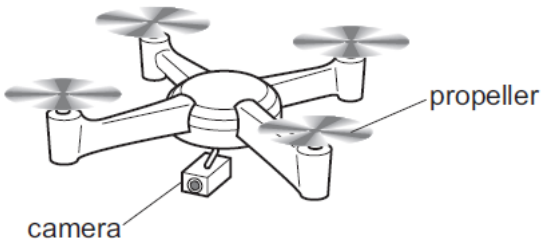
Dynamics – 2023 June AS Physics 9702

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

A camera drone of mass 1.20 kg hovers at a fixed point above the ground. The drone has four propellers.



In a time of 1.00 s, each propeller pushes a mass of 0.400 kg of air vertically downwards.

Assume that the air above the propellers is stationary.

What is the speed of the air leaving each propeller?

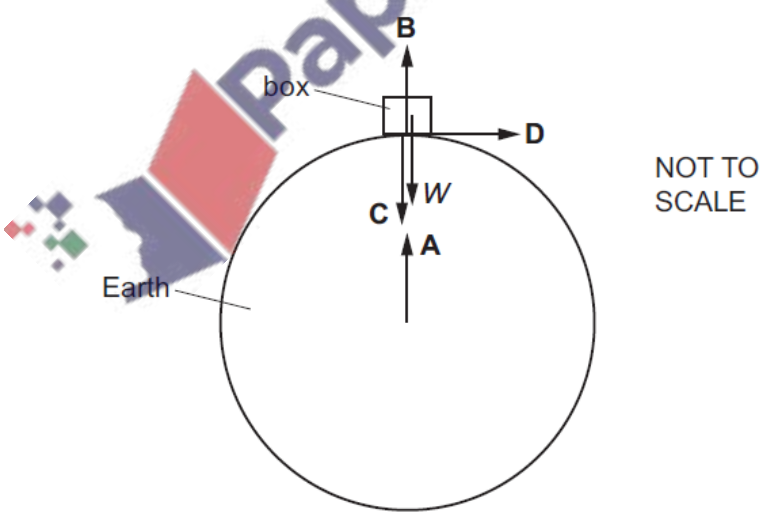
A $0.750\,m\,s^{-1}$ **B** $3.00\,m\,s^{-1}$ **C** $7.36\,m\,s^{-1}$ **D** $29.4\,m\,s^{-1}$

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

A box rests on the Earth, as shown.

Newton's third law describes how forces of the same type act in pairs. One of the forces of a pair is the weight *W* of the box.

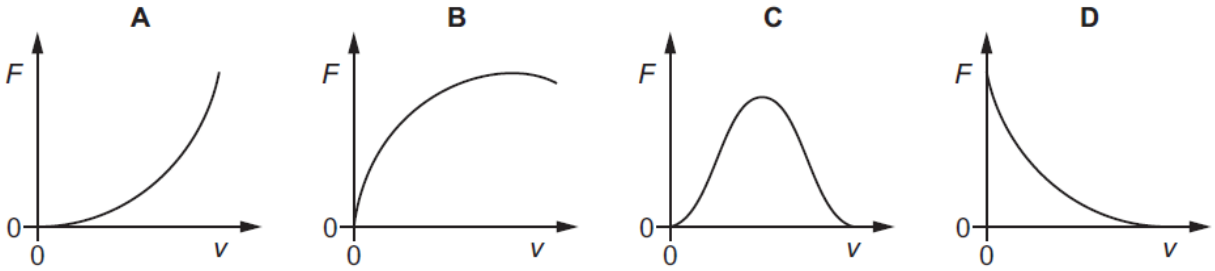
Which arrow represents the other force of this pair?



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

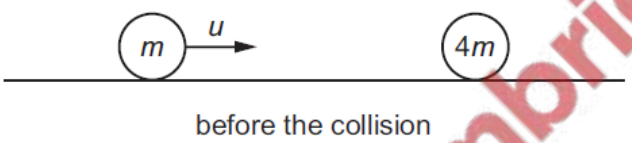
A small ball is held at the surface of liquid oil in a container. The ball is released from rest and falls through the oil. The ball has velocity v. A viscous (drag) force F acts on the ball.

Which graph could show the variation with v of F?



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

An object of mass m, moving at speed u along a frictionless horizontal surface, collides head-on with a stationary object of mass $4m$.



before the collision

After the collision, the object of mass m rebounds along its initial path with $\frac{1}{4}$ of its kinetic energy before the collision.

What is the speed of the object of mass $4m$ after the collision?

A $\frac{u}{8}$ **B** $\frac{3u}{16}$ **C** $\frac{5u}{16}$ **D** $\frac{3u}{8}$

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

Which statement describes the mass of an object?

A the force the object experiences due to gravity

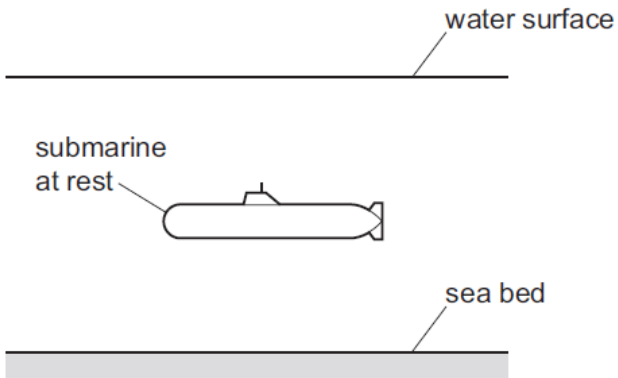
B the momentum of the object before a collision

C the resistance of the object to changes in motion

D the weight of the object as measured by a balance

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

A submarine of total mass 3200 kg is at rest underwater.



The total mass of the submarine is suddenly decreased by 200 kg by pumping water out of the submarine horizontally in a negligible time. The upthrust acting on the submarine is unchanged.

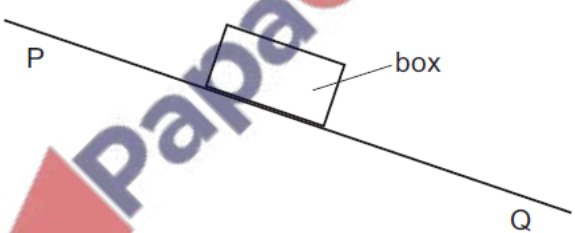
The change in the total weight of the submarine causes it to accelerate vertically upwards.

What is the initial upwards acceleration of the submarine?

A $0.613\,m\,s^{-2}$ **B** $0.654\,m\,s^{-2}$ **C** $9.81\,m\,s^{-2}$ **D** $10.5\,m\,s^{-2}$

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

A box in air slides with increasing speed down a rough slope from point P to point Q.



The slope surface exerts a constant frictional force on the box.

As the box moves from P to Q, there are changes to the magnitudes of its acceleration and the total resistive force acting on it.

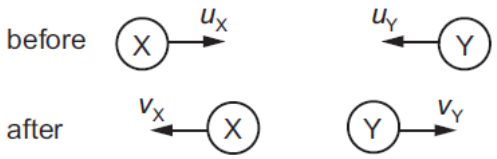
Which row describes the changes?

	magnitude of acceleration	magnitude of total resistive force
A	increases	decreases
B	decreases	decreases
C	increases	increases
D	decreases	increases

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

Two balls, X and Y, approach each other along the same straight line and collide. The collision is perfectly elastic.

Their initial speeds are u_X and u_Y respectively. After the collision they move apart with speeds v_X and v_Y respectively. Their directions are shown.



Which equation is correct?

A $u_X + u_Y = v_X + v_Y$

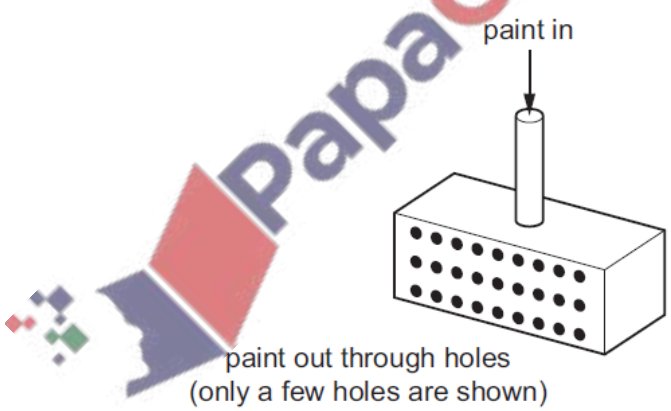
B $u_X + u_Y = v_X - v_Y$

C $u_X - u_Y = v_X + v_Y$

D $u_X - u_Y = v_X - v_Y$

9. June/2023/Paper_ 9702/13/No.7

A device for spraying paint consists of a box with its faces horizontal and vertical. One of its vertical faces contains small holes. Paint is fed into the box under pressure via a vertical tube and exits through the holes as fine streams moving horizontally.



The paint is ejected at a speed of $2.5\,m\,s^{-1}$ through 400 holes, each of area $0.4\,mm^2$. The density of the paint is $900\,kg\,m^{-3}$.

What is the horizontal force required to hold the device stationary as it ejects the paint?

A 0.36 N **B** 0.90 N **C** 2.3 N **D** 900 N

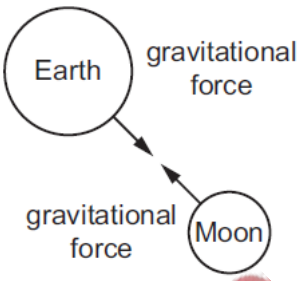
10. June/2023/Paper_ 9702/13/No.8

Each diagram illustrates a pair of forces of equal magnitude.

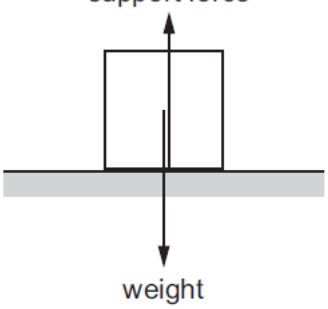
Which diagram gives an example of a pair of forces that is described by Newton's third law of motion?

A

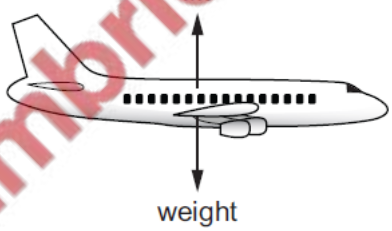
B



C



D



11. June/2023/Paper_ 9702/13/No.9

Two balls of identical shape and size but different masses are falling through the same liquid.

The sum of the drag force and upthrust acting on each ball is equal to its weight.

Which statement about the two balls is correct?

A The heavier ball has a larger acceleration than the lighter ball.

B The heavier ball has a smaller deceleration than the lighter ball.

C The heavier ball is falling at the same speed as the lighter ball.

D The heavier ball is falling at a larger speed than the lighter ball.

12. June/2023/Paper_ 9702/13/No.10

A perfectly elastic collision occurs between two objects X and Y. The mass of X is m and the mass of Y is $4m$. Object X travels at speed v before the collision and speed $\frac{3v}{5}$ in the opposite direction after the collision. Object Y is stationary before the collision.

What is the kinetic energy of Y after the collision?

A $\frac{8}{10}mv^2$ **B** $\frac{34}{50}mv^2$ **C** $\frac{16}{50}mv^2$ **D** $\frac{1}{5}mv^2$

13. June/2023/Paper_ 9702/21/No.3

A block is pulled in a straight line along a rough horizontal surface by a varying force X, as shown in Fig. 3.1.

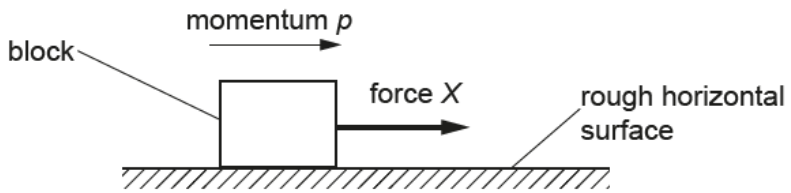


Fig. 3.1

Air resistance is negligible. Assume that the frictional force exerted on the block by the surface is constant and has magnitude 2.0 N.

The variation with time t of the momentum p of the block is shown in Fig. 3.2.

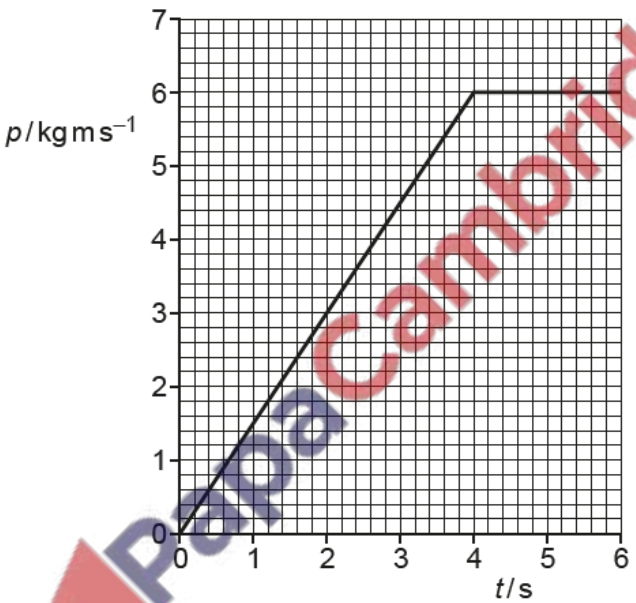


Fig. 3.2

(a) State Newton's second law of motion.

.....

..... [1]

(b) Use Fig. 3.2 to determine, for the block at time $t = 2.0\,s$, the magnitude of:

(i) the resultant force on the block

resultant force = ... N [1]

(ii) the force X.

X = ... N [1]

(c) On Fig. 3.3, sketch a graph to show the variation of force X with time t from $t = 0$ to $t = 6.0\,s$.

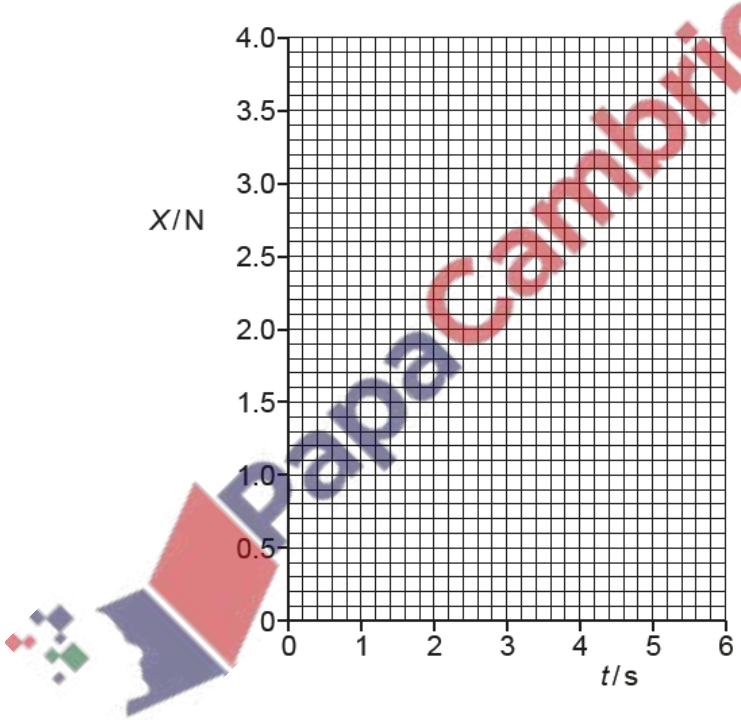


Fig. 3.3

[3]

[Total: 6]

A block is pulled by a force X in a straight line along a rough horizontal surface, as shown in Fig. 3.1.

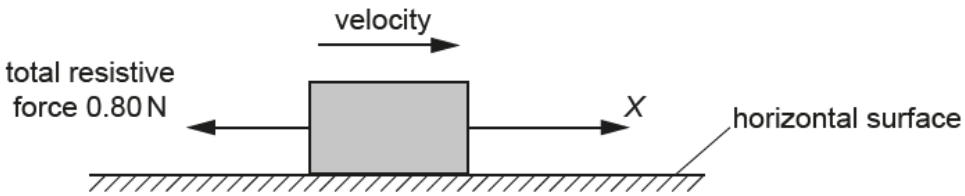


Fig. 3.1

Assume that the total resistive force opposing the motion of the block is 0.80 N at all speeds of the block.

The variation with time t of the magnitude of the force X is shown in Fig. 3.2.

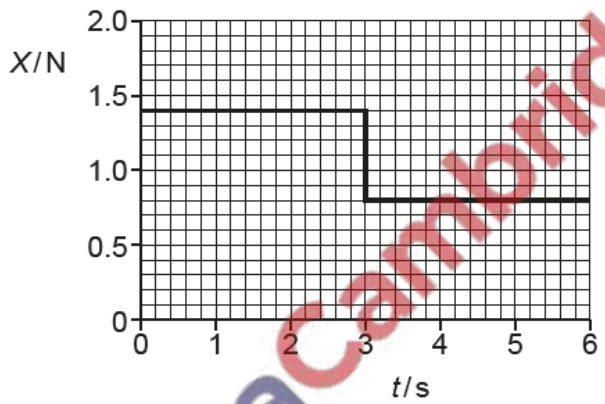


Fig. 3.2

(a) (i) Define force.

.....

..... [1]

(ii) Determine the change in momentum of the block from time $t = 0$ to time $t = 3.0$ s.

change in momentum = ... kg m s^{-1} [2]

(b) **(i)** Describe and explain the motion of the block between time $t = 3.0\,s$ and time $t = 6.0\,s$.

.....

.....

.....

..... [2]

(ii) Force X produces a total power of 2.0 W when moving the block between time $t = 3.0\,s$ and time $t = 6.0\,s$.

Calculate the distance moved by the block during this time interval.

distance = ... m [3]

(c) The block is at rest at time $t = 0$.

On Fig. 3.3, sketch a graph to show the variation of the momentum of the block with time t from $t = 0$ to $t = 6.0\,s$.
Numerical values of momentum are not required.

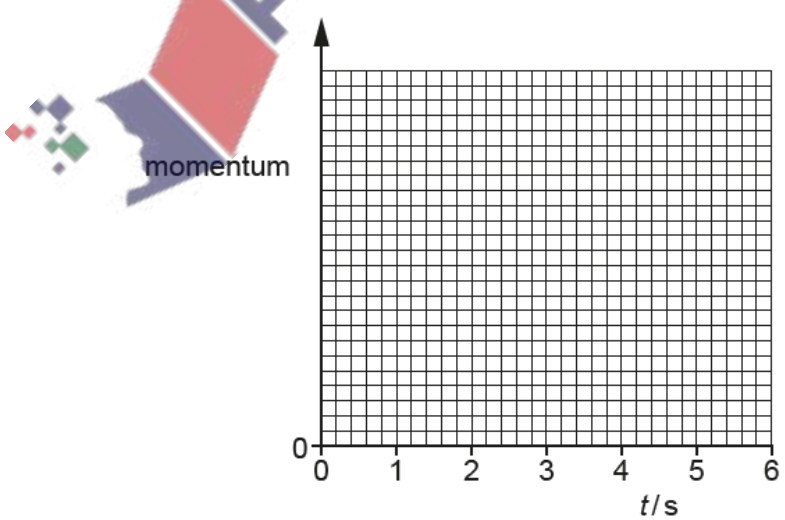


Fig. 3.3

[2]

[Total: 10]

(a) State the principle of conservation of momentum.

.....

.....

..... [2]

(b) A firework is initially stationary. It explodes into three fragments A, B and C that move in a horizontal plane, as shown in the view from above in Fig. 3.1.

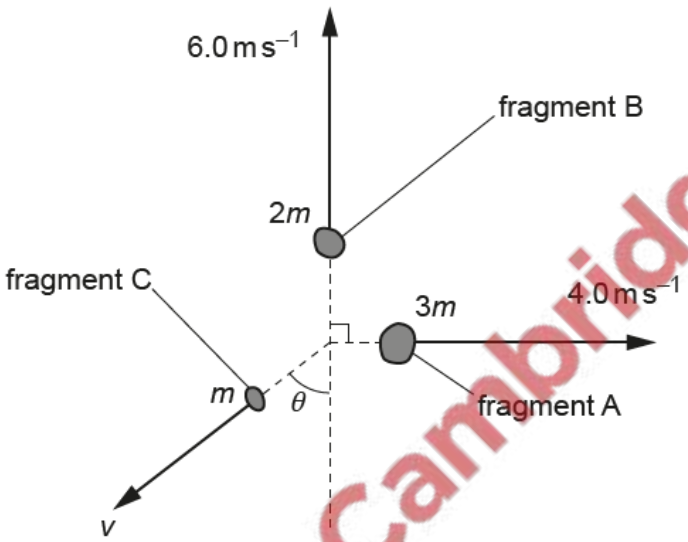


Fig. 3.1

Fragment A has a mass of $3m$ and moves away from the explosion at a speed of $4.0\,m\,s^{-1}$.

Fragment B has a mass of $2m$ and moves away from the explosion at a speed of $6.0\,m\,s^{-1}$ at right angles to the direction of A.

Fragment C has a mass of m and moves away from the explosion at a speed v and at an angle θ as shown in Fig. 3.1.

Calculate:

(i) the angle θ

$\theta =$ .....° [3]

(ii) the speed v.

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

(c) The firework in **(b)** contains a chemical that has mass 5.0 g and has chemical energy per unit mass 700 $J\,kg^{-1}$. When the firework explodes, all of the chemical energy is transferred to the kinetic energy of fragments A, B and C.

(i) Show that the total chemical energy in the firework is 3.5 J.

[1]

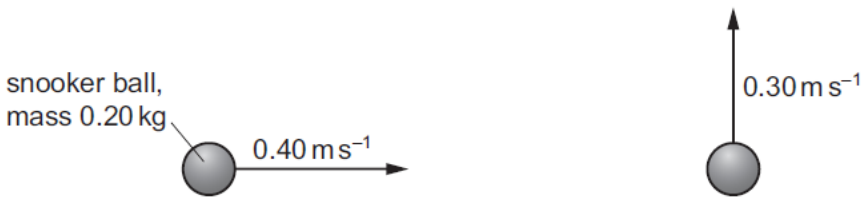
(ii) Calculate the mass m.

m = ... kg [3]

[Total: 11]

16. March/2023/Paper_ 9702/12/No.4

A snooker ball of mass 0.20 kg has a collision so that its direction of movement changes by an angle of 90°, as shown.



before the collision　　after the collision

The ball has a speed of 0.40 m s^{-1} before the collision and a speed of 0.30 m s^{-1} after the collision.

What is the **magnitude** of the change in momentum of the snooker ball?

A 0.020 kg m s^{-1}

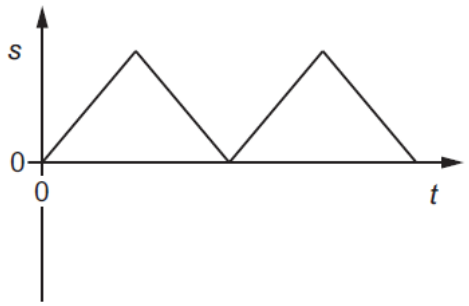
B 0.10 kg m s^{-1}

C 0.14 kg m s^{-1}

D 0.50 kg m s^{-1}

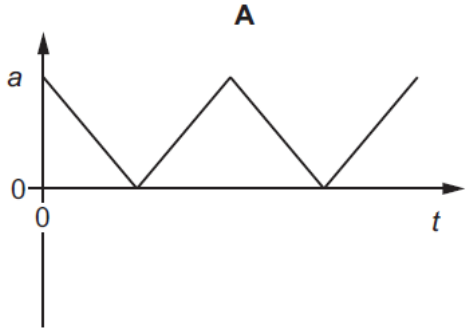
17. March/2023/Paper_ 9702/12/No.6

The graph shows the variation with time t of the displacement s of an object.

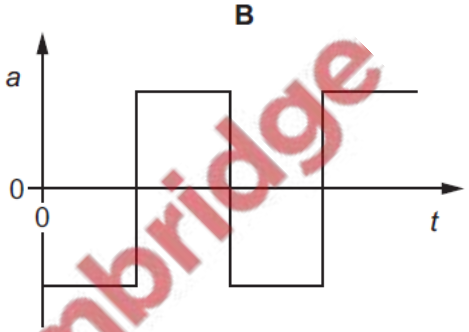


Which graph represents the variation with time t of the acceleration a of the object?

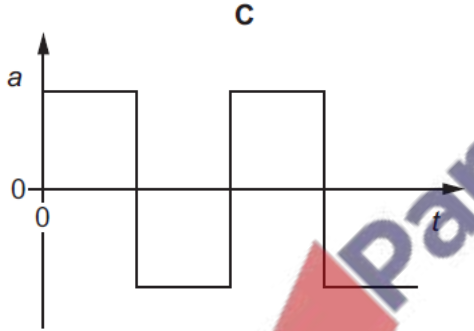
A



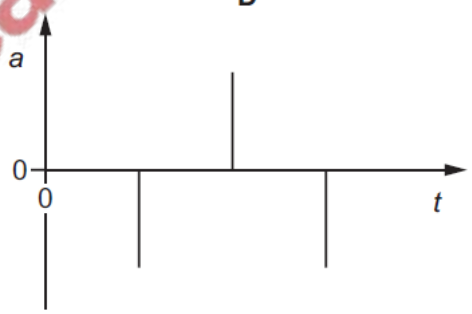
B



C



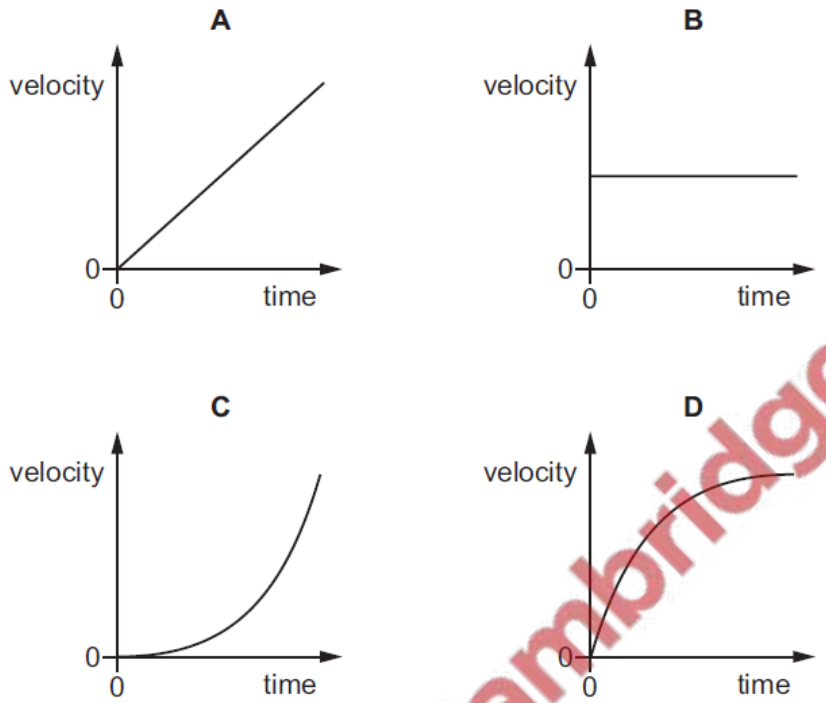
D



18. March/2023/Paper_ 9702/12/No.9

The velocity–time graphs of four different objects are shown.

Which graph represents an object falling from rest through a long distance in the Earth's atmosphere?



19. March/2023/Paper_ 9702/12/No.10

Which statement about collisions is correct?

A Kinetic energy is conserved in all collisions.

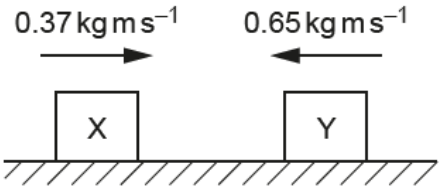
B Momentum is only conserved in perfectly elastic collisions.

C The relative speed of approach is equal to the relative speed of separation for perfectly elastic collisions.

D When two objects of different masses collide, they exert forces of different magnitudes on each other.

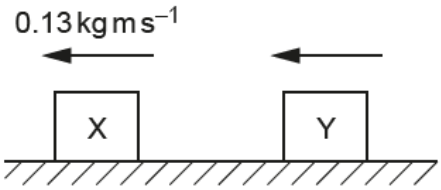
20. March/2023/Paper_ 9702/22/No.4

Two blocks slide directly towards each other along a frictionless horizontal surface, as shown in Fig. 4.1. The blocks collide and then move as shown in Fig. 4.2.



BEFORE COLLISION

Fig. 4.1



AFTER COLLISION

Fig. 4.2

Block X initially moves to the right with a momentum of $0.37\,kg\,m\,s^{-1}$. Block Y initially moves to the left with a momentum of $0.65\,kg\,m\,s^{-1}$. After the blocks collide, block X moves to the left back along its original path with a momentum of $0.13\,kg\,m\,s^{-1}$. Block Y also moves to the left after the collision.

(a) Block X has an initial kinetic energy of 0.30 J.

Calculate the mass of block X.

mass = ... kg [3]

(b) Determine the magnitude of the momentum of block Y after the collision.

momentum = ... $kg\,m\,s^{-1}$ [1]

(c) Block X exerts an average force of 7.7 N on block Y during the collision.

Calculate the time that the blocks are in contact with each other.

time = ... s [2]

[Total: 6]