Past-paper walk-through

Momentum ▪ 1.6

eXercise

Questions in this set

- 0625/21 N25 Q7 ▪ 1 mark
- 0625/22 N25 Q6 ▪ 1 mark
- 0625/23 N25 Q8 ▪ 1 mark
- 0625/43 N25 Q2 ▪ 5 marks
- 0625/21 J24 Q6 ▪ 1 mark
- 0625/41 J24 Q2 ▪ 8 marks
- 0625/21 N23 Q7 ▪ 1 mark
- 0625/41 N23 Q1 ▪ 9 marks

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 7

0625/21 N25 ▪ Q7 ▪ 1 mark

7 The momentum of a car changes from 10 000 kg m/s to 15 000 kg m/s in a time of 8.0 s.

What is the resultant force acting on the car?

A 630 N **B** 3100 N **C** 40 000 N **D** 200 000 N

Solution 7

Answer: **A**

Why

- Force is the rate of change of momentum, $F = \Delta p / \Delta t$.
- The momentum changes by $15\,000 - 10\,000 = 5000$ kg m/s.
- $F = 5000/8.0 = 630$ N.

Question 6

0625/22 N25 ▪ Q6 ▪ 1 mark

6 Diagram 1 shows a ball X of mass 0.15 kg travelling horizontally with a velocity of 2.1 m/s towards ball Y travelling at 0.4 m/s in the opposite direction.

Diagram 2 shows the velocities of the balls immediately after they collide.

diagram 1

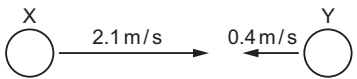
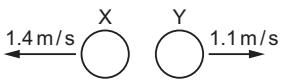


diagram 2



What is the mass of ball Y?

Question 6

A 0.15 kg **B** 0.19 kg **C** 0.35 kg **D** 0.79 kg

Solution 6

Answer: **C**

Why

- Momentum is conserved, so the total before the collision equals the total after.
- Take one direction as positive, which makes the opposing velocity negative.
- Total before $= 0.15(2.1) + m_Y(-0.4)$; set that equal to the total afterwards and solve.

Question 8

0625/23 N25 ▪ Q8 ▪ 1 mark

8 A ball is at rest on the ground. A boy kicks the ball. The boy's boot is in contact with the ball for a time of 0.040 s.

The average force on the ball is 200 N. The ball leaves the boy's boot with a speed of 20 m/s.

Which row gives the impulse of the boot on the ball and the average acceleration of the ball during the time of 0.040 s?

	impulse on ball / Ns	average acceleration of ball / m/s^2
A	8	0.8
B	8	500
C	5000	0.8
D	5000	500

Question 8

Solution 8

Answer: **B**

Why

- Impulse equals the change in momentum: $Ft = mv$.
- $200 \times 0.040 = 8.0$ kg m/s.
- The ball starts at rest, so $mv = 8.0$ – divide by the ball's mass to get its speed.

Question 2

0625/43 N25 ▪ Q2 ▪ 5 marks

2 A cricket ball is travelling at a speed of 25 m/s horizontally through the air. The mass of the ball is 0.14 kg.

A player catches the ball and the ball comes to rest.

(a) Calculate the change in momentum of the ball during the catch.

Question 2

(b) The player's hands are in contact with the moving ball for 9.7 ms.

Calculate the horizontal force exerted by her hands to bring the ball to rest.

Question 2

[Total: 5]

Solution 2

(a)

Mark scheme

- (–) 3.5 kgm / s
- (Δp =) m(Δ)u OR m{v – u} OR 0.14 × {25 (– 0)}

Solution 2

(b)

Mark scheme

- 360 N
- 0.0097 (s) OR 9.7 $\times$ 10–3 (s) OR 3.6 $\times$ 10n
- (F =) (Δ)p / t OR 3.5 / 0.0097

Question 6

0625/21 J24 ▪ Q6 ▪ 1 mark

6 A ball of mass m falls vertically and hits a hard surface.

Its speed on hitting the surface is v_1.

It rebounds vertically upwards with speed v_2.

What is the change in momentum of the ball?

A mv_1 **B** mv_2 **C** $m(v_1 + v_2)$ **D** $m(v_2 - v_1)$

Solution 6

Answer: **C**

Why

- Momentum is a vector, so the direction matters.
- Taking downwards as positive, the momentum changes from $+mv_1$ to $-mv_2$.
- The change is $-mv_2 - mv_1$, whose magnitude is $m(v_1 + v_2)$ – the speeds add because the ball reverses.

Question 2

0625/41 J24 ▪ Q2 ▪ 8 marks

2 Fig. 2.1 shows two identical trolleys, P and Q, held at rest on a frictionless horizontal surface. A load is fixed to trolley P.

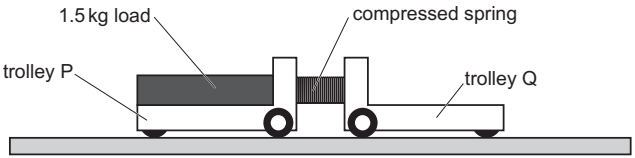


Fig. 2.1

There is a compressed spring between trolley P and trolley Q.

The trolleys are released. As the spring expands, it pushes the trolleys apart.

Question 2

Trolley Q moves to the right at a constant speed of 0.36 m / s.

The mass of each trolley is 1.2 kg. The mass of the load on trolley P is 1.5 kg.

The spring has negligible mass.

(a) Calculate:

(i) the speed at which trolley P moves to the left

Question 2

(ii) the kinetic energy of trolley Q when it moves at 0.36 m / s.

Question 2

(b) State the energy transfer that takes place as the spring expands.

Question 2

[Total: 8]

Solution 2

(a)(i)

Mark scheme

- 0.16 m / s
- conservation of momentum OR mP vP = mQvQ OR 2.7 × vP = 1.2 × 0.36 OR (mQvQ =) 0.432 seen
- (vP =) mQvQ / mP OR 1.2 × 0.36 / 2.7

Solution 2

(a)(ii)

Mark scheme

- 0.078 J
- (k.e. =) ½mv2 OR (k.e. =) ½ × 1.2 × 0.362
- (k.e. =) ½ × 1.2 × 0.362

Solution 2

(b)

Mark scheme

- (from) elastic (energy store in the compressed spring)
- to kinetic (as final energy store of trolleys)

Question 7

0625/21 N23 ▪ Q7 ▪ 1 mark

7 A sphere X collides head on with a second identical sphere Y which is stationary.

The mass of each sphere is 0.15 kg.

Sphere X is travelling at a velocity of 2.0 m/s before the collision and produces an impulse of 0.21 N s on sphere Y.

What is the velocity of sphere X after collision?

A 0.60 m/s in the opposite direction to Y

B 0.60 m/s in the same direction as Y

C 1.4 m/s in the opposite direction to Y

D 1.4 m/s in the same direction as Y

Solution 7

Answer: **B**

Why

- Impulse equals the change in momentum, $Ft = \Delta(mv)$.
- X's momentum before the collision is $0.15 \times 2.0 = 0.30$ kg m/s.
- Momentum is conserved, so whatever X loses Y gains – the impulse on Y is the momentum transferred to it.

Question 1

0625/41 N23 ▪ Q1 ▪ 9 marks

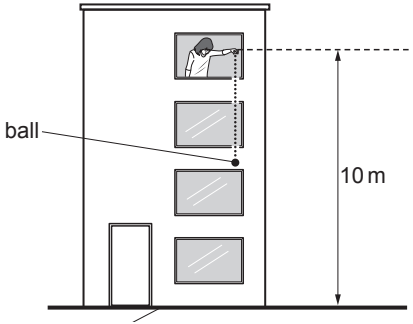
1 A girl holds a rubber ball out of a window of a tall building. The mass of the ball is 0.20 kg. The ball is at rest 10 m above a concrete path.

(a) Calculate the gravitational potential energy of the ball relative to the concrete path.

Question 1

(b) The girl releases the ball and it falls towards the path. The ball strikes the path and bounces vertically upwards.

Fig. 1.1 shows the ball falling towards the path.



Question 1

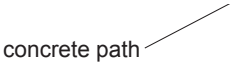


Fig. 1.1

The speed of the ball immediately **before** it strikes the path is 14 m/s.

The speed of the ball immediately **after** it strikes the path is 12 m/s.

(i) Calculate the kinetic energy of the ball immediately **after** it strikes the concrete path.

Question 1

Question 1

(ii) Show that the change in momentum of the ball when it bounces off the path is 5.2 kg m/s.

Question 1

[3]

(iii) The ball is in contact with the path for 0.25 s.

Calculate the average resultant force on the ball when it is in contact with the path.

Question 1

[Total: 9]

Solution 1

(a)

Mark scheme

- 20 J
- (Δ.Ep =) mg(Δ)h OR
- ( )
- 0.2 0 9.8 1 0
- ×
- ×

Solution 1

(b)(i)

Mark scheme

- 14 J
- (Ek =) ½mv2 OR ½ × 0.2(0) × 122

Solution 1

(b)(ii) Mark scheme

- p = mv OR (Δp =) mv−mu
- (Δp =)
- ( )
- 0.2 0
- 14
- 12
- ×
- +

Solution 1

- OR
- ( )
- 0.2 0
- {14
- 12
- ×
- −−
- }
- OR
- p before $= 0.2(0) \times 14$ AND p after $= 0.2(0) \times (-)12$

Solution 1

- ($\Delta p =$)
- 2.8
- 2.4
- $--$
- ($= 5.2\,\text{kg m / s}$) OR ($\Delta p =$)
- ( )
- 0.2 0
- 14
- 12
- $\times$

Solution 1

- ——

Solution 1

(b)(iii)

Mark scheme

- 21 N
- (F =) Δp / (Δ)t OR F = ( )mv / ( )t OR 5.2 / 0.25
- 0625/41
- October/November 2023