Bacterial growth

Worked solutions

GCSE science calculations

This topic online

1 A single bacterium is placed in some nutrient broth. It divides 5 times, and every cell divides each time.

Calculate the number of bacteria at the end. (1 mark)

Number = start x $2^{\text{divisions}}$

number = 1×2^5

32

2 A sample of milk contains 40 bacteria. The bacteria divide 6 times.

Calculate the number of bacteria after 6 divisions. (2 marks)

Number = start x $2^{\text{divisions}}$

number = 40×2^6

number = 40×64

2560

3 Jasmine places a paper disc soaked in antiseptic on an agar plate covered in bacteria. After incubation there is a circular clear zone around the disc with a radius of 6 mm.

Calculate the area of the clear zone in mm^2. (2 marks)

Area of a circle = πr^2

Square the radius first

$r^2 = 6^2 = 36$

area = $\pi \times 36$

area = 113.097... mm^2

113 mm^2

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4 A bacterium in a warm kitchen has a mean division time of 20 minutes.

Calculate the number of bacteria produced from this one bacterium after 3 hours. (3 marks)

Convert hours to minutes: 1 h = 60 min

$3\text{ h} = 3 \times 60 = 180\text{ min}$

Number of divisions = time ÷ mean division time

$\text{divisions} = 180 \div 20 = 9$

$\text{number} = 1 \times 2^9$

512

5 Daniel tests an antibiotic disc on a plate of bacteria. The clear zone around the disc has a diameter of 18 mm.

Calculate the area of the clear zone in mm^2. (3 marks)

18 mm is the diameter, so halve it

$r = 18 \div 2 = 9\text{ mm}$

Area of a circle = πr^2

$r^2 = 9^2 = 81$

$\text{area} = \pi \times 81$

$\text{area} = 254.469...\ mm^2$

254 mm^2

6 A hospital lab tests a new antibiotic. The clear zone around the antibiotic disc has a diameter of 2.4 cm.

Calculate the area of the clear zone in mm^2. (3 marks)

Radius = diameter ÷ 2

$r = 2.4 \div 2 = 1.2\text{ cm}$

Convert cm to mm: 1 cm = 10 mm

$r = 1.2 \times 10 = 12\text{ mm}$

Area of a circle = πr^2

$r^2 = 12^2 = 144$

$\text{area} = \pi \times 144$

$\text{area} = 452.389...\ mm^2$

452 mm^2

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7 A culture starts with 25 bacteria. After some time there are 6400 bacteria.

Calculate how many times the bacteria have divided. (3 marks)

Number = start x $2^{\text{divisions}}$

$6400 = 25 \times 2^{\wedge}$

Divide both sides by 25

$2^{\wedge} = 256$

Find the power of 2 that makes 256

$2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2 = 256$

8

8 Bacteria in a sample of chicken left out of the fridge divide 12 times in 4 hours.

Calculate the mean division time in minutes. (3 marks)

Convert hours to minutes: 1 h = 60 min

$4\text{ h} = 4 \times 60 = 240\text{ min}$

Number of divisions = time ÷ mean division time

$12 = 240 \div t$

Rearrange: t = time ÷ number of divisions

$t = 240 \div 12$

20 minutes

9 **Higher tier**

Mei measures the area of a clear zone around a disc of garlic extract. The area is 201 mm^2.

Calculate the radius of the clear zone. Give your answer to 2 significant figures. (3 marks)

Area of a circle = πr^2

$201 = \pi \times r^2$

Divide both sides by π

$r^2 = 201 \div \pi$

$r^2 = 63.980...$

Square root both sides

$r = \sqrt{63.980...}$

$r = 7.998...\text{ mm}$

8.0 mm

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10 A sample of water from a garden pond contains 500 bacteria. The bacteria have a mean division time of 25 minutes.

Calculate the number of bacteria after 5 hours. Give your answer in standard form to 2 significant figures. Show your working.

(4 marks)

Convert hours to minutes: 1 h = 60 min

$5\text{ h} = 5 \times 60 = 300\text{ min}$

Number of divisions = time ÷ mean division time

$\text{divisions} = 300 \div 25 = 12$

Number = start × $2^{\text{divisions}}$

$\text{number} = 500 \times 2^{12}$

$\text{number} = 500 \times 4096$

$\text{number} = 2\,048\,000$

$\boxed{2.0 \times 10^{6}}$

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11 Adebayo tests three antibiotics on the same type of bacteria. The table shows the diameter of the clear zone around each disc.

Antibiotic	Diameter of clear zone in mm
P	12
Q	20
R	16

a. Calculate the area of the clear zone for antibiotic Q in mm^2.

b. Calculate how many times larger the area of the clear zone for Q is than the area for P. Give your answer to 2 significant figures.

Show your working.

(4 marks)

a)

Radius = diameter ÷ 2

$r = 20 \div 2 = 10$ mm

Area of a circle = πr^2

$area = \pi \times 10^2$

$area = \pi \times 100 = 314.159...$ mm^2

314 mm^2

b)

$r = 12 \div 2 = 6$ mm

$area = \pi \times 6^2$

$area = \pi \times 36 = 113.097...$ mm^2

Divide the areas, not the diameters

$ratio = 314.159... \div 113.097...$

$ratio = 2.777...$

2.8

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12 Ellie grows bacteria in 10 cm^3 of nutrient broth incubated at 25 °C.

- At the start there are 2.0×10^3 bacteria.
- The mean division time is 45 minutes.

Calculate the number of bacteria after 6 hours. Give your answer in standard form. Show your working.

(4 marks)

10 cm^3 and 25 °C are not needed

Convert hours to minutes: 1 h = 60 min

6 h = 6 × 60 = 360 min

Number of divisions = time ÷ mean division time

divisions = 360 ÷ 45 = 8

Number = start × $2^{\text{divisions}}$

number = 2000 × 2^8

number = 2000 × 256

number = 512 000

5.12×10^5

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