $\frac{3}{2}mv^2$ **C** $\frac{9}{4}mv^2$ **D** $\frac{9}{2}mv^2$

9. Nov/2023/Paper_ 9702/13/No.6

The time taken for an object to fall from rest through a certain distance on Mars is T_M. The time taken for the same object to fall from rest through the same distance on Earth is T_E. The acceleration of free fall on Mars is $3.71\,m\,s^{-2}$.

Assume that air resistance is negligible on both Earth and Mars.

What is the ratio $\frac{T_M}{T_E}$?

A 0.378 **B** 0.615 **C** 1.63 **D** 2.64

10. Nov/2023/Paper_ 9702/13/No.7

Which statement about mass is correct?

A Mass has a magnitude and a direction.

B Mass resists changes in motion.

C The greater the mass of an object, the greater its acceleration when falling in a vacuum.

D The mass of an object depends on its location.

11. Nov/2023/Paper_ 9702/13/No.8

A snooker ball has a mass of 200 g. It hits the cushion of a snooker table and rebounds along its original path.

The ball arrives at the cushion with a speed of $14.0\,m\,s^{-1}$ and then leaves it with a speed of $7.0\,m\,s^{-1}$. The ball and the cushion are in contact for a time of 0.60 s.

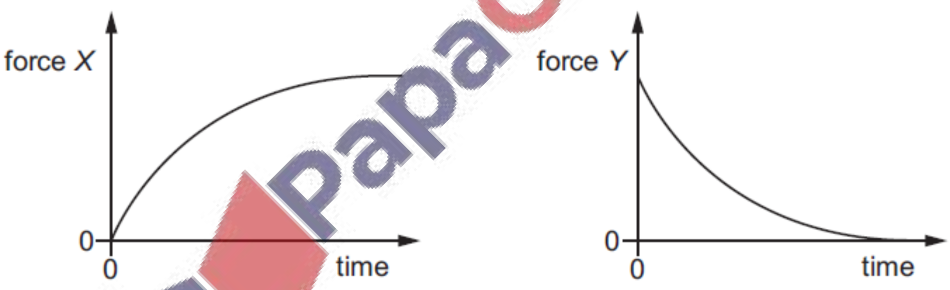
What is the average force exerted on the ball by the cushion?

A 1.4 N **B** 2.3 N **C** 4.2 N **D** 7.0 N

12. Nov/2023/Paper_ 9702/13/No.9

A ball falls from rest through air and eventually reaches a constant velocity.

For this fall, forces *X* and *Y* vary with time as shown.



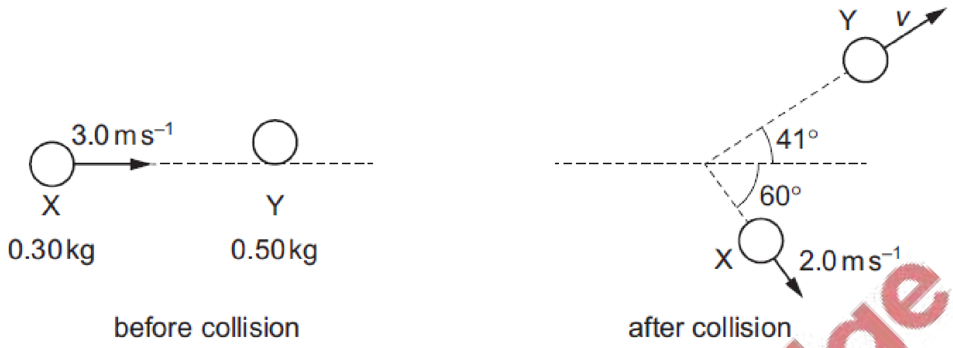
What could be forces *X* and *Y*?

	force *X*	force *Y*
A	air resistance	resultant force
B	air resistance	weight
C	upthrust	resultant force
D	upthrust	weight

13. Nov/2023/Paper_ 9702/13/No.10

An object X of mass 0.30 kg is travelling in a straight line at a constant velocity of 3.0 m s^{-1} on a horizontal frictionless surface. Object X collides with a stationary object Y of mass 0.50 kg.

After the collision, X moves with a velocity of 2.0 m s^{-1} at an angle of 60° to its direction before the collision. Object Y moves with a velocity *v* at an angle of 41° to the direction of X before the collision, as shown.



What is the value of *v*?

A 0.80 m s^{-1} **B** 1.2 m s^{-1} **C** 1.6 m s^{-1} **D** 1.8 m s^{-1}

14. Nov/2023/Paper_ 9702/21/No.3

A trolley A moves along a horizontal surface at a constant velocity towards another trolley B which is moving at a lower constant speed in the same direction. Fig. 3.1 shows the trolleys at time $t = 0$.

Fig. 3.1

Table 3.1 shows data for the trolleys.

Table 3.1

trolley	mass / kg	initial speed / m s^{-1}
A	0.25	0.48
B	0.75	0.12

The two trolleys collide elastically and then separate. Resistive forces are negligible.

Fig. 3.2 shows the variation with time t of the velocity v for trolley B.

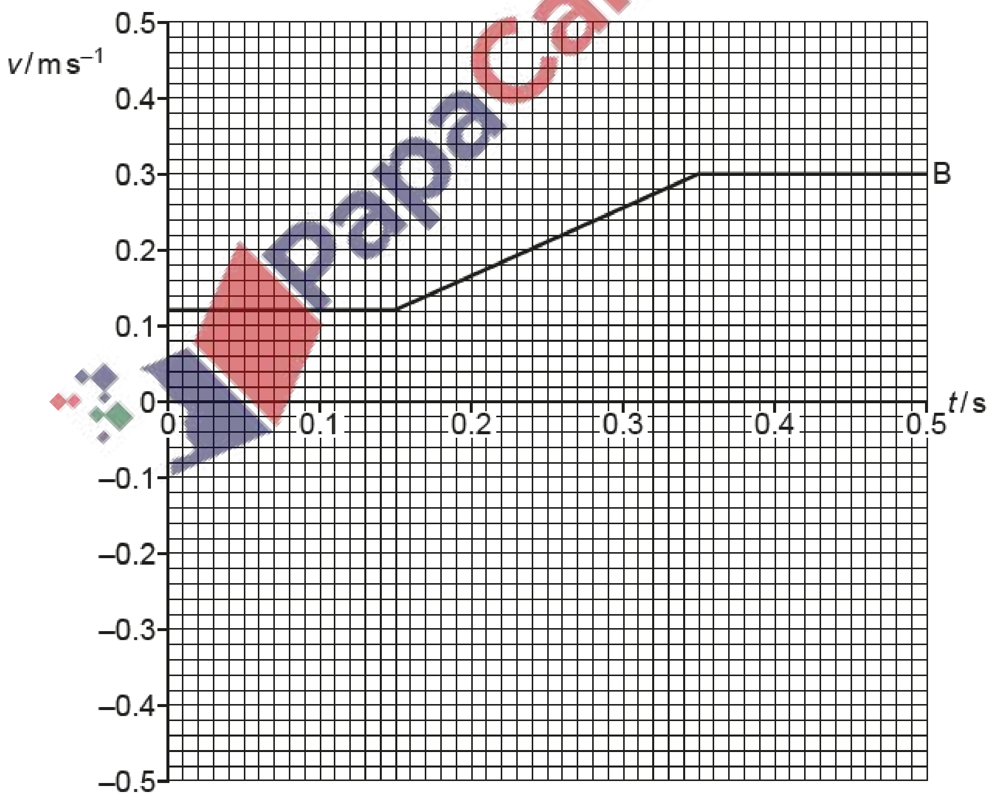


Fig. 3.2

(a) State what is represented by the area under a velocity–time graph.

.... [1]

(b) Use Table 3.1 and Fig. 3.2 to determine:

(i) the acceleration of trolley B during the collision

acceleration of B = ... $m\,s^{-2}$ [2]

(ii) the magnitude and direction of the final velocity of trolley A.

magnitude = ... $m\,s^{-1}$

direction ....

[3]

(c) On Fig. 3.2, sketch the variation of the velocity of trolley A with time *t* from *t* = 0 to *t* = 0.50 s. [3]

[Total: 9]

15. Nov/2023/Paper_ 9702/22/No.2(b, c)

A high-altitude balloon is stationary in still air. A solid sphere is suspended from the balloon by a string, as shown in Fig. 2.1.

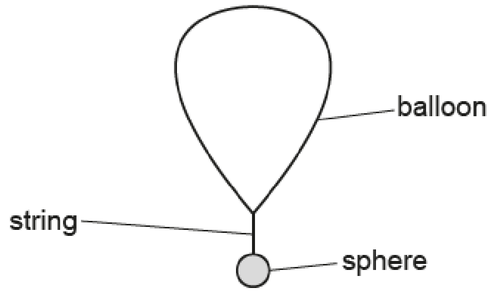


Fig. 2.1 (not to scale)

The volume of the balloon is 7.5 m^3. The total weight of the balloon, string and sphere is 65 N. The upthrust acting on the string and sphere is negligible.

(b) The string breaks, releasing the sphere.

(i) State the magnitude of the acceleration of the sphere immediately after the string breaks.

acceleration = ... $m s^{-2}$ [1]

(ii) State and explain the variation, if any, in the magnitude of the acceleration of the sphere when it is moving downwards **before** it reaches terminal (constant) velocity.

....

....

....

....

....

....

.... [3]

(c) The sphere has a mass of 4.0 kg.

Calculate the total resistive force acting on the sphere at the instant when its acceleration is $1.9\,\text{m}\,\text{s}^{-2}$.

resistive force = ... N [2]

16. Nov/2023/Paper_ 9702/22/No.4

(a) A ball Y moves along a horizontal frictionless surface and collides with a ball Z, as illustrated in the views from above in Fig. 4.1 and Fig. 4.2.

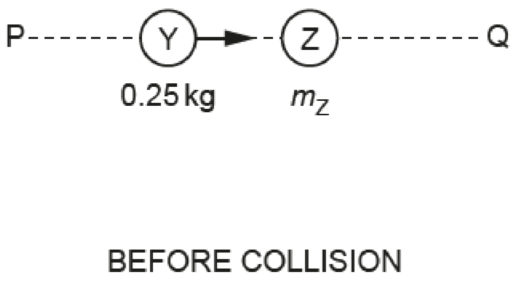


Fig. 4.1 (not to scale)

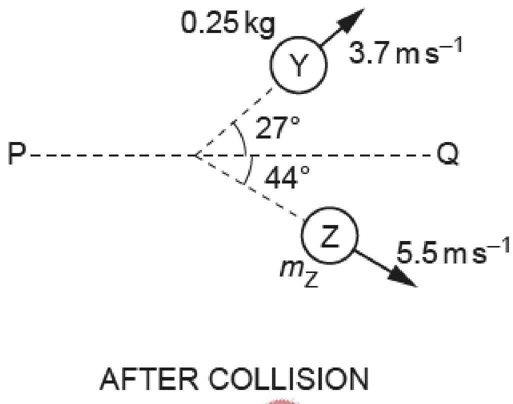


Fig. 4.2 (not to scale)

Ball Y has a mass of 0.25 kg and initially moves along a line PQ.
Ball Z has a mass m_Z and is initially stationary.

After the collision, ball Y has a final velocity of 3.7 m s^{-1} at an angle of 27° to line PQ and ball Z has a final velocity of 5.5 m s^{-1} at an angle of 44° to line PQ.

(i) Calculate the component of the final momentum of ball Y in the direction perpendicular to line PQ.

component of momentum = ... N s [2]

(ii) By considering the component of the final momentum of each ball in the direction perpendicular to line PQ, calculate m_Z.

m_Z = ... kg [1]

(iii) During the collision, the average force exerted on Y by Z is F_Y and the average force exerted on Z by Y is F_Z.

Compare the magnitudes and directions of F_Y and F_Z. Numerical values are not required.

magnitudes: ....

directions: ....

[2]

(b) Two blocks, A and B, move directly towards each other along a horizontal frictionless surface, as shown in the view from above in Fig. 4.3.

Fig. 4.3

The blocks collide perfectly elastically. Before the collision, block A has a speed of 4 m s^{-1} and block B has a speed of 6 m s^{-1}. After the collision, block B moves back along its original path with a speed of 2 m s^{-1}.

Calculate the speed of block A after the collision.

speed = ... m s^{-1} [1]

[Total: 6]

17. Nov/2023/Paper_ 9702/23/No.3(c)

(c) At a certain time, the airship in **(b)** is stationary. The thrust force exerted by a fan on the airship is 2800 N.

To produce this force, a mass of 64 kg of air is propelled through the blades of the fan in a time of 0.50 s. Assume that this air is initially stationary at the entrance to the fan.

Calculate:

(i) the change in momentum Δp of the air propelled through the fan blades in this time

Δp = ... $kg\,m\,s^{-1}$ [2]

(ii) the speed of the air as it leaves the fan

speed = ... $m\,s^{-1}$ [2]

(iii) the total kinetic energy of this air due to its movement through the fan.

kinetic energy = ... J [2]