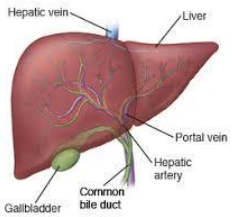
What Mathematical Skills do I need to Master?

<u>Retrieval Practice</u>: Yr. 9:
Cell Biology

Starter for 10:

1. P… t… …st

Bacteria do not have mitochondria, yet most bacterial cells are capable of aerobic respiration. ... Therefore, in bacteria, most of the enzymes of the TCA cycle are found in the cytoplasm, whereas the electron transport proteins are located in the plasma membrane. (don't worry you don't need to know this at GCSE level)
Bacteria range in size, some are about the same size or smaller than mitochondria.



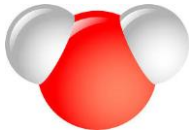
Liver
(human)

…hondria

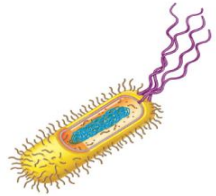
Ant

2. What is the role of the mitochondria?

To release energy from glucose in cellular respiration in eukaryotic cells.



Water Molecule

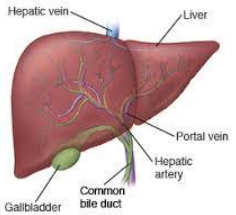


Bacterial Cell

Mitochondria

Plant Cell

Ant

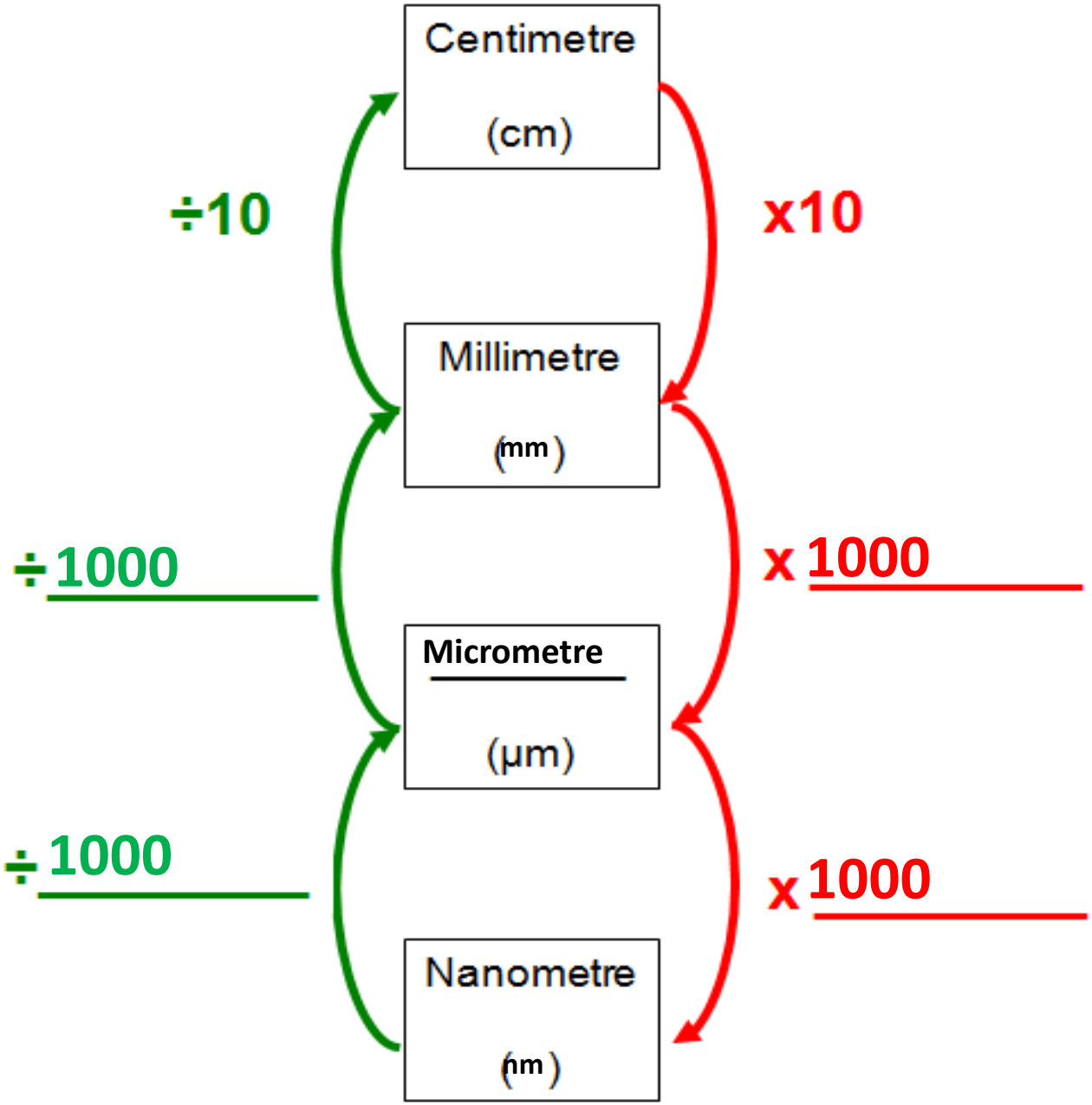


Liver
(human)

What Mathematical Skills Do I Need to Master?

Saturday, 16 March 2019

By the end of this lesson	Keywords
• use orders of magnitude to correctly order objects according to size. • use the formula: magnification = size of image/size of real object	• Magnification • Scale • Standard Form • Prefix


Centimetre
(cm)
÷10
x10
Millimetre
(mm)
÷1000
x 1000
Micrometre
(µm)
÷ 1000
x 1000
Nanometre
(nm)

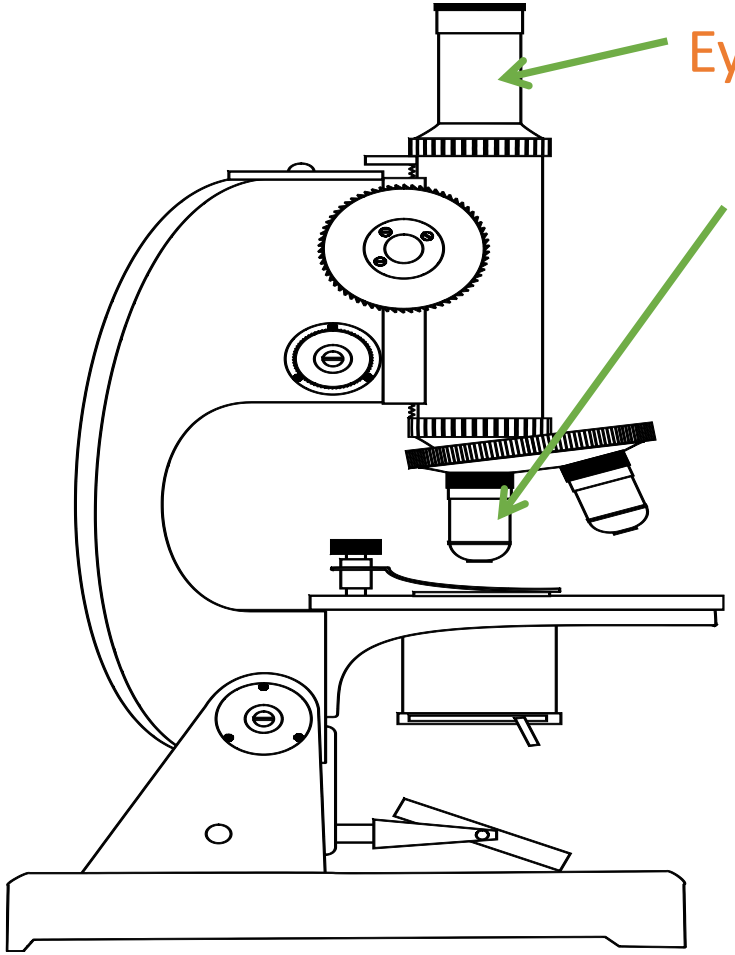
It is important that we are able to convert between different units.

Complete the table below to show the corresponding value nanometres, micrometres and millimetres for the measurements given in each row. The first row has been completed for you. Ensure that your answers use the correct unit symbols.

Nanometre	Micrometre	Millimetre
5	0.005	0.000005
1		
	1	
		1
	3	
7		
		0.5

Nanometre	Micrometre	Millimetre
5	0.005	0.000005
1	0.001	0.000001
1000	1	0.001
1 000 000	1000	1
3000	3	0.003
7	0.007	0.000007
500 000	500	0.5

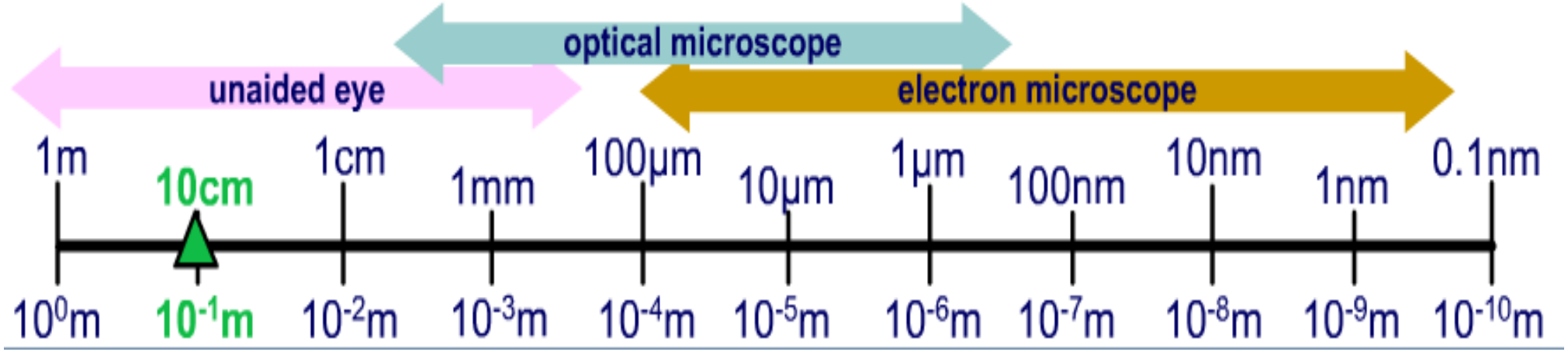
How do we find the overall magnification of a light microscope?



Eyepiece Magnification	Objective Magnification	Overall Magnification
X10	X4	40
X10	X10	100
X10	X40	400
X10	X100	1000

Standard Form

Standard index form is also known as standard form. It is very useful when writing very big or very small numbers.



15, 000, 000 would be written in standard form as 1.5×10^6

0.0015 would be written as 1.5×10^{-3}.

$A \times 10^n$

A is always a number between 1 and 10.

n – how many places to move the decimal.

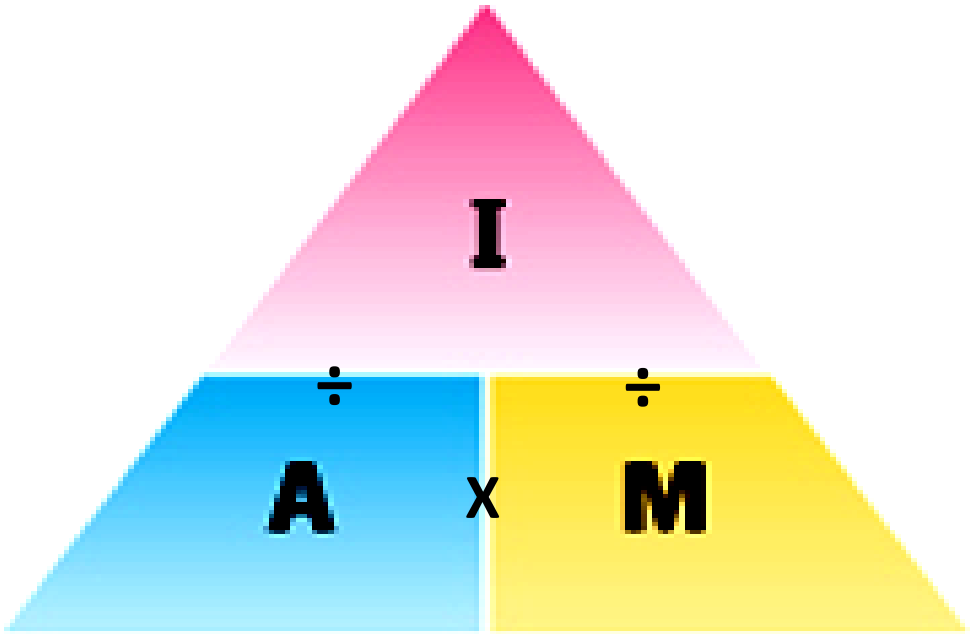
Task: Complete the table, be ready to give your answer on your whiteboard

Whiteboards: What is 1μm expressed as standard form, white your answer and get ready to show!

Unit	Size in Metres	Standard Form
1 m	1	10^{0}m
10 cm	0.1	10^{-1}m
1 cm	0.01	10^{-2}m
1 mm	0.001	10^{-3}m
100 μm	0.0001	10^{-4}m
10 μm	0.00001	10^{-5}m
1 μm	0.000001	10^{-6}m
100 nm	0.0000001	10^{-7}m
10 nm	0.00000001	10^{-8}m
1 nm	0.000000001	10^{-9}m
0.1 nm	0.0000000001	10^{-10}m

The Microscopy Calculation:

- We can use the formula:
  Magnification = $\frac{\text{size of image}}{\text{size of real object}}$
- We follow the same steps using the microscopy calculation as you would when you follow any physics calculations
- Use a formula triangle if needed to help you to re-arrange the formula.
- Always show ALL of your workings out!



Magnification = $\frac{\text{size of image}}{\text{size of real object}}$

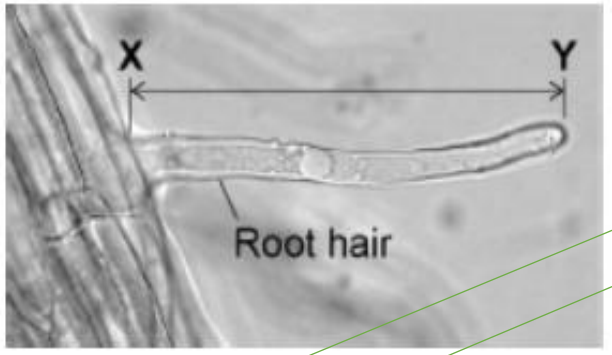
Actual size = $\frac{\text{image size}}{\text{magnification}}$

Image size = actual size X magnification

Applying to Exam Questions:

Exam Question:

The diagram below shows a root hair viewed using a microscope.:
The root hair was viewed at a magnification of ×50



The image length of the root hair **X–Y**43 mm

Calculate the real length of the root hair in micrometres (µm).

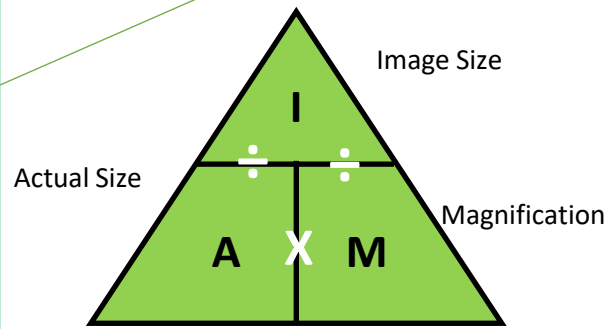
[4 marks]

So what do we know from reading the question?

Magnification = x50
Image size = 43mm
We need to calculate the real length (the actual size)
We will need to make sure our answer is given in µm

Now, what do we need to know?

The microscopy calculation & how to convert between units



Magnification = image size / actual size

Image size = actual size X magnification

Actual size = image size / magnification

1mm = 1000 µm

Model Answer

Step One: Place the given values into the equation:

50 x 43 / actual size [1 mark]

Step Two: re-arrange the formula to make *'actual size'* the focus of the equation:

Actual size = 43 / 50 [1 mark]

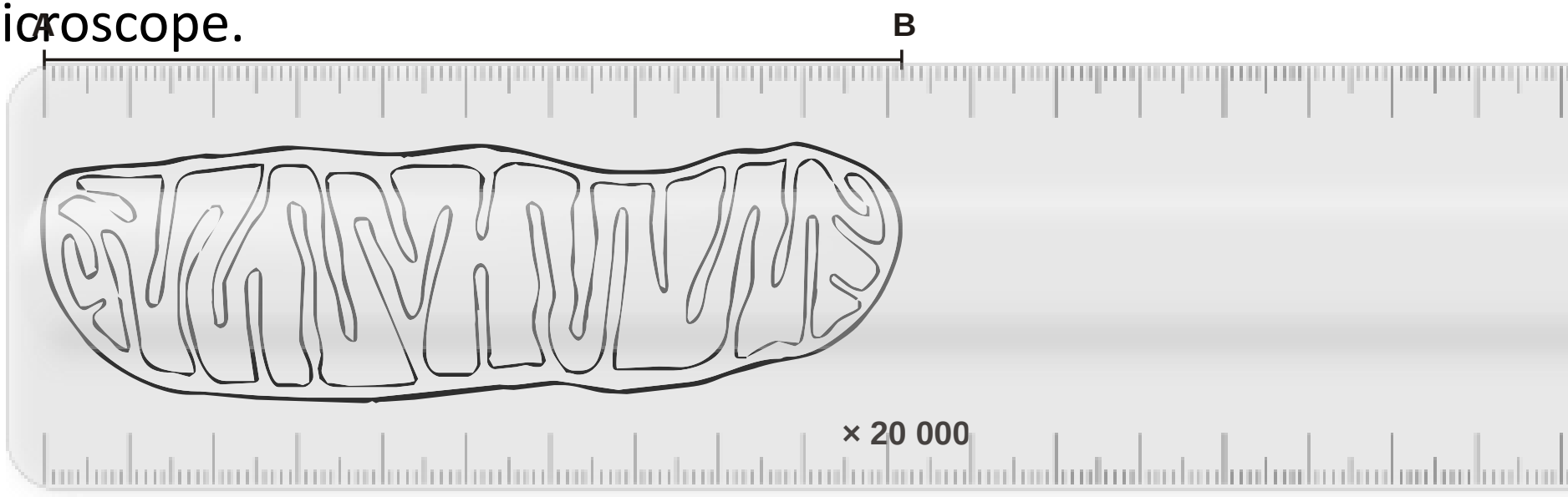
= 0.86mm [1 mark]

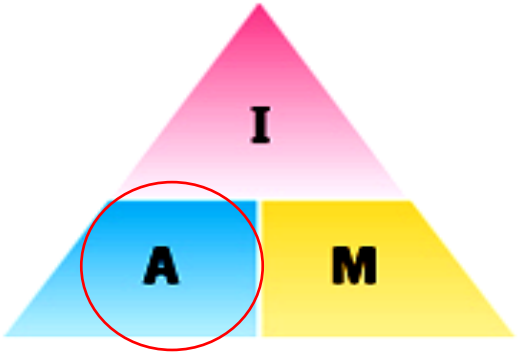
Step Three: convert the units from mm to µm by multiplying by 1000:

0.86 x 1000 = 860 µm [1 mark]

use the formula: magnification = size of image/size of real object

The diagram below is a drawing of an organelle from a ciliated cell as seen with an electron microscope.





Calculate the actual length of the organelle as shown by the line AB in the diagram. Express your answer to the nearest micrometer (mm).

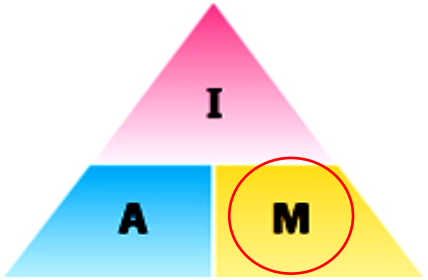
Show your working.

$$A = \frac{I}{M} = \frac{102mm}{20000} = \frac{102000\mu m}{20000}$$

5.1

Answer = ... μm

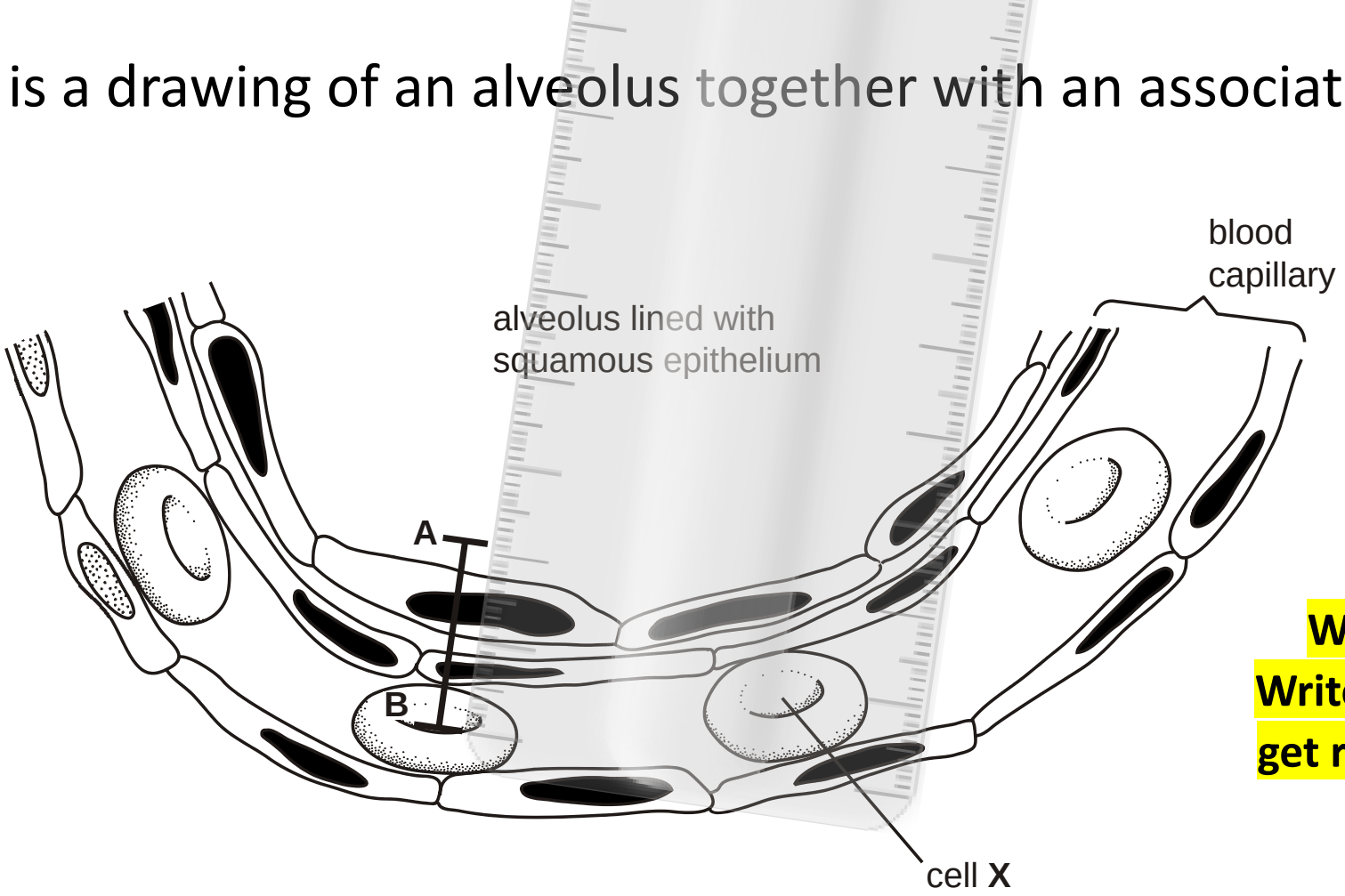
The diagram below is a drawing of an alveolus together with an associated blood capillary.



$$M = \frac{I}{A}$$

$$= \frac{21mm}{1.5\mu m}$$

$$= \frac{21000\mu m}{1.5\mu m}$$



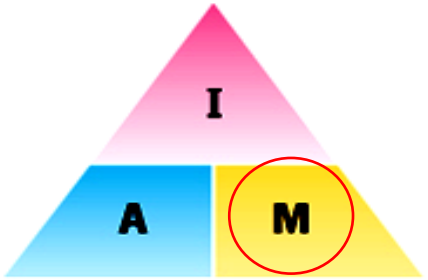
Whiteboards: Write your answer, get ready to show!

The line **AB** in the diagram represents an actual distance of 1.5 µm.

Calculate the magnification of the drawing. Show your working.

Answer = × **14000**

The diagram below shows the general structure of an animal cell as seen under an electron microscope.

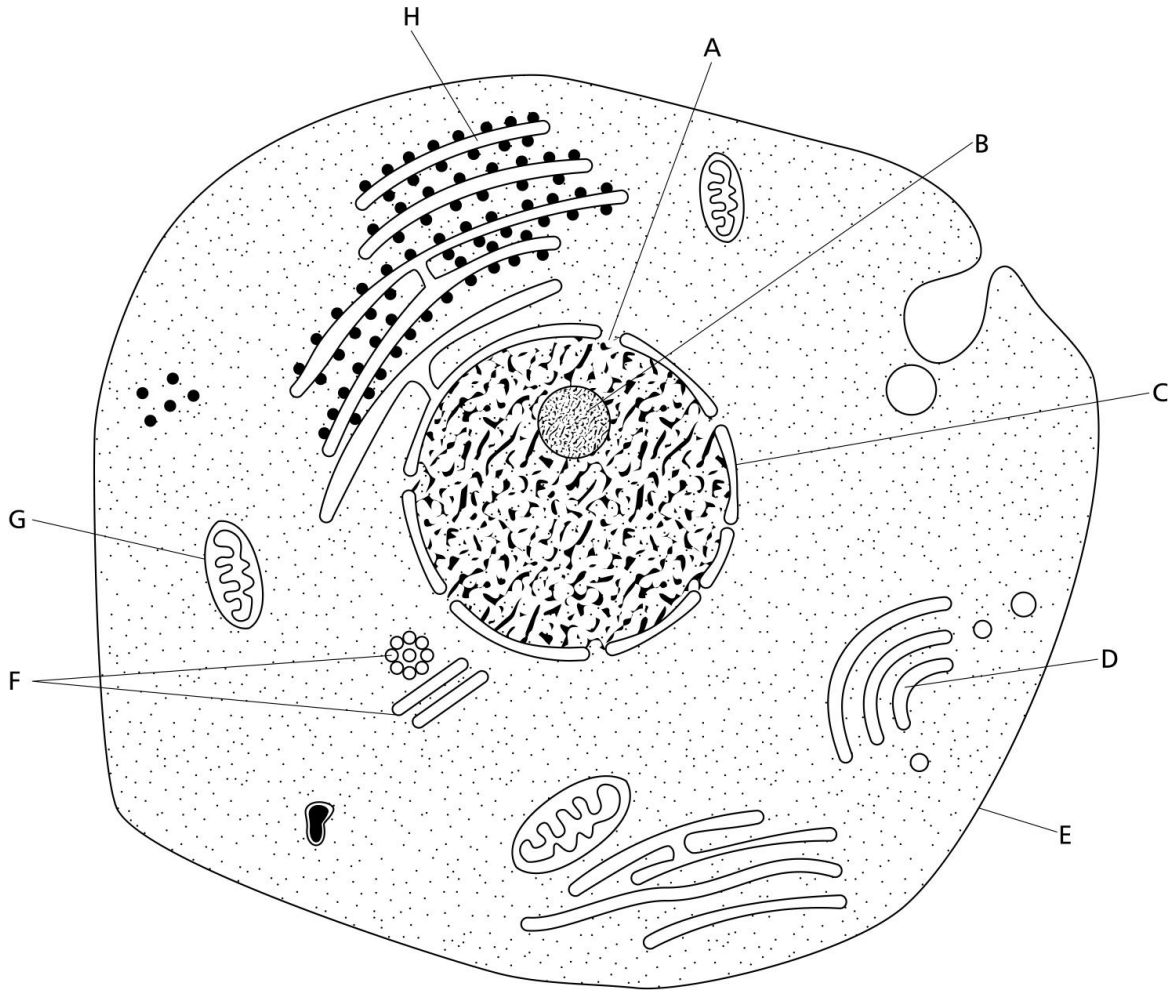


$$M = \frac{I}{A}$$

$$= \frac{24mm}{5\mu m}$$

$$= \frac{24000\mu m}{5\mu m}$$

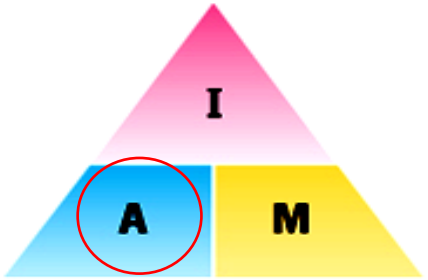
= 4800



5μm

1) Calculate the magnification factor of the diagram

The diagram below shows the general structure of an animal cell as seen under an electron microscope.

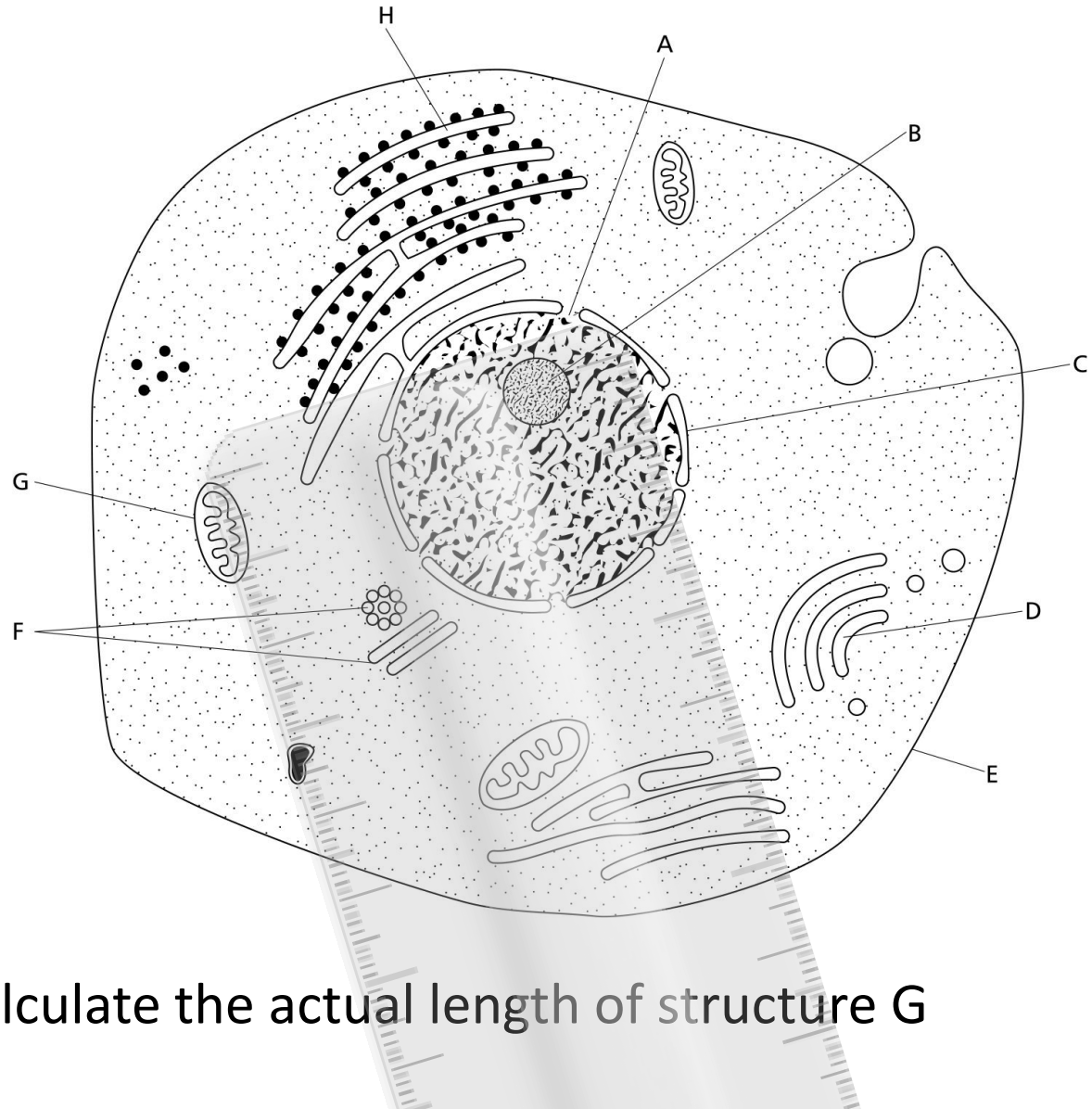


$$A = \frac{I}{M}$$

$$= \frac{12mm}{4800}$$

$$= \frac{12000\mu m}{4800}$$

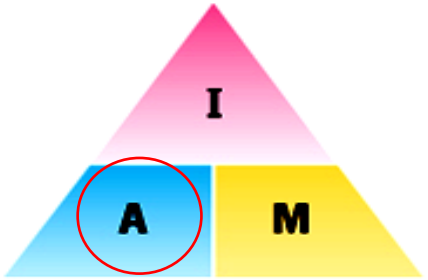
$= 2.5\mu m$



5μm

2) Calculate the actual length of structure G

The diagram below shows the general structure of an animal cell as seen under an electron microscope.



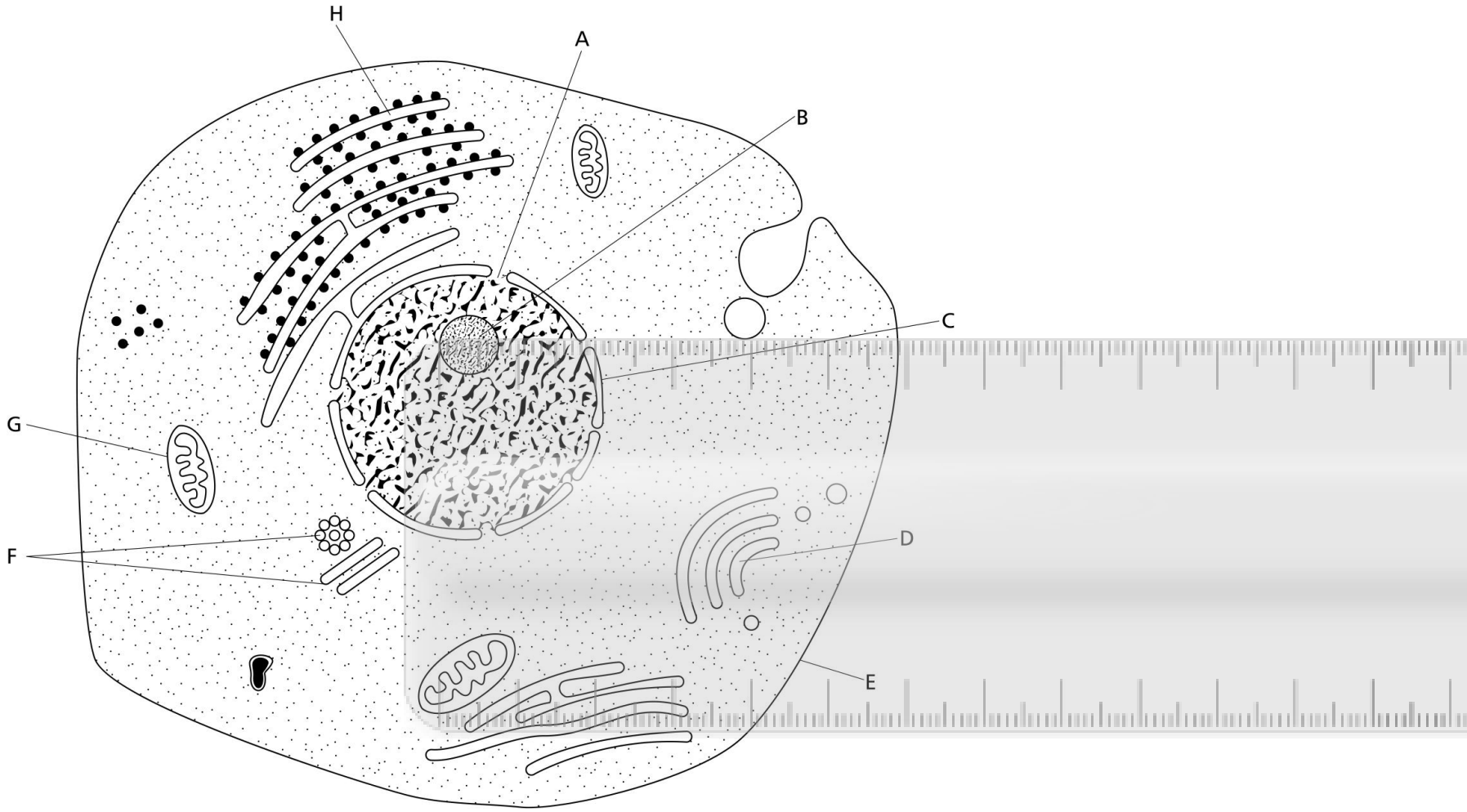
$$A = \frac{I}{M}$$

$$= \frac{8mm}{4800}$$

$$= \frac{8000\mu m}{4800}$$

$$= 1.666\mu m$$

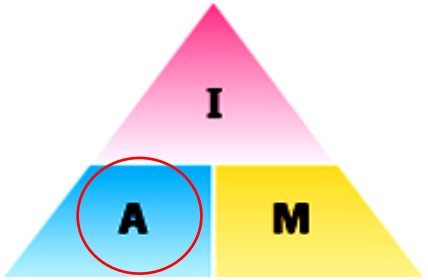
$$= \mathbf{1.7\mu m}$$



5μm

3) Calculate the diameter of the nucleolus (structure B)

The diagram below shows the general structure of an animal cell as seen under an electron microscope.

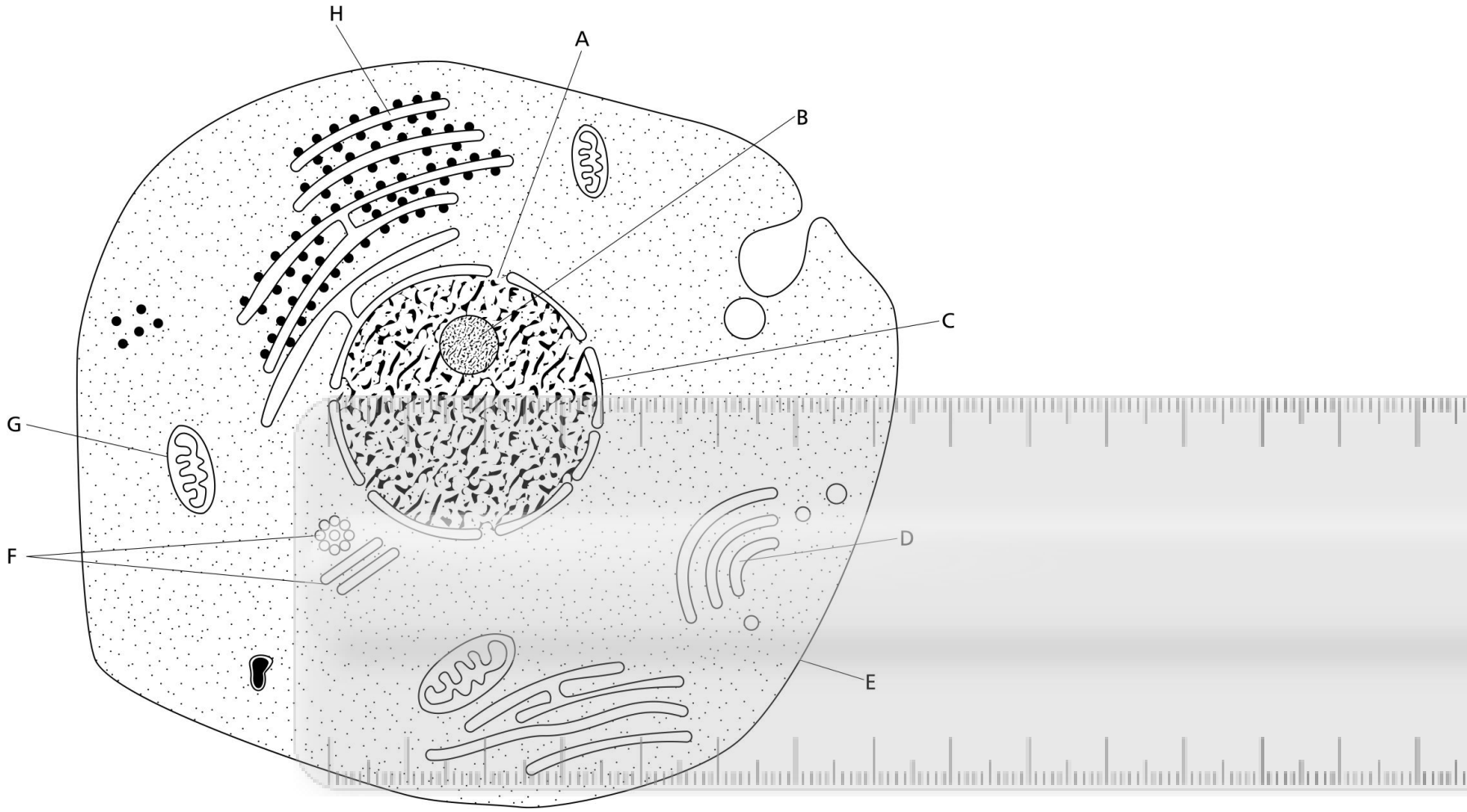


$$A = \frac{I}{M}$$

$$= \frac{36mm}{4800}$$

$$= \frac{36000\mu m}{4800}$$

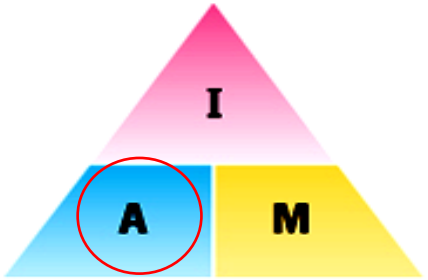
$$= \mathbf{7.5\mu m}$$



5μm

4) Calculate the diameter of the nucleus

The diagram below shows the general structure of an animal cell as seen under an electron microscope.



$$A = \frac{I}{M}$$

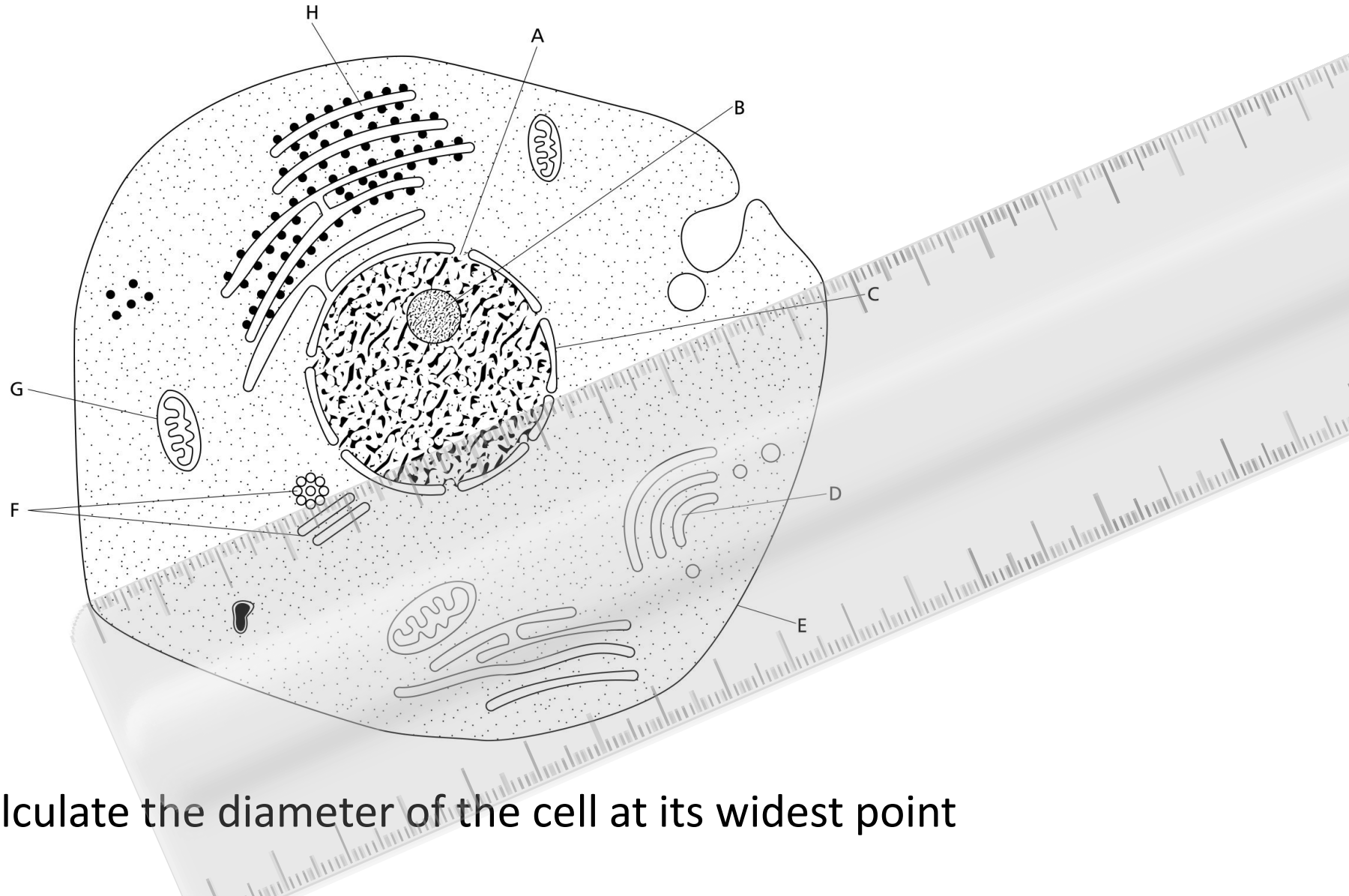
$$= \frac{116mm}{4800}$$

$$= \frac{116000\mu m}{4800}$$

$$= 24.16666\mu m$$

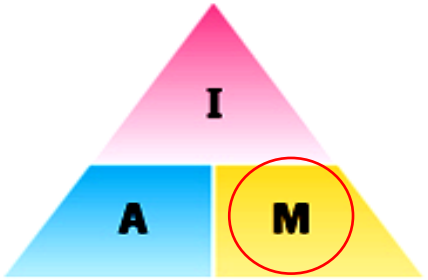
$$= \mathbf{24.2\mu m}$$

$5\mu m$



5) Calculate the diameter of the cell at its widest point

The diagram below shows the general structure of a plant cell when viewed under and electron microscope.

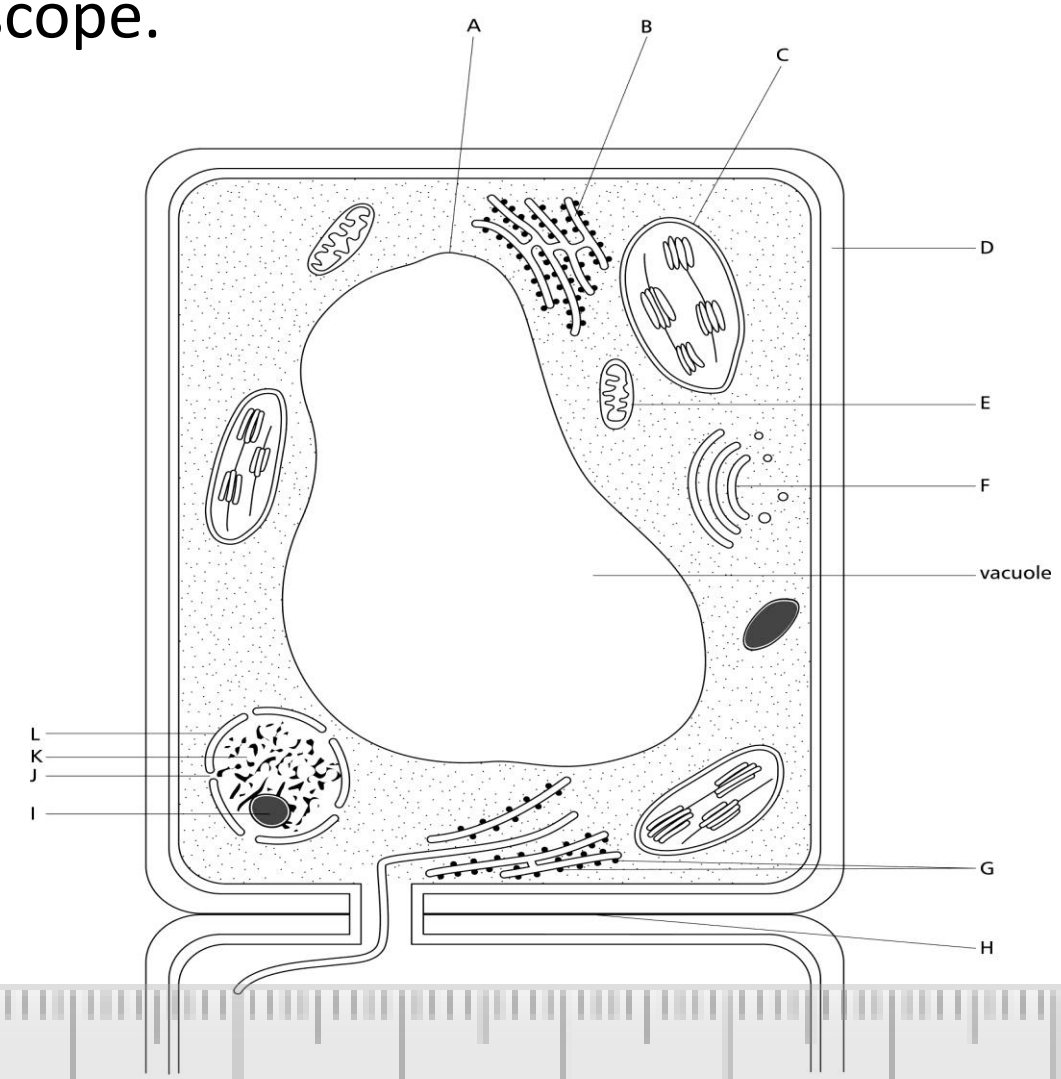


$$M = \frac{I}{A}$$

$$= \frac{23mm}{40\mu m}$$

$$= \frac{23000\mu m}{40\mu m}$$

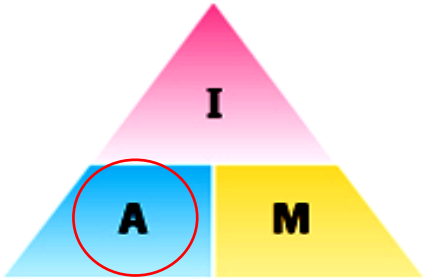
$$= 575$$



HINT: You will need to use the magnification you calculate here for the rest of the questions relating to this plant cell!

1) Calculate the magnification factor of the diagram

The diagram below shows the general structure of a plant cell when viewed under and electron microscope.



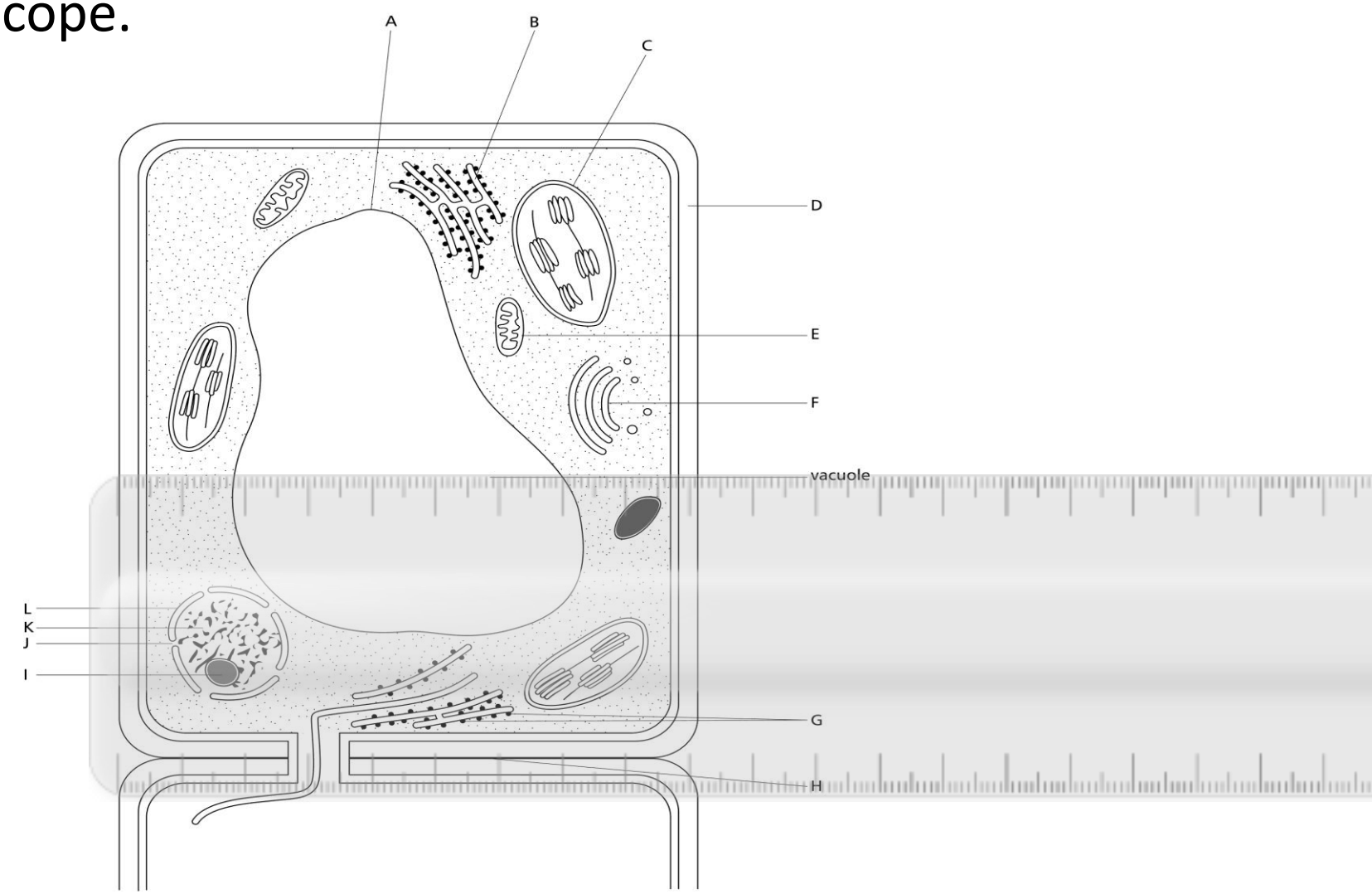
$$A = \frac{I}{M}$$

$$= \frac{3mm}{575}$$

$$= \frac{3000\mu m}{575}$$

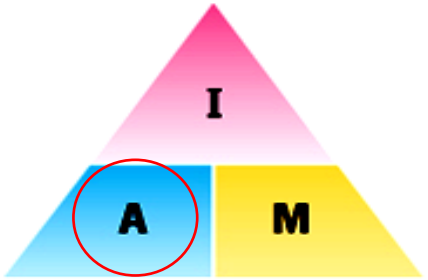
$$= \mathbf{5.2\mu m}$$

$$40\mu m$$



2) Calculate the thickness of the cellulose cell wall.

The diagram below shows the general structure of a plant cell when viewed under and electron microscope.



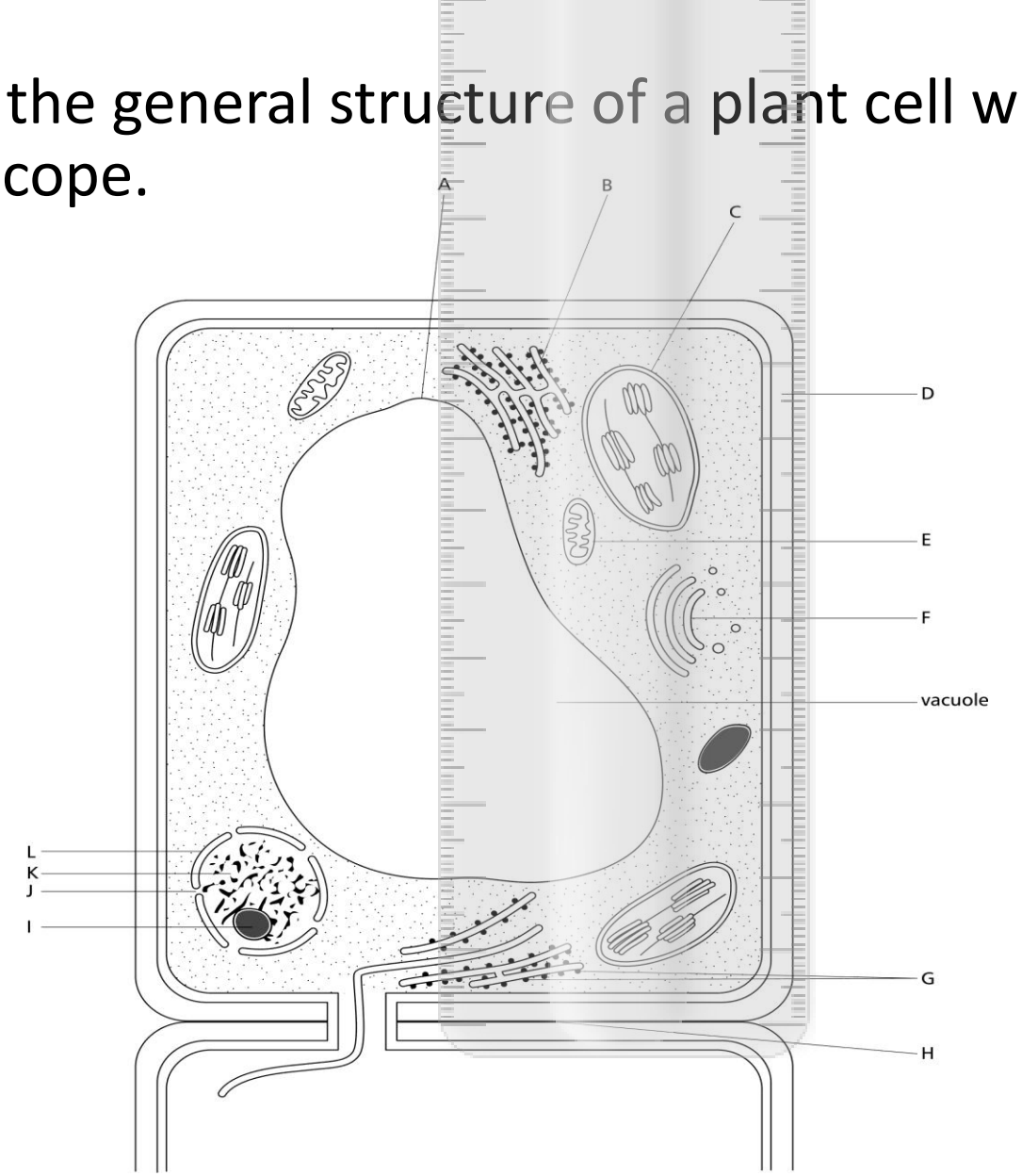
$$A = \frac{I}{M}$$

$$= \frac{98mm}{575}$$

$$= \frac{98000\mu m}{575}$$

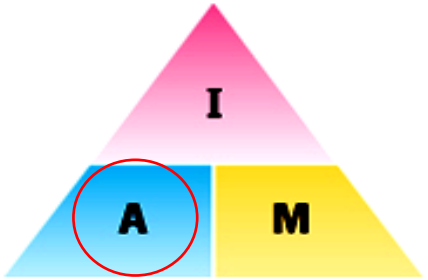
$$= \mathbf{107.4\mu m}$$

$$40\mu m$$



3) Calculate the length of the cell.

The diagram below shows the general structure of a plant cell when viewed under and electron microscope.



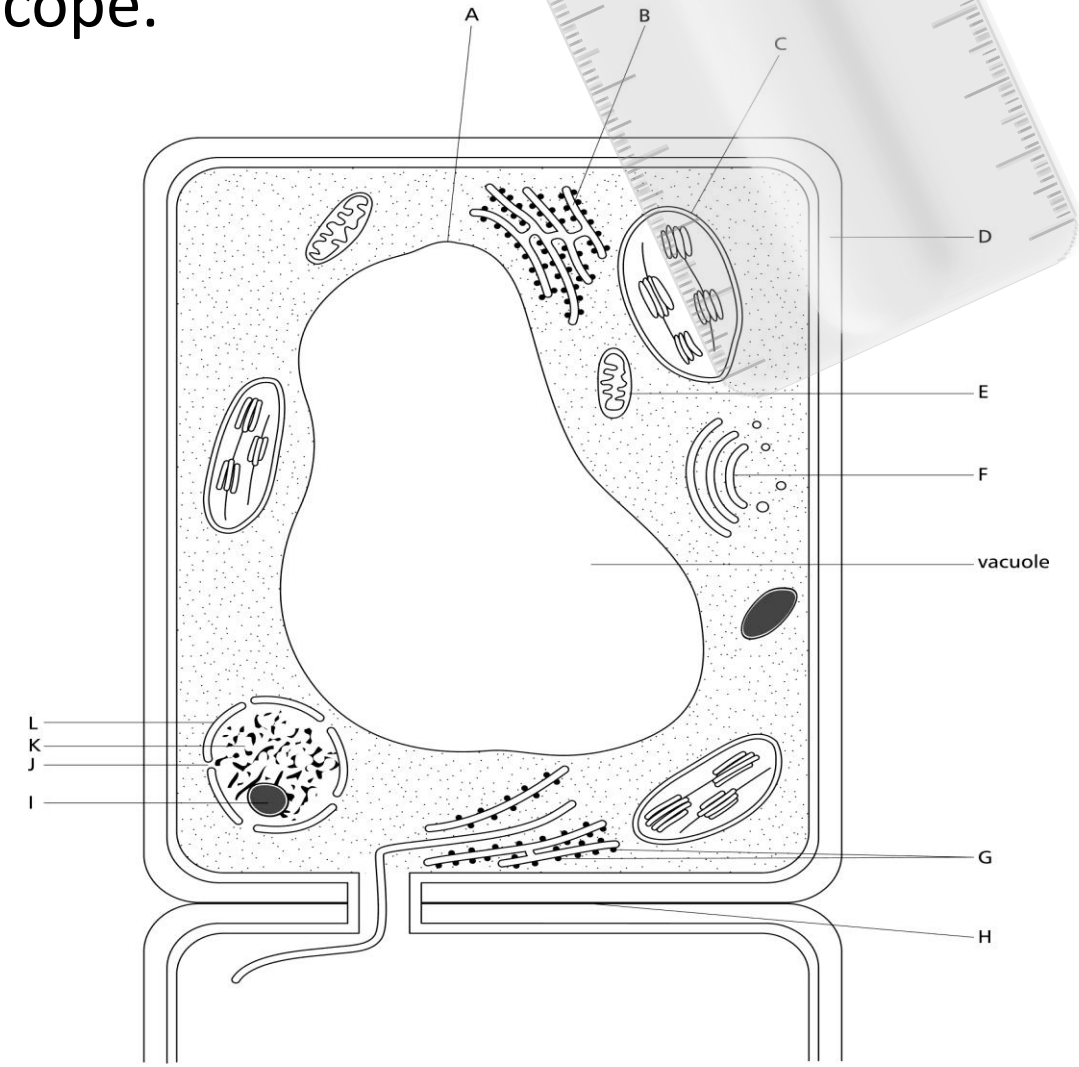
$$A = \frac{I}{M}$$

$$= \frac{24mm}{575}$$

$$= \frac{24000\mu m}{575}$$

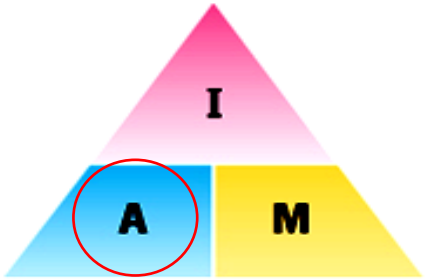
$$= \mathbf{41.7\mu m}$$

$$40\mu m$$



4) Calculate the length of structure C.

The diagram below shows the general structure of a plant cell when viewed under and electron microscope.



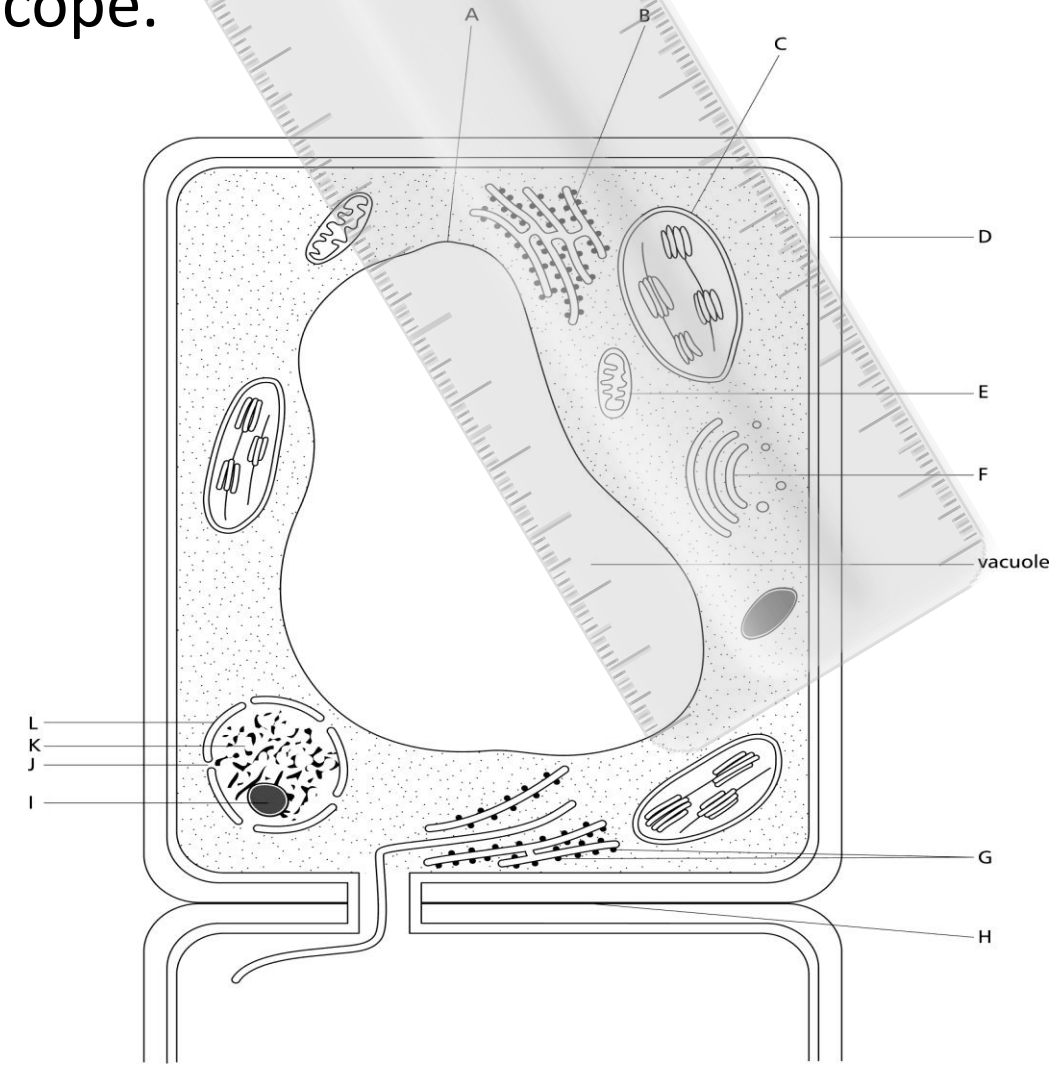
$$A = \frac{I}{M}$$

$$= \frac{71mm}{575}$$

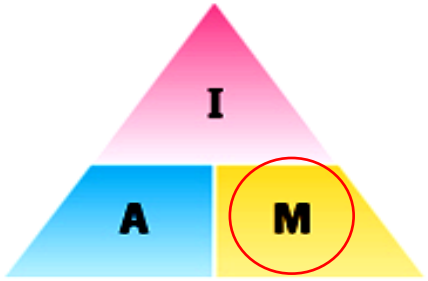
$$= \frac{71000\mu m}{575}$$

$$= \mathbf{123.5\mu m}$$

$$40\mu m$$



5) Calculate the length of the vacuole.



$$M = \frac{I}{A}$$

$$= \frac{82mm}{20\mu m}$$

$$= \frac{82000\mu m}{20\mu m}$$

= 4100

1 Fig. 1.1 is a diagram of an animal cell as seen using a transmission electron microscope.

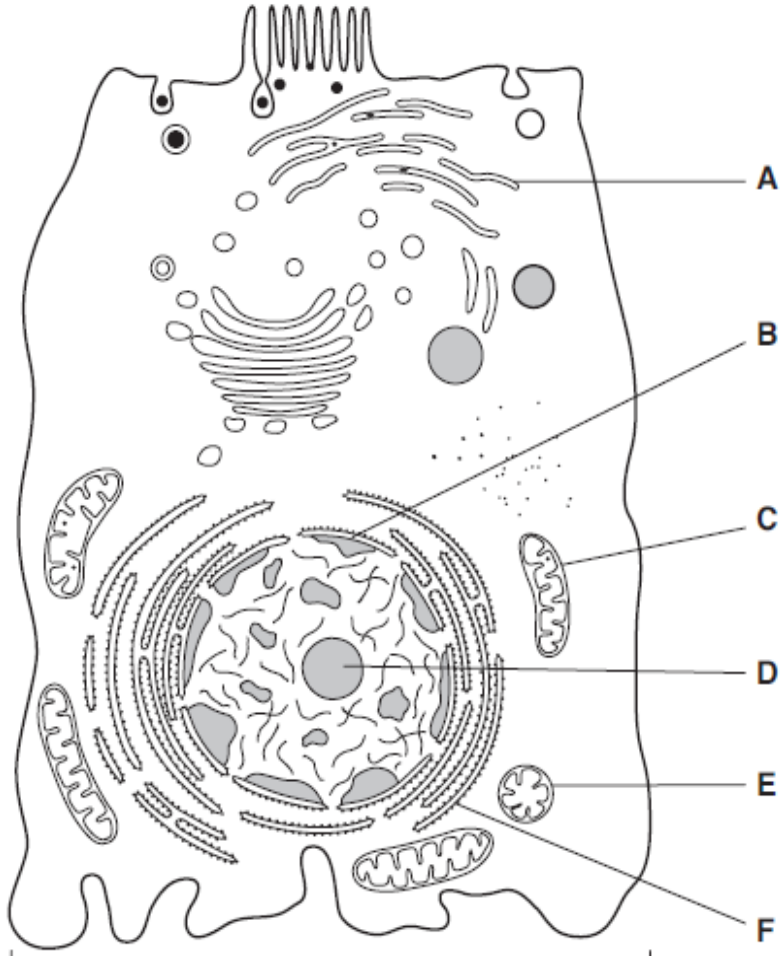
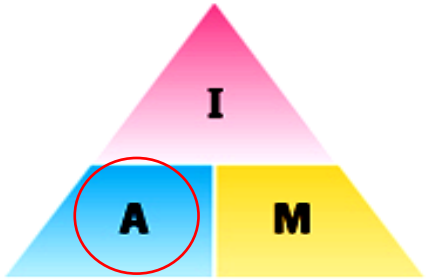


Fig. 1.1

Calculate the actual length of structure C.
Show your working and give your answer in micrometres (µm).

1 Fig. 1.1 is a diagram of an animal cell as seen using a transmission electron microscope.



$$M = \frac{I}{A}$$

$$= \frac{82mm}{20\mu m}$$

$$= \frac{82000\mu m}{20\mu m}$$

$$= 4100$$

$$A = \frac{I}{M}$$

$$= \frac{15mm}{4100}$$

$$= \frac{15000\mu m}{4100}$$

$$= \mathbf{3.6\mu m}$$

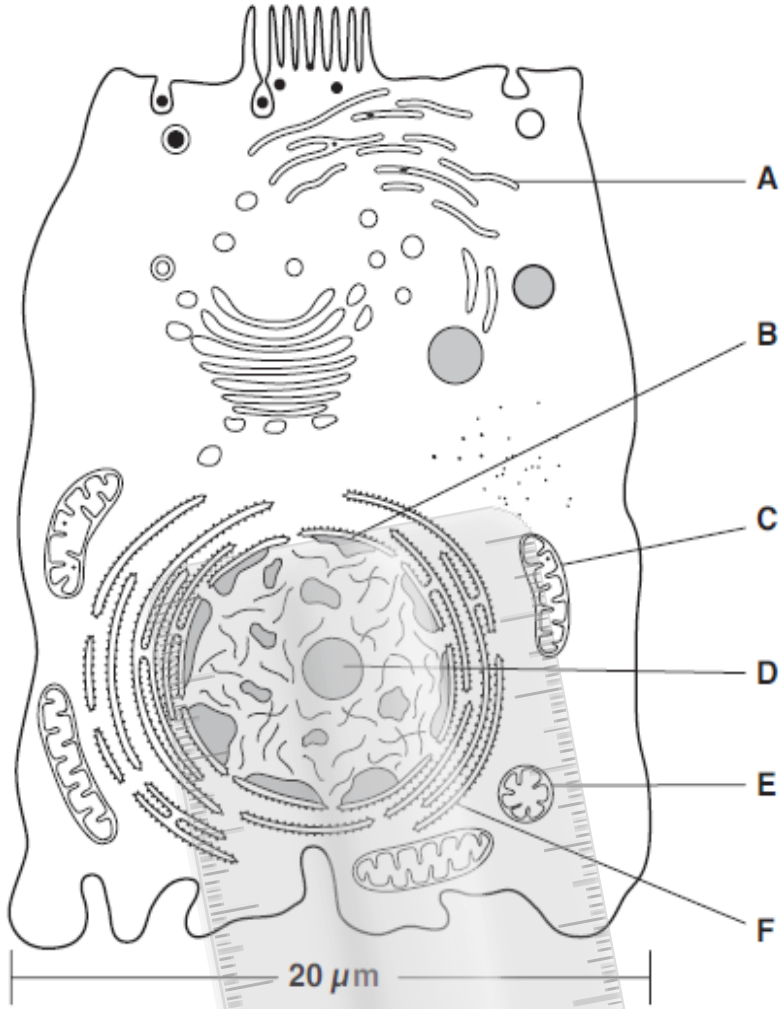


Fig. 1.1

Calculate the actual length of structure C.
Show your working and give your answer in micrometres (µm).

Your Turn: Final Review conversion of units:

There were three marks available for this question.

- The first mark was for conversion of units. Many students did not attempt a conversion but could still go on to achieve two marks. A range of different errors were made which included multiplying or dividing by 10, 100 or 10 000, rather than by 1000. Some did not appreciate that a micrometre is smaller than a millimetre.

- The second mark was for correctly substituting into the rearranged equation to calculate magnification. This mark was allowed even if their initial conversion was incorrect.

- The final mark was for an answer of 400. Some students added a unit to their answer and this negated the mark.

[3 marks]

as the correct rearrangement is needed 1

*an answer of 400 (×) scores **3** marks* 1

How well did you do?

Mathematic Skills	Use prefixes centi, milli, micro and nano.		Use of standard form to simplify large or small numbers.			
	Calculate total magnification.		Use the formula: magnification = size of image/size of real object.		Re-arrange the magnification equation and measure the size of cells.	
	Use orders of magnitude to correctly order objects according to size.		Use orders of magnitude to compare sizes of organisms.		Compare sizes of cells using units of length and standard form.	