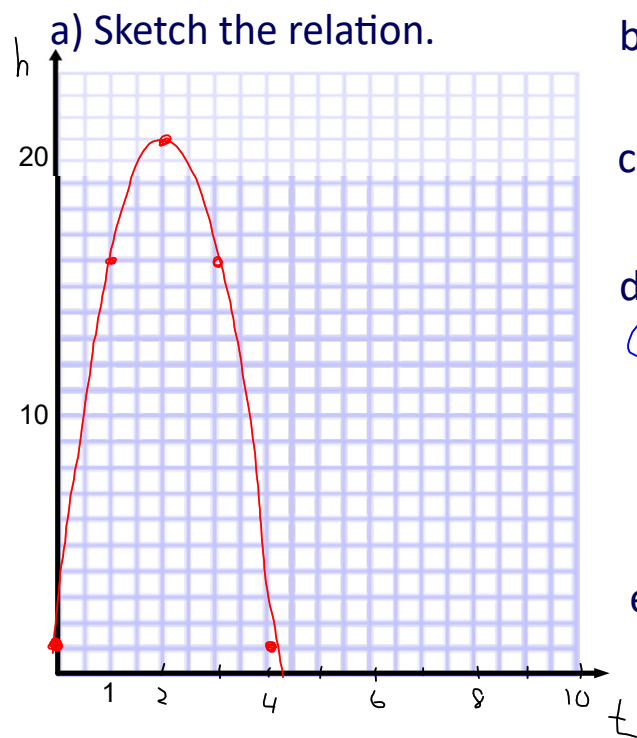


### 3.5 Applications: Vertex Form

Ex 1: A video tracking device recorded the height,  $h$ , in metres, of a baseball after it was hit. The data collected can be modelled by the relation:  $h = -5(t-2)^2 + 21$ , where  $t$  is the time in seconds after the ball was hit.  $V(2, 21)$



b) What was the maximum height of the ball?  $21\text{m}$

c) When did the maximum height occur?  $\text{at } 2\text{s}$

d) From what height was the ball hit?  
 @  $t=0$ ? OR  $h = -5(0-2)^2 + 21$   
 $(0, 1) = 1$   
 $\therefore 1\text{m}$

e) How high was the ball after 1 s?  
 Determine another time when the ball was this height.

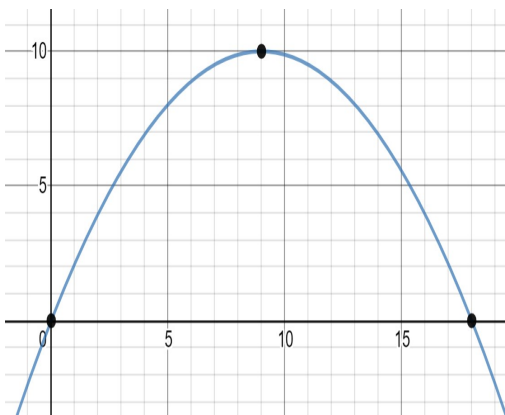
$$\begin{aligned} \text{@ } t=1? \quad h &= -5(1-2)^2 + 21 \\ &= -5(1) + 21 \\ &= 16 \end{aligned}$$

$\therefore 16\text{m}$

Ex 2: Sketch each parabola, then determine its equation. Algebraically determine the value of 'a'.

- a) The parabola is 18 metres wide and reaches a maximum height of 10 metres.

Is there only one possible answer to this question?  
What would be the same?  
What could be different?



$V(9, 10)$

$$y = a(x-h)^2 + k$$

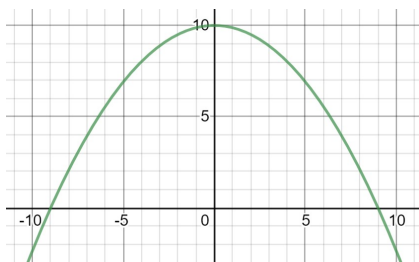
$$y = a(x-9)^2 + 10$$

Sub in (0,0)

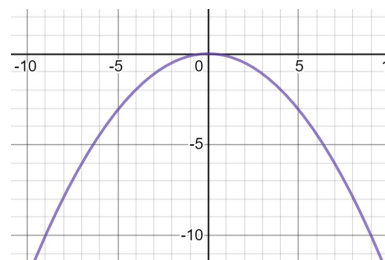
$$0 = a(0-9)^2 + 10$$

$$-10 = 81a$$

$$a = -\frac{10}{81}$$

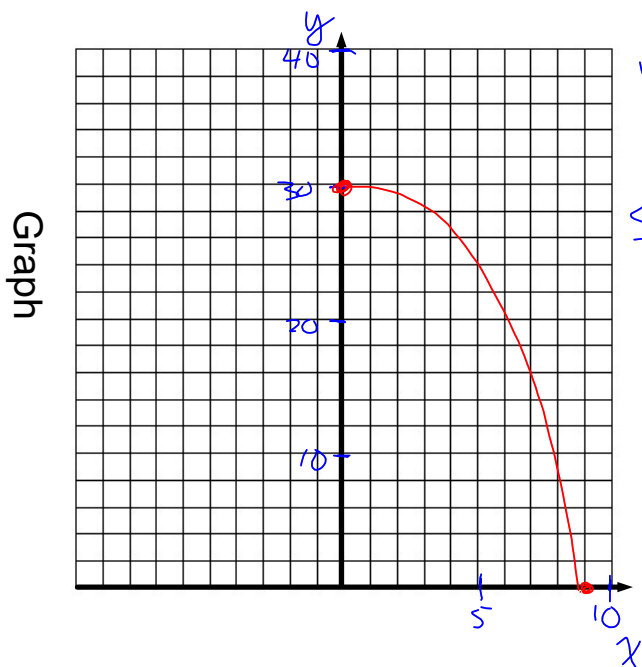


$$\therefore y = -\frac{10}{81}(x)^2 + 10$$



$$\therefore y = -\frac{10}{81}x^2$$

- b) The parabola starts at the highest point of 30 m. It drops to zero 9 metres to the right of the highest point.



$$V(0, 30) \quad y = a(x-h)^2 + k$$

$$y = a(x)^2 + 30$$

Sub in (9,0)

$$0 = a(9)^2 + 30$$

$$-30 = 81a$$

$$a = \frac{-30}{81}$$

$$a = -\frac{10}{27}$$

Ex 3: A projectile is launched from ground level and reaches a maximum height of 122.5 m after 5 seconds.

$$V(5, 122.5) \quad (0, 0)$$

a) Write an equation to model this situation. Find "a" algebraically.

$$y = a(x-h)^2 + k$$

$$V(5, 122.5)$$

$$y = a(x-5)^2 + 122.5$$

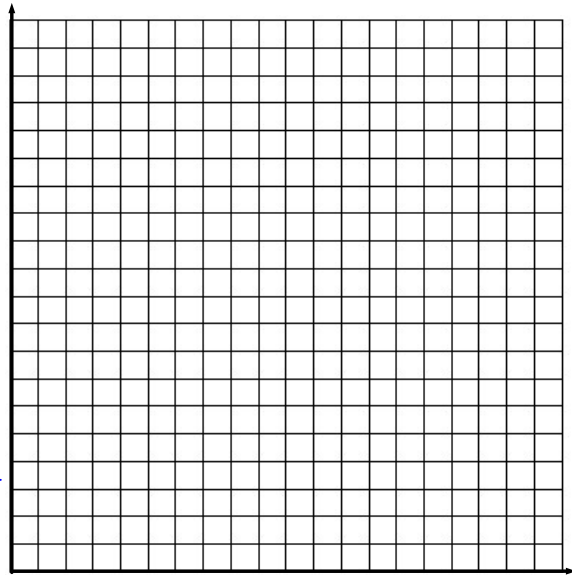
Sub in (0,0)

$$0 = a(0-5)^2 + 122.5$$

$$-122.5 = 25a$$

$$-4.9 = a$$

$$\therefore y = -4.9(x-5)^2 + 122.5$$



b) When does the projectile hit the ground?

Axis of symmetry!  $0 \quad 5 \quad 10$  at 10 seconds

c) What is the projectile's height after 3 seconds?

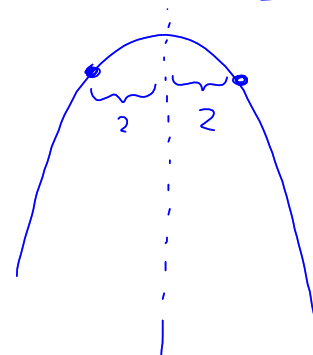
At what other time does it reach the same height?

$$\rightarrow @ x = 3 \quad y = -4.9(3-5)^2 + 122.5$$

$$= -4.9(4) + 122.5$$

$$= 102.9$$

3 5 (7)



$\rightarrow$  at 7 seconds

Ex 4: Find the equation of a parabola that has:

- a) vertex at (-2,5) and goes through (1,-3)

$$y = a(x-h)^2 + k$$

$$y = a(x+2)^2 + 5$$

Sub (1, -3)

$$-3 = a(1+2)^2 + 5$$

$$-8 = a(3)^2$$

$$-8 = 9a$$

$$\frac{-8}{9} = a$$

$$\therefore y = -\frac{8}{9}(x+2)^2 + 5$$

- b) stretch factor of 2, reflected  $a = -2$

about the x-axis, equation of the axis of symmetry  $x = 3$  and goes through the point (2,5)  $\rightarrow h = 3$

$$y = a(x-h)^2 + k$$

$$y = -2(x-3)^2 + k$$

Sub in (2,5)

$$5 = -2(2-3)^2 + k$$

$$5 = -2 + k$$

$$7 = k$$

$$\therefore y = -2(x-3)^2 + 7$$



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