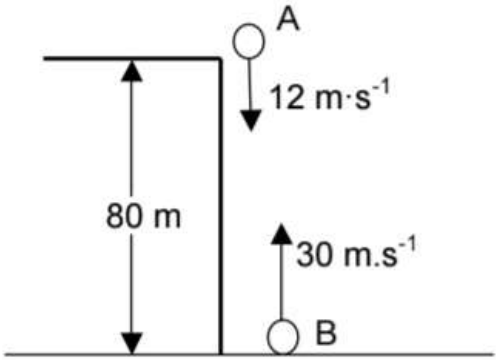
QUESTION 3 (Begin on a new page.)

Ball **A** is thrown vertically downwards from the top of a building, 80 m high, at a velocity of 12 $m \cdot s^{-1}$. At the same instant a second identical ball **B** is thrown upwards at a velocity of 30 $m \cdot s^{-1}$. Ball **A** and ball **B** pass each other after 2,135 s. Ignore all effects of air friction.



3.1 Give the direction of the acceleration of ball **B** while moving upwards. (1)

3.2 Calculate the velocity of ball **B** the moment it passes ball **A**. (3)

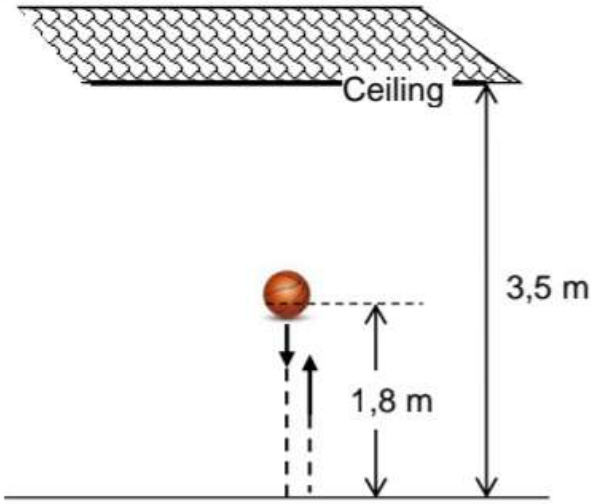
3.3 Calculate the distance between ball **A** and **B** 2,5 s after it was projected. (6)

3.4 Sketch a position-time graph for the motion of ball **A** till it reaches the ground as well as for the motion of ball **B** until it passes ball **A**. Use the ground as zero position. Clearly indicate the time at which the balls pass each other. (3)

[13]

QUESTION 3 (Start on a new page)

A girl stands on a platform in a classroom. She throws a ball vertically downwards to the floor hoping that the ball, after it bounced on the floor, will hit the ceiling of the classroom. She throws the ball with a speed of 8 $m \cdot s^{-1}$ from a height of 1,8 m above the floor. Ignore the effects of air friction.



3.1 Write down the magnitude and direction of the acceleration of the ball immediately after the ball left her hand. (2)

3.2 Is the motion of the ball, while it is moving downwards towards the floor, *free fall*? Explain the answer. (2)

3.3 Calculate the magnitude of the velocity with which the ball hits the floor. (4)

3.4 How long does it take the ball to hit the floor? (3)

The ball bounces INELASTICALLY on the floor where the speed of the ball DECREASES by 20%. The ball is in contact with the floor for 0,01 s.

3.5 Determine by means of calculations, whether the ball will reach the ceiling after it bounced. (5)

3.6 Sketch a velocity-time graph for the motion of the ball, from the time the ball is thrown until it reaches the maximum height after the bounce.

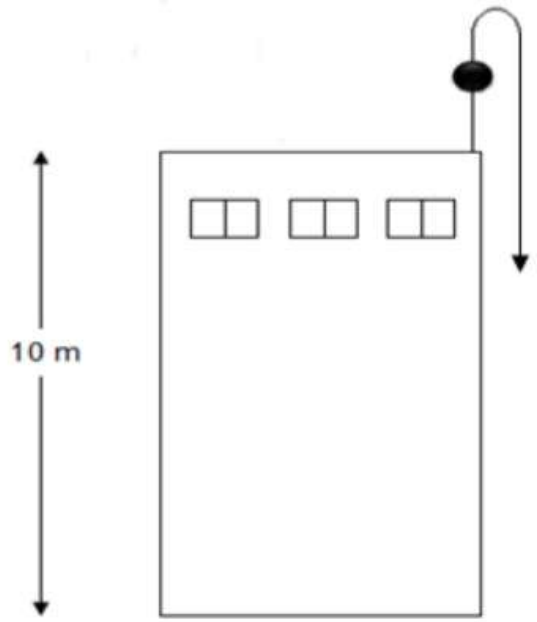
Clearly show the following on the graph:

- The initial velocity of the ball.
- The velocity and time when the ball hits the floor.
- The velocity and time when the ball leaves the floor.

(4)
[20]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards at a velocity of 4 $m.s^{-1}$ from the roof of a building with a of height 10 m. The ball strikes the ground and rebounds to a height of 3 m.
Ignore the effects of friction.



3.1 Calculate the:

3.1.1 Time taken for the ball to reached its maximum height. (3)

3.1.2 Maximum height the ball reaches above the ground. (4)

3.2 The ball strikes the ground 1,09 s after it was thrown and remains in contact with the ground for 0,2 s before bouncing upwards.

Sketch a graph (not to scale) of position versus time representing the entire motion of the ball.

USE THE GROUND AS ZERO REFERENCE.

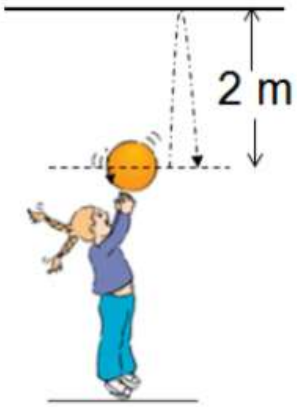
Indicate the following on the graph:

- Height from which the ball was thrown
- Maximum height of the ball from ground
- Height reached by the ball after bouncing
- Time the ball strikes the ground
- Contact time of the ball with the ground (5)

[13]

QUESTION 4 [START ON A NEW PAGE]

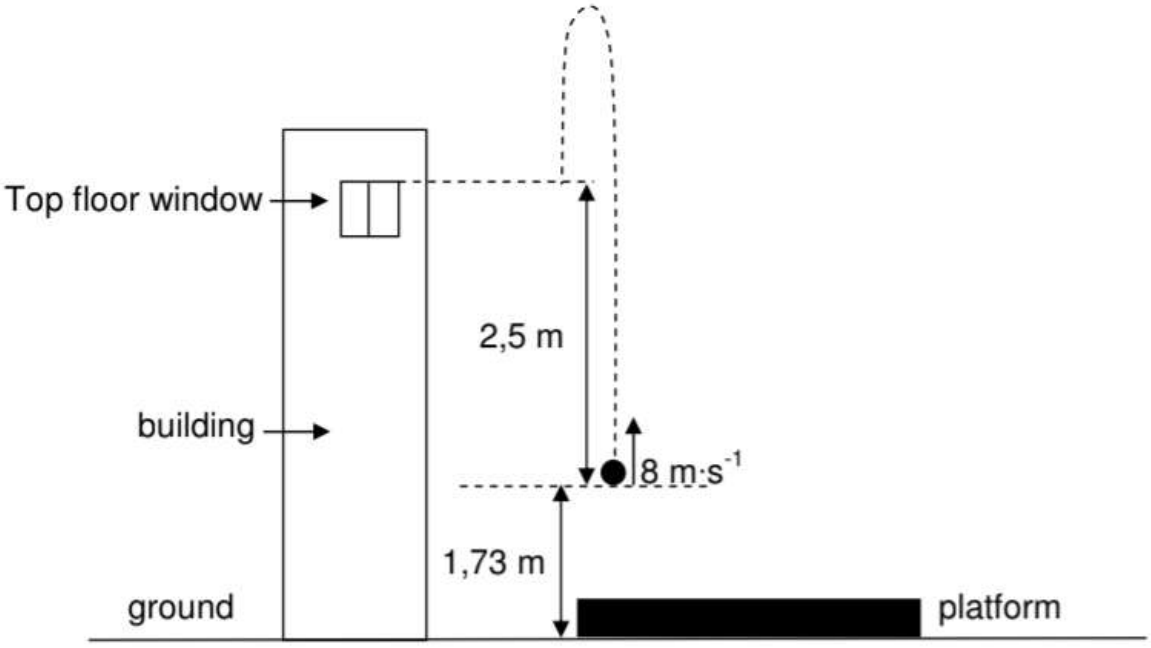
A girl throws a ball vertically upwards with an initial velocity of 8 $m \cdot s^{-1}$. It bounces against the ceiling after travelling 2 m. She catches the ball again 0,65 s after it has left her hand. Assume that the contact time of the ball with the ceiling is negligible. Ignore air friction. Take upwards as positive.



4.1	Calculate the speed of the ball when it reaches the ceiling for the first time.		(3)
4.2	Calculate the speed of the ball immediately after it bounces off the ceiling.		(6)
4.3	Draw a velocity vs time graph for the motion of the ball from the moment it leaves her hand until the moment she catches it again. Indicate the velocity of the ball as it leaves the girl's hand, as well as the velocity of the ball immediately before and after it bounces off the ceiling. Choose upwards as the positive direction.		(5)
			[14]

QUESTION 3 [BEGIN ON A NEW PAGE]

Sandile, who is standing on a platform, throws a small metal ball vertically upward, from a height of 1,73 m above the ground, into the air at 8 $m \cdot s^{-1}$. The ball travels pass the top of the building and returns to Sandile's hand which is still at 1,73 m above the ground. Ignore the effects of friction.



3.1 With what speed does the ball strike Sandile's hand? (1)

3.2 Using an equation of motion and NOT energy principles, calculate the maximum height that the ball reaches above the ground. (4)

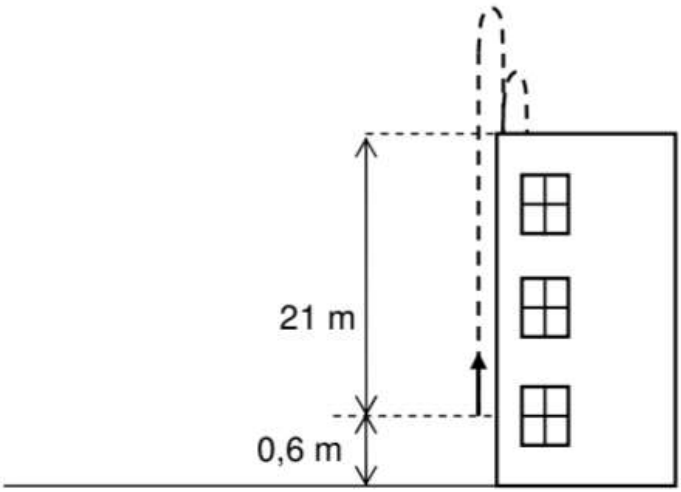
3.3 If a window on the top floor of the building is at a height of 2,5 m above Sandile's hand, calculate the time taken for the ball, from the moment it was thrown, to pass the top of the window on its return to Sandile's hand. (5)

3.4 Taking upward direction as positive, draw a sketch graph of position versus time graph of the ball's motion from the moment it left Sandile's hand until it lands back into his hands. Indicate all relevant position values. Use Sandile's hand as reference. (5)

[15]

QUESTION 3 (Start on a new page.)

A boy kicks a ball vertically upwards from a height of 0,6 m above the ground. The ball moves past the top of a building, 21 m higher than the point from where he kicked the ball. The ball hits the roof of the building 3,1 s after it was kicked. The ball bounces once off the roof of the building and then comes to rest. Ignore all effects of air resistance.



3.1 Write down the magnitude and direction of the acceleration of the ball at point X. (2)

3.2 Calculate the magnitude of the velocity with which the ball was kicked. (4)

3.3 Calculate the maximum height that the ball reaches above the ground. (4)

3.4 Refer to the sketch and state whether the collision of the ball on the roof is ELASTIC or INELASTIC. Give a reason for the answer. (2)

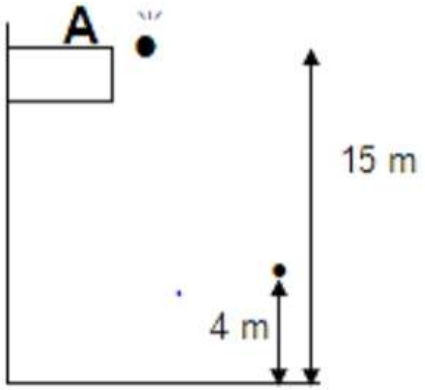
3.5 Sketch a postion versus time graph for the complete motion of the ball, from the moment it was kicked until it comes to rest. Use the roof of the building as the zero of position.
Indicate the following on the graph:

- The position of the ball when the boy kicks it.
- The position at point X.
- The time when the ball hits the roof the first time.

(5)
[17]

QUESTION 2 (Start on a new page.)

A cricket ball, mass 156 g, is dropped from point **A** on a tall building, 15 m high. It strikes the concrete pavement and it then bounces to a maximum height of 4 m.



2.1 Calculate the velocity with which the cricket ball strikes the pavement. (3)

2.2 If the effects of air friction are NOT ignored during the fall of the cricket ball, how would the value you calculated in QUESTION 2.1 change? Write down HIGHER, LOWER or STAYS THE SAME. (1)

2.3 The cricket ball is in contact with the concrete pavement of 0,8 s. Ignore the effects of air friction. Take DOWNWARD motion as POSITIVE.

2.3.1 Calculate the impulse of the cricket ball on the pavement. (8)

2.3.2 Calculate the (net) average force exerted by the pavement on the cricket ball. (4)

2.4 Sketch the **position versus time** graph for the motion of the cricket ball from the moment it is dropped until it reaches its maximum height after the bounce.

USE POINT **A** AS THE ZERO POSITION.

Indicate the following on the graph:

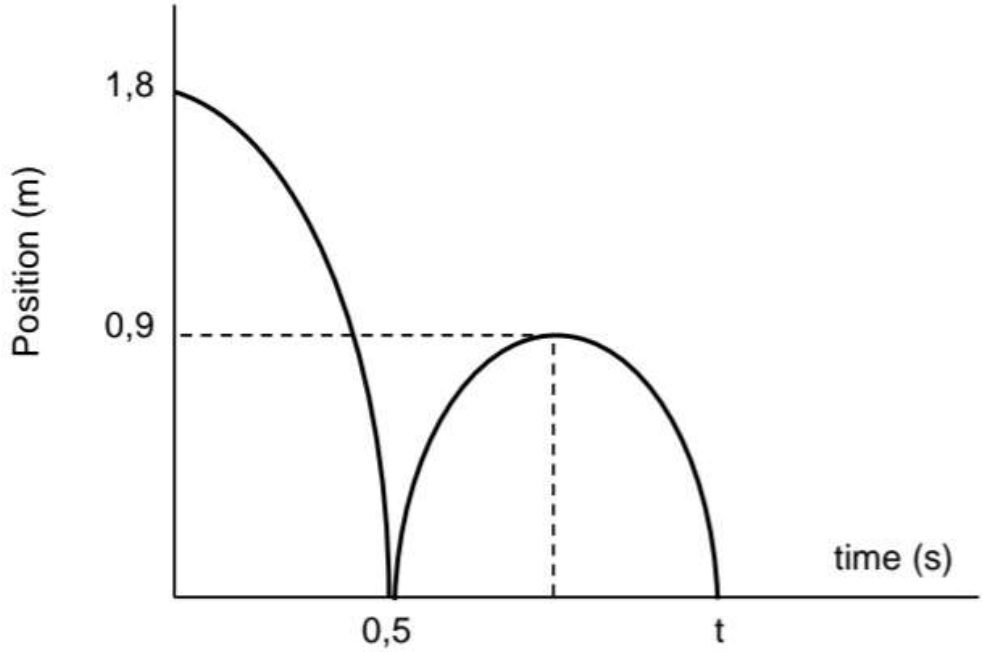
- The height from which the cricket ball is dropped
- The height reached by the cricket ball after the bounce
- Time with which the cricket ball is in contact with the concrete pavement (4)

2.5 The cricket ball is now replaced with a softer ball of similar mass. State how the (net) average force exerted by the concrete pavement on the softer ball compares with your answer in QUESTION 2.3.2. (Write down only GREATER, SMALLER or STAYS THE SAME). Use physics principles to explain your answer. (3)

[23]

QUESTION 3 (Start on a new page)

The position-time graph is given for a ball which is thrown down from a vertical height of 1,8 m and bounces once on reaching the ground. The contact time between the ball and the floor can be ignored.



3.1 Calculate the initial velocity with which the ball was thrown. (3)

3.2 At what speed does the ball strike the ground? (3)

3.3 At what speed did the ball leave the ground after bouncing? (3)

3.4 Calculate the value of time t. (4)

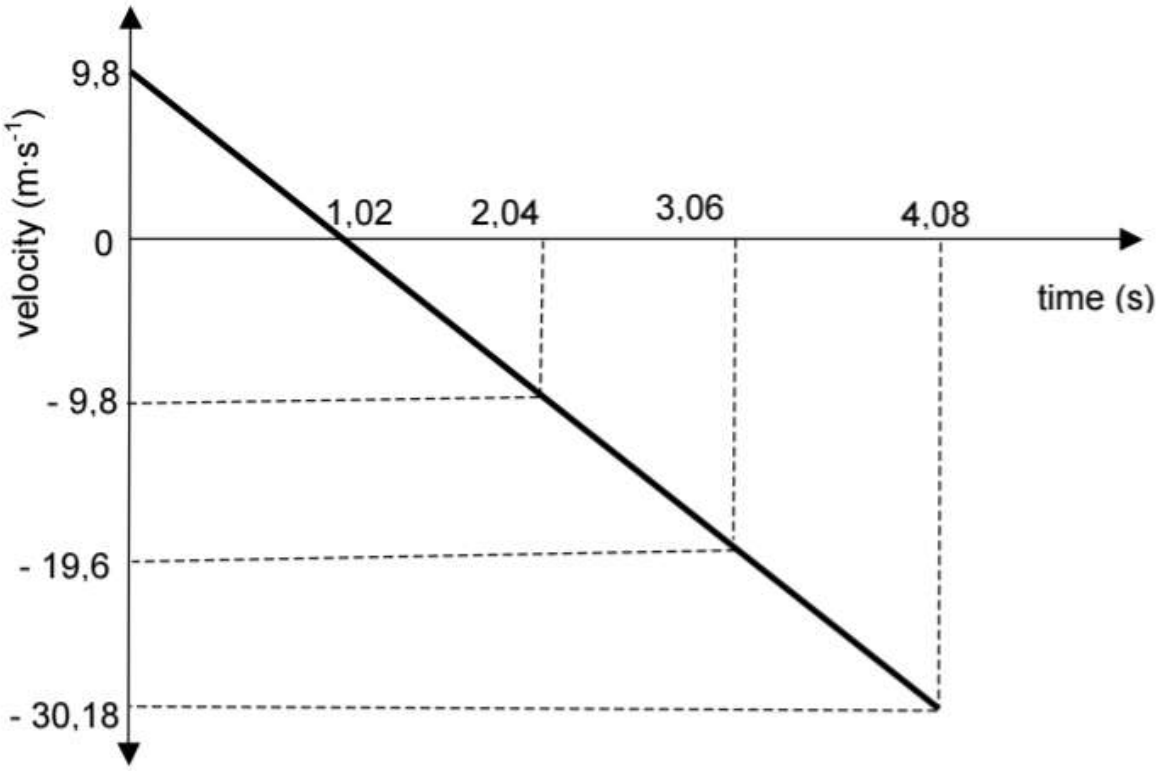
3.5 Sketch a velocity-time graph to represent the motion of the ball. Indicate the following values on the graph:

- The initial velocity at which the object was thrown.
- The velocity at which the ball strikes the ground.
- The velocity at which the ball bounces off the ground.
- The time at which the ball strikes the ground for the first time.
- The time, t, when the ball strikes the ground after the first bounce. (6)

[19]

QUESTION 4

A boy throws a ball vertically into the air from the top of a building. The ball strikes the ground after 4,08 s. The velocity-time graph below represents the entire motion of the ball. Ignore the effects of air friction.



4.1 Explain what is meant by a *projectile*. (2)

4.2 What is the acceleration of the ball at time 1,02 s? (2)

4.3 Calculate the displacement of the ball. (4)

4.4 Sketch a position versus time graph for the entire motion of the ball.
Indicate the following on the graph:

- Initial position
- Maximum height
- Final position
- Time (*t*) values

(4)
[12]