Rates in biology

Worked solutions

GCSE science calculations

This topic online

1 Amara places some pondweed in a beaker of water under a lamp. She counts 54 bubbles of gas coming from the cut end of the stem in 3 minutes.

Calculate the rate of bubble production in bubbles per minute. (2 marks)

Rate = amount ÷ time

rate = 54 ÷ 3

18 bubbles per minute

2 Ravi mixes amylase with starch solution. Every 10 seconds he tests a drop of the mixture with iodine. After 40 s the iodine no longer turns blue-black, so all the starch has been broken down.

Calculate the rate of the reaction in s^{-1}. (2 marks)

Rate = 1 ÷ time

rate = 1 ÷ 40

0.025 s^{-1}

3 Chloe collects the oxygen given off by some pondweed in a gas syringe.

- At the start, the syringe reads 2.0 cm^3.
- After 5 minutes, the syringe reads 9.5 cm^3.

Calculate the rate of oxygen production in cm^3 per minute. (2 marks)

Use the volume collected, not the final reading

volume = 9.5 − 2.0 = 7.5 cm^3

Rate = amount ÷ time

rate = 7.5 ÷ 5

1.5 cm^3/min

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4 A sample of algae balls in a sealed tube releases 3.6 cm^3 of oxygen in 12 minutes.

Calculate the rate of oxygen production in cm^3 per hour. (3 marks)

Convert minutes to hours: 1 h = 60 min

12 min = 12 ÷ 60 = 0.2 h

Rate = amount ÷ time

rate = 3.6 ÷ 0.2

18 cm^3/h

5 In a Year 10 practical, Tomasz adds protease to a cloudy suspension of milk powder. The mixture turns clear after 2 minutes 5 seconds.

Calculate the rate of the reaction in s^{-1}. (3 marks)

Convert the time to seconds: 1 min = 60 s

time = 2 x 60 + 5 = 125 s

Rate = 1 ÷ time

rate = 1 ÷ 125

0.008 s^{-1}

6 Isla counts the bubbles given off by some pondweed in 5 minutes. She repeats the count four times.

Repeat	1	2	3	4
Number of bubbles in 5 minutes	64	71	35	66

One of the results is anomalous.

Calculate the mean rate of bubble production in bubbles per minute. (3 marks)

35 is anomalous, so leave it out

mean = (64 + 71 + 66) ÷ 3

mean = 201 ÷ 3 = 67 bubbles

Rate = amount ÷ time

rate = 67 ÷ 5

13.4 bubbles per minute

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7 Grace measures the rate of a reaction catalysed by catalase at 35 °C. The rate is 0.016 s^{-1}.
Calculate the time taken for the reaction in seconds. (2 marks)

Rate = 1 ÷ time

$0.016 = 1 \div t$

Rearrange: time = 1 ÷ rate

$t = 1 \div 0.016$

62.5 s

8 Some pondweed in a garden pond produces oxygen at a rate of 0.35 cm^3 per minute.
Calculate the volume of oxygen it produces in 1.5 hours. (3 marks)

Convert hours to minutes: 1 h = 60 min

$1.5 \text{ h} = 1.5 \times 60 = 90 \text{ min}$

Rate = amount ÷ time

$0.35 = \text{amount} \div 90$

Multiply both sides by 90

$\text{amount} = 0.35 \times 90$

31.5 cm^3

9 Under a bright lamp, a piece of pondweed gives off 24 bubbles per minute.
Calculate how long it takes to give off 300 bubbles. Give your answer in seconds. (3 marks)

Rate = amount ÷ time

$24 = 300 \div t$

Rearrange: time = amount ÷ rate

$t = 300 \div 24$

$t = 12.5 \text{ min}$

Convert minutes to seconds: 1 min = 60 s

$t = 12.5 \times 60$

750 s

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10 Kwame times how long amylase takes to break down all the starch in a solution at two temperatures. He does three repeats at each temperature.

Temperature in °C	Repeat 1 in s	Repeat 2 in s	Repeat 3 in s
25	52	48	50
40	21	19	23

a. Calculate the rate of the reaction at 25 °C in s^{-1}.

b. Calculate the rate of the reaction at 40 °C in s^{-1}. Give your answer to 2 significant figures.

Show your working. (4 marks)

a)

Find the mean time first

mean = (52 + 48 + 50) ÷ 3

mean = 150 ÷ 3 = 50 s

Rate = 1 ÷ time

rate = 1 ÷ 50

0.02 s^{-1}

b)

mean = (21 + 19 + 23) ÷ 3

mean = 63 ÷ 3 = 21 s

rate = 1 ÷ 21

rate = 0.047619... s^{-1}

0.048 s^{-1}

11 **Higher tier**

Ifeoma uses a 40 W LED lamp to light some pondweed. With the lamp 12 cm from the pondweed, the light intensity at the pondweed is 900 lux.

She moves the lamp so that it is 36 cm from the pondweed.

Calculate the new light intensity at the pondweed. Show your working. (3 marks)

The 40 W is not needed: only the distances matter

Light intensity ∝ 1 ÷ distance²

distance factor = 36 ÷ 12 = 3

Square the distance factor

$3^2 = 9$

new intensity = 900 ÷ 9

100 lux

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12 **Higher tier**

In a school greenhouse, a grow lamp gives a light intensity of 1500 lux at a seed tray 20 cm below it.

A gardener wants a light intensity of 240 lux at a second tray.

Calculate how far the second tray should be from the lamp. Show your working. (4 marks)

Light intensity $\propto 1 \div$ distance^2

intensity factor $= 1500 \div 240 = 6.25$

distance^2 goes up by 6.25, so take the square root

distance factor $= \sqrt{6.25} = 2.5$

new distance $= 20 \times 2.5$

50 cm

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