SA-STUDENT

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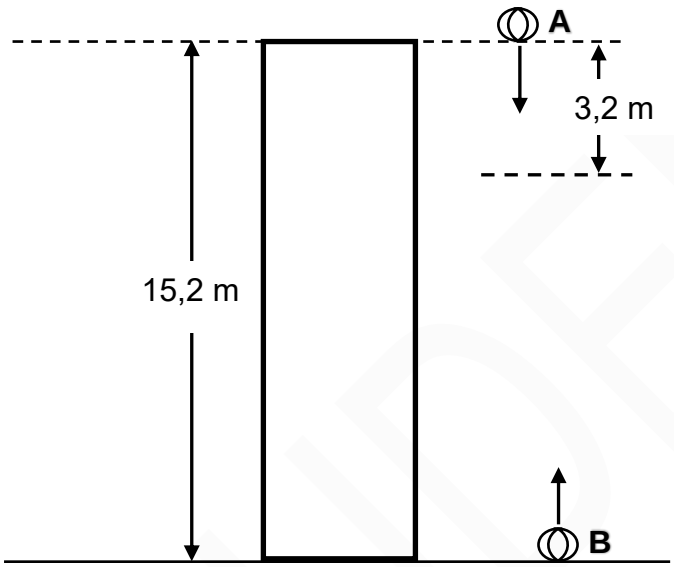
QUESTION 3 (Start on a new page.)

Ball **A** is dropped from rest from the top of a building 15,2 m high.

After ball **A** has fallen 3,2 m, a second ball **B** is projected vertically upwards from the ground. After a while, the two balls strike the ground at the SAME time.

Ignore the effects of air resistance.



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

3.2 Calculate the:

3.2.1 Time taken for ball **A** to strike the ground (3)

3.2.2 Magnitude of the velocity with which ball **B** was projected from the ground (5)

3.3 On the same system of axes, draw position-time graphs to show the motions of both ball **A** and ball **B** from the instant ball **A** is dropped until the time it reaches the ground.

Take the ground as the zero position.

Label the graphs **A** and **B**.

Clearly indicate the following on the graphs:

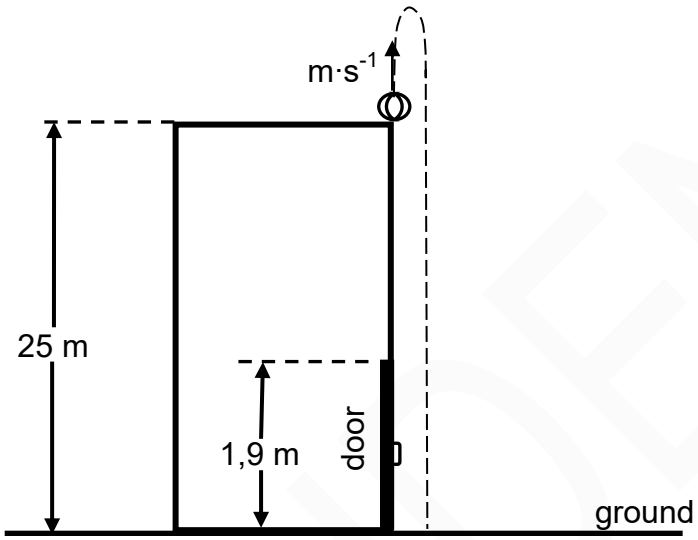
- The starting time for each ball
- The initial position of each ball
- The time when the balls strike the ground (5)

[15]

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards from the top of a building of height 25 m with a velocity of m·s^{-1}. On its way down, the ball passes a door which has a height of 1,9 m and then strikes the ground, as shown in the diagram below.

Ignore the effects of air friction.



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

3.2 Calculate the:

3.2.1 Time taken for the ball to reach its maximum height (3)

3.2.2 Velocity with which the ball strikes the ground (4)

3.2.3 Time it took the ball to move from the top of the door to the ground (4)

3.3 Draw a velocity versus time graph for the motion of the ball from the moment that the ball is thrown upwards until it strikes the ground. Use the ground as zero reference.

Clearly indicate the following on your graph:

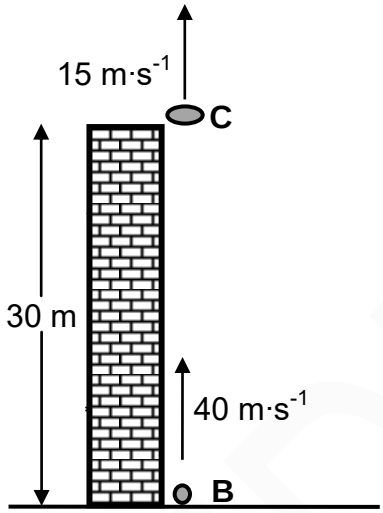
- The velocity with which the ball was thrown upwards
- Time taken by the ball to reach its maximum height
- The velocity with which the ball strikes the ground (3)

[16]

QUESTION 3 (Start on a new page.)

A small disc, **C**, is thrown vertically upwards at a speed of 15 $m \cdot s^{-1}$ from the edge of the roof of a building of height 30 m. AFTER 0,5 s, a small ball **B** is shot vertically upwards from the foot of the building at a speed of 40 $m \cdot s^{-1}$ in order to hit disc **C**.

Ignore the effects of air resistance.



3.1 Explain the term *projectile*. (2)

3.2 Calculate the:

3.2.1 Time taken by disc **C** to reach its maximum height (3)

3.2.2 Maximum height above the ground reached by disc **C** (4)

3.3 Calculate the time from the moment that disc **C** was thrown upwards until the time ball **B** hits the disc. (6)

3.4 On the same set of axes, sketch graphs of velocity versus time for disk **C** and ball **B** from the moment that disc **C** was thrown upwards until ball **B** hits disc **C**.

Label the graph for ball **B** as B and the graph for disc **C** as C.

Clearly indicate the following on the graphs:

- The initial velocities of ball **B** and disc **C**
- The time at which ball **B** was shot upward
- The time at which disc **C** reaches its maximum height
- The time at which ball **B** hits disc **C**

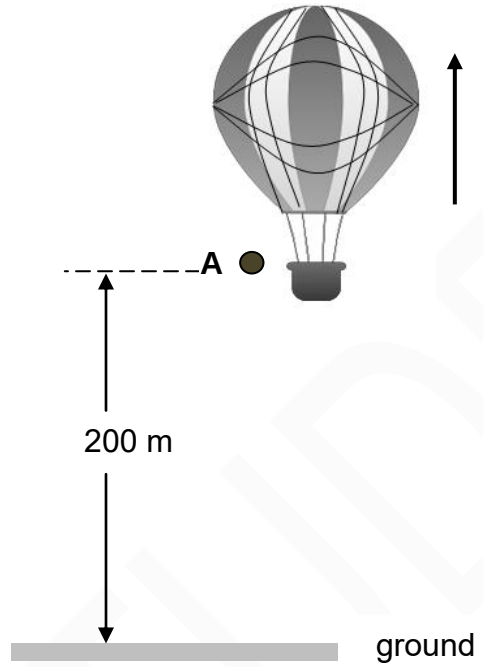
(5)
[20]

QUESTION 3 (Start on a new page.)

A hot-air balloon is moving upwards at a CONSTANT UNKNOWN speed.

3.1 Is the hot air balloon in free fall? Choose from YES or NO.

Give a reason for the answer. (2)



When the balloon is 200 m above the ground, a small stone **A** is dropped from the balloon. See the diagram above. Another small stone **B** is dropped 5 s later from the balloon while the balloon is still moving upwards at constant velocity.

Stone **A** strikes the ground at a speed of 62,68 $m \cdot s^{-1}$.

Ignore air resistance.

3.2 Calculate the:

3.2.1 Speed of the hot air balloon (3)

3.2.2 Time it takes stone **A** to strike the ground (3)

3.2.3 Distance between the hot-air balloon and stone **B** at the instant when stone **A** strikes the ground (6)

3.3 On the same set of axes, draw position-time graphs for both the hot-air balloon and stone **A** from the moment the stone is dropped until it strikes the ground.

Use the ground as zero reference.

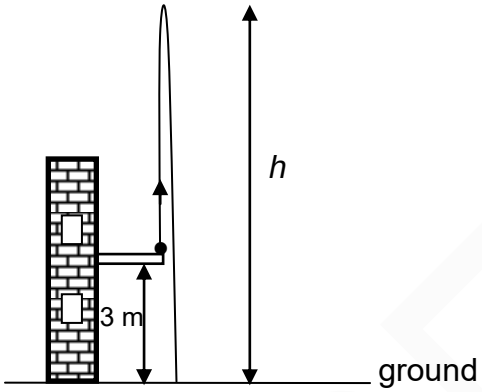
Label your graphs **BALLOON** and **A**. (4)

[18]

QUESTION 3 (Start on a new page.)

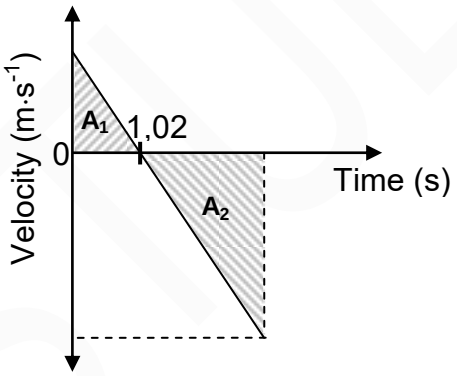
A ball, of mass 0,06 kg, is thrown vertically upwards from the balcony of a building, 3 m above the ground. The ball reaches a maximum height *h* above the ground, as shown in the diagram below.

Ignore the effects of air resistance.



3.1 Name the force acting on the ball while it is in free fall. (1)

The velocity-time graph below represents the motion of the ball from the instant it is thrown upwards until it hits the ground.



3.2 Write down the acceleration of the ball at time t = 1,02 s. (2)

3.3 Consider the areas $\mathbf{A_1}$ and $\mathbf{A_2}$ shown in the graph above. Write down the numerical value represented by the DIFFERENCE in areas $\mathbf{A_1}$ and $\mathbf{A_2}$. (1)

3.4 Calculate the:

3.4.1 Speed at which the ball is thrown upwards (3)

3.4.2 Height *h* (4)

After hitting the ground, the ball bounces vertically upwards and reaches a new maximum height in 1,1 s.

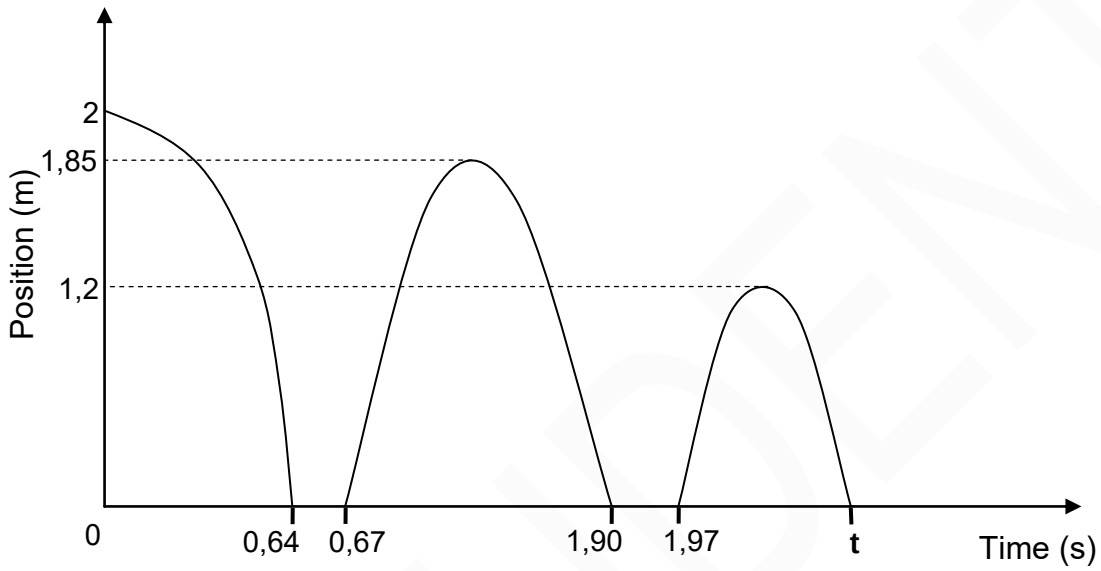
3.5 Calculate the work done by the ground on the ball while the ball is in contact with the ground. (6)

[17]

QUESTION 3 (Start on a new page.)

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 below, not drawn to scale, represents the motion of the ball.



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

3.2 Use the graph and determine:

3.2.1 The time that the ball is in contact with the floor before the first bounce (2)

3.2.2 The time it takes the ball to reach its maximum height after the first bounce (2)

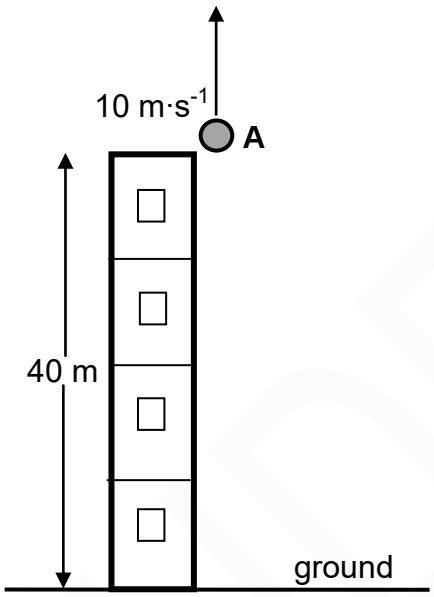
3.2.3 The speed at which the ball leaves the floor at the first bounce (3)

3.2.4 Time **t** indicated on the graph (6)
[15]

QUESTION 3 (Start on a new page.)

Stone **A** is thrown vertically upwards with a speed of 10 $m \cdot s^{-1}$ from the edge of the roof of a 40 m high building, as shown in the diagram below.

Ignore the effects of air friction. Take the ground as reference.



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

3.2 Calculate the maximum HEIGHT ABOVE THE GROUND reached by stone **A**. (4)

3.3 Write down the magnitude and direction of the acceleration of stone **A** at this maximum height. (2)

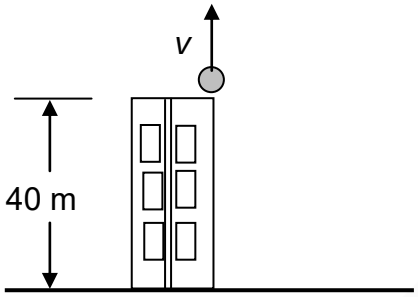
Stone **B** is dropped from rest from the edge of the roof, x seconds after stone **A** was thrown upwards.

3.4 Stone **A** passes stone **B** when the two stones are 29,74 m *above the ground*.

Calculate the value of x. (6)

QUESTION 3 (Start on a new page.)

A ball is thrown vertically upwards, with velocity *v*, from the edge of a roof of a 40 m tall building. The ball takes 1,53 s to reach its maximum height. Ignore air resistance.



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

3.2 Calculate the:

3.2.1 Magnitude of the initial velocity *v* of the ball (3)

3.2.2 Maximum height reached by the ball above the edge of the roof (3)

3.3 Take the edge of the roof as reference point. Determine the position of the ball relative to the edge of the roof after 4 s. (3)

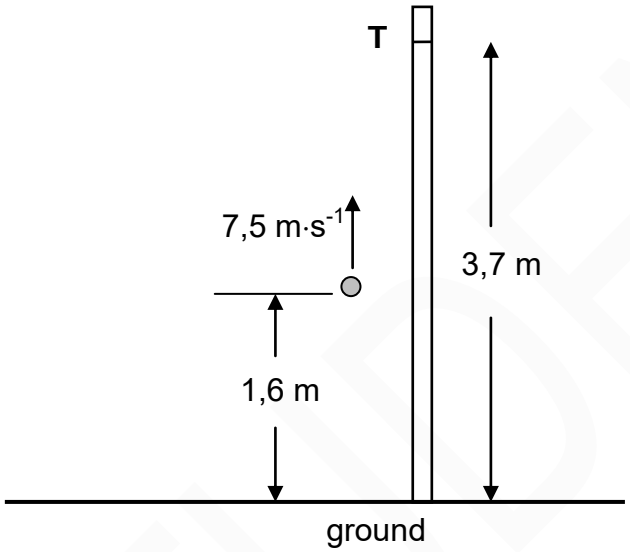
3.4 Will any of the answers to QUESTIONS 3.2 and 3.3 change if the height of the building is 30 m? Choose from YES or NO.

Give a reason for the answer. (3)
[14]

QUESTION 3 (Start on a new page.)

In a competition, participants must attempt to throw a ball vertically upwards past point **T**, marked on a tall vertical pole. Point **T** is 3,7 m above the ground. Point **T** may, or may not, be the highest point during the motion of the ball.

One participant throws the ball vertically upwards at a velocity of 7,5 $m \cdot s^{-1}$ from a point that is 1,6 m above the ground, as shown in the diagram below. Ignore the effects of air resistance.



3.1 In which direction is the net force acting on the ball while it moves towards point **T**?
Choose from: UPWARDS or DOWNWARDS. Give a reason for the answer. (2)

3.2 Calculate the time taken by the ball to reach its highest point. (3)

3.3 Determine, by means of a calculation, whether the ball will pass point **T** or not. (6)

3.4 Draw a velocity-time graph for the motion of the ball from the instant it is thrown upwards until it reaches its highest point.

Indicate the following on the graph:

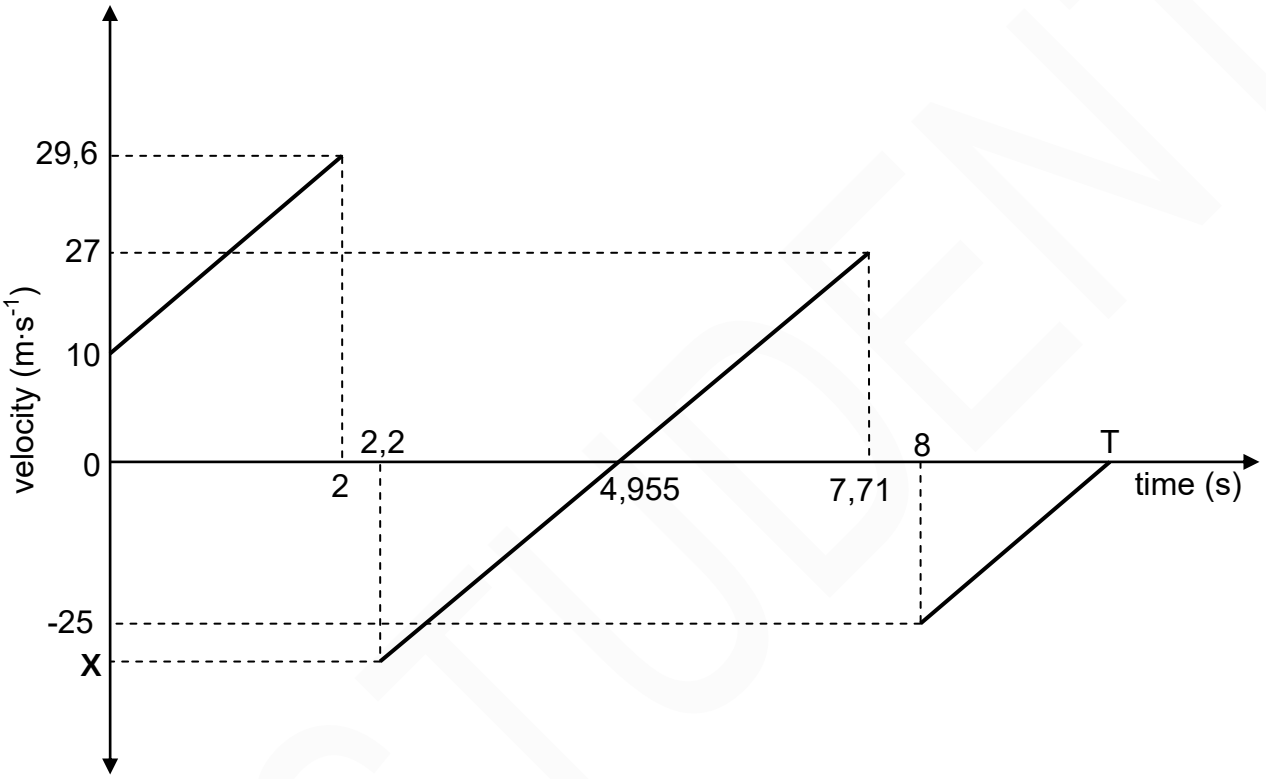
- The initial velocity and final velocity
- Time taken to reach the highest point (2)

[13]

QUESTION 3 (Start on a new page.)

A ball is thrown **vertically downwards** from the top of a building and bounces a few times as it hits the ground. The velocity-time graph below describes the motion of the ball from the time it is thrown, up to a certain time **T**.

Take downwards as the positive direction and the ground as zero reference. The graph is NOT drawn to scale. The effects of air friction are ignored.



3.1 Write down the speed with which the ball is thrown downwards. (1)

3.2 ALL parts of the graph have the same gradient. Give a reason for this. (2)

3.3 Calculate the:

3.3.1 Height from which the ball is thrown (3)

3.3.2 Time (T) shown on the graph (4)

3.4 Write down the:

3.4.1 Time that the ball is in contact with the ground at the first bounce (1)

3.4.2 Time at which the ball reaches its maximum height after the first bounce (2)

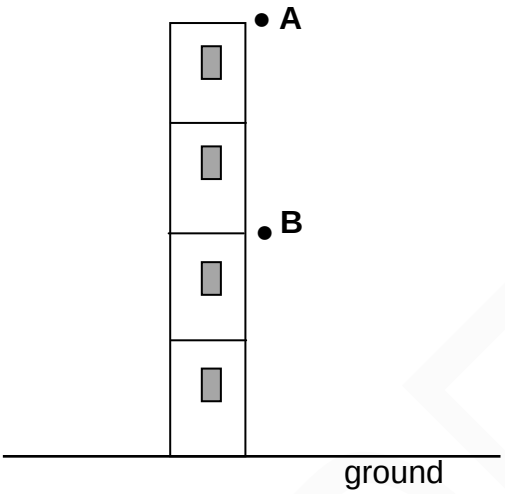
3.4.3 Value of **X** (1)

3.5 Is the collision of the ball with the ground *elastic* or *inelastic?* Give a reason for the answer using information in the graph. (2)

[16]

QUESTION 3 (Start on a new page.)

In the diagram below, point **A** is at the top of a building. Point **B** is exactly **halfway** between the point **A** and the ground. Ignore air resistance.



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

A ball of mass 0,4 kg is dropped from point **A**. It passes point **B** after 1 s.

3.2 Calculate the height of point **A** above the ground. (3)

When the ball strikes the ground it is in contact with the ground for 0,2 s and then bounces vertically upwards, reaching a maximum height at point **B**.

3.3 Calculate the magnitude of the velocity of the ball when it strikes the ground. (3)

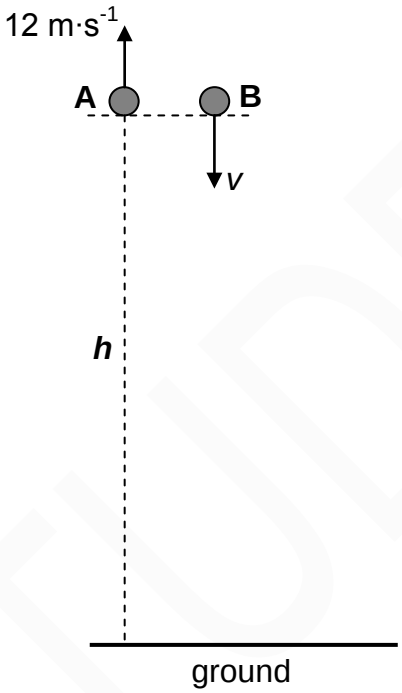
3.4 Calculate the magnitude of the average net force exerted on the ball while it is in contact with the ground. (6)
[14]

QUESTION 3 (Start on a new page.)

Stone **A** is projected vertically upwards at a speed of 12 m·s^{-1} from a height ***h*** *above the ground*. Ignore the effects of air resistance.

3.1 Calculate the time taken for stone **A** to reach its maximum height. (3)

At the same instant that stone **A** is projected upwards, stone **B** is thrown vertically downwards from the same height at an *unknown speed*, *v.* Refer to the diagram below.



When stone **A** reaches its maximum height, the speed of stone **B** is 3*v*.

3.2 Calculate the speed, *v*, with which stone **B** is thrown downwards. (4)

At the instant stone **A** passes its initial position on its way down, stone **B** hits the ground.

3.3 Calculate the height ***h***. (3)

3.4 Sketch velocity-time graphs for the complete motions of stones **A** and **B** on the same set of axes. Label your graphs for stones **A** and **B** clearly.

Show the following on the graphs:

- The time taken for stone **A** to reach its maximum height
- The velocity with which stone **B** is thrown downwards (4)

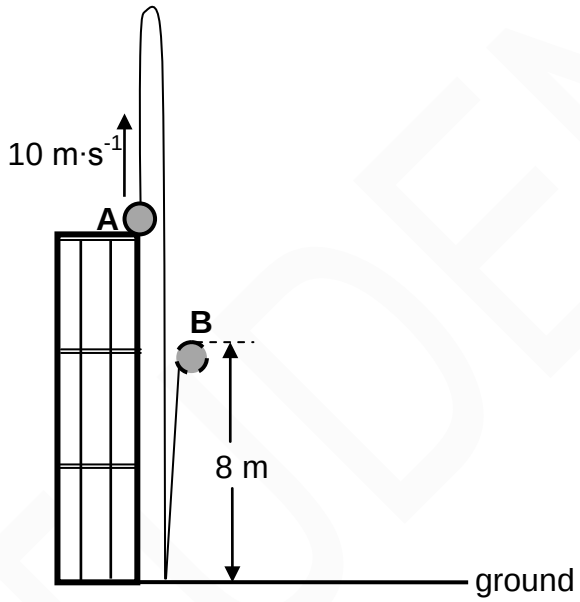
[14]

QUESTION 3 (Start on a new page.)

A ball is projected vertically upwards with a speed of 10 $m \cdot s^{-1}$ from point **A**, which is at the top edge of a building.

The ball hits the ground after 3 s. It is in contact with the ground for 0,2 s and then bounces vertically upwards, reaching a maximum height of 8 m at point **B**. See the diagram below.

Ignore the effects of friction.



3.1 Why is the ball considered to be in free fall during its motion? (2)

3.2 Calculate the:

3.2.1 Height of the building (3)

3.2.2 Speed with which the ball hits the ground (3)

3.2.3 Speed with which the ball leaves the ground (3)

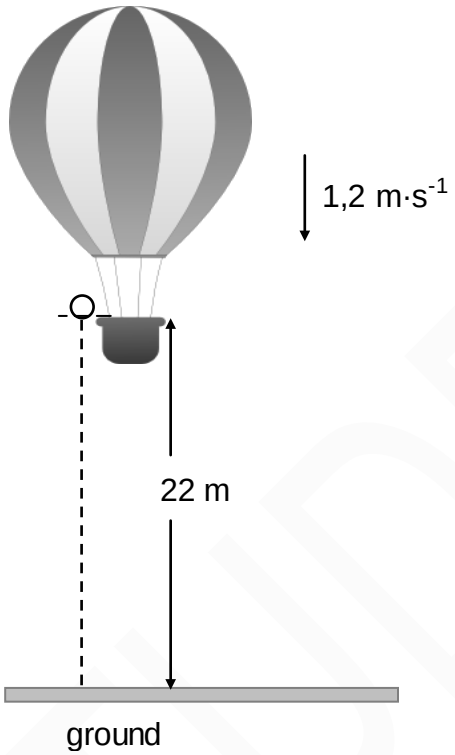
3.3 Draw a velocity versus time graph for the complete motion of the ball from **A** to **B**. Show the following on the graph:

- The magnitude of the velocity with which it hits the ground
- The magnitude of the velocity with which it leaves the ground
- The time taken to reach the ground, as well as the time at which it leaves the ground (4)

[15]

QUESTION 3 (Start on a new page.)

A hot-air balloon moves vertically downwards at a constant velocity of 1,2 $m \cdot s^{-1}$. When it reaches a height of 22 m from the ground, a ball is dropped from the balloon. Refer to the diagram below.



Assume that the dropping of the ball has no effect on the speed of the hot-air balloon. Ignore air friction for the motion of the ball.

3.1 Explain the term *projectile motion*. (2)

3.2 Is the hot-air balloon in free fall? Give a reason for the answer. (2)

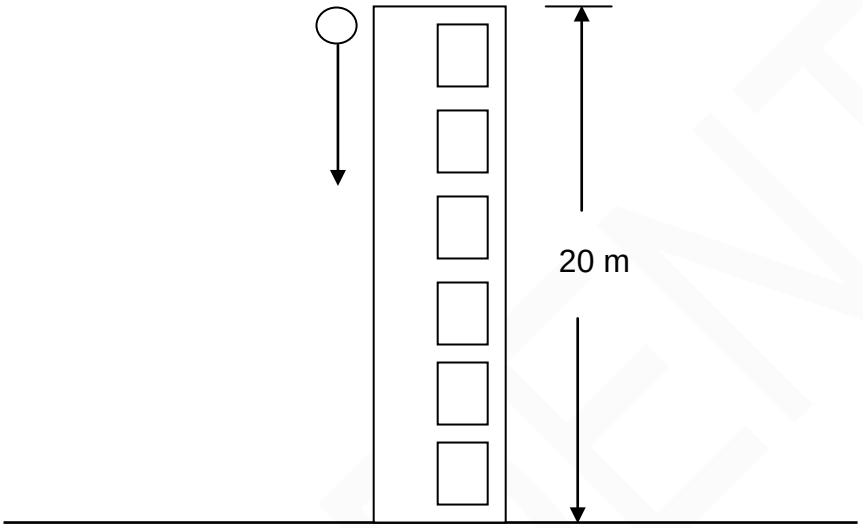
3.3 Calculate the time it takes for the ball to hit the ground after it is dropped. (4)

When the ball lands on the ground, it is in contact with the ground for 0,3 s and then it bounces vertically upwards with a speed of 15 $m \cdot s^{-1}$.

3.4 Calculate how high the balloon is from the ground when the ball reaches its maximum height after the first bounce. (6)
[14]

QUESTION 3 (Start on a new page.)

A ball is dropped from the top of a building 20 m high. Ignore the effects of air resistance.



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

3.2 Calculate the:

3.2.1 Speed at which the ball hits the ground (4)

3.2.2 Time it takes the ball to reach the ground (3)

3.3 Sketch a velocity-time graph for the motion of the ball (no values required). (2)
[11]

QUESTION 3 (Start on a new page.)

Ball **A** is projected vertically upwards from the ground, near a tall building, with a speed of 30 $m \cdot s^{-1}$. Ignore the effects of air friction.

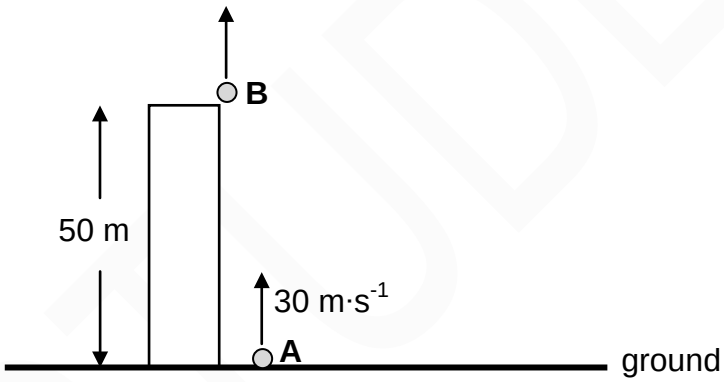
3.1 Explain what is meant by a *projectile*. (2)

3.2 Calculate:

3.2.1 The total time that ball **A** will be in the air (4)

3.2.2 The distance travelled by ball **A** during the last second of its fall (4)

3.3 TWO SECONDS after ball **A** is projected upwards, ball **B** is projected vertically upwards from the roof of the same building. The roof the building is 50 m above the ground. Both balls **A** and **B** reach the ground *at the same time*. Refer to the diagram below. Ignore the effects of air friction.



Calculate the speed with which ball **B** was projected upwards from the roof. (4)

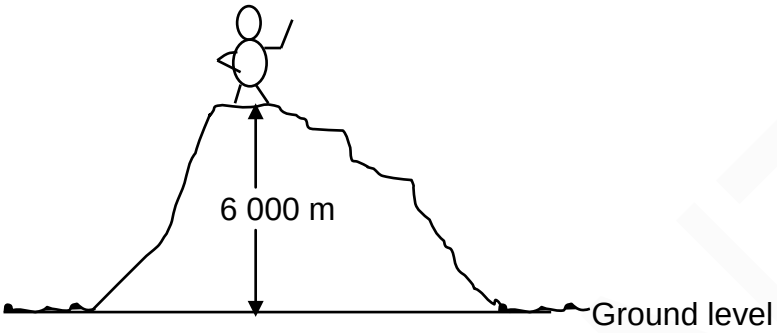
3.4 Sketch velocity-time graphs for the motion of both balls **A** and **B** on the *same set of axes.* Clearly label the graphs for balls **A** and **B** respectively.

Indicate the following on the graphs:

(a) Time taken by both balls **A** and **B** to reach the ground
(b) Time taken by ball **A** to reach its maximum height (4)

[18]

2.2 A person of mass 60 kg climbs to the top of a mountain which is 6 000 m above ground level.



2.2.1 State Newton's Law of Universal Gravitation in words. (2)

2.2.2 Calculate the *difference* in the weight of the climber at the top of the mountain and at ground level. (6)
[18]

QUESTION 3 (Start on a new page.)

A man throws ball **A** downwards with a speed of 2 $m \cdot s^{-1}$ from the edge of a window, 45 m above a dam of water. One second later he throws a second ball, ball **B**, downwards and observes that both balls strike the surface of the water in the dam at the same time. Ignore air friction.

3.1 Calculate the:

3.1.1 Speed with which ball **A** hits the surface of the water (3)

3.1.2 Time it takes for ball **B** to hit the surface of the water (3)

3.1.3 Initial velocity of ball **B** (5)

3.2 On the same set of axes, sketch a velocity versus time graph for the motion of balls **A** and **B**. Clearly indicate the following on your graph:

- Initial velocities of both balls **A** and **B**
- The time of release of ball **B**
- The time taken by both balls to hit the surface of the water (5)

[16]

QUESTION 3 (Start on a new page.)

Ball **A** is projected vertically upwards at a velocity of 16 $m \cdot s^{-1}$ from the ground. Ignore the effects of air resistance. **Use the ground as zero reference.**

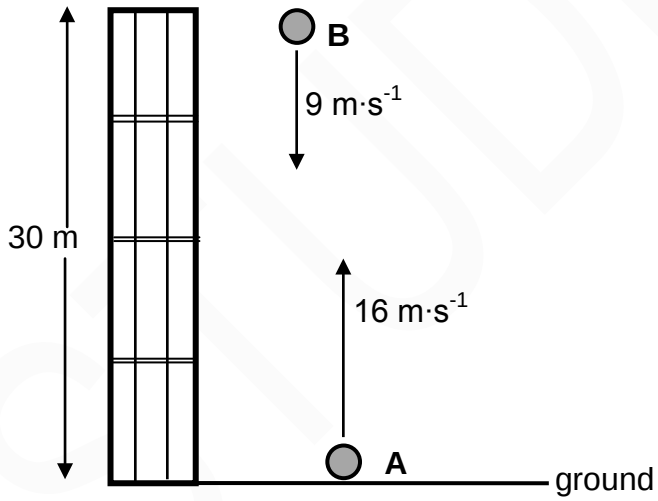
3.1 Calculate the time taken by ball **A** to return to the ground. (4)

3.2 Sketch a velocity-time graph for ball **A**.

Show the following on the graph:

(a) Initial velocity of ball **A**
(b) Time taken to reach the highest point of the motion
(c) Time taken to return to the ground (3)

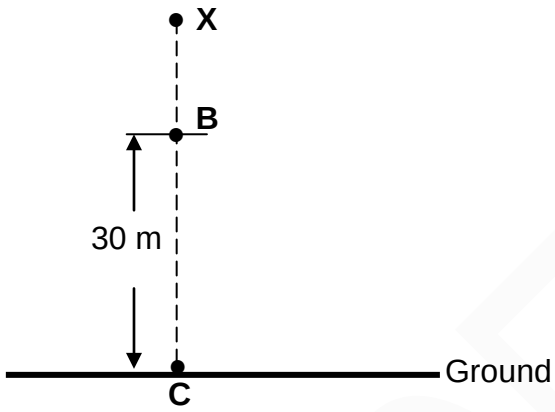
ONE SECOND after ball **A** is projected upwards, a second ball, **B**, is thrown vertically downwards at a velocity of 9 $m \cdot s^{-1}$ from a balcony 30 m above the ground. Refer to the diagram below.



3.3 Calculate how high above the ground ball **A** will be at the instant the two balls pass each other. (6)
[13]

QUESTION 3 (Start on a new page.)

An object is released from rest from a point **X,** above the ground as shown in the diagram below. It travels the last 30 m (**BC**) in 1,5 s before hitting the ground. Ignore the effects of air friction.



3.1 Name the type of motion described above. (1)

3.2 Calculate the:

3.2.1 Magnitude of the velocity of the object at point **B** (4)

3.2.2 Height of point **X** above the ground (5)

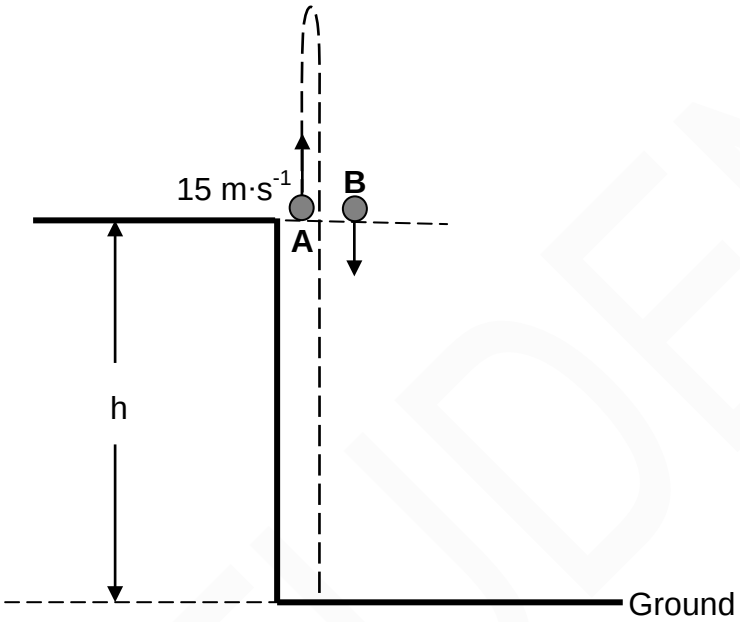
After hitting the ground, the object bounces once and then comes to rest on the ground.

3.3 Sketch an acceleration-time graph for the entire motion of the object. (3)
[13]

QUESTION 3 (Start on a new page.)

A ball, **A**, is thrown vertically upward from a height, h, with a speed of 15 $m \cdot s^{-1}$. AT THE SAME INSTANT, a second identical ball, **B**, is dropped from the same height as ball **A** as shown in the diagram below.

Both balls undergo free fall and eventually hit the ground.



3.1 Explain the term *free fall.* (2)

3.2 Calculate the time it takes for ball **A** to return to its starting point. (4)

3.3 Calculate the distance between ball **A** and ball **B** when ball **A** is at its maximum height. (7)

3.4 Sketch a velocity-time graph in the ANSWER BOOK for the motion of ball **A** from the time it is projected until it hits the ground.

Clearly show the following on your graph:

- The initial velocity
- The time it takes to reach its maximum height
- The time it takes to return to its starting point

(4)
[17]

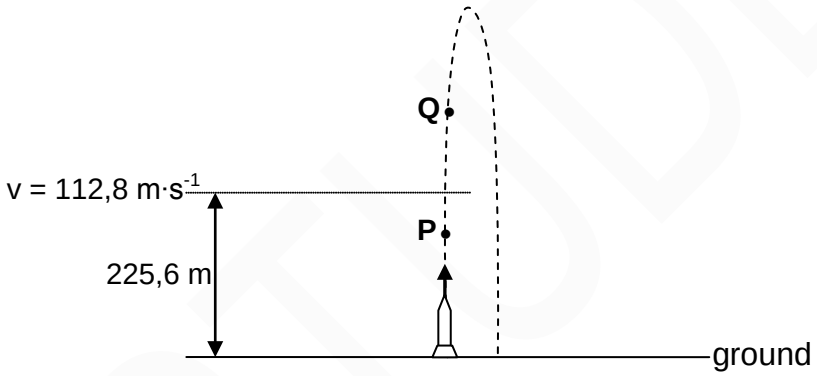
SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A stationary rocket on the ground is launched vertically upwards. After 4 s, the rocket's fuel is used up and it is 225,6 m above the ground. At this instant the velocity of the rocket is 112,8 $m \cdot s^{-1}$. The diagram below shows the path followed by the rocket. Ignore the effects of air friction. Assume that g does not change during the entire motion of the rocket.



3.1 Write down the direction of the acceleration of the rocket at point:

3.1.1 **P** (1)

3.1.2 **Q** (1)

3.2 At which point (**P** or **Q**) is the rocket in free fall? Give a reason for the answer. (2)

3.3 TAKING UPWARD MOTION AS POSITIVE, USE EQUATIONS OF MOTION to calculate the time taken from the moment the rocket is launched until it strikes the ground. (6)

3.4 Sketch a velocity versus time graph for the motion of the rocket from the moment it runs out of fuel until it strikes the ground. Take the time when the rocket runs out of fuel as t = 0 s.

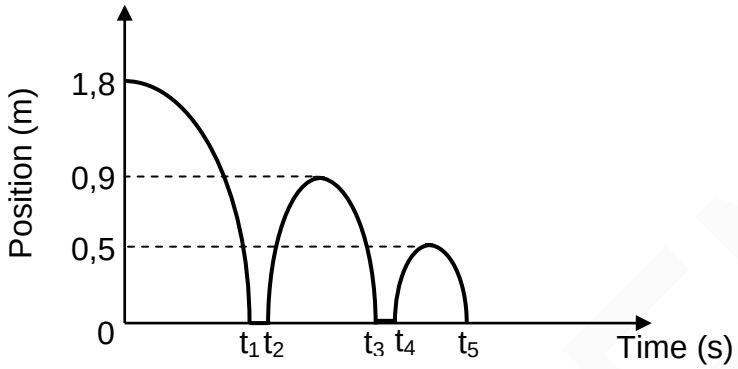
Indicate the following values on the graph:

- Velocity of the rocket when it runs out of fuel
- Time at which the rocket strikes the ground (5)

[15]

QUESTION 3 (Start on a new page.)

A ball of mass 0,5 kg is projected vertically downwards towards the ground from a height of 1,8 m at a velocity of 2 $m \cdot s^{-1}$. The position-time graph for the motion of the ball is shown below.



3.1 What is the maximum vertical height reached by the ball after the second bounce? (1)

Calculate the:

3.2 Magnitude of the time t_1 indicated on the graph (5)

3.3 Velocity with which the ball rebounds from the ground during the first bounce (4)

The ball is in contact with the ground for 0,2 s during the first bounce.

3.4 Calculate the magnitude of the force exerted by the ground on the ball during the first bounce if the ball strikes the ground at 6,27 $m \cdot s^{-1}$. (4)

3.5 Draw a velocity-time graph for the motion of the ball from the time that it is projected to the time when it rebounds to a height of 0,9 m.

Clearly show the following on your graph:

- The time when the ball hits the ground
- The velocity of the ball when it hits the ground
- The velocity of the ball when it rebounds from the ground (3)

[17]

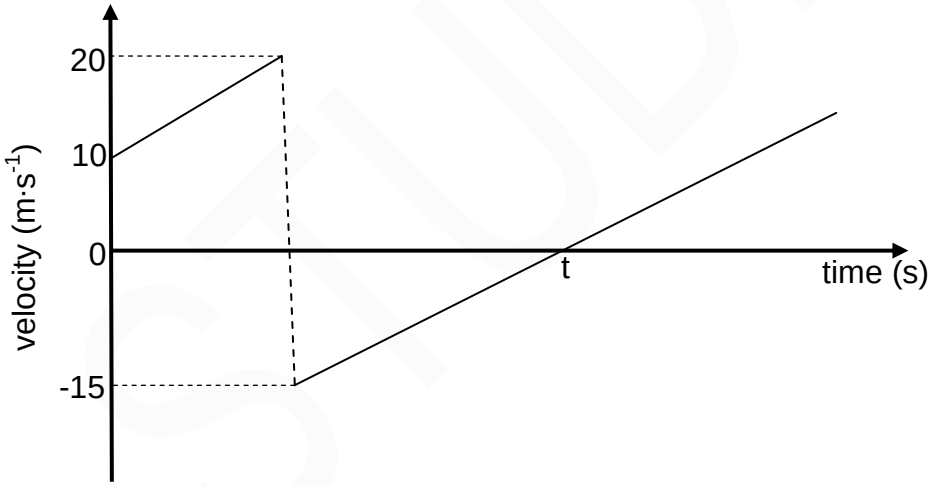
SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A ball of mass 0,15 kg is thrown vertically downwards from the top of a building to a concrete floor below. The ball bounces off the floor. The velocity versus time graph below shows the motion of the ball. Ignore the effects of air friction. TAKE DOWNWARD MOTION AS POSITIVE.



3.1 From the graph, write down the magnitude of the velocity at which the ball bounces off the floor. (1)

3.2 Is the collision of the ball with the floor ELASTIC or INELASTIC? Refer to the data on the graph to explain the answer. (3)

3.3 Calculate the:

3.3.1 Height from which the ball is thrown (4)

3.3.2 Magnitude of the impulse imparted by the floor on the ball (3)

3.3.3 Magnitude of the displacement of the ball from the moment it is thrown until time *t* (4)

3.4 Sketch a position versus time graph for the motion of the ball from the moment it is thrown until it reaches its maximum height after the bounce. USE THE FLOOR AS THE ZERO POSITION.

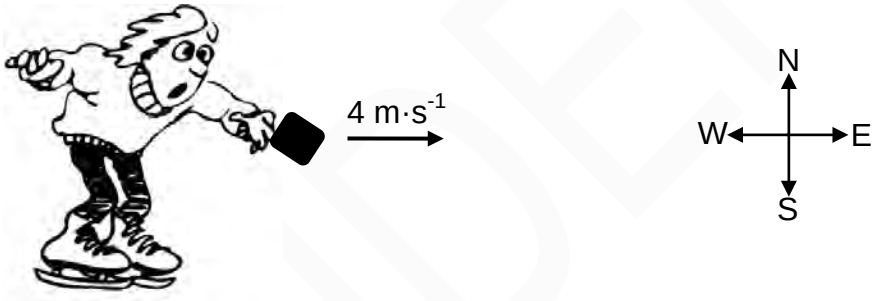
Indicate the following on the graph:

- The height from which the ball is thrown
- Time *t*

(4)
[19]

QUESTION 4 (Start on a new page.)

A boy on ice skates is stationary on a frozen lake (no friction). He throws a package of mass 5 kg at 4 $m \cdot s^{-1}$ horizontally east as shown below. The mass of the boy is 60 kg.



At the instant the package leaves the boy's hand, the boy starts moving.

4.1 In which direction does the boy move? Write down only EAST or WEST. (1)

4.2 Which ONE of Newton's laws of motion explains the direction in which the boy experiences a force when he throws the package? Name and state this law in words. (3)

4.3 Calculate the magnitude of the velocity of the boy immediately after the package leaves his hand. Ignore the effects of friction. (5)

4.4 How will the answer to QUESTION 4.3 be affected if:

(Write down INCREASES, DECREASES or REMAINS THE SAME.)

4.4.1 The boy throws the same package at a higher velocity in the same direction (1)

4.4.2 The boy throws a package of double the mass at the same velocity as in QUESTION 4.3. Explain the answer. (3)
[13]

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
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4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A ball of mass 0,2 kg is dropped from a height of 0,8 m onto a hard floor. It bounces to a maximum height of 0,6 m. The floor exerts a force of 50 N on the ball. Ignore the effects of friction.

3.1 Write down the magnitude and direction of the force that the ball exerts on the floor. (2)

3.2 Calculate the:

3.2.1 Velocity at which the ball strikes the floor (4)

3.2.2 Time that the ball is in contact with the floor if it bounces off the floor at a speed of 3,43 $m \cdot s^{-1}$ (4)

3.3 The ball takes 0,404 s from the moment it is dropped until it strikes the floor.

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 is dropped
- Height reached by the ball after the bounce
- Time at which the ball bounces off the floor (5)

[15]

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

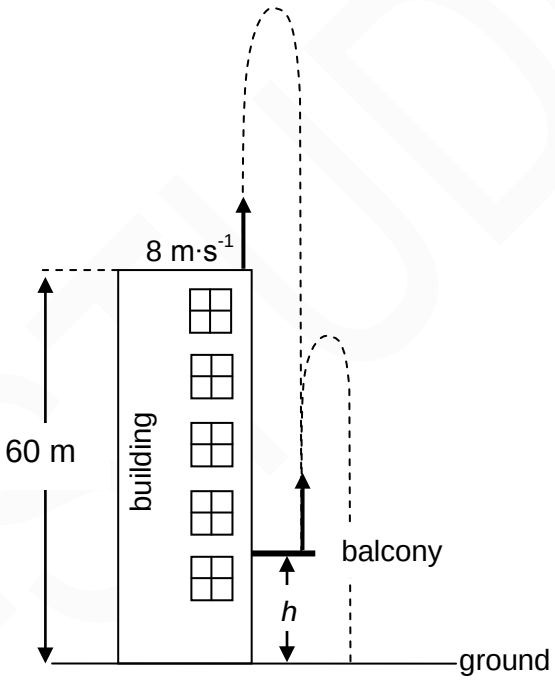
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

An object is projected vertically upwards at 8 $m \cdot s^{-1}$ from the roof of a building which is 60 m high. It strikes the balcony below after 4 s. The object then bounces off the balcony and strikes the ground as illustrated below. Ignore the effects of friction.



3.1 Is the object's acceleration at its maximum height UPWARD, DOWNWARD or ZERO? (1)

3.2 Calculate the:

3.2.1 Magnitude of the velocity at which the object strikes the balcony (4)

3.2.2 Height, *h*, of the balcony above the ground (5)

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.
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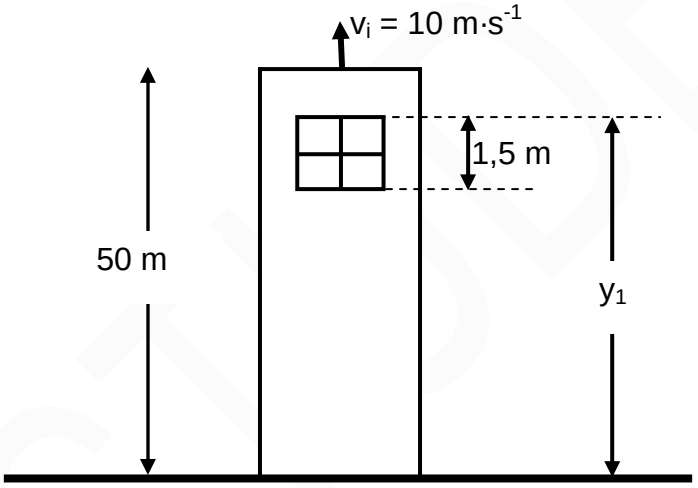
3. Show the formulae and substitutions in ALL calculations.
4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A stone is thrown vertically upward at a velocity of 10 $m \cdot s^{-1}$ from the top of a tower of height 50 m. After some time the stone passes the edge of the tower and strikes the ground below the tower. Ignore the effects of friction.



3.1 Draw a labelled free-body diagram showing the force(s) acting on the stone during its motion. (1)

3.2 Calculate the:

3.2.1 Time taken by the stone to reach its maximum height above the ground (4)

3.2.2 Maximum height that the stone reaches above the ground (4)

3.3 USING THE GROUND AS REFERENCE (zero position), sketch a position-time graph for the entire motion of the stone. (3)

3.4 On its way down, the stone takes 0,1 s to pass a window of length 1,5 m, as shown in the diagram above.

Calculate the distance (y_1) from the top of the window to the ground. (7)
[19]

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start EACH question on a NEW page.

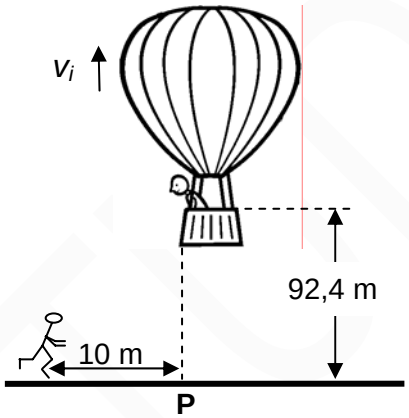
2. Leave ONE line between two subquestions, for example between QUESTION 3.1 and QUESTION 3.2.

3. Show the formulae and substitutions in ALL calculations.

4. Round off your final numerical answers to a minimum of TWO decimal places.

QUESTION 3 (Start on a new page.)

A hot-air balloon is moving vertically upwards at a constant speed. A camera is accidentally dropped from the balloon at a height of 92,4 m as shown in the diagram below. The camera strikes the ground after 6 s. Ignore the effects of friction.



3.1 At the instant the camera is dropped, it moves upwards. Give a reason for this observation. (1)

3.2 Calculate the speed v_i at which the balloon is rising when the camera is dropped. (4)

3.3 Draw a sketch graph of velocity versus time for the entire motion of the camera.

Indicate the following on the graph:

- Initial velocity
- Time at which it reaches the ground (4)

3.4 If a jogger, 10 m away from point **P** as shown in the above diagram and running at a constant speed of 2 $m \cdot s^{-1}$, sees the camera at the same instant it starts falling from the balloon, will he be able to catch the camera before it strikes the ground?

Use a calculation to show how you arrived at the answer. (5)
[14]

SECTION B

INSTRUCTIONS AND INFORMATION

1. Start each question on a NEW page.

2. Leave one line between two subquestions, for example between QUESTION 4.1 and QUESTION 4.2.

3. The formulae and substitutions must be shown in ALL calculations.

4. Round off your answers to TWO decimal places where applicable.

QUESTION 4 (Start on a new page.)

The following extract comes from an article in a school newspaper.

THE LAWS OF PHYSICS ARE ACCURATE!

Two construction workers, Alex and Pete, were arguing about whether a smaller brick would hit the ground quicker than a larger brick when both are released from the same height.

Alex said that the larger brick should hit the ground first. Pete argued that the smaller brick would hit the ground first.

4.1 Are their statements correct? Give a reason for your answer. (3)

4.2 A group of Physical Sciences learners decide to test Alex's and Pete's hypotheses. They drop two bricks, one small and the other much larger, from one of the floors of the school building.

4.2.1 Write down TWO precautions they should take to ensure that the result is reliable. (2)

4.2.2 Give a reason why, despite all the necessary precautions, they might not get the correct result. (1)

4.3 In another experiment, the learners **drop** a brick A from a height of 8 m. After 0,6 s, they **throw** a second brick B downwards from the same height. Both bricks, A and B, hit the ground at the same time.

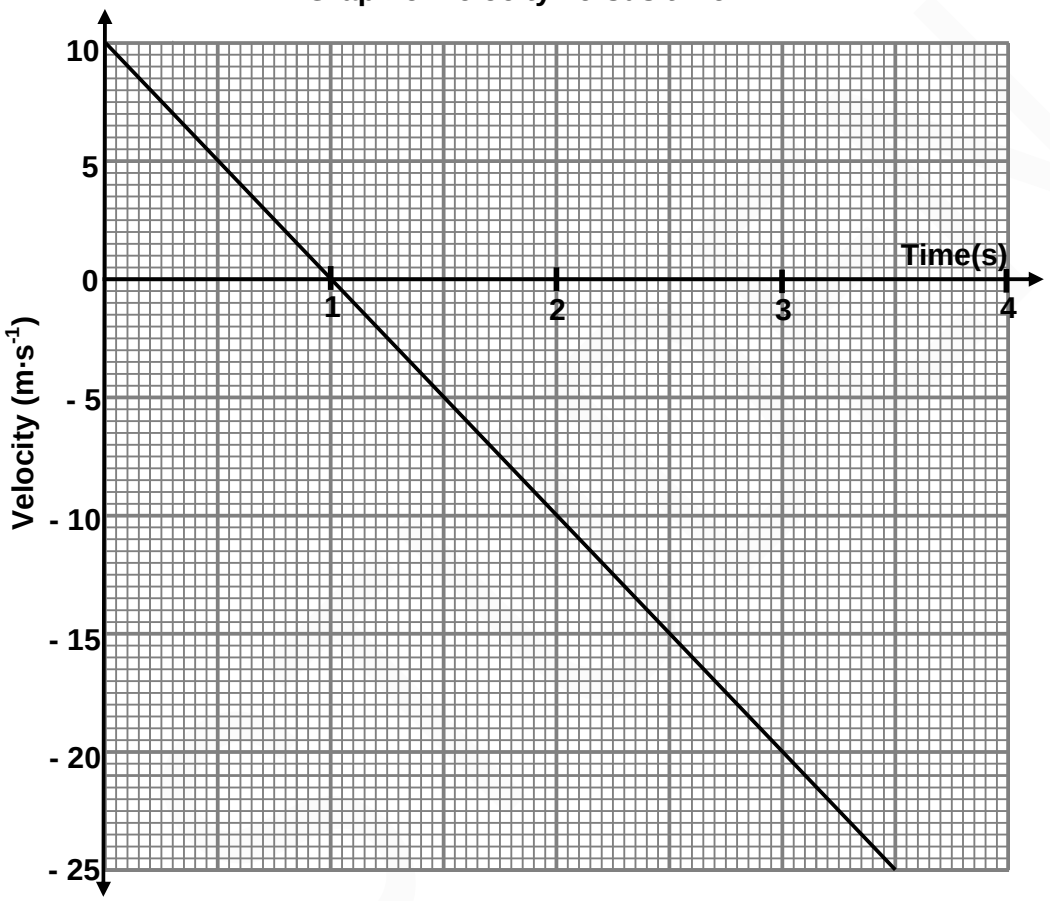
Ignore the effects of friction and calculate the speed at which brick B was thrown. (7)

[13]

QUESTION 6

A boy stands at the edge of a high cliff. He throws a stone vertically upwards with an initial velocity of 10 $m \cdot s^{-1}$. The stone strikes the ground at a point below the cliff after 3,5 s. The velocity-time graph below was obtained from *measurements* made during the motion of the stone.

Graph of velocity versus time



Use the information on the graph to answer the following questions:

6.1 Calculate the acceleration of the stone between times t = 2 s and t = 3 s. (3)

6.2 At which time(s) is the stone moving at a speed of 5 $m \cdot s^{-1}$? (2)

6.3 After how many seconds does the stone reach its highest point? (1)

6.4 Determine the height of the cliff from which the stone was thrown. (4)

6.5 Using the top of the cliff as the initial position of the stone, sketch the position-time graph (displacement-time graph) for the motion of the stone **from its highest point until it reaches the ground**. Only indicate relevant time values on the x-axis. (3)

[13]