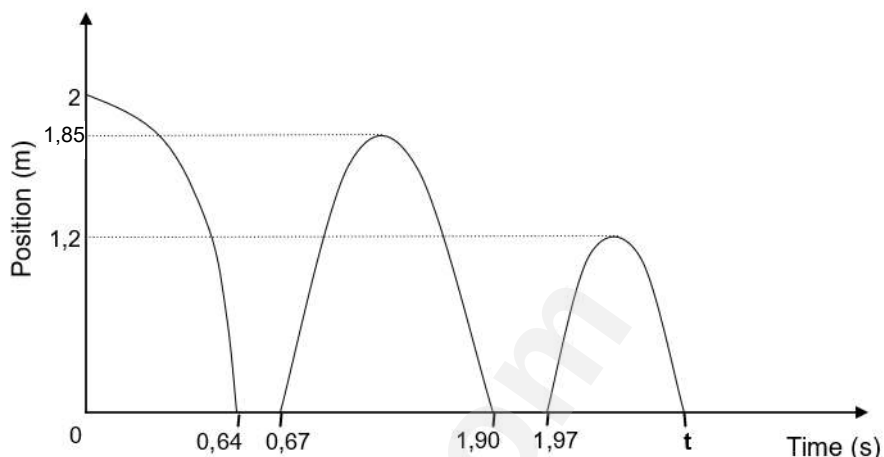




eduresourceza.com

QUESTION 16

A small ball is dropped from a height of 2 m and bounces a few times after landing on a cement floor. Ignore air friction. The position-time graph, not drawn to scale, represents the motion of the ball.



16.1 Define the term *free fall*. (2)

16.2 Use the graph and determine:

16.2.1 The time that the ball is in contact with the floor before the first bounce

16.2.2 The time it takes the ball to reach its maximum height after the first bounce

16.2.3 The speed at which the ball leaves the floor at the first bounce

16.2.4 Time t indicated on the graph

(2)

(2)

(3)

(6)

[15]**MOMENTUM AND IMPULSE****QUESTION 1**

Dancers have to learn many skills, including how to land correctly. A dancer of mass 50 kg leaps into the air and lands feet first on the ground. She lands on the ground with a velocity of $5 \text{ m}\cdot\text{s}^{-1}$. As she lands, she bends her knees and comes to a complete stop in 0,2 seconds.

1.1 Calculate the momentum with which the dancer reaches the ground. (3)

1.2 Define the term *impulse of a force*. (2)

1.3 Calculate the magnitude of the net force acting on the dancer as she lands. (3)

Assume that the dancer performs the same jump as before but lands without bending her knees.

1.4 Will the force now be GREATER THAN, SMALLER THAN or EQUAL TO the force calculated in QUESTION 1.3? (1)

1.5 Give a reason for the answer to QUESTION 1.4. (3)

[12]**QUESTION 2**

Percy, mass 75 kg, rides at $20 \text{ m}\cdot\text{s}^{-1}$ on a quad bike (motorcycle with four wheels) with a mass of 100 kg. He suddenly applies the brakes when he approaches a red traffic light on a wet and slippery road. The wheels of the quad bike lock and the bike slides forward in a straight line. The force of friction causes the bike to stop in 8 s.

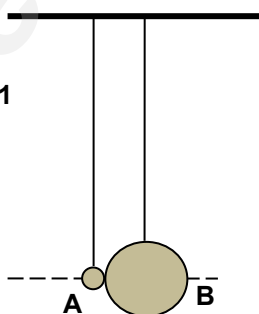
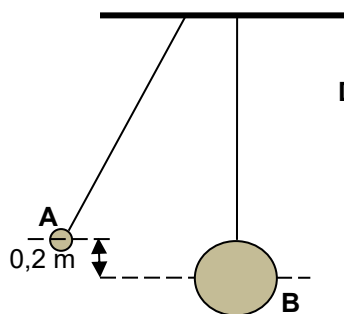
2.1 Define the concept *momentum* in words. (2)

2.2 Calculate the change in momentum of Percy and the bike, from the moment the brakes lock until the bike comes to a stop. (4)

2.3 Calculate the average frictional force exerted by the road on the wheels to stop the bike. (4)

[10]**QUESTION 3**

Two stationary steel balls, **A** and **B**, are suspended next to each other by massless, inelastic strings as shown in **Diagram 1** below.

Diagram 1**Diagram 2**

Ball **A** of mass 0,2 kg is displaced through a vertical distance of 0,2 m, as shown in **Diagram 2** above. When ball **A** is released, it collides elastically and head-on with ball **B**. Ignore the effects of air friction.

- 3.1 What is meant by an *elastic collision*? (2)
- Immediately after the collision, ball **A** moves horizontally backwards (to the left). Ball **B** acquires kinetic energy of 0,12 J and moves horizontally forward (to the right). Calculate the:
- 3.2 Kinetic energy of ball **A** just before it collides with ball **B** (Use energy principles only.) (3)
- 3.3 Speed of ball **A** immediately after the collision (4)
- 3.4 Magnitude of the impulse on ball **A** during the collision (5)

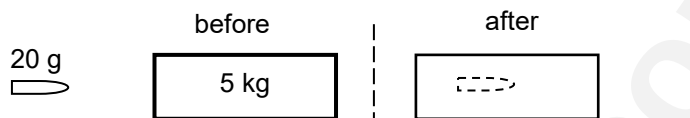
[14]

QUESTION 4

A bullet of mass 20 g is fired from a stationary rifle of mass 3 kg. Assume that the bullet moves horizontally. Immediately after firing, the rifle recoils (moves back) with a velocity of $1,4 \text{ m}\cdot\text{s}^{-1}$.

- 4.1 Calculate the speed at which the bullet leaves the rifle. (4)

The bullet strikes a stationary 5 kg wooden block **fixed** to a flat, horizontal table. The bullet is brought to rest after travelling a distance of 0,4 m **into the block**. Refer to the diagram below.

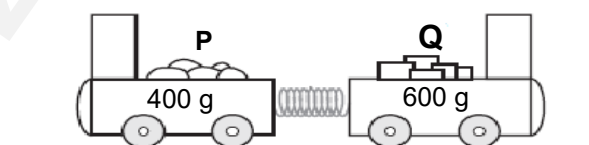


- 4.2 Calculate the magnitude of the average force exerted by the block on the bullet. (5)
- 4.3 How does the magnitude of the force calculated in QUESTION 3.2 compare to the magnitude of the force exerted by the bullet on the block? Write down only LARGER THAN, SMALLER THAN or THE SAME. (1)

[10]

QUESTION 5

The diagram shows two trolleys, **P** and **Q**, held together by means of a compressed spring on a flat, frictionless horizontal track. The masses of **P** and **Q** are 400 g and 600 g respectively. When the trolleys are released, it takes 0,3 s for the spring to unwind to its natural length. Trolley **Q** then moves to the right at $4 \text{ m}\cdot\text{s}^{-1}$.

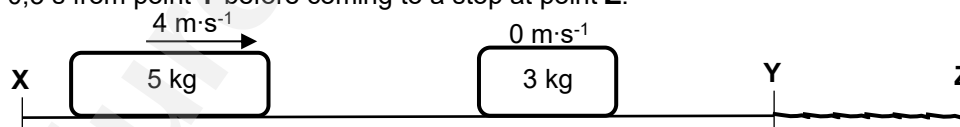


- 5.1 State the *principle of conservation of linear momentum* in words. (2)
- 5.2 Calculate the:
- 5.2.1 Velocity of trolley **P** after the trolleys are released (4)
- 5.2.2 Magnitude of the average force exerted by the spring on trolley **Q** (4)
- 5.3 Is this an elastic collision? Only answer YES or NO. (1)

[11]

QUESTION 6

The diagram below shows two sections, **XY** and **YZ**, of a horizontal, flat surface. Section **XY** is smooth, while section **YZ** is rough. A 5 kg block, moving with a velocity of $4 \text{ m}\cdot\text{s}^{-1}$ to the right, collides head-on with a stationary 3 kg block. After the collision, the two blocks stick together and move to the right, past point **Y**. The combined blocks travel for 0,3 s from point **Y** before coming to a stop at point **Z**.

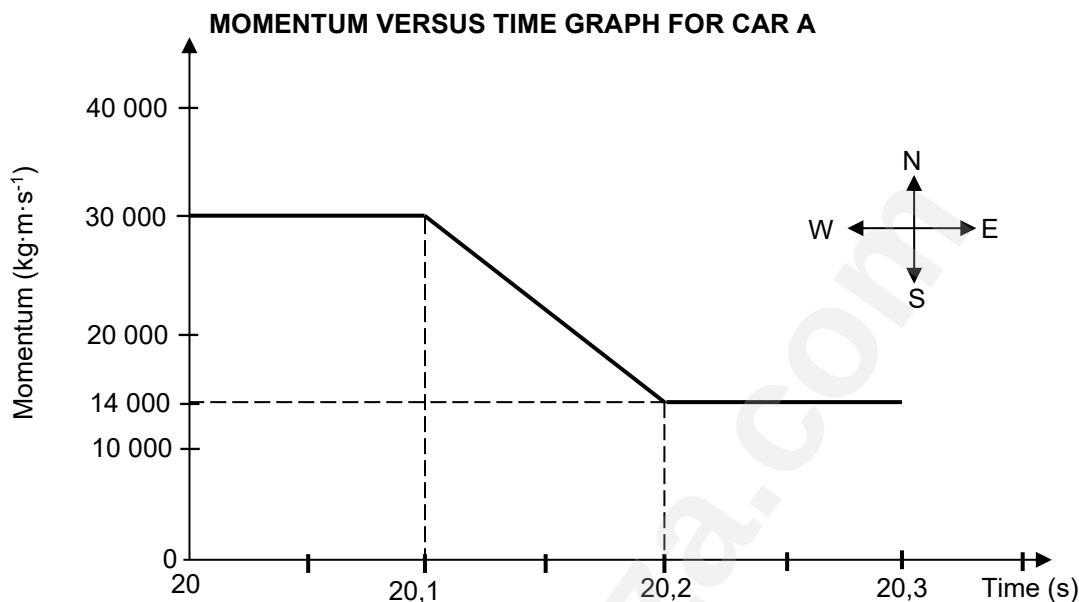


- 6.1 State the *principle of conservation of linear momentum* in words. (2)
- 6.2 Calculate the magnitude of the:
- 6.2.1 Velocity of the combined blocks at point **Y** (4)
- 6.2.2 Net force acting on the combined blocks when they move through section **YZ** (4)

[10]

QUESTION 7

The graph below shows how the momentum of car **A** changes with time *just before* and *just after* a head-on collision with car **B**. Car **A** has a mass of 1 500 kg, while the mass of car **B** is 900 kg. Car **B** was travelling at a constant velocity of $15 \text{ m}\cdot\text{s}^{-1}$ west before the collision. Take east as positive and consider the system as isolated.



7.1 What do you understand by the term *isolated system* as used in physics?

(1)

Use the information in the graph to answer the following questions.

7.2 Calculate the:

7.2.1 Magnitude of the velocity of car **A** just before the collision

(3)

7.2.2 Velocity of car **B** just after the collision

(5)

7.2.3 Magnitude of the net average force acting on car **A** during the collision

(4)

[13]**QUESTION 8**

A teacher demonstrates the principle of conservation of linear momentum using two trolleys. The teacher first places the trolleys, **A** and **B**, some distance apart on a flat frictionless horizontal surface, as shown in the diagram. The mass of trolley **A** is 3,5 kg and that of trolley **B** is 6,0 kg.

Trolley **A** moves towards trolley **B** at constant velocity. The table below shows the position of trolley **A** for time intervals of 0,4 s before it collides with trolley **B**.



RELATIONSHIP BETWEEN POSITION AND TIME FOR TROLLEY A				
Position of trolley A (m)	0	0,2	0,4	0,6
Time (s)	0	0,4	0,8	1,2

8.1 Use the table above to prove that trolley **A** is moving at constant velocity before it collides with trolley **B**.

(3)

8.2 State the *principle of conservation of linear momentum* in words.

(2)

At time $t = 1,2 \text{ s}$, trolley **A** collides with stationary trolley **B**. The collision time is 0,5 s after which the two trolleys move off together.

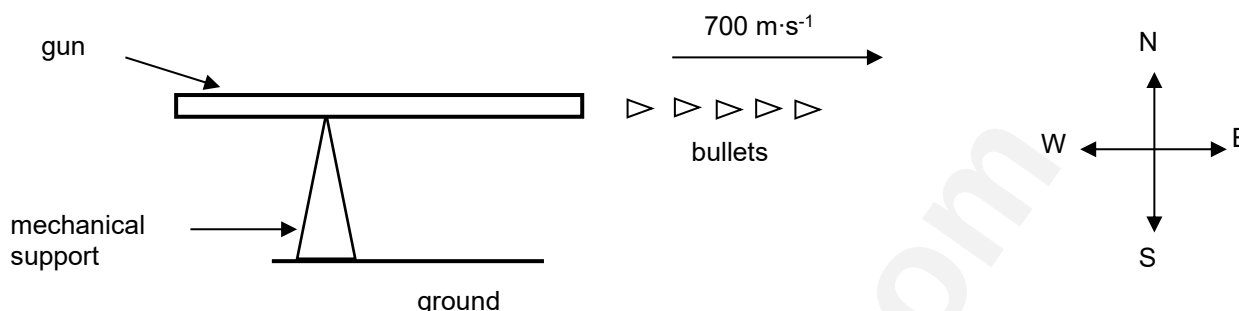
8.3 Calculate the magnitude of the average net force exerted on trolley **B** by trolley **A**.

(6)

[11]

QUESTION 9

- 9.1 Define the term *impulse* in words. (2)
- 9.2 The diagram below shows a gun mounted on a mechanical support which is fixed to the ground. The gun is capable of firing bullets rapidly in a horizontal direction. Each bullet travels at a speed of $700 \text{ m}\cdot\text{s}^{-1}$ in an easterly direction when it leaves the gun. (Take the initial velocity of a bullet, before being fired, as zero.)



The gun fires 220 bullets per minute. The mass of each bullet is $0,03 \text{ kg}$.

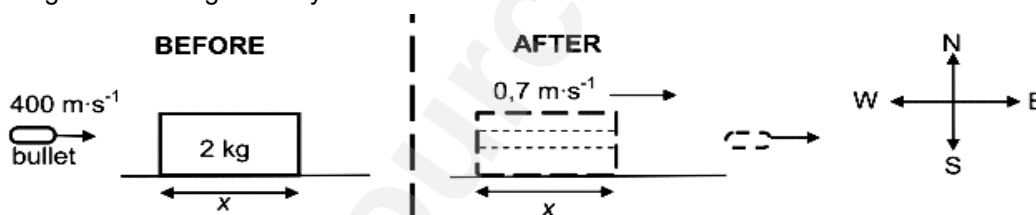
Calculate the:

- 9.2.1 Magnitude of the momentum of each bullet when it leaves the gun (3)
- 9.2.2 The net average force that each bullet exerts on the gun (5)
- 9.3 Without any further calculation, write down the net average horizontal force that the mechanical support exerts on the gun. (2)

[12]

QUESTION 10

A 2 kg block is at rest on a smooth, frictionless, horizontal table. The length of the block is x . A bullet of mass $0,015 \text{ kg}$, travelling east at $400 \text{ m}\cdot\text{s}^{-1}$, strikes the block and passes straight through it with constant acceleration. Refer to the diagram below. Ignore any loss of mass of the bullet and the block.



- 10.1 State the *principle of conservation of linear momentum* in words. (2)
- The block moves eastwards at $0,7 \text{ m}\cdot\text{s}^{-1}$ after the bullet has emerged from it.
- 10.2 Calculate the magnitude of the velocity of the bullet immediately after it emerges from the block. (4)
- 10.3 If the bullet takes $0,002 \text{ s}$ to travel through the block, calculate the length, x , of the block. (5)

[11]

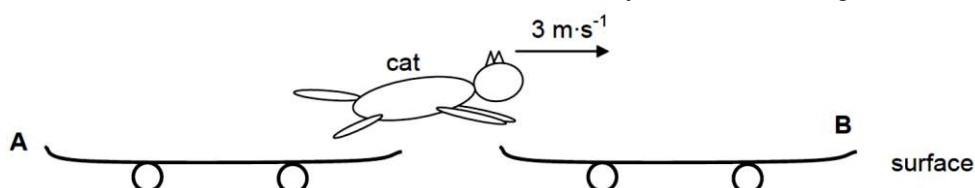
QUESTION 11

The diagram below shows two skateboards, **A** and **B**, initially at rest, with a cat standing on skateboard **A**. The skateboards are in a straight line, one in front of the other and a short distance apart. The surface is flat, frictionless and horizontal.



- 11.1 State the principle of conservation of linear momentum in words. (2)

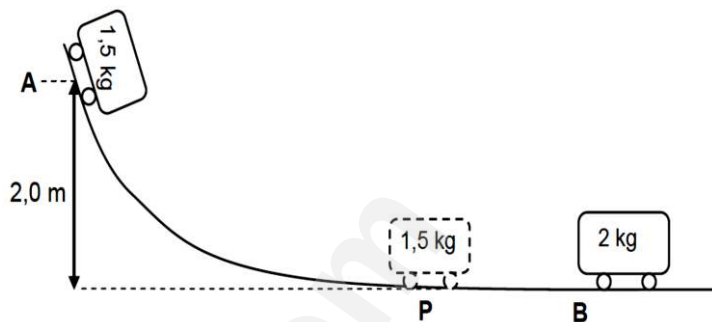
EACH skateboard has a mass of $3,5 \text{ kg}$. The cat, of mass $2,6 \text{ kg}$, jumps from skateboard **A** with a horizontal velocity of $3 \text{ m}\cdot\text{s}^{-1}$ and lands on skateboard **B** with the same velocity. Refer to the diagram below.



- 11.2 Calculate the velocity of skateboard **A** just after the cat has jumped from it. (5)
- 11.3 Immediately after the cat has landed, the cat and skateboard **B** move horizontally to the right at $1,28 \text{ m}\cdot\text{s}^{-1}$. Calculate the magnitude of the impulse on skateboard **B** as a result of the cat's landing. (3)
- [10]

QUESTION 12

A trolley of mass $1,5 \text{ kg}$ is held stationary at point **A** at the top of a frictionless track. When the $1,5 \text{ kg}$ trolley is released, it moves down the track. It passes point **P** at the bottom of the incline and collides with a stationary 2 kg trolley at point **B**. Refer to the diagram. Ignore air resistance and rotational effects.



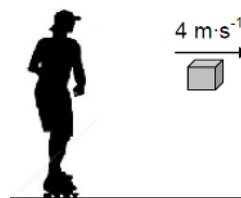
- 12.1 Use the principle of conservation of mechanical energy to calculate the speed of the $1,5 \text{ kg}$ trolley at point **P**. (4)

When the two trolleys collide, they stick together and continue moving with constant velocity.

- 12.2 The principle of conservation of linear momentum is given by the incomplete statement below.
In a/an ... system, the ... linear momentum is conserved.
Rewrite the complete statement and fill in the missing words or phrases. (2)
- 12.3 Calculate the speed of the combined trolleys immediately after the collision. (4)
- 12.4 Calculate the distance travelled by the combined trolleys in 3 s after the collision. (3)
- [13]

QUESTION 13

Initially a girl on roller skates is at rest on a smooth horizontal pavement. The girl throws a parcel, of mass 8 kg , horizontally to the right at a speed of $4 \text{ m}\cdot\text{s}^{-1}$. Immediately after the parcel has been thrown, the girl-roller-skate combination moves at a speed of $0,6 \text{ m}\cdot\text{s}^{-1}$. Ignore the effects of friction and rotation.

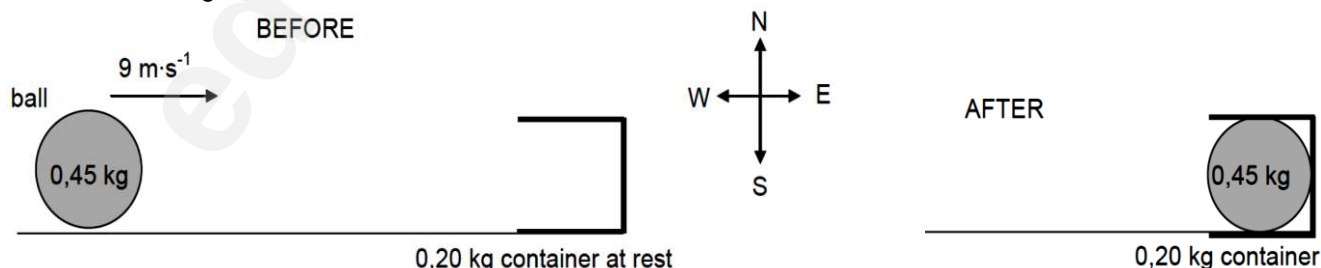


- 13.1 Define the term *momentum* in words. (2)
- 13.2 Will the girl-roller-skate combination move TO THE RIGHT or TO THE LEFT after the parcel is thrown? NAME the law in physics that can be used to explain your choice of direction. (2)
- The total mass of the roller skates is 2 kg .
- 13.3 Calculate the mass of the girl. (5)
- 13.4 Calculate the magnitude of the impulse that the girl-roller-skate combination is experiencing while the parcel is being thrown. (3)
- 13.5 Without any further calculation, write down the change in momentum experienced by the parcel while it is being thrown. (2)
- [14]

QUESTION 14

A soccer player kicks a ball of mass $0,45 \text{ kg}$ to the east. The ball travels horizontally at a velocity of $9 \text{ m}\cdot\text{s}^{-1}$ along a straight line, without touching the ground, and enters a container lying at rest on its side, as shown in the diagram below. The mass of the container is $0,20 \text{ kg}$.

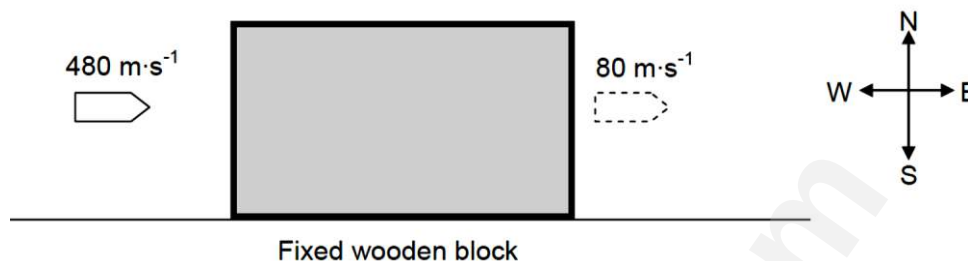
The ball is stuck in the container after the collision. The ball and container now move together along a straight line towards the east. Ignore friction and rotational effects.



- 14.1 State the *principle of conservation of linear momentum* in words. (2)
- 14.2 Calculate the magnitude of the velocity of the ball-container system immediately after the collision. (4)
- 14.3 Determine, by means of a suitable calculation, whether the collision between the ball and container is elastic or inelastic. (5)
- [11]

QUESTION 15

A bullet moves east at a velocity of $480 \text{ m}\cdot\text{s}^{-1}$. It hits a wooden block that is fixed to the floor. The bullet takes $0,01 \text{ s}$ to move through the stationary block and emerges from the block at a velocity of $80 \text{ m}\cdot\text{s}^{-1}$ east. See the diagram below. Ignore the effects of air resistance. Consider the block-bullet system as an isolated system.



15.1 Explain what is meant by an *isolated system* as used in Physics. (2)

The magnitude of the momentum of the bullet before it enters the block is $24 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$.

15.2 Calculate the:

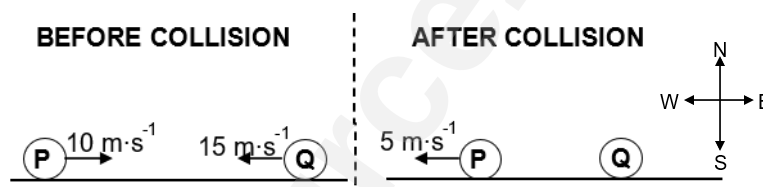
15.2.1 Mass of the bullet (3)

15.2.2 Average net force exerted by the wooden block on the bullet (5)

[10]

QUESTION 16

Ball **P** of mass $0,16 \text{ kg}$, moving east at a speed of $10 \text{ m}\cdot\text{s}^{-1}$, collides head-on with another ball **Q** of mass $0,2 \text{ kg}$, moving west at a speed of $15 \text{ m}\cdot\text{s}^{-1}$. After the collision, ball **P** moves west at a speed of $5 \text{ m}\cdot\text{s}^{-1}$, as shown in the diagram below. Ignore the effects of friction and the rotational effects of the balls.



16.1 Define the term *momentum* in words. (2)

16.2 Calculate the:

16.2.1 Velocity of ball **Q** after the collision (5)

16.2.2 Magnitude of the impulse on ball **P** during the collision (3)

[10]

OPTION 5

Downwards positive

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$1,2 \checkmark = 0 + \frac{1}{2}(9,8) \Delta t^2 \checkmark$$

$$\Delta t = 0,49 \text{ s}$$

$$t = 1,97 + \checkmark 2(0,49) \checkmark$$

$$= 2,96 \text{ s} \checkmark$$

Upwards positive

$$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2 \checkmark$$

$$-1,2 \checkmark = 0 + \frac{1}{2}(-9,8) \Delta t^2 \checkmark$$

$$\Delta t = 0,49 \text{ s}$$

$$t = 1,97 + \checkmark 2(0,49) \checkmark$$

$$= 2,96 \text{ s} \checkmark$$

(6)

[15]

MOMENTUM AND IMPULSE**QUESTION 1**

- 1.1 $p = mv \checkmark$
 $= 50(5) \checkmark = 250 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1} \checkmark$ (downward) **OR** $p = mv \checkmark = 50(-5) \checkmark = -250 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$
 $\therefore 250 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1} \checkmark$ (downward) (3)
- 1.2 The product of the net force and the time interval during which the force acts. $\checkmark \checkmark$ (2)
- 1.3 $\Delta p = F_{\text{net}} \Delta t \checkmark$
 $0 - 250 \checkmark = F_{\text{net}}(0,2)$
 $F_{\text{net}} = -1\,250 \text{ N} \therefore F_{\text{net}} = 1\,250 \text{ N} \checkmark$ $\Delta p = F_{\text{net}} \Delta t \checkmark$
 $250 - 0 \checkmark = F_{\text{net}}(0,2)$
 $F_{\text{net}} = 1\,250 \text{ N} \checkmark$ $\Delta p = F_{\text{net}} \Delta t \checkmark$
 $50(0 - (-5)) \checkmark = F_{\text{net}}(0,2)$
 $F_{\text{net}} = 1\,250 \text{ N} \checkmark$ (3)
- 1.4 Greater than $\checkmark$ (1)
- 1.5 For the same momentum change, $\checkmark$
the stopping time (contact time) $\checkmark$ will be smaller (less), $\checkmark$
 $\therefore$ the (upward) force exerted (on her) is greater. (3)

[12]

QUESTION 2

- 2.1 Momentum is the product of an object's mass and its velocity. $\checkmark \checkmark$ (2)
- 2.2 **Direction of motion positive:**
 $\Delta p = mv_f - mv_i \checkmark$
 $= (175)(0 - (+20)) \checkmark = -3\,500 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1} \checkmark$
 $\therefore \Delta p = 3\,500 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$ opposite to direction of motion $\checkmark$
- Direction of motion negative:**
 $\Delta p = mv_f - mv_i \checkmark$
 $= (175)(0 - (-20)) \checkmark = 3\,500 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1} \checkmark$
 $\therefore \Delta p = 3\,500 \text{ kg} \cdot \text{m} \cdot \text{s}^{-1}$ opposite to direction of motion $\checkmark$ (4)
- 2.3 **Direction of motion positive:**
 $F_{\text{net}} \Delta t = \Delta p \checkmark$
 $f(8) = -3\,500 \checkmark$
 $f = -437,5 \text{ N} \checkmark$
 $\therefore f = 437,5 \text{ N}$ opposite to direction motion $\checkmark$
- Direction of motion negative:**
 $F_{\text{net}} \Delta t = \Delta p \checkmark$
 $f(8) = 3\,500 \checkmark$
 $f = 437,5 \text{ N} \checkmark$
 $\therefore f = 437,5 \text{ N}$ opposite to direction of motion $\checkmark$ (4)

[10]

QUESTION 3

- 3.1 A collision in which both total momentum and total kinetic energy are conserved. $\checkmark \checkmark$ (2)

OPTION 1

For ball A

$$(E_{\text{mech}})_{\text{top}} = (E_{\text{mech}})_{\text{bottom}}$$

$$(E_K + E_P)_{\text{top}} = (E_K + E_P)_{\text{bottom}}$$

$$(\frac{1}{2}mv^2 + mgh)_{\text{top}} = (\frac{1}{2}mv^2 + mgh)_{\text{bottom}}$$

$$\frac{1}{2}(0,2)(0)^2 + (0,2)(9,8)(0,2)_{\text{top}} = E_K + m(9,8)(0)_{\text{bottom}} \checkmark$$

$$E_K = 0,39 \text{ J} \checkmark$$

Any one $\checkmark$ **OPTION 2**

$$W_{\text{nc}} = \Delta E_p + \Delta E_K \checkmark \therefore 0 = mg(h_f - h_i) + \frac{1}{2}m(v_f^2 - v_i^2)$$

$$0 = (0,2)(9,8)(0,2 - 0) + \frac{1}{2}mv_f^2 - \frac{1}{2}(0,2)(0)^2 \checkmark \therefore E_K = 0,39 \text{ J} \checkmark$$

(3)

3.3

$$\Sigma E_{K\text{before}} = \Sigma E_{K\text{after}}$$

$$E_{K\text{IA}} + E_{K\text{IB}} = E_{K\text{fA}} + E_{K\text{fB}}$$

$$E_{K\text{IA}} + E_{K\text{IB}} = \frac{1}{2}m_A v_{\text{fA}}^2 + E_{K\text{fB}}$$

$$0,39 + 0 \checkmark = \frac{1}{2}(0,2)v_{\text{fA}}^2 + 0,12 \checkmark \therefore v_{\text{fA}} = 1,64 \text{ m} \cdot \text{s}^{-1} \checkmark$$

 $\checkmark$ Any one

(4)

3.4

$$E_{k\text{before}} = \frac{1}{2} m_A v_{iA}^2 \therefore 0,39 = \frac{1}{2} (0,2) v_{iA}^2 \checkmark \therefore v_{iA} = 1,98 \text{ m}\cdot\text{s}^{-1}$$

$$\left. \begin{array}{l} \text{Impulse} = m(v_f - v_i) \\ \text{Impulse} = m(v_{iA} - v_{fA}) \end{array} \right\} \checkmark \text{Any one}$$

$$= 0,2(-1,64) \checkmark - (0,2)(1,98) \checkmark = 0,72 \text{ N}\cdot\text{s} \checkmark$$

(5)
[14]

QUESTION 4

4.1

OPTION 1

Take motion to the right as positive.

$$\Sigma p_i = \Sigma p_f$$

$$(m_1 + m_2)v_i = m_1 v_{f1} + m_2 v_{f2} \checkmark \text{Any one}$$

$$(3 + 0,02)(0) \checkmark = (3)(-1,4) + (0,02) v_{f2} \checkmark$$

$$v_{f2} = 210 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OPTION 2

Take motion to the left as positive.

$$\Sigma p_i = \Sigma p_f$$

$$(m_1 + m_2)v_i = m_1 v_{f1} + m_2 v_{f2} \checkmark \text{Any one}$$

$$(3 + 0,02)(0) \checkmark = (3)(1,4) + (0,02) v_{f2} \checkmark$$

$$v_{f2} = -210 \text{ m}\cdot\text{s}^{-1} \therefore \text{speed} = 210 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

4.2

OPTION 1

$$v_f^2 = v_i^2 + 2a\Delta x \checkmark$$

$$0 = 210^2 + 2a(0,4) \checkmark$$

$$a = -55\,125 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma \checkmark$$

$$= (0,02)(-55\,125) \checkmark$$

$$= -1\,102,5 \text{ N}$$

$$\text{Magnitude of force} = 1\,102,5 \text{ N} \checkmark$$

OPTION 2

$$\Delta x = \left(\frac{v_i + v_f}{2} \right) \Delta t \checkmark \therefore 0,4 = \left(\frac{210 + 0}{2} \right) \Delta t \checkmark$$

$$\therefore \Delta t = 0,004 \text{ s } (0,00381 \text{ s})$$

$$F_{\text{net}} \Delta t = \Delta p = m \Delta v \checkmark \therefore F_{\text{net}} = \frac{(0,02)(0 - 210)}{0,004} \checkmark$$

$$= -1\,050 \text{ N}$$

$$\text{Magnitude of force} = 1\,050 \text{ N} \checkmark$$

(5)

4.3 The same as/equal ✓

(1)
[10]

QUESTION 5

5.1 The total (linear) momentum of an isolated/(closed system) ✓ is constant/conserved. ✓

(2)

5.2.1

$$\Sigma p_i = \Sigma p_f \checkmark$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$$

$$(m_1 + m_2) v_i = m_1 v_{1f} + m_2 v_{2f}$$

$$0 \checkmark = (0,4) v_{1f} + 0,6 (4) \checkmark$$

$$v_{1f} = -6 \text{ m}\cdot\text{s}^{-1}$$

$$= 6 \text{ m}\cdot\text{s}^{-1} \text{ to the left/na links} \checkmark$$

(4)

5.2.2

OPTION 1

$$\Delta p = F_{\text{net}} \Delta t \checkmark$$

$$[(0,6)(4) - 0] \checkmark = F_{\text{net}} (0,3) \checkmark$$

$$F_{\text{net}} = 8 \text{ N} \checkmark$$

OR/OF

$$m(v_f - v_i) = F_{\text{net}} \Delta t \checkmark$$

$$0,6(4 - 0) \checkmark = F_{\text{net}} (0,3) \checkmark$$

$$F_{\text{net}} = 8 \text{ N} \checkmark$$

OPTION 2

$$v_f = v_i + a \Delta t$$

$$4 = 0 + a(0,3)$$

$$a = 13,33 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma$$

$$= 0,6(13,33)$$

$$F_{\text{net}} = 8 \text{ N} \checkmark$$

OPTION 3

$$\Delta p = F_{\text{net}} \Delta t \checkmark$$

$$[(0,4)(6) - 0] \checkmark = F_{\text{net}} (0,3) \checkmark$$

$$F_{\text{net}} = 8 \text{ N} \checkmark$$

OR/OF

$$m(v_f - v_i) = F_{\text{net}} \Delta t \checkmark$$

$$0,4(6 - 0) \checkmark = F_{\text{net}} (0,3) \checkmark$$

$$F_{\text{net}} = 8 \text{ N} \checkmark$$

(4)

5.3

No ✓

(1)
[11]

QUESTION 6

6.1 The total (linear) momentum of an isolated/closed system ✓ is constant/conserved. ✓

(2)

6.2.1

OPTION 1

$$\Sigma p_i = \Sigma p_f$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f} \checkmark \text{any one}$$

$$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$$

$$(5)(4) + (3)(0) \checkmark = (5 + 3) v_f \checkmark \therefore v = 2,5 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OPTION 2

$$\Delta p_{5\text{kg}} = -\Delta p_{3\text{kg}} \checkmark$$

$$m v_f - m v_i = m v_f - m v_i$$

$$5 v_f - (5)(4) \checkmark = 3 v_f - (3)(0) \checkmark$$

$$v_f = 2,5 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

6.2.2

OPTION 1

$$F_{\text{net}} \Delta t = \Delta p = (p_f - p_i) = (m v_f - m v_i) \checkmark \therefore F_{\text{net}} (0,3) \checkmark = 8 [(0 - (2,5))] \checkmark$$

$$\therefore F_{\text{net}} = -66,67 \text{ N} \therefore F_{\text{net}} = 66,67 \text{ N} \checkmark$$

OPTION 2

$$F_{\text{net}} = ma \checkmark = \frac{m(v_f - v_i)}{\Delta t} = \frac{8(0 - 2,5)}{0,3} \checkmark$$

$$= -66,67 \text{ N} \therefore F_{\text{net}} = 66,67 \text{ N} \checkmark$$

OPTION 3

$$v_f = v_i + a \Delta t \therefore 0 = 2,5 + a(0,3) \checkmark \therefore a = -8,333 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma \checkmark = 8 (-8,333) \checkmark = -66,67 \text{ N}$$

$$\therefore F_{\text{net}} = 66,67 \text{ N} \checkmark$$

(4)

[10]

QUESTION 7

7.1	A system on which the resultant/net external force is zero. ✓		(2)
7.2.1	OPTION 1 $p = mv \checkmark \therefore 30\,000 = (1\,500)v \checkmark$ $\therefore v = 20 \text{ m}\cdot\text{s}^{-1} \checkmark$	OPTION 2 $\Delta p = mv_f - mv_i \checkmark \therefore 0 = (1\,500)v_f - 30\,000 \checkmark$ $\therefore v = 20 \text{ m}\cdot\text{s}^{-1} \checkmark$	(3)
7.2.2	OPTION 1 $\Sigma p_i = \Sigma p_f$ $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f} \checkmark$ for any $30\,000 + (900)(-15) \checkmark = 14\,000 + 900v_B \checkmark$ $\therefore v_B = 2,78 \text{ m}\cdot\text{s}^{-1} \checkmark$ east ✓	OPTION 2 $\Delta p_A = -\Delta p_B$ $p_f - p_i = -(mv_f - mv_i) \checkmark$ for any $14\,000 - 30\,000 \checkmark = 900v_f - 900(-15) \checkmark$ $v_f = 2,78 \text{ m}\cdot\text{s}^{-1} \checkmark$ east	(4)
7.2.3	OPTION 1 $\text{Slope} = \frac{\Delta p}{\Delta t} = F_{\text{net}} \checkmark = \frac{(14\,000 - 30\,000)}{20,2 - 20,1} \checkmark$ $= -160\,000 \therefore F_{\text{net}} = 160\,000 \text{ N} \checkmark$	OPTION 2 $F_{\text{net}} \Delta t = \Delta p \checkmark$ $F_{\text{net}}(0,1) \checkmark = 14\,000 - 30\,000 \checkmark$ $F_{\text{net}} = -160\,000 \text{ N}$ $F_{\text{net}} = 160\,000 \text{ N} \checkmark$	(4)
	OPTION 3 $F_{\text{net}} \Delta t = \Delta p \checkmark \therefore F_{\text{net}}(0,1) \checkmark = 900[(2,78) - (-15)] \checkmark \therefore F_{\text{net}} = -160\,020 \text{ N}$ $F_A = -F_B \therefore F_{\text{net}} = 160\,020 \text{ N} \checkmark$		[13]

QUESTION 8

8.1	$v = \frac{\Delta x}{\Delta t} = \frac{0,2}{0,4} = 0,5 \text{ m}\cdot\text{s}^{-1}$	$v = \frac{\Delta x}{\Delta t} = \frac{0,4}{0,8} = 0,5 \text{ m}\cdot\text{s}^{-1}$	$v = \frac{\Delta x}{\Delta t} = \frac{0,6}{1,2} = 0,5 \text{ m}\cdot\text{s}^{-1}$	(3)
	✓ Formula ✓ Correct substitution in all three equations. ✓ Arriving at correct answer.			(2)
8.2	The total linear momentum of a closed/isolated system is constant/is conserved.			
8.3	$\Sigma p_i = \Sigma p_f$ $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f} \checkmark$ Any one $(3,5)(0,5) \checkmark = (3,5 + 6)v_f \checkmark$ $v_f = v_{6\text{kg}} = 0,184 \text{ m}\cdot\text{s}^{-1}$ For trolley B: $F_{\text{net}} \Delta t = \Delta p = m \Delta v \checkmark$ $F_{\text{net}}(0,5) = 6(0,184 - 0) \checkmark \therefore F_{\text{net}} = 2,21 \text{ N} \checkmark$ $\therefore$ Magnitude of the average net force experienced by trolley B = 2,21 N ✓ For trolley A: $F_{\text{net}} \Delta t = \Delta p = m \Delta v \checkmark$ $F_{\text{net}}(0,5) = 3,5(0,184 - 0,5) \checkmark \therefore F_{\text{net}} = -2,21 \text{ N}$ $\therefore$ Magnitude of the average net force experienced by trolley B = 2,21 N ✓			

QUESTION 9

9.1	It is the product of the resultant/net force acting on an object ✓ and the time the resultant/net force acts on the object. ✓		(2)
9.2.1	$p = mv \checkmark = (0,03)(700) \checkmark = 21 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} \checkmark$		(3)
9.2.2	OPTION 1 Δt for a bullet = $\frac{60}{220} \checkmark = 0,27 \text{ s}$ $F_{\text{net}} \Delta t = \Delta p = (p_f - p_i) = (mv_f - mv_i) \text{ OR } F_{\text{ave gun on bullet}} = \frac{\Delta p}{\Delta t} = \frac{21 - 0}{0,27} \checkmark = 77,01 \text{ N} \checkmark (77,78 \text{ N})$ $\therefore$ average force of bullet on gun = 77,01 N / 77,8 N to the west ✓ OPTION 2 $F_{\text{net}} \Delta t = \Delta p = (p_f - p_i) = (mv_f) - mv_i \checkmark$ Any one $F_{\text{av}} = \frac{\Delta p}{\Delta t}$ $\Delta p_{\text{tot}} = (21)(220) \checkmark = 4\,620 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$ $F_{\text{ave gun on bullet}} = \frac{4\,620 - 0}{60} \checkmark = 77,00 \text{ N} \checkmark$ $\therefore$ average force of bullet on gun = 77,01 N / 77,78 N to the west ✓		(5)
9.3	77 N / 77,78 N ✓ to the east ✓		(2)

QUESTION 10

10.1	The total linear momentum of a closed/isolated system is constant/conserved. ✓✓		(2)
10.2	$\Sigma p_i = \Sigma p_f$ $m_B v_{Bi} + m_b v_{bi} = m_B v_{Bf} + m_b v_{bf} \checkmark$ Any one $\Delta p_{\text{bullet}} = -\Delta p_{\text{block}}$ $(0,015)(400) \checkmark + 0 = (0,015)v_{Bf} + 2(0,7) \checkmark \therefore v_{Bf} = 306,67 \text{ m}\cdot\text{s}^{-1} \checkmark$		(4)

10.3

OPTION 1

$$F_{\text{net}}\Delta t = \Delta p$$

$$\Delta p = mv_f - mv_i \quad \left. \vphantom{\begin{matrix} F_{\text{net}}\Delta t = \Delta p \\ \Delta p = mv_f - mv_i \end{matrix}} \right\} \checkmark \text{ Any one}$$

For bullet:

$$\Delta p = (0,015)(306,666 - 400) \checkmark$$

$$= -1,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$$

$$F_{\text{net}}(0,002) = -1,4 \therefore F_{\text{net}} = -700 \text{ N}$$

For block:

$$\Delta p = (2)(0,7 - 0) \checkmark$$

$$= 1,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1}$$

$$F_{\text{net}}(0,002) = 1,4 \therefore F_{\text{net}} = 700 \text{ N}$$

$$W_{\text{net}} = \Delta E_k$$

$$F_{\text{net}}\Delta x \cos\theta = \frac{1}{2} m(v_f^2 - v_i^2)$$

$$(700)\Delta x \cos 180^\circ = \frac{1}{2}(0,015)(306,67^2 - 400^2) \checkmark$$

$$\therefore \Delta x = 0,71 \text{ m} \checkmark$$

$$F_{\text{net}} = ma$$

$$-700 = (0,015)a \text{ OR } 700 = (0,015)a$$

$$a = -46\,666,67 \text{ OR } 46\,665 \text{ m}\cdot\text{s}^{-2}$$

$$\Delta x = v_i\Delta t + \frac{1}{2} a\Delta t^2$$

$$= (400)(0,002) \checkmark + \frac{1}{2}(-46\,666,67)(0,002)^2 \checkmark$$

$$= 0,71 \text{ m } (0,70667) \text{ m} \checkmark$$

OR

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$(306,67)^2 \checkmark = (400)^2 + 2(-46\,666,67)\Delta x \checkmark$$

$$\Delta x = 0,71 \text{ m } (0,70667 \text{ m}) \checkmark$$

OPTION 2

$$v_f = v_i + a\Delta t \checkmark \therefore 306,666 = 400 + a(0,002) \checkmark \therefore a = -46\,667 \text{ m}\cdot\text{s}^{-2}$$

$$v_f^2 = v_i^2 + 2a\Delta x \therefore (306,666)^2 \checkmark = 400^2 + 2(-46\,667)\Delta x \checkmark \therefore \Delta x = 0,71 \text{ m } (0,706 \text{ m}) \checkmark$$

(5)

[11]**QUESTION 11**

11.1 The total linear momentum of a closed/isolated system remains constant/is conserved. ✓✓ (2)

$$\Sigma p_i = \Sigma p_f$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f} \quad \left. \vphantom{\Sigma p_i = \Sigma p_f} \right\} \checkmark \text{ any one}$$

For the system cat-skate board A

$$(3,5)(0) + (2,6)(0) \checkmark = (3,5)v_{\text{skateboard}} + (2,6)(3) \checkmark \therefore v_{\text{skateboard}} = 2,23 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ to the left} \checkmark$$

(5)

11.3

OPTION 1

$$F_{\text{net}}\Delta t = \Delta p = mv_f - mv_i \checkmark$$

$$= (3,5)(1,28 - 0) \checkmark = 4,48 \text{ N}\cdot\text{s} \checkmark$$

OPTION 2

$$F_{\text{net}}\Delta t = \Delta p = mv_f - mv_i \checkmark$$

$$= (2,6)(1,28 - 3) \checkmark = -4,48 \text{ N}\cdot\text{s} \checkmark$$

(3)

[10]**QUESTION 12**

$$E_{(\text{mech top})} = E_{(\text{mech bottom})}$$

$$(E_p + E_k)_{\text{top/bo}} = (E_p + E_k)_{\text{bottom}} \quad \left. \vphantom{\begin{matrix} E_{(\text{mech top})} = E_{(\text{mech bottom})} \\ (E_p + E_k)_{\text{top/bo}} = (E_p + E_k)_{\text{bottom}} \end{matrix}} \right\} \checkmark \text{ for any}$$

$$(mgh + \frac{1}{2}mv^2)_{\text{top}} = (mgh + \frac{1}{2}mv^2)_{\text{bottom}}$$

$$(1,5)(9,8)(2) + 0 \checkmark = 0 + \frac{1}{2}(1,5)v^2 \checkmark \therefore v = 6,26 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

12.2 The total linear momentum of a closed/isolated system is constant/conserved. ✓✓ (2)

$$\Sigma p_i = \Sigma p_f$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f} \quad \left. \vphantom{\Sigma p_i = \Sigma p_f} \right\} \checkmark \text{ for any}$$

$$m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v$$

$$(1,5)(6,26) + 0 \checkmark = (1,5 + 2)v_f \checkmark \therefore v_f = 2,68 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

12.4

OPTION 1

$$\Delta x = v\Delta t \checkmark = (2,68)(3) \checkmark$$

$$= 8,04 \text{ m} \checkmark$$

OPTION 2

$$\Delta x = v_i\Delta t + \frac{1}{2}a\Delta t^2 \checkmark$$

$$= (2,68)(3) + \frac{1}{2}(0)(3)^2 \checkmark$$

$$= 8,04 \text{ m} \checkmark \quad (\text{Range } 8,04 - 8,05)$$

(3)

[13]**QUESTION 13**

13.1 Momentum is the product of the mass of an object and its velocity. ✓✓ (2)

13.2 To the left ✓ Newton's third law ✓ (2)

NOTE: For QUESTIONS 13.3 and 13.4 motion to the right has been taken as positive.

13.3

OPTION 1

$$\Sigma p_i = \Sigma p_f \quad \left. \vphantom{\Sigma p_i = \Sigma p_f} \right\} \checkmark$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f}$$

mass of girl is m

$$\{(m+2)(0)\} + \{8(0)\} \checkmark = \{(m+2)(-0,6)\} \checkmark + (8)(4) \checkmark \therefore m = 51,33 \text{ kg} \checkmark$$

OPTION 2

$$\Sigma p_i = \Sigma p_f$$

$$m_1v_{1i} + m_2v_{2i} = m_1v_{2f} + m_2v_{2f}$$

$$0 = m_1v_{1f} + m_2v_{2f}$$

$$0 \checkmark = (8)(4) \checkmark + m_2(-0,6) \checkmark$$

$$\therefore m_2 = 53,33 \text{ kg} \checkmark \quad m_{\text{girl}} = 53,33 - 2 = 51,33 \text{ kg} \checkmark$$

OPTION 3

$$\Delta p_{\text{girl}} = -\Delta p_{\text{parcel}} \checkmark$$

$$m(v_f - v_i) = -m(v_f - v_i)$$

$$(m+2)(-0,6 - 0) \checkmark = -8(4 - 0) \checkmark$$

$$m = 51,33 \text{ kg} \checkmark$$

(5)

13.4 Impulse = $\Delta p = m(v_f - v_i) \checkmark = (51,33 + 2)(-0,6 - 0) \checkmark = -32 \text{ N}\cdot\text{s}/\text{kg}\cdot\text{m}\cdot\text{s}^{-1}$

Magnitude of impulse is $32 \text{ N}\cdot\text{s} / 32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} \checkmark$

OR

Impulse = $\Delta p_{\text{parcel}} = m(v_f - v_i) \checkmark = (8)(4 - 0) \checkmark = 32 \text{ kg m}\cdot\text{s}^{-1} \therefore \Delta p_{\text{girl}} = 32 \text{ kg m}\cdot\text{s}^{-1} \checkmark$

13.5 $32 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1} \checkmark$ to the right/opposite direction $\checkmark$

(3)

(2)

[14]

QUESTION 14

14.1 The total (linear) momentum in a isolated/closed system remains constant/is conserved. $\checkmark\checkmark$

(2)

14.2 OPTION 1

$$\sum p_i = \sum p_f$$

$$m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f} \checkmark \text{Any one}$$

$$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$$

$$\{0,45(9) + 0,20(0)\} \checkmark = (0,45 + 0,20)v \checkmark \therefore v = 6,23 \text{ m}\cdot\text{s}^{-1} \checkmark$$

OR

$$\Delta p_{\text{ball}} = -\Delta p_{\text{cont}} \checkmark \therefore 0,45(v - 9) \checkmark = -0,2(v - 0) \checkmark \therefore v = 6,23 \text{ m}\cdot\text{s}^{-1} \checkmark$$

(4)

14.3 $K = \frac{1}{2} m v^2 \checkmark$

Total kinetic energy before collision: $\frac{1}{2} (0,45)(9)^2 + 0 \checkmark = 18,225 \text{ J}$

Total kinetic energy after collision: $\frac{1}{2} (0,45 + 0,20)(6,23)^2 \checkmark = 12,614 \text{ J}$

$\sum K_{\text{before}} \neq \sum K_{\text{after}} \therefore$ Collision is inelastic. $\checkmark\checkmark$

(5)

[11]

QUESTION 15

15.1 Isolated system is a system on which the resultant/net external force is zero. $\checkmark\checkmark$

(2)

15.2.1 $p = mv \checkmark$

$24 = m(480) \checkmark$

$m = 0,05 \text{ kg} \checkmark$

(3)

15.2.2

OPTION 1

$$F_{\text{net}} \Delta t = \Delta p$$

$$F_{\text{net}} \Delta t = (p_{\text{bullet}})_f - (p_{\text{bullet}})_i$$

$$F_{\text{net}} \Delta t = (m v_{\text{bullet}})_f - (m v_{\text{bullet}})_i$$

$$F_{\text{net}}(0,01) \checkmark = (0,05)(80) - 24 \checkmark$$

$$F_{\text{net}} = -2\,000 \text{ N}$$

$$F_{\text{net}} = 2\,000 \text{ N} \checkmark \text{ west} \checkmark$$

$\checkmark$ Any one

OPTION 2

$$v_f = v_i + a \Delta t$$

$$80 = 480 + a(0,01) \checkmark$$

$$a = -40\,000 \text{ m}\cdot\text{s}^{-2}$$

$$F_{\text{net}} = ma \checkmark$$

$$= (0,05)(-40\,000) \checkmark$$

$$= -2\,000 \text{ N}$$

$$F_{\text{net}} = 2\,000 \text{ N} \checkmark \text{ west} \checkmark$$

(5)

[10]

QUESTION 16

16.1 (Linear) momentum (of an object) is the product of mass and velocity. $\checkmark\checkmark$

(2)

16.2.1

OPTION 1

East as positive

$$\sum p_i = \sum p_f$$

$$m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf}$$

$\checkmark$ Any one

$$(0,16)(10) + (0,2)(-15) \checkmark = (0,16)(-5) + (0,2)v_{Qf} \checkmark$$

$$v_{Qf} = -3 \text{ m}\cdot\text{s}^{-1}$$

$$v_{Qf} = 3 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ west} \checkmark$$

OPTION 2

West as positive

$$\sum p_i = \sum p_f$$

$$m_p v_{pi} + m_Q v_{Qi} = m_p v_{pf} + m_Q v_{Qf}$$

$\checkmark$ Any one

$$(0,16)(-10) + (0,2)(15) \checkmark = (0,16)(5) + (0,2)v_{Qf} \checkmark$$

$$v_{Qf} = 3 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ west} \checkmark$$

OPTION 3

$$\Delta p_p = -\Delta p_Q \checkmark$$

$$(0,16)(-5 - 10) \checkmark = -(0,2)(v - (-15)) \checkmark$$

$$v = -3 \text{ m}\cdot\text{s}^{-1}$$

$$= 3 \text{ m}\cdot\text{s}^{-1} \checkmark \text{ west} \checkmark$$

IF: $\Delta p_p = \Delta p_Q: \frac{0}{5}$

(5)

16.2.2 For ball P West as negative Impulse = Δp $F_{\text{net}}\Delta t = \Delta p$ $\Delta p = m(v_{\text{Pf}} - v_{\text{Pi}})$ $= 0,16(-5 - 10) \checkmark$ $= -2,4$ $\therefore 2,4 \text{ N}\cdot\text{s} \checkmark (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$ OR West as positive Impulse = Δp $F_{\text{net}}\Delta t = \Delta p$ $= m(v_{\text{Pf}} - v_{\text{Pi}})$ $= 0,16(5 - (-10)) \checkmark$ $= 2,4 \text{ N}\cdot\text{s} \checkmark$	For ball Q West as negative Impulse = Δp $F_{\text{net}}\Delta t = \Delta p$ $= m(v_{\text{Qf}} - v_{\text{Qi}})$ $= 0,2[-3 - (-15)] \checkmark$ $= 2,4 \text{ N}\cdot\text{s} \checkmark (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$ OR West as positive Impulse = Δp $F_{\text{net}}\Delta t = \Delta p$ $= m(v_{\text{Qf}} - v_{\text{Qi}})$ $= 0,16(3 - (15)) \checkmark$ $= -2,4 \text{ N}\cdot\text{s}$ $\therefore 2,4 \text{ N}\cdot\text{s} \checkmark (2,4 \text{ kg}\cdot\text{m}\cdot\text{s}^{-1})$
---	---

(3)
[10]

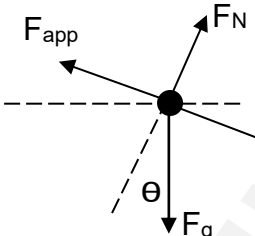
WORK, ENERGY AND POWER

QUESTION 1

- 1.1.1 In an isolated/closed system, $\checkmark$ the total mechanical energy is conserved/remains constant. $\checkmark$ (2)
 1.1.2 No $\checkmark$ (1)
 1.1.3

OPTION 1 Along AB $E_{\text{mech at A}} = E_{\text{mech at B}}$ $(E_p + E_k)_A = (E_p + E_k)_B$ $(mgh + \frac{1}{2}mv^2)_A = (mgh + \frac{1}{2}mv^2)_B$ $(10)(9,8)(4) + 0 = 0 + \frac{1}{2}(10)v_f^2 \checkmark$ $v_f = 8,85 \text{ m}\cdot\text{s}^{-1}$	OPTION 2 Along AB $W_{\text{net}} = \Delta E_k \checkmark$ $F_g \Delta h \cos \theta = \frac{1}{2}m(v_f^2 - v_i^2)$ $(10)(9,8)(4) \cos 0^\circ = \frac{1}{2}(10)(v_f^2 - 0) \checkmark$ $v_f = 8,85 \text{ m}\cdot\text{s}^{-1}$
Substitute $8,85 \text{ m}\cdot\text{s}^{-1}$ in one of the following options	
Along BC $W_{\text{net}} = \Delta K \checkmark \therefore f \Delta x \cos \theta = \Delta K$ $f(8) \cos 180^\circ \checkmark = \frac{1}{2}(10)(0 - 8,85^2) \checkmark$ $f = 48,95 \text{ N} \checkmark$	Along BC $W_{\text{nc}} = \Delta K + \Delta U \checkmark \therefore f \Delta x \cos \theta = \Delta K + \Delta U$ $f(8) \cos 180^\circ \checkmark = \frac{1}{2}(10)(0 - 8,85^2) + 0 \checkmark$ $f = 48,95 \text{ N} \checkmark$

- 1.2.1 $f_k = \mu_k N \checkmark = \mu_k mg \cos \theta = (0,19)(300)(9,8) \cos 25^\circ \checkmark = 506,26 \text{ N} \checkmark$ (6)
 1.2.2



$F_{\text{net}} = 0 \text{ OR } F_{\text{app}} + (-F_g \sin \theta) + (-f) = 0 \checkmark$
 $F_{\text{app}} - (300)(9,8) \sin 25^\circ \checkmark - 506,26 \checkmark = 0$
 $F_{\text{app}} = 1\,748,76 \text{ N}$
 $P_{\text{ave}} = F_{\text{ave}} \checkmark = 1\,748,76 \times 0,5 \checkmark = 874,38 \text{ W} \checkmark$

(6)
[18]

QUESTION 2

- 2.1 $\Delta U + \Delta K = 0 \checkmark$
 $(5)(9,8)(5) + 0 \checkmark + (0 + \frac{1}{2}(5v_f^2)) \checkmark = 0$
 $v_f = \sqrt{2 \times 9,8 \times 5}$
 $= 9,90 \text{ m}\cdot\text{s}^{-1} \checkmark (9,899 \text{ m}\cdot\text{s}^{-1})$ (4)
 2.2 No friction/zero resultant force $\checkmark$ and thus no loss in energy. $\checkmark$
OR Only conservative forces are present. **OR** Mechanical energy is conserved. (2)
 2.3 The force for which the work done is path dependent. $\checkmark \checkmark$ (2)
 2.4

OPTION 1 $W_{\text{nc}} = \Delta U + \Delta K \checkmark$ $F \Delta x \cos \theta = \Delta U + \Delta K$ $(18 \Delta x \cos 180^\circ) = (5)(9,8)(3 - 0) \checkmark + \frac{1}{2}(5)(0 - 9,90^2) \checkmark$ $\Delta x = 5,4458 \text{ m} \checkmark$ $\theta = \sin^{-1} \frac{3}{5,4458} \checkmark$ $\theta = 33,43^\circ \checkmark$
--