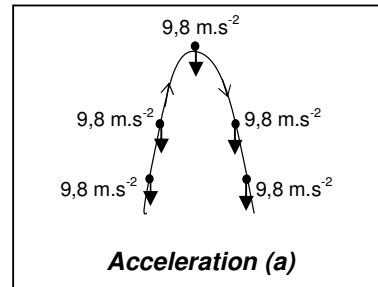
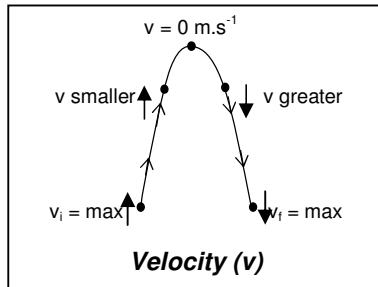


SUMMARY projectile motion p52 - 70

PROJECTILE MOTION

FREE FALL

- Projectile motion is considered when gravitation is the only force exerted on an object $\therefore$ free fall.
- **Gravitational acceleration**(g) = $9,8 \text{ m}\cdot\text{s}^{-2}$ downwards.
- During free fall all objects accelerate **downwards** at **constant acceleration of $9,8 \text{ ms}^{-2}$** . It doesn't matter if the object is moving upwards or downwards or is at zero velocity at the maximum height.



EQUATIONS OF MOTION

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

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

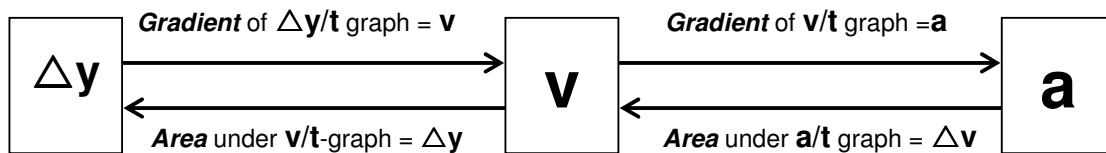
$$v_f^2 = v_i^2 + 2a\Delta y$$

$$\Delta y = \frac{1}{2}(v_i + v_f)\Delta t$$

v_i =initial velocity ($\text{m}\cdot\text{s}^{-1}$)
 v_f =final velocity ($\text{m}\cdot\text{s}^{-1}$)
 a = gravitational acceleration = $9,8 \text{ m}\cdot\text{s}^{-2}$ downwards
 Δt = time (s)
 Δy = position (displacement) (m)

GRADIENTS AND AREAS

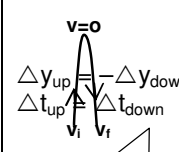
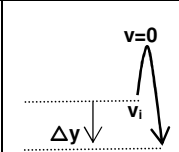
- Use the **gradient** of a line or the **area** under the curve if you are asked to do a calculation "from the graph" or "without using an equation of motion". No marks will be given if the candidate uses an equation in this case.
- For example: the acceleration on a velocity-time-graph is determined by the gradient of the curve.



- Any method can be used if the question does not state that a certain method has to be used.

SITUATIONS FOR FREE FALL

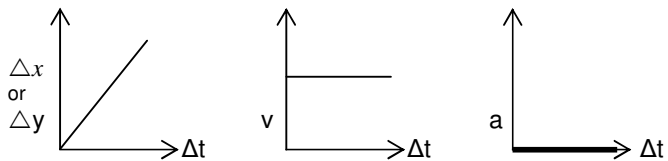
- There are 3 situations. The candidate has to choose a positive direction (upwards or downwards). Make sure that the directions of v_i , v_f and Δy correspond with the choice of direction.

		Downwards + ↓ is positive	Upwards + ↑ is positive
1. An object is dropped from a certain height.	↓	$v_i = 0$ $a = g = +9,8 \text{ m}\cdot\text{s}^{-2}$ v_f and Δy is $\oplus$	-----
2. An object is thrown upwards into the air with an initial velocity and caught again at the same height.	 Time for upwards = time for downwards is known as Time symmetry	$a = g = +9,8 \text{ m}\cdot\text{s}^{-2}$ <u>For total motion:</u> $v_i \ominus$ $v_f \oplus$ - and $-v_i = v_f$ $\Delta y = 0$	$a = g = -9,8 \text{ m}\cdot\text{s}^{-2}$ <u>For total motion:</u> $v_i \oplus$ $v_f \ominus$ - and $v_i = -v_f$ $\Delta y = 0$
3. An object is thrown upwards into the air and falls beyond its starting point.		$a = g = +9,8 \text{ m}\cdot\text{s}^{-2}$ <u>For total motion:</u> $v_i \ominus$ $v_f \oplus$ $\Delta y \oplus$	$a = g = -9,8 \text{ m}\cdot\text{s}^{-2}$ <u>For total motion:</u> $v_i \oplus$ $v_f \ominus$ $\Delta y \ominus$

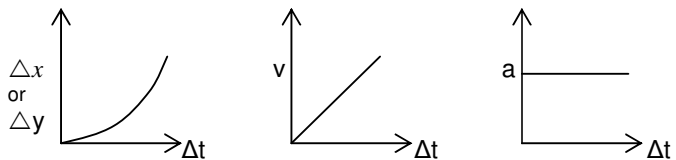
The choice of direction that is recommended is framed in the table above. With this choice the interpretation of graphs is easier. (Also see page 4.)

Gr 10 GRAPHS

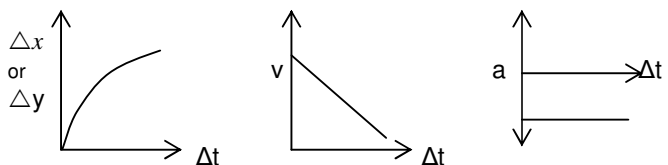
- Constant velocity** ($a = 0$): equal distances in equal times.



- Object moves **faster** at constant acceleration: ($a > 0$): velocity increases.

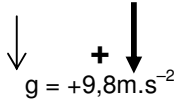
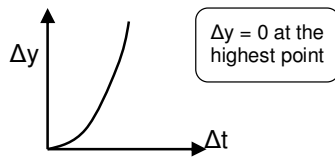
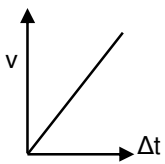
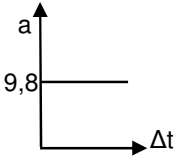
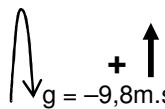
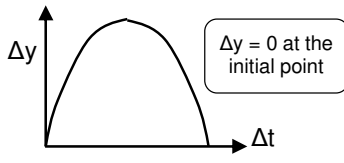
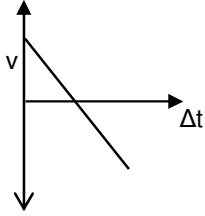
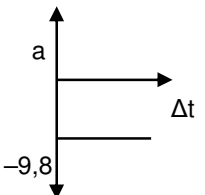
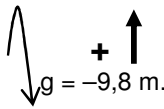
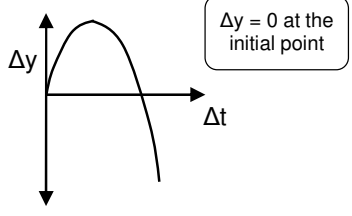
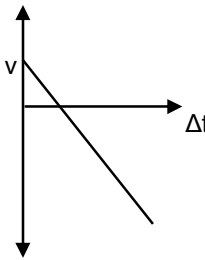
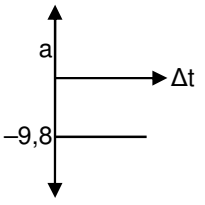


- Object moves **slower** at constant acceleration: ($a < 0$): velocity decreases.



GRAPHS FOR PROJECTILE MOTION

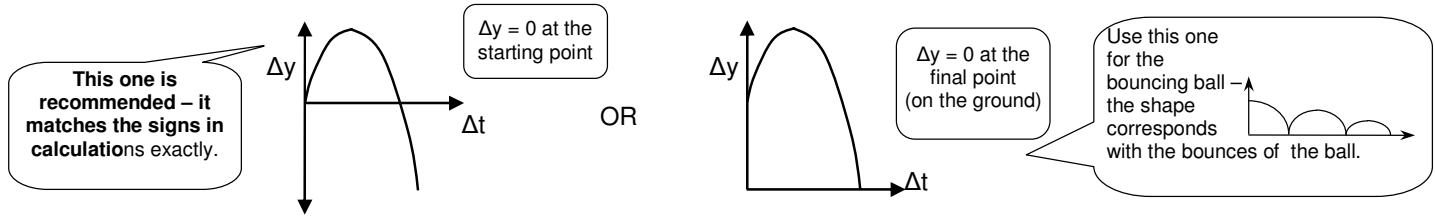
- We use grade 10 graphs of motion to draw graphs for the 3 situations of free fall.
- It is easier to draw and interpret the graphs when the positive direction is chosen as follows:
 - Situation 1: An object is dropped from a certain height → DOWNWARDS IS POSITIVE.
 - Situation 2: An object is thrown upwards into the air with a initial velocity and caught again at the same height → UPWARDS IS POSITIVE.
 - Situation 3: An object is thrown upwards into the air and falls beyond its starting point → UPWARDS IS POSITIVE.

1. An object is dropped from a certain height.  $g = +9,8 \text{ m.s}^{-2}$			
2. An object is thrown upwards into the air with a initial velocity and caught again at the same height.  $g = -9,8 \text{ m.s}^{-2}$			
3. An object is thrown upwards into the air and falls beyond its starting point..  $g = -9,8 \text{ m.s}^{-2}$			

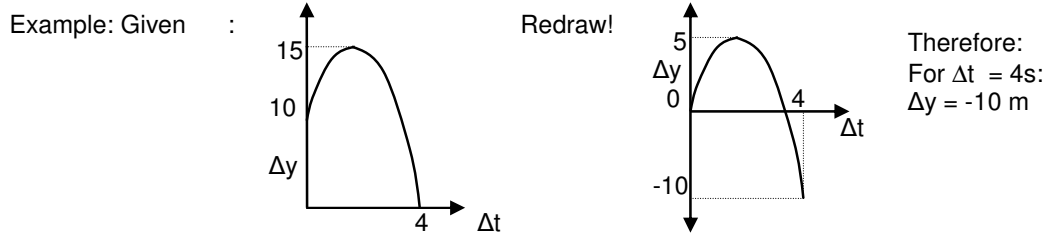
VARIATIONS ON GRAPHS – SITUATION 3

- There are two kinds of questions:
 - a graph is given, and you have to do calculations from the graph;
 - you do calculations, and have to draw graphs eventually and fill in your calculated values.
- Always stay with your choice of sign (we choose upwards +). If you have to do the drawing, draw the graphs as above. But if the examiner draws the graphs, it can be given in other shapes. Have a look at the following variations:

- Variation on $\Delta y / \Delta t$:



Both graphs are correct and you will receive all the marks when you draw it, BUT if you are given the graph on the right and you have to do calculation, REDRAW! When we use equations of motion, it is always assumed that the starting point ($\Delta y = 0$) is at $\Delta t = 0$ and not on the ground!

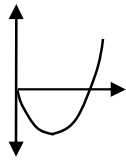
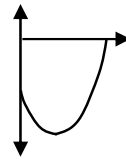
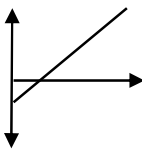
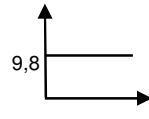
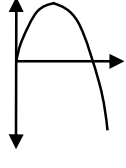
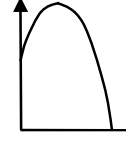
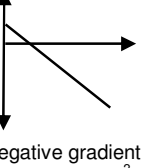
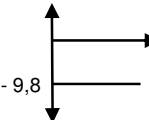


GRAPHS FOR ALL SIGN CONVENTIONS

- The recommended graphs are again framed.

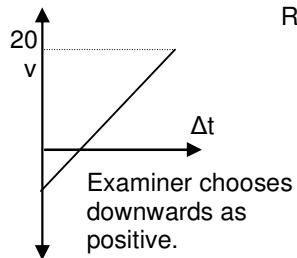
		$\Delta y / \Delta t$	$v / \Delta t$	$a / \Delta t$
1.	downwards positive + ↓ $g = +9,8 \text{ m.s}^{-2}$			
	upwards positive + ↑ $g = -9,8 \text{ m.s}^{-2}$			

		$\Delta y / \Delta t$	$v / \Delta t$	$a / \Delta t$
2.	downwards positive + ↓ $g = +9,8 \text{ m.s}^{-2}$			
	upwards positive + ↑ $g = -9,8 \text{ m.s}^{-2}$			

		$\Delta y / \Delta t$		$v / \Delta t$	$a / \Delta t$
3.	downwards positive + ↓ $g = +9,8 \text{ m.s}^{-2}$	$\Delta y \equiv \text{start}$ 	$\Delta y \equiv \text{ground}$ 	positive gradient $\therefore a = +9,8 \text{ m.s}^{-2}$ 	
	upwards positive + ↑ $g = -9,8 \text{ m.s}^{-2}$			negative gradient $\therefore a = -9,8 \text{ m.s}^{-2}$ 	

The examiner can also give a graph with the other choice of direction (that is downwards as positive).
AGAIN, REDRAW!

Example : Given:



Redraw!

