education

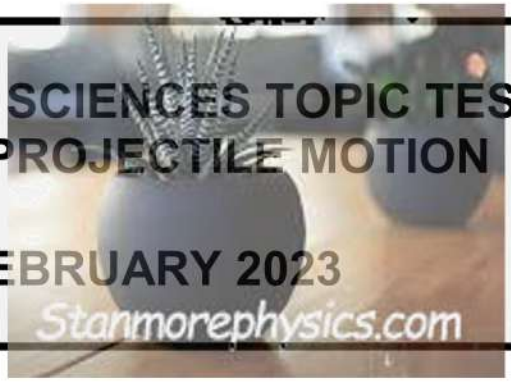
DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

GERT SIBANDE DISTRICT

GRADE 12

PHYSICAL SCIENCES TOPIC TEST
TOPIC: PROJECTILE MOTION

FEBRUARY 2023



MARKS: 50

TIME: 1:00 HOUR

This question paper consists of 7 pages including the data sheet

INSTRUCRIONS AND INFORMATION

1. Answer ALL questions.
2. Number all your answers correctly.
3. You are advised to use the attached DATA SHEET.
4. Write neatly and legibly.

QUESTION 1

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A-D) next to the question number (1.1
- 1.3) in the answer sheet, eg; 1.4 A.

1.1 An object is thrown vertically upwards. Which ONE of the following regarding the object's velocity and acceleration at the highest point of its motion is CORRECT? Ignore the effects of friction.

	VELOCITY	ACCELERATION
A	Zero	Zero
B	Zero	Upwards
C	Maximum	Zero
D	Zero	Downwards

(2)

1.2 A learner drops an object from the top floor of a high building. One second later the learner drops another identical object from the same position. As both objects are in free fall, the distance between them will .....

A increase.
B decrease.
C initially increase, then decrease.
D remain the same. (2)

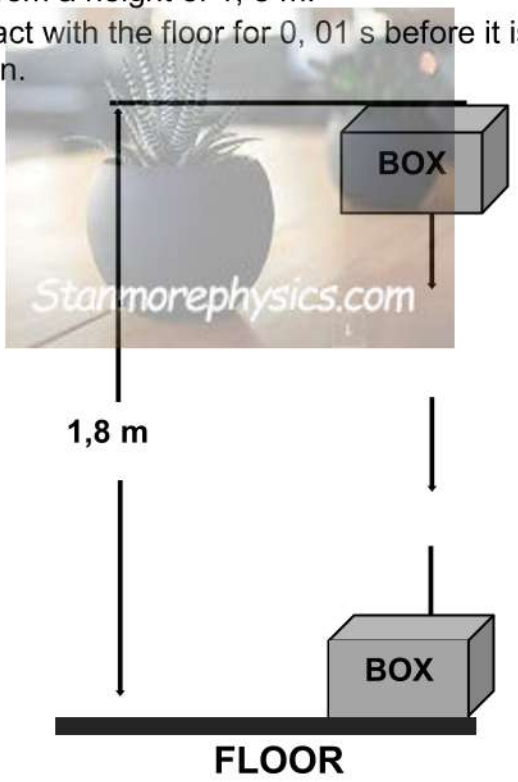
1.3 A stone is dropped from a certain height above the ground. Which ONE of the following combinations is TRUE while the stone is moving downwards? Ignore the effects of air resistance.

	NET FORCE ACTING ON THE STONE	MECHANICAL ENERGY OF THE STONE
A	Remains the same	Increases
B	Decreases	Remains the same
C	Remains the same	Remains the same
D	Increases	Decreases

(2)
[6]

QUESTION 2

A box of mass 0, 5 kg is projected vertically downwards, at a velocity of 8 $m.s^{-1}$ towards the floor from a height of 1, 8 m.
The box is in contact with the floor for 0, 01 s before it is picked up. Ignore the effects of air friction.



2.1 Is the box in a free fall directly after being projected?
Write down only YES or NO. Give a reason for the answer. (2)

2.2 Write down the magnitude and direction of the acceleration of the box immediately after it is projected. (1)

2.3 Calculate:

2.3.1 The magnitude of the velocity with which the box hits the floor. (3)

2.3.2 The time it takes the box to hit the floor. (3)

2.3.3 The net force exerted by the box on the floor. (3)

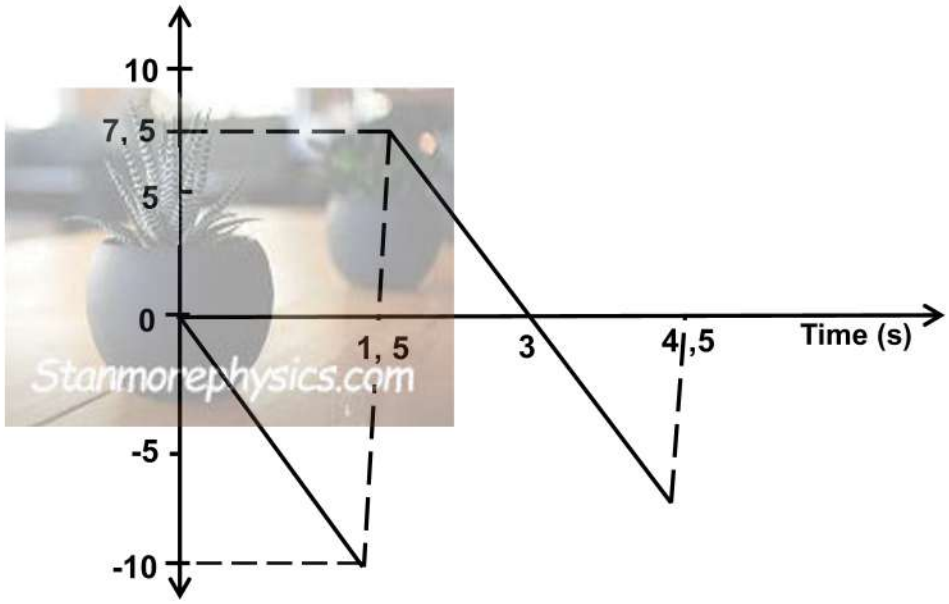
2.4 Sketch an acceleration-time graph for the motion of the box (No indication of values is required). (2)

[14]

QUESTION 3

A ball of mass 200 g is dropped 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 UPWARD MOTION AS POSITIVE.



3.1 Use the graph **only**:

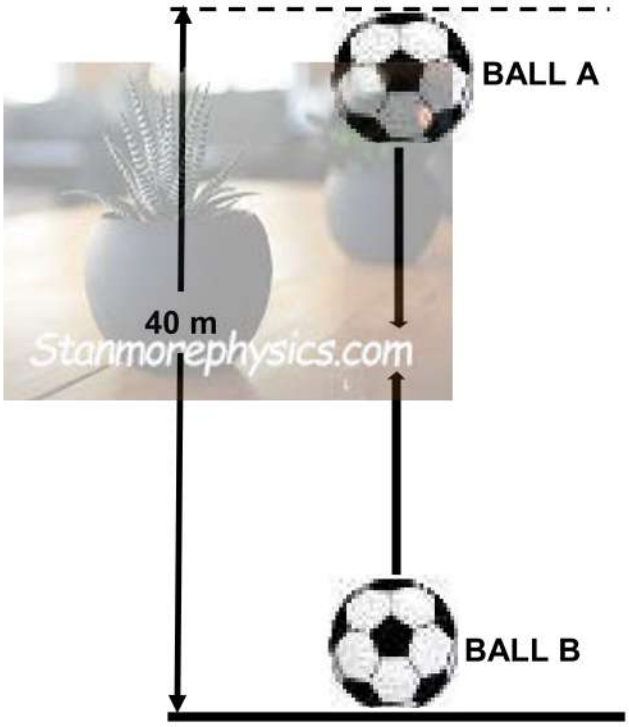
3.1.1 To determine the number of times the ball bounces off the floor. (1)

3.1.2 To determine whether the collision between the ball and the floor is elastic or inelastic. Provide a reason for the answer. (2)

3.1.3 To calculate the height from which the ball is dropped. (3)

3.2 Calculate the impulse that the ball exerts on the floor when it strikes the floor for the first time. (3)

3.3 In the diagram below, ball **A** is dropped from a height of 40 m and simultaneously ball **B** is thrown vertically up ward at a velocity of 20 $m.s^{1}$. Ignore the effects of air friction.

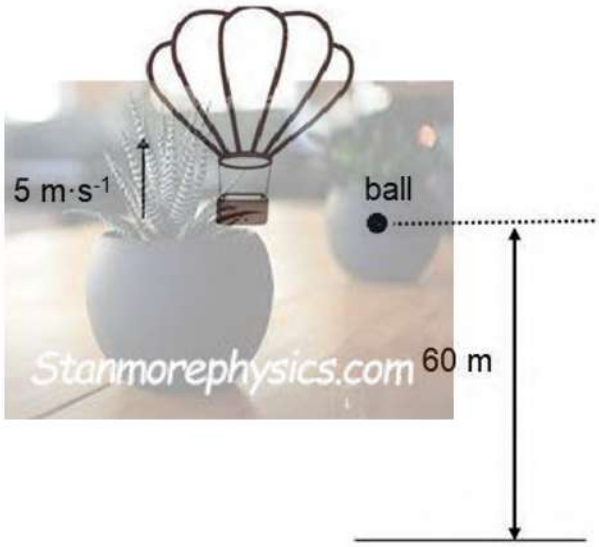


Calculate the height from the ground at which the two balls collide. (6)

[15]

QUESTION 4

A hot air balloon is rising upwards with a constant velocity of 5 $m \cdot s^{-1}$. When the balloon is 60 m above the ground, a ball is released from it and the ball falls freely up to the ground.



4.1 Define the term *free fall.* (1)

4.2 What is the velocity and direction of the ball at the moment when it is released from the balloon? (1)

4.3 Calculate maximum height **above the ground** reached by the ball. (4)

4.4 How far apart will the ball and the balloon be, 3 s after the ball is released? (5)

4.5 Sketch a velocity-time graph for the motion of the ball, from the time the ball is released until it hits the ground.
Clearly show the following on the graph:

- The initial velocity of the ball (as Vi).
- The velocity (as Vf) and time (as Tf) when the ball hits the ground.
- The time taken by the stone to reach the maximum height (as T_{max}). (4)

[15]

TOTAL: 50

TABLE 1: PHYSICAL CONSTANTS

NAME	SYMBOL	VALUE
Acceleration due to gravity	g	9,8 $m \cdot s^{-2}$

TABLE 2: MOTION

$v_f = v_i + a\,\Delta t$	$\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ or $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$
$v_f^2 = v_i^2 + 2a\Delta y$ or $v_f^2 = v_i^2 + 2a\Delta x$	$\Delta y = \left(\frac{v_f + v_i}{2} \right) \Delta t$

TABLE 3: FORCE

$F_{net} = ma$	$p = mv$
$F_{net} \Delta t = \Delta p$ $\Delta p = mv_f - mv_i$	$w = mg$

TABLE 4: ENERGY

$U = mgh$ or $E_P = mgh$	
$K = \frac{1}{2} mv^2$ or $E_k = \frac{1}{2} mv^2$	$\Delta K = K_f - K_i$ or $\Delta E_k = E_{kf} - E_{ki}$

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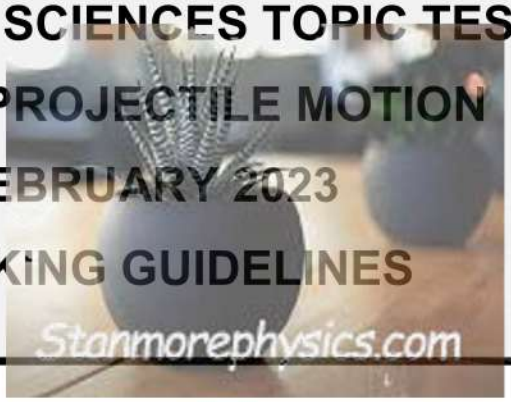
MARKING GUIDELINES



MARKS: 50

These marking guidelines consist of 10 pages

QUESTION 1

1.1 D✓✓ (2)

1.2 A✓✓ (2)

1.3 C✓✓ (2)

[6]

QUESTION 2

2.1 Yes; ✓ It is under the influence of gravitational force only✓ (2)

2.2 9, 8 $m.s^{-2}$ down ward ✓ (1)

2.3.1

OPTION 1	
Downwards positive: $V_f^2 = v_i^2 + 2a\Delta y$ ✓ $= 8^2 + \underline{2(9,8)(1,8)}$ ✓ $V_f = 9,96\ m{\cdot}s^{-1}$ ✓	**Upwards positive:** $V_f^2 = v_i^2 + 2a\Delta y$ ✓ $= (-8)^2 + \underline{2(-9,8)\ (-1,8)}$ ✓ $V_f = 9,96\ m{\cdot}s^{-1}$ ✓
OPTION 2 $(mgh + ½mv^2)_{top} = (mgh + ½mv^2)_{floor}$ ✓ $\underline{m}(9,8)(1,8) + ½m(8)^2 = 0 + ½mv^2$ ✓ $17,64 + ½(64) = ½v^2$ $Vf = 9,96\ m{\cdot}s^{-1}$ ✓	**OPTION 3** $\Delta y = v_i\Delta t + ½a\Delta t^2$ $\underline{1,8 = 8\Delta t + ½(9,8)\Delta t^2}$ ✓ $\Delta t = 0,2$ s **Both Formulae** ✓ $V_f = v_i + a\Delta t$ $V_f = \underline{8 + (9,8)(0,2)}$ $V_f = 9,96\ m{\cdot}s^{-1}$ ✓
NOTE: V_f without direction should not be penalised.	

(3)

2.3.2

POSITIVE MARKING FROM Q 2.3.1

OPTION 1

Downwards positive:

$v_f = v_i + a\Delta t$ ✓

$\underline{9,96 = 8 + 9,8\Delta t}$ ✓

$\Delta t = 0,20$ s ✓

Upwards positive:

$v_f = v_i + a\Delta t$ ✓

$-9,96 = -8 + (-9,8)\Delta t$ ✓

$\Delta t = 0,20$ s ✓

OPTION 2

Downwards positive:

$$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$$ ✓

$$1,8 = \left(\frac{9,98+8}{2}\right)\Delta t$$ ✓

$\Delta t = 0,20$ s ✓

Upwards positive:

$$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$$ ✓

$$-1,8 = \left(\frac{-9,96+(-8)}{2}\right)\Delta t$$ ✓

$\Delta t = 0,20$ s ✓

OPTION 3

Downwards positive:

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

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

$\Delta t = 0,20$ s ✓

Upwards positive:

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

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

$\Delta t = 0,20$ s ✓

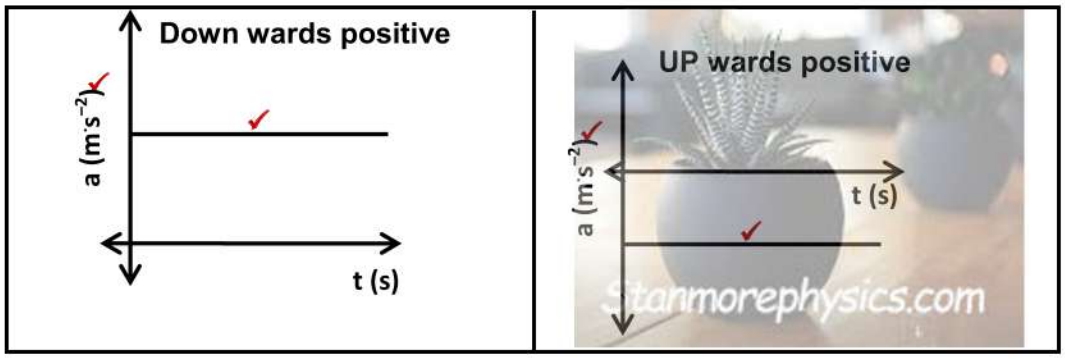
(3)

2.3.3 **POSITIVE MARKING FROM Q 2.3.1**

DOWNWARDS POSITIVE	UPWARDS POSITIVE
Fnet Δt = ΔP✓ Fnet (0,01) = 0,5(9,96 – 8) ✓ Fnet = 98 N Downwards ✓	Fnet Δt = ΔP✓ Fnet (0,01) = 0,5(-9,96 –(- 8)✓ Fnet = - 98 N Fnet = 98 N Downwards✓

(3)

2.4



(2)
[14]

QUESTION 3

3.1.1 1/one✓ (1)

3.1.2 inelastic ✓
The velocity (7, 5 cm^{-1}) at which the ball bounces off the floor is less than the velocity (10$m.s^{-1}$) at which it hits the floor.
✓
OR: There is a decrease/change in velocity when the ball hits the floor.
OR: There is a change/decrease in kinetic energy due to the change/decrease in the velocity when the ball hits the floor. (2)

3.1.3 $\Delta Y = \frac{1}{2} \times b \times h$✓

$\Delta Y = 0,5 \times 1,5 \times (10)$ ✓
$\Delta Y = 7,5\ m$✓

(3)

3.2

OPTION 1	OPTION 2
$Fnet\Delta t_{(floor\ on\ ball)} = \Delta P$✓ $= 0,2(7, 5 - (-10)$✓ $= 3, 5$ NS Hence; $Fnet\Delta t_{(ball\ on\ floor)} = -3, 5$ NS $= 3, 5$ NS down wards✓	$Fnet\Delta t_{(ball\ on\ floor)} = \Delta P$✓ $Fnet\Delta t_{(ball\ on\ floor)} = 0,2(-7, 5 - 10)$✓ $Fnet\Delta t_{(ball\ on\ floor)} = -3, 5$ NS $Fnet\Delta t_{(ball\ on\ floor)} = 3, 5$ NS down wards✓

(3)

3.3

UP WARD IS POSITIVE

Let the distance moved by ball **A** before collision be (Y) m
Hence the distance moved by ball **B** before collision is (40 – Y) m

BALL A	BALL B
$\Delta y = (-Y)$ m $Vi = 0$ m.s^{-1} $A = -9,8$ m.s^{-2} $\Delta t = t$	$\Delta y = +(40 - Y)$ m $Vi = +20$ m.s^{-1} $A = -9,8$ m.s^{-2} $\Delta t = t$
$\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2$✓ $-Y = 0 + \frac{1}{2}(-9,8)\ t^2$✓ $-Y = -4,9\ t^2$---------- (1)	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $40-Y = 20t + \frac{1}{2}(-9,8)\ t^2$✓ $40-Y = 20t - 4,9\ t^2$ $-Y = -40 + 20t - 4,9\ t^2$ ---------- (2)

(1) = (2)

$-4,9\ t^2 = -40 + 20t - 4,9\ t^2$✓

$t = 2$ s

From; $-Y = -4,9\ t^2$

$-Y = -4,9\ (2)^2$✓

$Y = 19, 6$ m✓

DOWN WARDWARD IS POSITIVE

Let the distance moved by ball **A** before collision be (Y) m
Hence the distance moved by ball **B** before collision is (40 – Y) m

BALL A	**BALL B**
$\Delta y = (+Y)$ m $V_i = 0$ m.s^{-1} $A = 9,8$ m.s^{-2} $\Delta t = t$	$\Delta y = -(40 - Y)$ m $V_i = -20$ m.s^{-1} $A = 9,8$ m.s^{-2} $\Delta t = t$
$\Delta y = v_i \Delta t + \frac{1}{2}a\Delta t^2$ ✓ $Y = 0 + \frac{1}{2}(9,8)\, t^2$ ✓ $Y = 4,9\, t^2$ ---------- (1)	$\Delta y = v_i\Delta t + \frac{1}{2}a\Delta t^2$ $-(40-Y) = -20t + \frac{1}{2}(9,8)\, t^2$ ✓ $-40+Y = -20t + 4,9\, t^2$ $Y = 40 - 20t + 4,9\, t^2$ ---------- (2)

(1) = (2)

$4,9\, t^2 = 40 - 20t + 4,9\, t^2$ ✓

$t = 2$ s

From; $Y = 4,9\, t^2$

$Y = 4,9\,(2)^2$ ✓

$Y = 19,6$ m ✓

(6)
[15]

QUESTION 4

4.1 Motion during which the **only** force acting on an object is the force of gravity.✓
[1 or 0 mk] (1)

4.2 5 $m \cdot s^{-1}$ upwards✓ (1)

4.3 **Marking Criteria**

- Any appropriate formula ✓
- All substitutions to calculate the value of Δy✓
- Addition of 60 +Δy ✓
- Final answer✓

OPTION 1

UPWARDS POSITIVE

$V_f^2 = V_i^2 + 2a\Delta y$✓

$(0)^2 = 5^2 + 2(-9,8)\ \Delta y$ ✓

Δy = 1, 28 m / (1, 275m)

Height = 1,28 m

The ball will reach a maximum height of (60 +1, 28)✓= 61, 28 m✓ (above the ground)

DOWNWARDS POSITIVE

$V_f^2 = V_i^2 + 2a\Delta y$ ✓

$(0)^2 = -5^2 + 2\ (9,8)\ \Delta y$ ✓

Δy = -1,28 m

Height = 1,28 m / (1,275m)

The ball will reach a maximum height of (60 +1, 28) ✓= 61, 28 m ✓ above the ground.

OPTION 2

$V_f = V_i + a\Delta t$

$0 = 5 + (-9, 8)\ \Delta t$✓

Δt = 0,51s ✓ **(For both equations)**

$$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$$

$$\Delta y = \left(\frac{0+5}{2}\right)0,51$$✓

Δy = 1, 28 m/ (1, 275m)

The ball will reach a maximum height of (60 +1, 28) = 61,28 m✓above the ground.

OPTION 3

$V_f = V_i + a\Delta t$ ← Any one ✓

$0 = 5 + (-9,8)\ \Delta t$ ✓

$\Delta t = 0,51$ s

$\Delta y = V_i\Delta t + ½\ a\Delta t^2$

$\Delta y = 5 \times 0,51 + ½\ (-9,8) \times 0,51^2$ ✓

$\Delta y = 1,28$ m / (1,275m)

The ball will reach a maximum height of (60 +1,28) = 61, 28 m ✓ above the ground. (4)

4.4 **OPTION 1**

The distance travelled by the ballon after 3s;

(The hot- air balloon moved upwards at a constant velocity)

$\Delta y = v_i\Delta t + ½\ a\Delta t^2$ ✓

$\Delta y = (5)(3) + 0$ ✓

$\Delta y = 15$ m

After 3 s the hot- air balloon will be 15 m above the starting point.

The distance travelled by the ball after 3s;

$\Delta y = v_i\Delta t + ½\ a\Delta t^2$

$\Delta y = (5)(3) + ½\ (-9,8)\ (3)^2$ ✓

$\Delta y = -29,1$ m

The ball is 29,1 m below the point from where it was released.

After 3 s the hot air balloon and the ball will be (15 + 29,1) ✓ = 44,1 m ✓ apart.

OPTION 2

The distance travelled by the ballon after 3s;

$V_{ave} = \frac{\Delta y}{\Delta t}$

$\Delta y = (5)(3)$ ✓

$= 15$ m

The distance travelled by the ball after 3s;

$V_f = V_i + a\Delta t$

$= 5 + (-9,8)(3)$ ✓

$= -24,4\ m{\cdot}s^{-1}$

$\Delta y = \left(\frac{v_f + v_i}{2}\right)\Delta t$

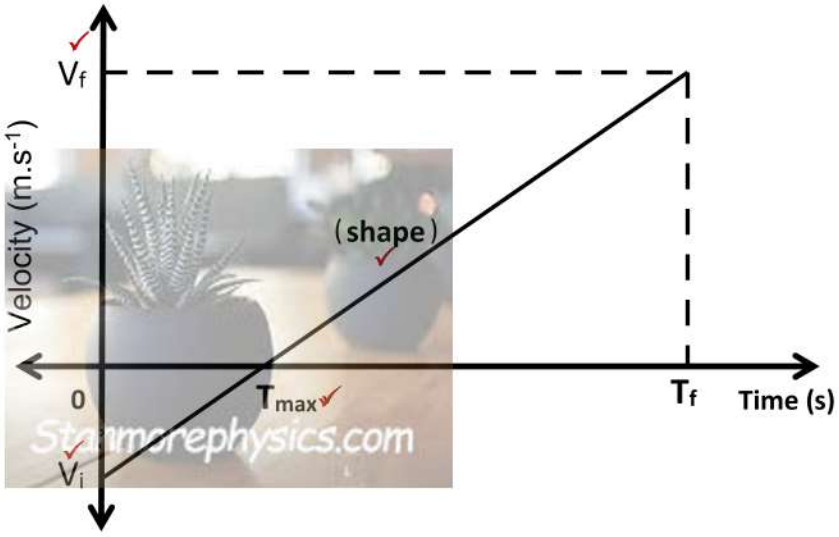
$\Delta y = \left(\frac{-24,4 + 5}{2}\right)(3)$ ✓

Δy = -29,1 m
The ball is 29,1 m below the point from where it was released.
After 3 s the hot air balloon and the ball will be (15 + 29,1) ✓= 44,1 m✓ apart (5)

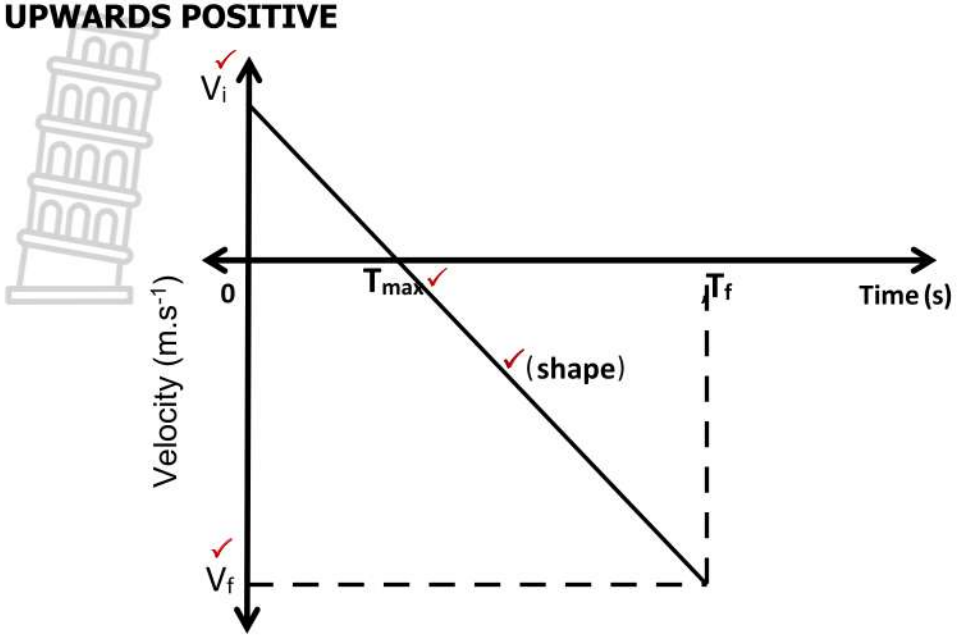
4.5

Marking criteria of the graph.	
V_i correctly labelled.	**1 mk**
V_f & T_f correctly labelled.	**1 mk**
T_{max} correctly labelled.	**1 mk**
Correct shape.	**1 mk**

DOWNWARDS POSITIVE



UPWARDS POSITIVE



(4)

[15]

TOTAL: 50