# Arithmetic and Numerical Computation (M0): OCR A Level Biology Exam

18 questions · 32 marks · about 38 minutes. Answer in the spaces, then check the mark schemes at the end.

**Question 1 · A level Paper 3 · June 2022 · Q3(c)(i) · 1 mark**

**(c)** Another student plans to investigate the effect of gibberellin concentration on the rate of stem elongation in the pea plant, *Pisum sativum*.

**(i)** Suggest appropriate units for the dependent variable in this investigation.

..... **[1]**

**Question 2 · A level Paper 3 · June 2017 · Q4(c)(i) · 2 marks**

**(c)** Many species of bacteria act as decomposers within ecosystems by breaking down organic material.

Scientists analysed the energy flow within a grassland ecosystem.

They estimated that the energy in the decomposers' trophic level was 950 000 $J\,m^{-2}\,yr^{-1}$.

The energy within the producers' trophic level was 800% greater than that of the decomposers.

**(i)** Calculate the energy in the producers' trophic level in **$kJ\,m^{-2}\,yr^{-1}$**.

Answer: ..... $kJ\,m^{-2}\,yr^{-1}$ **[2]**

**Question 3 · A level Paper 1 · November 2021 · Q20(c)(ii) · 2 marks**

**(ii)** In this investigation, the student calculated the rate of transpiration to be 30 $mm^3\,min^{-1}$.

They estimated the total leaf surface area of the shoot to be 37 $cm^2$.

Calculate the rate of transpiration in $cm^3\,hr^{-1}\,cm^{-2}$.

Give your answer in standard form to **2** significant figures.

Rate = ..... $cm^3\,hr^{-1}\,cm^{-2}$ **[2]**


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**Question 4 · information from earlier in the question**

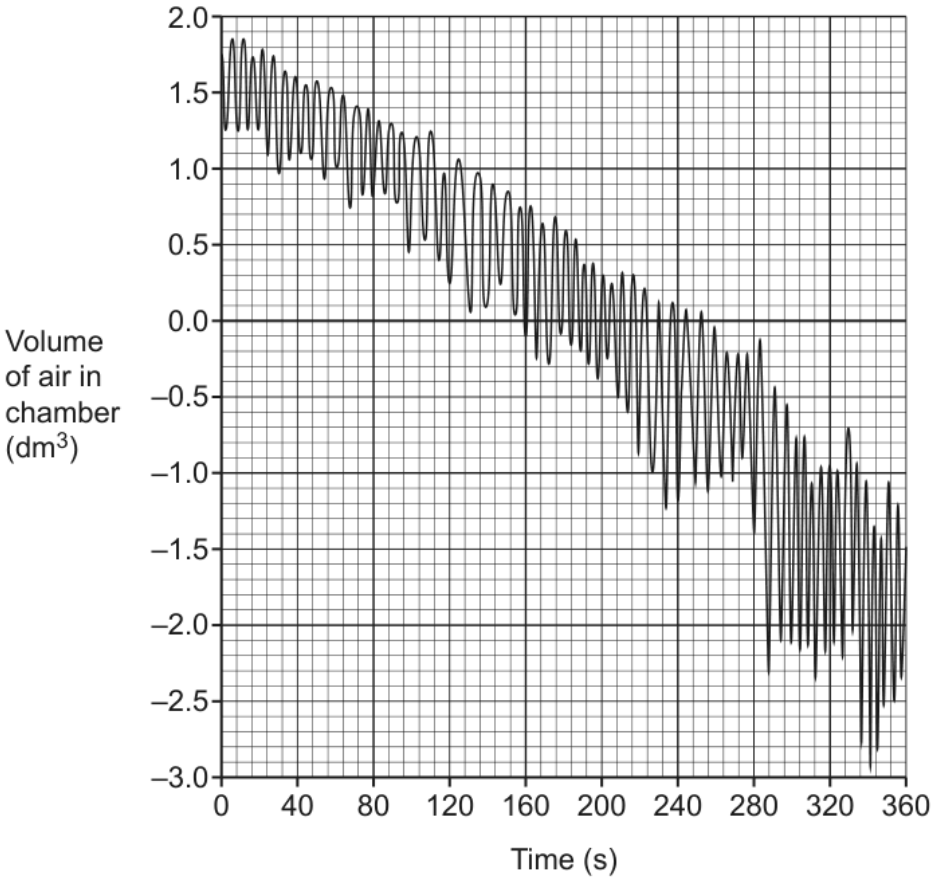
**20** A student investigated ventilation and heart rate in a resting subject.

The subject breathed in and out through a spirometer.

The spirometer chamber was filled with room air. Soda lime was present to absorb carbon dioxide.

The results are shown in **Fig. 20.1**.

**Fig. 20.1**






**(a)**

**(i)** The downward slope of the spirometer trace in **Fig. 20.1** is due to oxygen consumption.

The subject exhales the same volume of air as they inhale.

State why the trace slopes downwards.

.....

.....

..... **[1]**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**Question 4 · A level Paper 1 · June 2024 · Q20(a)(ii) · 2 marks**

**(ii)** The subject had a mass of 75 kg.

Calculate the subject's oxygen consumption in $cm^3\,kg^{-1}$ during the first 2 minutes of the experiment.

Give your answer to **2** significant figures.

Oxygen consumption = ..... $cm^3\,kg^{-1}$ **[2]**

**Question 5 · A level Paper 1 · November 2020 · Q20(c)(iii) · 2 marks**

**(iii)** The student prepared a starter culture using $2.5 \times 10^{-3}$ g yeast cells in 1 $dm^3$ nutrient broth.

The average mass of a yeast cell is $2.0 \times 10^{-11}$ g.

Calculate the number of cells in the starter culture.

Give your answer in standard form.

number of cells = ..... **[2]**


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**Question 6 · A level Paper 2 · June 2018 · Q21(b) · 2 marks**

**(b)** The speed at which DNA can be sequenced has been increasing rapidly since the introduction of DNA sequencing.

The length of DNA that can be sequenced in a given time is measured in base pairs or kilobase pairs.

In 1980, the speed at which DNA could be sequenced by a single machine was approximately 500 **base pairs** per hour. In 2016 that speed had increased to approximately 50 million **kilobase pairs** per hour.

Calculate how many times faster the speed of DNA sequencing is in 2016 compared with 1980.

Answer ..... times faster **[2]**

Turn over


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**Question 7 · A level Paper 3 · June 2017 · Q2(b)(iii) · 2 marks**

**(iii)** Scientists wanted to estimate the number of yeast cells in a 25 $cm^3$ solution of *S. cerevisiae*. They carried out the following two dilutions:

- 1 $cm^3$ of the original solution was mixed with 9 $cm^3$ of nutrient solution to make solution 2.
- 1 $cm^3$ of solution 2 was mixed with 9 $cm^3$ of nutrient solution to make solution 3.

The scientists transferred 0.1 $cm^3$ of solution 3 onto an agar plate. 15 separate colonies grew on the plate.

Calculate the number of yeast cells in the original 25 $cm^3$ solution.

Express your answer in standard form to **three** significant figures. Show your working.

Answer ..... **[2]**

**Question 8 · A level Paper 3 · June 2022 · Q2(b)(ii) · 2 marks**

**(ii)** A scientist calculated two values for the lysosomes in a white blood cell:

- mean volume of a lysosome = $6.5 \times 10^{-14}$ $cm^3$
- mean number of $H^+$ ions per lysosome = $1.3 \times 10^{-21}$ mol

Use these values to calculate the mean $H^+$ ion concentration per lysosome in this white blood cell.

Give your answer in mol $dm^{-3}$.

Mean $H^+$ ion concentration = ..... mol $dm^{-3}$ **[2]**

**Turn over**


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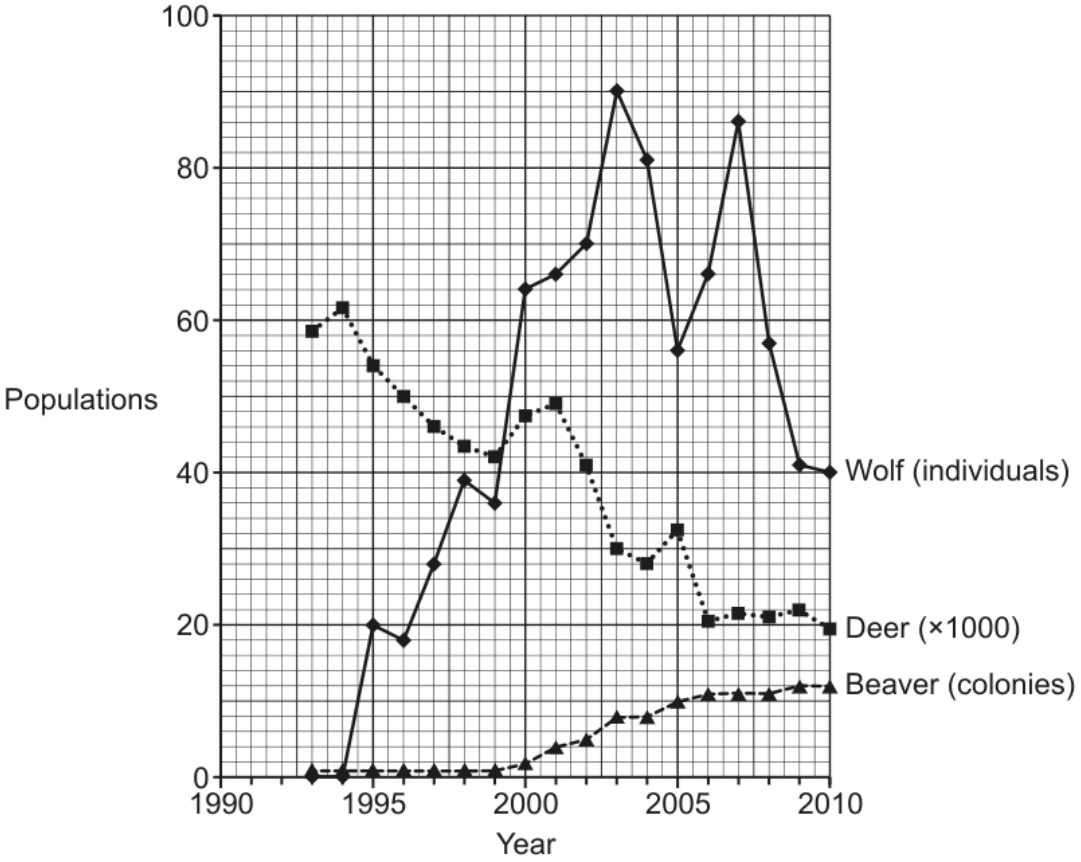
**Question 9 · information from earlier in the question**

**20** Grey wolves became extinct in an area of North America in the 1920s. In 1993 some grey wolves were reintroduced into the same area.

Grey wolves feed mainly on large herbivores, such as deer.

The graph shows the population of grey wolves and some other species since the reintroduction.




**(a)** Describe the changes in the deer population since 1993.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**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**Question 9 · A level Paper 2 · June 2023 · Q20(b)(i) · 2 marks**

**(b) (i)** Calculate the percentage increase in the wolf population between 1995 and 2003.

Percentage increase = ..... **[2]**

**Question 10 · AS Paper 2 · June 2024 · Q4(a)(i) · 1 mark**

**4**

**(a)** An aneurysm is a bulge in a blood vessel caused by a weakness in the wall of the blood vessel.

If an aneurysm bursts it can be very serious or even fatal.

**(i)** Scientists can measure the size of an aneurysm. An investigation measured the ratio of collagen to elastin in the blood vessel wall in five patients with an aneurysm.

The table shows some of their findings.

| Patient | Size of aneurysm (cm) | Ratio of collagen to elastin |
|---|---|---|
| A | 0.00 | 2 : 1 |
| B | 0.03 | 3 : 1 |
| C | 0.50 | 4 : 1 |
| D | 1.10 | 7 : 1 |
| E | 2.20 | 8 : 1 |

Based only on the data in the table, suggest a hypothesis on the formation of aneurysms.

.....

.....

..... **[1]**


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**(c)** Cells can use fatty acids instead of carbohydrates as respiratory substrates. A process called beta oxidation is used to break down fatty acids to acetyl CoA for use in respiration.

Fig. 2 shows a simplified example of beta oxidation.

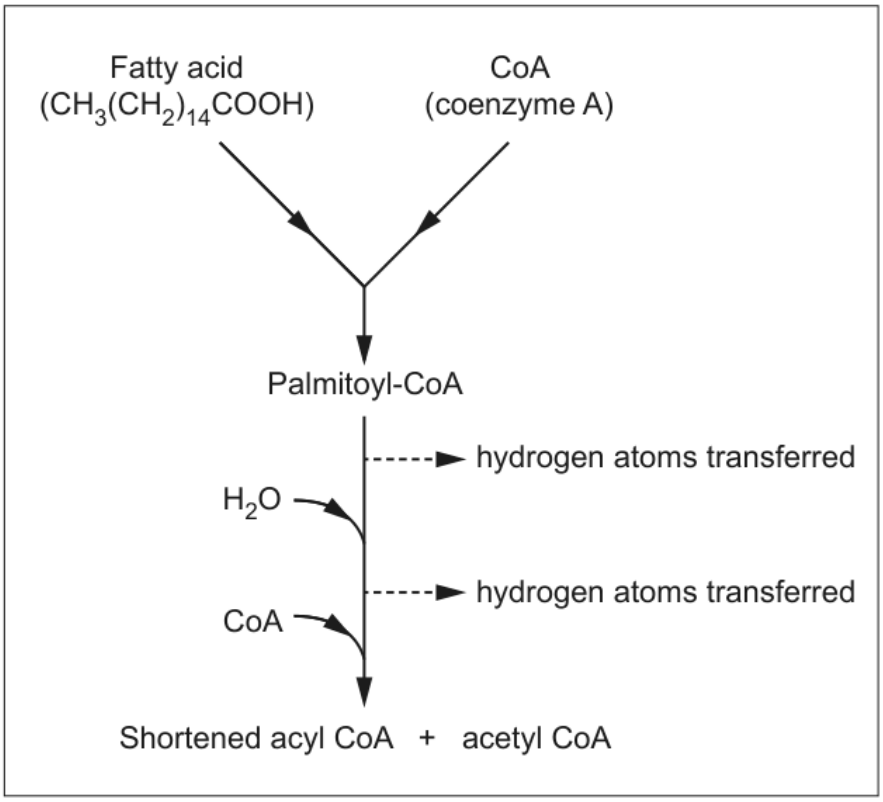


**Fig. 2**

**(i)** Using the information in Fig. 2, calculate the percentage of carbon atoms in the fatty acid that are able to enter the Krebs cycle.

Answer = ..... % **[1]**


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**Question 12 · A level Paper 2 · June 2024 · Q21(c) · 2 marks**

**(c)** The cell cycle of an onion cell is estimated to be 15 h.

A root-tip squash from an onion contained 124 cells.

16 of the cells were undergoing mitosis.

Calculate the mean length of time each cell spent undergoing mitosis.

Give your answer in minutes to **3** significant figures.

Time spent undergoing mitosis = ..... min **[2]**

**Question 13 · AS Paper 2 · June 2019 · Q5(b)(i) · 2 marks**

**(b)** An experiment was carried out in which the frequency of vacuole contraction was observed when *Paramecium* was bathed in different concentrations of sodium chloride solution. The results are shown in Table 5.

| Concentration of sodium chloride solution ($mol\,dm^{-3}$) | Mean number of contractions ($min^{-1}$) |
|---|---|
| 0.00 | 6.5 |
| 0.01 | 6.2 |
| 0.03 | 5.7 |
| 0.05 | 4.9 |
| 0.10 | 4.4 |
| 0.15 | 3.9 |
| 0.20 | 1.2 |

**Table 5**

**(i)** Calculate the percentage decrease in the mean number of contractions as the concentration of sodium chloride solution increases from 0.00 $mol\,dm^{-3}$ to 0.15 $mol\,dm^{-3}$.

percentage decrease = ..... % **[2]**


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**(b)** The resistance of different varieties of *S. tuberosum* to infection by *P. infestans* was investigated.

- Three different clones, A, B and C, of *S. tuberosum* were used.
- The clones were grown in adjacent fields over the same time period.
- The percentage of leaf area affected by the disease was estimated at regular intervals.

The results are shown in Fig. 18.

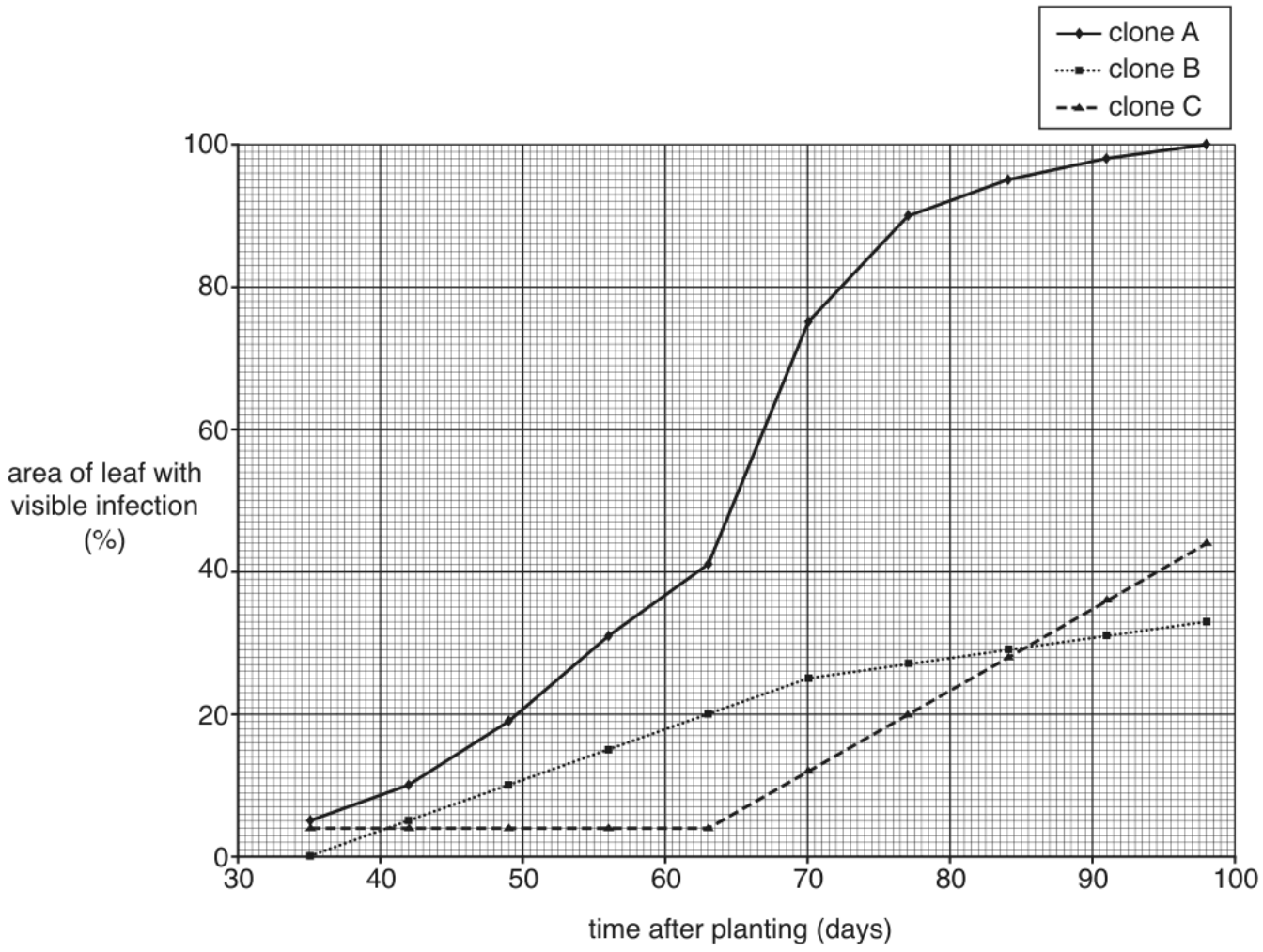


**Fig. 18**

**(i)** Suggest why it is important to use clones in an investigation such as this.

.....

.....

.....

..... **[2]**

Turn over


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**Question 14 · A level Paper 2 · June 2017 · Q18(b)(iii) · 3 marks**

**(iii)** The extent of infection is estimated by comparing the area under the curve from the graph. The area under the curve for clone **B** is 1250. (Units can be ignored in this instance.)

**Using Fig. 18**, calculate the approximate area under the curve, between day 35 and day 98, for clone **C**.

*Answer* ..... **[3]**

**Question 15 · information from earlier in the question**

**18** The Lake District is the largest National Park in England, covering an area of 2362 $km^2$.

It contains a wide variety of species, some of which are under threat or endangered. The resident human population is 41 000. In 2016 the Lake District received 18.4 million tourists.

The proportion of Lake District land used for different purposes is shown in Fig. 18.

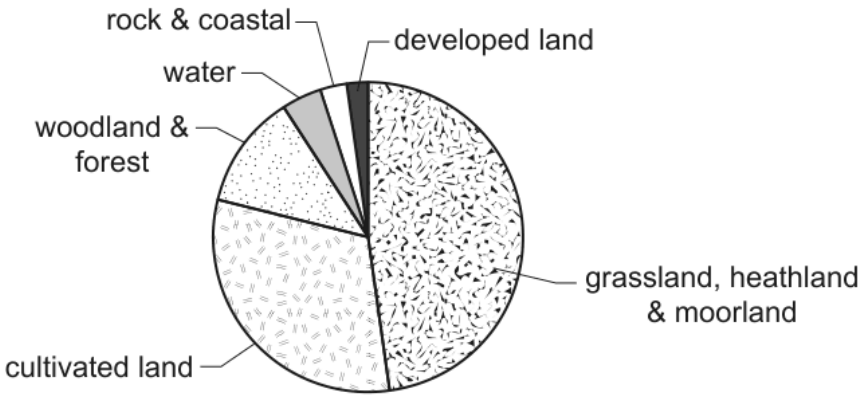


**Fig. 18**

**(a)** Explain **one** way in which tourists can lead to an increase in the biodiversity of an area.

.....

.....

.....

..... **[2]**


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**Question 15 · A level Paper 2 · June 2019 · Q18(b)(i) · 1 mark**

**(b)** The Lake District contains large areas where timber is produced. One of the aims of the management of National Parks is to produce timber sustainably.

**(i)** Using Fig. 18, **estimate** the percentage of land that is covered by woodland and forest.

estimate = ..... % **[1]**

**Question 16 · information from earlier in the question**

**(ii)** A scientist calculated two values for the lysosomes in a white blood cell:

- mean volume of a lysosome = $6.5 \times 10^{-14}\,cm^3$
- mean number of $H^+$ ions per lysosome = $1.3 \times 10^{-21}\,mol$

Use these values to calculate the mean $H^+$ ion concentration per lysosome in this white blood cell.

Give your answer in $mol\,dm^{-3}$.

Mean $H^+$ ion concentration = ..... $mol\,dm^{-3}$ **[2]**

Turn over


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**Question 16 · A level Paper 3 · June 2022 · Q2(b)(iii) · 1 mark**

**(iii)** The formula used to calculate pH is

$pH = -\log [H^+]$
where $[H^+]$ is $H^+$ ion concentration in mol $dm^{-3}$.

Use your answer from **part (ii)** to calculate the mean pH of the lysosomes in this white blood cell.

Give your answer to **2** significant figures.

pH = ..... **[1]**

**Question 17 · A level Paper 2 · June 2023 · Q16(d) · 2 marks**

**(d)** During meiosis, the independent assortment of chromosomes leads to the formation of genetically different gametes.

Gametes of the western clawed frog contain 10 chromosomes.

Calculate the number of genetically different gametes resulting from the independent assortment of chromosomes that would be produced by an individual frog.

Number of different gametes = ..... **[2]**

**Question 18 · A level Paper 3 · June 2018 · Q4(c)(ii) · 2 marks**

**(ii)** DNA samples can be amplified using the polymerase chain reaction (PCR).

In theory, how many fragments of DNA might be present after 12 cycles of PCR?

Assume one DNA fragment was present at the beginning of the PCR process. Represent your answer as a $\log_{10}$ value.

..... fragments **[2]**


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## Mark schemes

**Question 1 · A level Paper 3 · June 2022 · Q3(c)(i) · 1 mark**

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | (c) | (i) | mm $h^{-1}$ **or** cm $h^{-1}$ **or** mm $d^{-1}$ **or** cm $d^{-1}$ ✓ | 1 | 3.3 | |

**ALLOW** 'day' for 'd' 'hour' for 'h'

**DO NOT ALLOW** s / secs/ seconds /min / minutes

**ALLOW** '/' for $^{-1}$
**IGNORE** 'per'
**DO NOT ALLOW** use of both $^{-1}$ and '/' together

**Question 2 · A level Paper 3 · June 2017 · Q4(c)(i) · 2 marks**

| | | | | |
|---|---|---|---|---|
| c | i | 8550 (kJ $m^{-2}$ $yr^{-1}$) ✓✓ | 2 | **AWARD** one mark for 8 550 000 (J $m^{-2}$ $yr^{-1}$)<br>**OR**<br>**AWARD** one mark for 9 x 950 000<br>**OR**<br>**AWARD** one mark for 7600 (kJ $m^{-2}$ $yr^{-1}$) |

**Question 3 · A level Paper 1 · November 2021 · Q20(c)(ii) · 2 marks**

| | | | |
|---|---|---|---|
| 20 | (c) | (ii) | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 4.9 x $10^{-2}$ award 2 marks**<br>30 $mm^3$ $min^{-1}$ = 1 800 $mm^3$ $hr^{-1}$ = 1.8 $cm^3$ $hr^{-1}$ ✓<br>1.8 ÷ 37 = 0.0486 = 4.9 x $10^{-2}$ $cm^3$ $hr^{-1}$ $cm^{-2}$ ✓ |

| | |
|---|---|
| 2 | **Must** be **2SF** and **standard form** for 2 marks<br>If answer is incorrect **ALLOW** for 1 mark |
| 2.6 | 0.049 / 0.0486 |
| 2.6 | |


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**Question 4 · A level Paper 1 · June 2024 · Q20(a)(ii) · 2 marks**

| | | | | |
|---|---|---|---|---|
| 20 | (a) | (ii) | **FIRST CHECK ANSWER ON ANSWER LINE**<br>**If answer = 12 / 13 / 14 / 15** ($cm^3\ kg^{-1}$) **award 2 marks** ✓✓<br>oxygen consumption in 120 s = 1.0 $dm^3$ = 1000 $cm^3$<br>so consumption $\frac{1000}{75} = 13$ ($cm^3\ kg^{-1}$) | 2 |

**If answer is incorrect**
**MAX** 1 mark for answer not to 2 sig. figs.

Range of 0.9 to 1.1$dm^3$ from **Fig.20.1**

**ALLOW** 1 mark for failure to convert to $cm^3$
e.g.1.3 x $10^{-2}$ / 0.013 / 0.014 ($dm^3\ kg^{-1}$)
**OR**
volume ÷ 75 (Kg)

**Question 5 · A level Paper 1 · November 2020 · Q20(c)(iii) · 2 marks**

| | | | |
|---|---|---|---|
| (iii) | $1.25 \times 10^8$ ✓✓ | **2** 2.4 | **FIRST CHECK ON THE ANSWER LINE if answer = $1.25 \times 10^8$, award 2 marks**<br>**If answer incorrect:**<br>**ALLOW** 1 mark for<br>answer not in standard form<br>**OR**<br>incorrect standard form e.g. 125 x $10^6$<br>**OR**<br>use of equation with correct figures<br>$number\ of\ cells = \frac{2.5 \times 10^{-3}}{2.0 \times 10^{-11}}$ |

**Question 6 · A level Paper 2 · June 2018 · Q21(b) · 2 marks**

| | |
|---|---|
| **(b)** | 100 000 000 / 100 million / 1.0 x$10^8$ / 1 x$10^8$ ✓✓ |

| | |
|---|---|
| **2** | **ALLOW** 1 mark for 100 000 / 1 x$10^5$ / $10^8$ |


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**Question 7 · A level Paper 3 · June 2017 · Q2(b)(iii) · 2 marks**

| | | | |
|---|---|---|---|
| **iii** | 3.75 ✓<br><br>x $10^5$ ✓ | **2** | **One mark** awarded for a correct calculation with the wrong number of significant figures or not in standard form<br>(e.g. 375000 , 375 x $10^3$ ,3.8 x$10^5$) |

**Question 8 · A level Paper 3 · June 2022 · Q2(b)(ii) · 2 marks**

| | | | | | |
|---|---|---|---|---|---|
| **2** | **(b)** | **(ii)** | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 2 x $10^{-5}$ award 2 marks**<br>1.3 x $10^{-21}$ / 6.5 x $10^{-14}$ = 2 x $10^{-8}$ (mol $cm^{-3}$) ✓<br>2 x $10^{-8}$ (mol $cm^{-3}$) x 1000 = 2 x $10^{-5}$ (mol $dm^{-3}$) ✓ | **2** | 2.2 |

**ALLOW** 0.00002 for 2 marks

**ALLOW** 'x 1000' seen anywhere in the answer

**Question 9 · A level Paper 2 · June 2023 · Q20(b)(i) · 2 marks**

| | | | | |
|---|---|---|---|---|
| **(b)** | **(i)** | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 350 award 2 marks**<br>90−20 = 70<br>70/20 x 100 ✓<br>= 350 ✓ | **2** | 2.6 |

*Max 1* if answer given to > 3 s.f.

*If answer is incorrect* **ALLOW 1 mark for**

90−20/20

**ALLOW** 350%


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**Question 10 · AS Paper 2 · June 2024 · Q4(a)(i) · 1 mark**

| | | | |
|---|---|---|---|
| 4 | (a) | (i) | 3:1 / higher, collagen:elastin ratio, leads to, an aneurysm forming / a larger aneurysm ✓ |

| | |
|---|---|
| 1 | **IGNORE** as the aneurysm size increases the collagen:elastin ratio increases |

**Question 11 · A level Paper 3 · June 2018 · Q2(c)(i) · 1 mark**

| | | | | |
|---|---|---|---|---|
| c | i | 12.5 /13 (%) ✓ | 1 | • 16 carbon atoms in the fatty acid<br>• 2 carbon atoms in acetyl CoA (which enters the Krebs cycle)<br>• 2/16 x 100 = 12.5% |

**Question 12 · A level Paper 2 · June 2024 · Q21(c) · 2 marks**

| | | |
|---|---|---|
| 21 | (c) | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 116 (min) award 2 marks**<br>*calculate proportion of cells undergoing mitosis*<br>(16/124 =) 0.129 ✓<br>*calculate time represented by that proportion of cells, convert to minutes **and** answer to 3 significant figures*<br>(0.129 x 900 =) 116 min ✓ |

| | | |
|---|---|---|
| 2 | 2.5 | **ALLOW** 1 mark for 1.93 h or 1 h 56 min<br>**ALLOW** 1 mark for 0.129 or 12.9% |

**Question 13 · AS Paper 2 · June 2019 · Q5(b)(i) · 2 marks**

| | | | | |
|---|---|---|---|---|
| (b) | (i) | 40 ✓✓ | 2 | **Correct answer = 2 marks** even if no working shown.<br>**IGNORE** minus sign<br>**If answer is incorrect,** then **award 1 mark** for:<br>*dividing by end fig*: 66.6 (recurring) / 67<br>*calculating with 0.20 NaCl fig:* 81.5 / 82<br>*working:* (6.5 – 3.9) ÷ 6.5 x 100<br>**or**<br>2.6 ÷ 6.5 x 100 |


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**Question 14 · A level Paper 2 · June 2017 · Q18(b)(iii) · 3 marks**

| | | | |
|---|---|---|---|
| **(iii)** | clone C = 952 ± 2 ✓✓✓ | **3** | **ALLOW** 2 marks for any answer between 915 and 990<br>*If answer is incorrect*<br>**ALLOW** 1 mark for 700 (area of triangle)<br>and<br>**ALLOW 1** mark for 252 (area of rectangle) |

**Question 15 · A level Paper 2 · June 2019 · Q18(b)(i) · 1 mark**

| | | | | |
|---|---|---|---|---|
| **(b)** | **(i)** | 10 / 11 / 12 / 13 / 14 ✓ | **1** | **DO NOT CREDIT** if more than 2 s.f. |

**Question 16 · A level Paper 3 · June 2022 · Q2(b)(iii) · 1 mark**

| | | | | | |
|---|---|---|---|---|---|
| **2** | **(b)** | **(iii)** | (-log 0.00002 =) 4.7 ✓ | **1** | 2.2 |

**This mark is for a correct calculation**, therefore **ALLOW ECF** from part (ii) if the pH value calculated is given to 2 sig figs, even if outside the normal pH range, including correctly calculated negative values

**Question 17 · A level Paper 2 · June 2023 · Q16(d) · 2 marks**

| | | | | | | |
|---|---|---|---|---|---|---|
| **16** | **(d)** | | **FIRST CHECK ON ANSWER LINE**<br>**If answer = 1024 award 2 marks**<br><br>number of combinations = $2^n$ ✓<br>$2^{10} = 1024$ ✓ | **2** | 2.2 | *If answer is incorrect*<br><br>**ALLOW** 1 mark for 512 or 2048 or 1000 |

| Question | Answer | Marks | AO element | Guidance |
|---|---|---|---|---|

**Question 18 · A level Paper 3 · June 2018 · Q4(c)(ii) · 2 marks**

| | | |
|---|---|---|
| **ii** | $10^{3.61}$ ✓ ✓ | **2** |

**ALLOW** 4096 /3.61/ 3.612 for 1 mark

**ALLOW** $10^{3.612}$ for 2 marks


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