OCR
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Maths tutorial booklet for

M4: Geometry and trigonometry

Name:_____

Target grade:_____

Quiz score:

M4.1 Calculate the circumference, surface areas and volumes of regular shapes =

University of East Anglia

Maths skills – M4.1 Calculate the circumference, surface areas and volumes of regular shapes

Tutorials

Learners may be tested on their ability to:

- Calculate the circumference and area of a circle
- Calculate the surface area and volume of rectangular prisms, of cylindrical prisms and of spheres
- e.g. calculate the surface area or volume of a cell.

Being able to calculate the circumference, surface areas and volumes of regular shapes is an essential skill in biology and is used in many contexts, for example in calculating the surface area or volume of a cell.

The calculations you need to know will have been covered in GCSE maths. You must note that the formulae for calculations involving circles and cuboids will not be provided in the exam, so you need to learn them!

For circles there are two formulae that you need to know – one is to calculate the circumference and one is to calculate the area. For the circumference of a circle the formula is $2\pi r$ where *r* is the radius of the circle (the distance from the centre point to the edge).

$$Circumference = 2\pi r$$

The area of a circle is found using the formula πr^2

$$Area\ of\ circle = \pi r^2$$

You also need to know how to calculate the surface areas and volumes of cuboids, cylinders and spheres. For a cuboid these calculations involve the base (*b*), length (*l*) and height (*h*). Here is the formula for the surface area of a cuboid:

$$Surface\ area\ of\ cuboid = 2(bh + bl + hl)$$

The formula for the volume of a cuboid is height, times the base, times the length:

$$Volume\ of\ Cuboid = hbl$$

For cylinders the calculations for surface area and volume use the length of the cylinder (*l*) and the radius of the circle at the end (*r*).

The formula for the surface area of a cylinder is this:

$$Surface\ area\ of\ cylinder = 2\pi r(r + l)$$

The formula for the volume of a cylinder is this:

$$Volume\ of\ cylinder = \pi r^2 l$$

You can also use the radius to calculate the surface area and volume of a sphere. The surface area is calculated using the formula $4\pi r^2$

$$Surface\ area\ of\ sphere = 4\pi r^2$$

The volume of a sphere is found using the formula $\frac{4}{3}\pi r^3$.

$$Volume\ of\ sphere = \frac{4}{3}\pi r^3$$

So here are the geometry formulae you need to remember for the exam:

1) $Circumference = 2\pi r$
2) $Area\ of\ circle = \pi r^2$
3) $Surface\ area\ of\ cuboid = 2(bh + bl + hl)$
4) $Volume\ of\ Cuboid = hbl$

And here are the geometry formulae you will be given in the exam if you need them:

1) $Surface\ area\ of\ cylinder = 2\pi r(r + l)$
2) $Volume\ of\ cylinder = \pi r^2 l$
3) $Surface\ area\ of\ sphere = 4\pi r^2$
4) $Volume\ of\ sphere = \frac{4}{3}\pi r^3$

Let's go through an example. Imagine a bacterial cell, *Bacillus* for example which is rod-shaped, so can be approximated as a cylinder with a length of $4\ \mu m$ and radius of $0.5\ \mu m$:

$4\ \mu m$

We want to work out the surface area to volume ratio for this bacterium (surface area to volume ratio is covered in section M0.3). The formula for finding the surface area of a cylinder is this:

$$Surface\ area\ of\ cylinder = 2\pi r(r + l)$$

By substituting the numerical values for the radius and length into the formula (covered in section M2.3) we get:

$$S.A = 2\pi r(r + l)$$

$$S.A = 2\pi \times 0.5(0.5 + 4)$$

Putting this into the calculator we get an answer of 14.13716694 μm^2. Remember, for areas the units are always squared.

$$S.A\ =\ 14.13716694\ \mu m^2$$

Now we need to work out the volume of the cylinder using the formula $V = \pi r^2 l$. Again, we substitute in the numerical values for the radius and the length, giving us the equation $\pi \times 0.5^2 \times 4$. This gives an answer of 3.141592654 μm^3, with the units being cubed because we have calculated a volume.

$$V = \pi r^2 l$$

$$V\ = \pi \times 0.5^2 \times 4$$

$$V\ =\ 3.141592654\ \mu m^3$$

Reporting these answers each to one decimal place gives us a surface area of 14.1 μm^2 and a volume of 3.1 μm^3. Therefore the surface area to volume ratio is 14.1:3.1. Surface area to volume ratios are usually reported as something to one, so by dividing both sides by 3.1 we get a surface area to volume ratio of 4.5:1.

14.1:3.1

4.5:1

Maths skills – M4.1 Calculate the circumference, surface areas and volumes of regular shapes

Quiz

Calculate the following correct to 3 significant figures.

1. Circumference of circle

Radius =

a) 0.50 µm

b) 3.00 mm

2. Area of circle

Radius =

a) 0.50 µm

b) 3.00 mm

3. Surface area of cuboid

a) b = 4.00 cm l = 6.00 cm h = 1.00 cm

b) b = 3.00 mm l = 4.00 mm h = 3.00 mm

4. Volume of cuboid

a) b = 4.00 cm l = 6.00 cm h = 1.00 cm

b) b = 3.00 mm l = 4.00 mm h = 3.00 mm

5. Surface area of cylinder

a) r = 0.500 µm l = 4.00 µm

b) r = 3.00 mm l = 10.0 mm

6. Volume of cylinder

a) r = 0.500 µm l = 4.00 µm

b) r = 3.00 mm l = 10.0 mm

7. Surface area of sphere

a) r = 0.500 µm

b) r = 3.00 mm

8. Volume of sphere

a) r = 0.50 µm

b) r = 3.00 mm

9. Calculate the surface area to volume ratio of a mitochondrion that is approximately cylindrical in shape and has a length of 7.0 µm and a radius of 0.50 µm.

