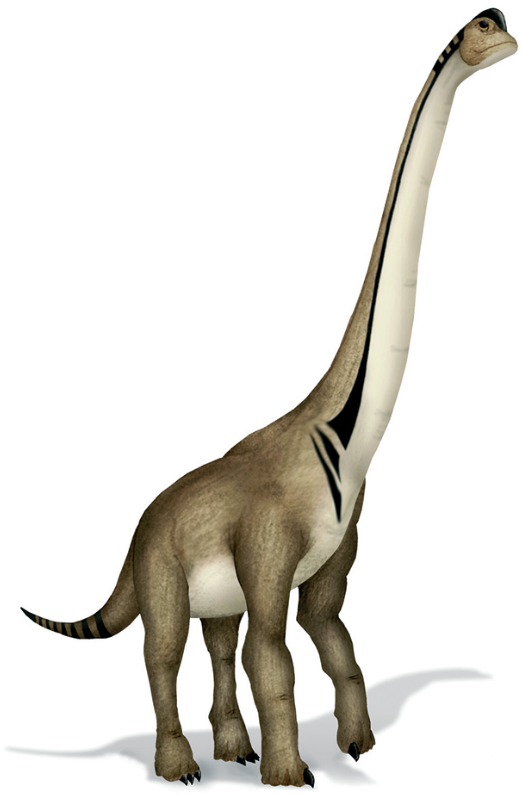
Ultrasaurus

Reasoning in the classroom



Support materials for teachers

Year 6

Llywodraeth Cymru
Welsh Government

Year 6 Reasoning in the classroom – Ultrasaurus

These Year 6 activities have a common theme of tall buildings. The first activity was included in the 2015 National Numeracy Tests (Reasoning). This is followed by one further activity.

Activity 1

Ultrasaurus

Many books and websites claim that an Ultrasaurus was so tall it would have been able to see into the window of a fourth floor building. Learners use information about the heights of floors in a block of flats to work out whether this claim could be true.

Includes:

- Teachers' script
- PowerPoint presentation
- Ultrasaurus question
- Markscheme

Activity 2

All those steps

Learners collect data to estimate the time taken to run up four flights of stairs. They compare this value with the fastest time taken to run up 86 flights of stairs in the Empire State Building, New York – just 9 minutes and 33 seconds!

Includes:

- Explain and question – instructions for teachers
- Whiteboard – Stairs
- Whiteboard – Empire State Building
- Resource sheet – Vertical running facts and figures
- Teachers' sheet – Solutions and questions

Reasoning skills required

Identify

Learners choose their methods, transferring their mathematical skills to the real-life context of vertical running. They know when it is appropriate to use a calculator.

Communicate

They consider various ways of representing collected data and work together to explain their reasoning.

Review

They interpret answers, including calculator displays, within the context of the problem and draw conclusions from their results.

Procedural skills

- Four rules of number
- Addition and subtraction of simple fractions
- Time including conversion of minutes and seconds to seconds
- Averages (mean, median, mode)
- Rounding

Numerical language

- Data
- Mean, median, mode
- Facts and figures
- Speed
- Average (used in relation to the mean)

Activity 1

Ultrasaurus

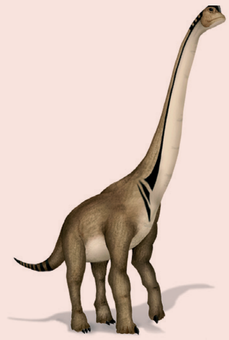
Activity 1 – Ultrasaurus

or

Outline

The PowerPoint presentation that accompanies this activity introduces learners to a boy who lives on the fourth floor of a block of flats. He reads that if a dinosaur called an Ultrasaurus were alive now its great height would enable it to see into his bedroom window.

Learners use information about the block of flats to present a reasoned argument showing whether or not this claim could be true.



You will need

TS **Teachers' script**

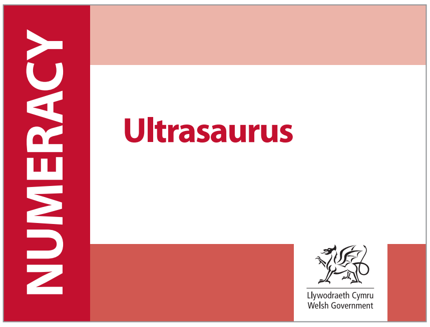
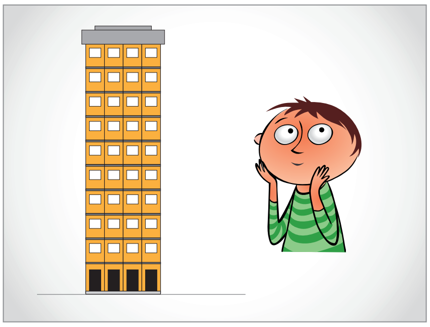
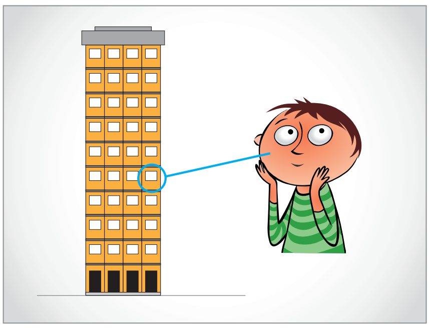
PowerPoint presentation

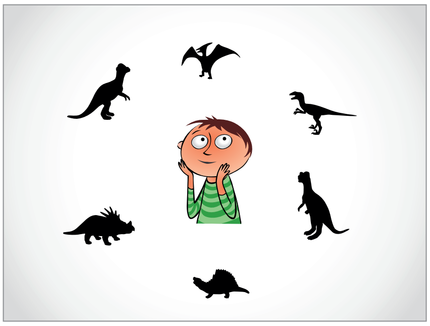
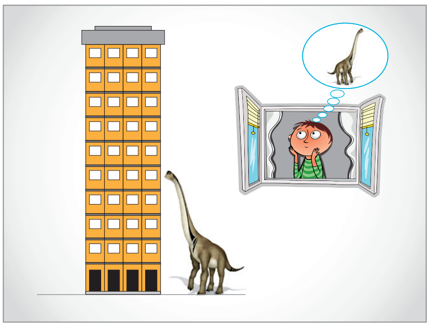
Q **Ultrasaurus question**
Two pages for each learner, must not be printed double-sided

M **Markscheme**

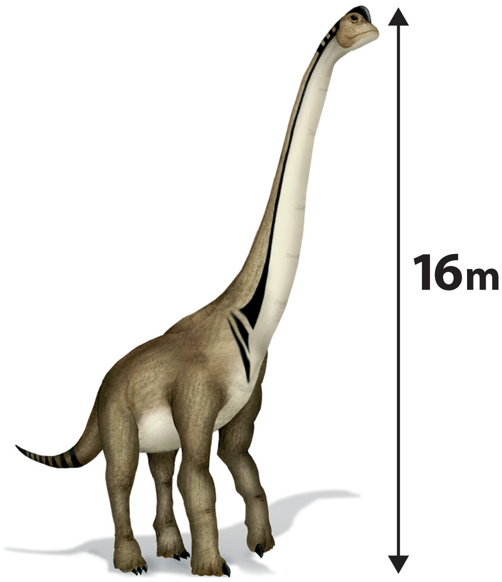
Presentation to be shown to learners before they work on Ultrasaurus

The text in the right-hand boxes (but not italics) should be read to learners. You can use your own words, or provide additional explanation of contexts, if necessary. However, if you are using this as an assessment item, no help must be given with the numeracy that is to be assessed.

Slide 1		*(Keep this slide on the screen until you are ready to start the presentation.)*
Slide 2		This is Kayne. He lives with lots of other families in a very tall building. This floor *(point)* is the ground floor, where people go in and out of the building. This row *(point to the lowest floor that has white windows)* is the first floor. This row *(point)* is the second floor, this row *(point)* is the third floor, and so on.
Slide 3		This is Kayne's bedroom *(point)*. What do you think this white rectangle is? *(window)* Which floor does Kayne live on? *(fourth)* *(Note that learners who have lived abroad may think of the ground floor as the first floor. Support them as needed.)* Kayne likes living here, and he has lots of hobbies. Most of all, he likes finding out about …

Slide 4		… dinosaurs! And his favourite dinosaur is …
Slide 5		… an Ultrasaurus. No one knows for certain exactly what an Ultrasaurus looked like, but scientists have found some of their bones. They think that an Ultrasaurus might be the tallest dinosaur that ever lived. I wonder how tall an Ultrasaurus was? Lots of books say that an Ultrasaurus was so tall that if it were alive now and stood next to a very tall building it would be able to see into a window on the fourth floor.
Slide 6		Kayne is thinking about the Ultrasaurus. If it were alive now, would it **really** be tall enough to see into his window? In your booklet you will find some measurements. Your task is to use those measurements to work out whether the Ultrasaurus really would have been tall enough to stand next to his building and see into his window on the fourth floor. Remember to set out your work clearly so that someone else can understand what you are doing and why. *(If you are using this item for assessment purposes, you may wish to limit the time available, e.g. 10 minutes.)*

The Ultrasaurus was **16m** high.

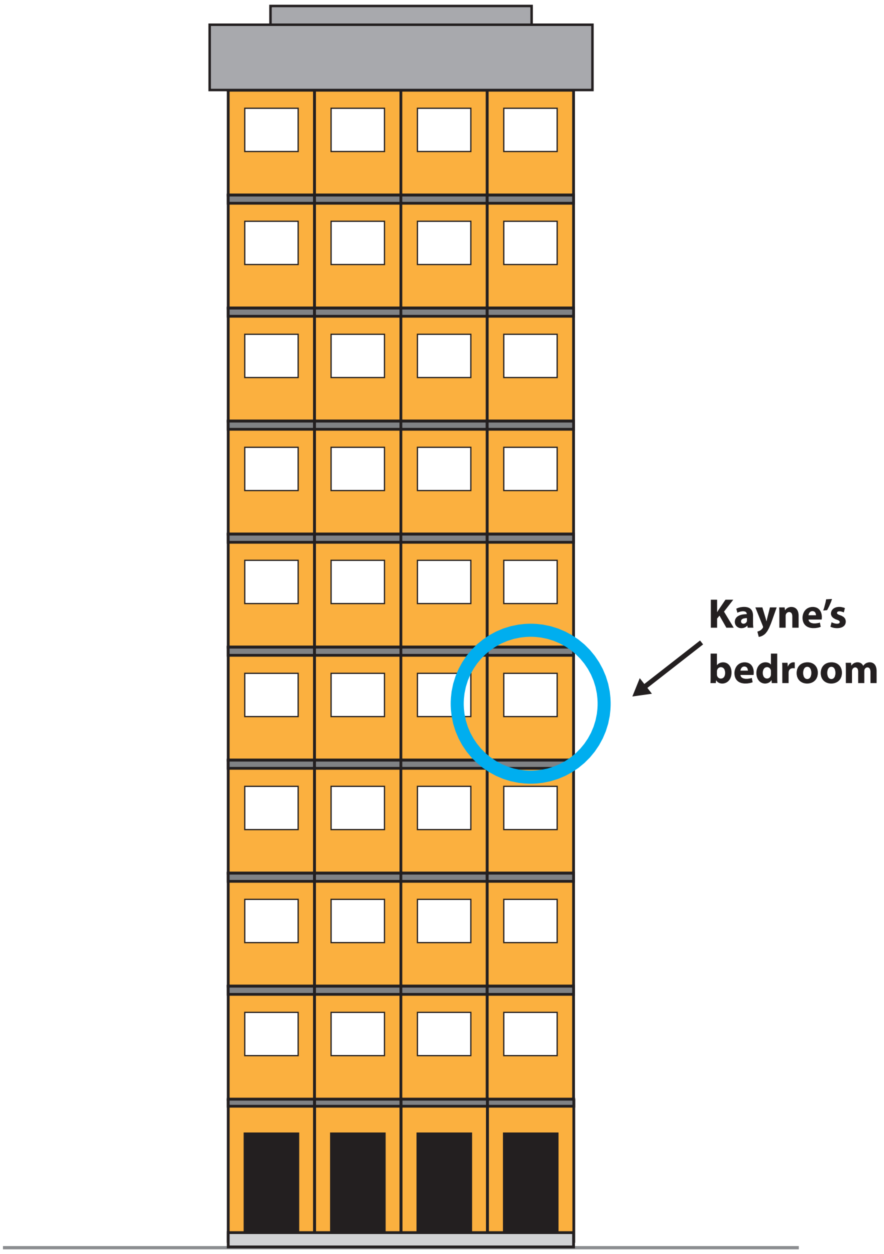


Use the information on the next page.

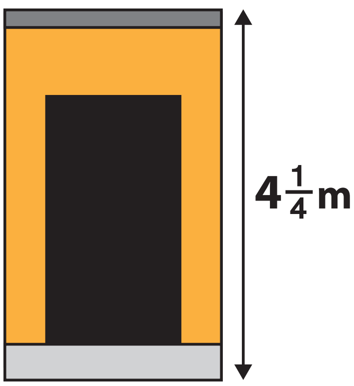
Could the Ultrasaurus see into Kayne's bedroom?

Show calculations to explain how you know.

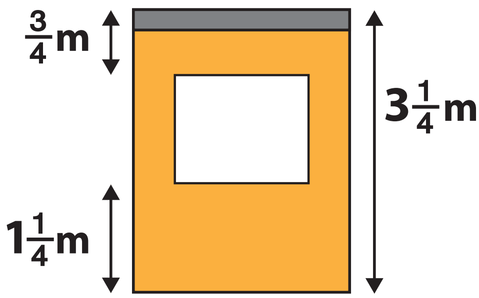
5m



Ground floor

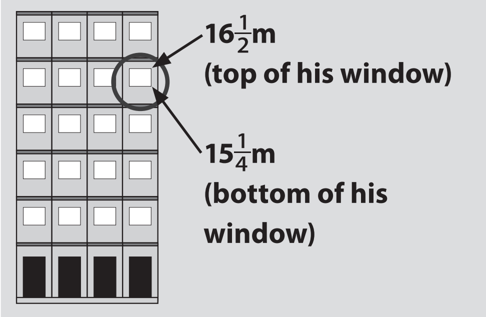


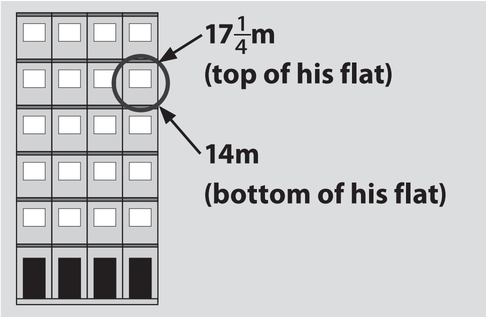
Other floors

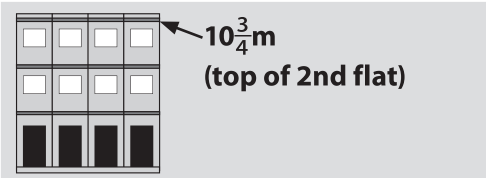


Activity 1 – Ultrasaurus – Markscheme

Marks	Answer
5m	Shows **$15\frac{1}{4}$** or **$16\frac{1}{2}$** to support their conclusion that the dinosaur **can** see in
Or 4m	Shows **$15\frac{1}{4}$** or **$16\frac{1}{2}$** but the conclusion is incorrect or omitted
Or 3m	Shows **$17\frac{1}{4}$** or **14**
Or 2m	Shows **$10\frac{3}{4}$** or **13** or **$9\frac{3}{4}$** Or Tries to work out $4\frac{1}{4}$ + 4 lots of $3\frac{1}{4}$ or $4\frac{1}{4}$ + 3 lots of $3\frac{1}{4}$
Or 1m	Shows **$7\frac{1}{2}$** Or Tries to work out 4 lots of $3\frac{1}{4}$ or 3 lots of $3\frac{1}{4}$

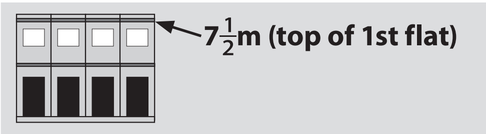




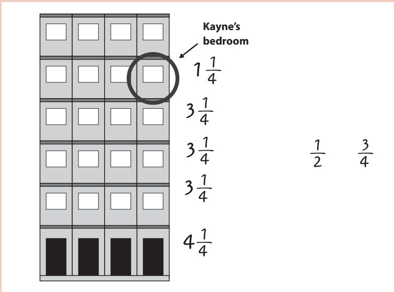


$13 = 4 \times 3\frac{1}{4}$ (4 flats, no ground floor)

$9\frac{3}{4} = 3 \times 3\frac{1}{4}$ (3 flats, no ground floor)



Activity 1 – Ultrasaurus – Exemplars



$3 + 3 + 3 + 1 + 1 + 4 + \frac{1}{4} = 15\frac{1}{4}$
so I now the Ultrasus is bigger so it can look in and give him a scare.

Correct; **5 marks**

- $15\frac{1}{4}$ seen and 'it can look in' means that all 5 marks can be given. This learner records dimensions on the diagram; this supports their thinking. The mathematical communication is clear and concise.

$3\frac{1}{4} \times 2 = 6\frac{1}{2}$
$6\frac{1}{2} \times 2 = 13$
$13 - \frac{3}{4} = 12\frac{1}{4}$
$12\frac{1}{4} + 4\frac{1}{4} = 16$m 50
but the window is more than 50cm so that is how I know the Ultrasaurus can see him.

Correct; **5 marks**

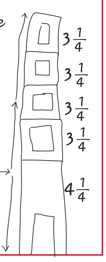
- 16m 50 seen (equivalent to $16\frac{1}{2}$) and it 'can see him' means that all 5 marks can be given. This learner has worked out the height to the top of the window.

No the window is too high because the window is 16 $\frac{1}{2}$ meter tall and the dinosaur is only 16 meters tall

$3 + 3 + 3 + 3 + 4 = 16$

$\frac{1}{2} + \frac{1}{4} + \frac{1}{4} + \frac{1}{4} + 1 = 17\frac{1}{4}$

$17\frac{1}{4} - \frac{3}{4} = 16\frac{1}{2}$



Shows $16\frac{1}{2}$; **4 marks**

Common error $16\frac{1}{2}$, the top of the window, is shown in the working. However, the learner has forgotten that this is the top, not the bottom, of the window and so the conclusion is incorrect.

The Ultrasaurus can't reach the Fourth Floor because the ground floor is $4\frac{1}{4}$ metres and the 4 of the flats are 13 meters. It all adds upto 17.25 meters. So the answre is it can't reach it.

Shows $17\frac{1}{4}$; **3 marks**

Common error The lack of calculations within this response is something that could usefully be discussed with the learner after the test. However, 17.25 (equivalent to $17\frac{1}{4}$, the height in metres of the top of the fourth floor flat), scores 3 marks.

Activity 1 – Ultrasaurus – Exemplars (continued)

$4\frac{1}{4} + 3\frac{1}{4} = 7\frac{1}{2} + 3\frac{1}{4} = 10\frac{1}{2} + 3\frac{1}{4} = 13\frac{3}{4}$ so it can see in if it bends its head down	Tries to work out $4\frac{1}{4}$ + 3 lots of $3\frac{1}{4}$; **2 marks** • If this learner had done the calculation correctly, the answer, 14, would have scored 3 marks.
$4 \times 3\frac{1}{4} = 12\frac{4}{4}$ $12\frac{4}{4} + 4\frac{1}{4} = 16\frac{5}{4}$ it is bigger so it can see in	Tries to work out $4\frac{1}{4}$ + 4 lots of $3\frac{1}{4}$; **2 marks** • The use of improper fractions suggests that this learner is not confident when working with simple fractions. For 3m, $17\frac{1}{4}$ would need to be shown.
I worked it out on my calculator and the dinosaur can see in to his room because the Utrasoroses height is right for the window, not too big and not too small	No evidence; **0 marks** Common error The conclusion that the dinosaur can see in must be supported by calculations.
I think the ultrasaurus is tall enough to reach to Keynes bedroom because $4\frac{1}{4}$ metres $+\frac{3}{4}$ metres $+ 3\frac{1}{4}$ $+1\frac{1}{4}$ metres does not = to 16 metres	Incorrect; **0 marks** Common error This learner has put aside common sense to add the four dimensions shown on the question paper for the ground floor and other floors.
I measured with my ruler so I know he can see in but its dead so it can't really	Incorrect; **0 marks** Common error Another common error is to measure, ignoring the given dimensions.

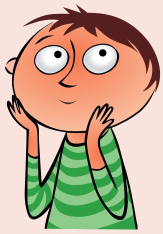
Activity 2

All those steps

Activity 2 – All those steps

or

Outline



In this Year 6 activity learners collect data to estimate the likely time it would take to run up four flights of stairs. They compare this value with the fastest time taken to run up 86 flights of stairs in the Empire State Building, New York – an amazing 9 minutes and 33 seconds!

The activity offers opportunities to work out averages and consider rounding within a real-life context; a calculator is essential. Some learners may benefit from greater teacher input than usual as the activity is fairly demanding.

One week or so before the activity is undertaken, ask learners to collect data about the number of steps between floors in different venues, e.g. the school or shopping centres. (An alternative is given for those who live in areas in which this is not possible.)

You will need

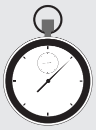
WB **Whiteboard – Stairs**

WB **Whiteboard – Empire State Building**

R **Resource sheet – Vertical running facts and figures**

T **Teachers' sheet – Solutions and questions**

Each pair/group will need a calculator



Stopwatch (optional)

Activity 2 – All those steps

Explain

Remind learners about **Activity 1 – Ultrasaurus** in which Kayne lives in a block of flats. Say that the lift is out of order. About how many steps might Kayne need to climb to get to the fourth floor where he lives? Record their suggestions on the whiteboard. *(These responses should be informed by research undertaken before the activity starts. If such research is not possible, show* **Stairs** *as a starting point to the discussion that follows.)*

Ask why the answers are not all the same *(different buildings have different heights of floors)* then say that we want to use just one value to represent the number of steps in four flights of stairs. What value should we use and why? Ask learners to discuss these questions in their small groups. When appropriate bring the class together and ask for suggestions, linking their responses to the mode, median, mean and range of the data set. *(The actual value is unimportant – what matters is the numerical process that learners go through in order to find the answer. The mean is unlikely to be a whole number, which gives an opportunity to discuss rounding.)*

Now say that Kayne is going to run up the four flights of stairs to his flat. About how many seconds is he likely to take? If possible gather real data but if this is not possible, ask learners to make their best guess and record suggestions on the board.

Show **Empire State Building** and point out the building, comparing its height to other buildings around it. Tell learners that, amazingly, each year there is a race in this building to find the person who can most quickly run up 86 flights of stairs. This sport, called vertical running, is becoming popular with runners across the world. Give each group/pair a copy of **Vertical running facts and figures** and ask them to work together to solve the problems shown. *(See* **Solutions and questions***.)*

Question

See **Solutions and questions**.

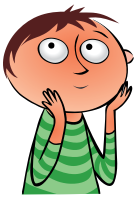
How many stairs in four flights of steps?

Facts about vertical running in the Empire State Building

Number of flights of stairs: 86

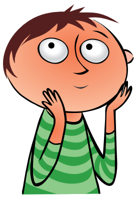
Number of steps climbed: 1576

Best ever time: Paul Crake (in 2003) who took 9 minutes and 33 seconds



How fast could I run up 86 flights of stairs?

1. Think about the number of seconds for Kayne to run up 4 flights of stairs.
   If he could keep running at that speed, how many seconds would he take to run up 86 flights of stairs?
   How long is that to the nearest minute?



What can I work out from the facts about the race?

2. What is the average number of steps in a flight of stairs at the Empire State Building? How does your answer show that not all flights of stairs have the same number of steps?

3. Altogether, how many seconds did Paul Crake take to run the race?

4. On average, how many steps did he run in one second? How does that compare to Kayne?

5. A vertical running race is held in London in a building with 932 steps.
   The best ever time was by Thomas Gold who took 3 minutes and 58 seconds.
   Who ran faster – Paul Crake or Thomas Gold? How do you know?

Vertical running up the Empire State Building: Solutions and questions

Questions on resource sheet	Solution	Questions to ask learners
1. Think about the number of seconds for Kayne to run up 4 flights of stairs. If he could keep running at that speed, how many seconds would he take to run up 86 flights of stairs? How long is that to the nearest minute?	As $86 \div 4 = 21.5$, it would take Kayne $21.5 \times$ his estimated time for four flights of stairs.	• In real life, would the speed be the same for each flight of stairs? Why not? *(Tiredness, spurt of energy when nearing the end, different number of steps per flight, etc.)* • How do you change seconds to minutes? *($\div$ 60)* How do you know what this time is to the nearest minute? *(If the decimal is .5 or more, round up, otherwise round down.)*
2. What is the average number of steps in a flight of stairs at the Empire State Building? How does your answer show that not all flights of stairs have the same number of steps?	$1576 \div 86 = 18.3255813\ldots$ As the answer is not a whole number, it is not possible for all flights of stairs to have the same number of steps.	• How can you find the average number of steps? Some people think they should work out $86 \div 1576$. Why must that calculation be wrong? *(It would give the average number of steps as less than 1.)* • What sort of average have you found? *(Mean)*
3. Altogether, how many seconds did Paul Crake take to run the race?	$9 \times 60 + 33 = 573$ seconds	• Some people think 9.33 minutes = 9 minutes 33 seconds. How would you help them understand why they are wrong? *(For example, 9.33 minutes is less than 9.5 minutes which is 9 minutes and 30 seconds.)*
4. On average, how many steps did he run in one second? How does that compare to Kayne?	He ran up 1576 steps in 573 seconds which is 2.7504363… steps per second. Kayne's steps per second are likely to be less.	• What is 2.7504363… to the nearest whole number? *(3)* Is 2.7507504363… closer to 3 or 2.5? *(Closer to 3, just)*
5. A vertical running race is held in London in a building with 932 steps. The best ever time was by Thomas Gold who took 3 minutes and 58 seconds. Who ran faster – Paul Crake or Thomas Gold? How do you know?	3 minutes and 58 seconds = 238 seconds, so Gold ran up 932 steps in 238 seconds which is 3.9159663… steps per second. This is faster than Crake.	• Why do you think Thomas Gold ran faster than Paul Crake? *(The number of steps is considerably less – this compares to long distance runners versus sprinters in which sprinters run much faster per second.)*