AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level BIOLOGY

Paper 2

Time allowed: 2 hours

Materials

For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 91.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

Answer **all** questions in the spaces provided.

Do not write outside the box

0 1 . 1 In the following passage the numbered spaces can be filled with biological terms.

During photosynthesis, plants produce ____(1)____ compounds which contain carbon, such as carbohydrates, lipids and proteins. Most of the sugars synthesised by plants are used by the plant in ____(2)____. The rest are used to make other groups of biological molecules. These biological molecules form the biomass of the plants. Biomass can be measured in terms of mass of ____(3)____ per given area per given time. The chemical energy store in dry biomass can be estimated using ____(4)____.

Write the correct biological term beside each number below, that matches the space in the passage.

[2 marks]

(1) _____

(2) _____

(3) _____

(4) _____

Do not write outside the box

0 1 . 2 Describe the **light-independent** reaction of photosynthesis.

[6 marks]

8

Do not write outside the box

0 2 . 1 Put a tick (✓) in the box next to the equation that shows how the net production of consumers, *N*, can be calculated where
I represents the chemical energy store in ingested food
F represents the chemical energy lost to the environment in faeces and urine
R represents the respiratory losses to the environment.

[1 mark]

$N = (I - F) + R$ ☐

$N = I - (F + R)$ ☐

$N = I + (F + R)$ ☐

$N = I - (F - R)$ ☐

In the UK, some female cattle are only used for breeding. This female breeding herd has dairy cows and beef cows.

Table 1 shows data on dairy cows and beef cows in the UK female breeding herd in December 2013 and December 2017.

Table 1

Date	Total number in female breeding herd / millions	Percentage of total female breeding herd	
		Dairy cows	Beef cows
December 2013	3.35	54	46
December 2017	3.45	55	45

Do not write outside the box

0 2 . 2 In December 2017, the female breeding herd was 48% of all female cattle in the UK. Use **Table 1** to calculate the percentage of all female cattle that were beef cows in the UK in December 2017.

[1 mark]

Answer _____ %

0 2 . 3 Use **Table 1** to calculate the increase in the number of dairy cows in the UK female breeding herd between December 2013 and December 2017.

Show your working.

[2 marks]

Increase in number _____

0 2 . 4 Farming cattle for humans to eat is less efficient than farming crops because of energy transfer.
Explain why.

[2 marks]

_____

_____

_____

_____

_____

_____

_____

_____

6

Do not write outside the box

0 3 Nitrogen-fixing bacteria such as *Azotobacter chroococcum* use the enzyme nitrogenase to produce ammonia from nitrogen gas in the air. *A. chroococcum* can use ammonium chloride as a direct source of ammonia. When a source of ammonia is not available this bacterium uses nitrogen fixation.

A scientist investigated the effect of an increase in the concentration of ammonium chloride on the activity of nitrogenase in this bacterium. He prepared several liquid medium cultures of the bacterium. Each liquid culture had the same volume. He grew each culture in a different concentration of ammonium chloride.

In each culture:

- he recorded the nitrogenase activity in arbitrary units
- he removed the bacteria and then recorded the concentration of ammonium chloride remaining in each liquid medium.

Table 2 shows the scientist's results.

Table 2

Concentration of ammonium chloride / µg cm^{-3}	**Nitrogenase activity / arbitrary units**	**Concentration of ammonium chloride remaining in liquid medium / µg cm^{-3}**
0	45	0
20	30	0
40	17	0
60	7	0
80	0	6
100	0	14
120	0	20

0 3 . 1 Apart from temperature and pH, give **two** variables the scientist would have controlled when **preparing** the liquid medium cultures.

[2 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

Do not write outside the box

0 3 . 2 A student concluded that this investigation showed that ammonia inhibits nitrogenase activity in nitrogen-fixing bacteria. Use all the information to evaluate the student's conclusion.

[3 marks]

0 3 . 3 Nitrogenase catalyses the reduction of nitrogen during nitrogen fixation. The reaction requires 16 molecules of ATP for each molecule of nitrogen that is reduced.
When ammonia inhibits nitrogenase activity, nitrogen-fixing bacteria may benefit.
Explain how.

[2 marks]

7

Do not write outside the box

0 4 . 1 Put a tick (✓) in the box next to the process that occurs in anaerobic respiration but does **not** occur in aerobic respiration.

[1 mark]

Phosphorylation of glucose ☐

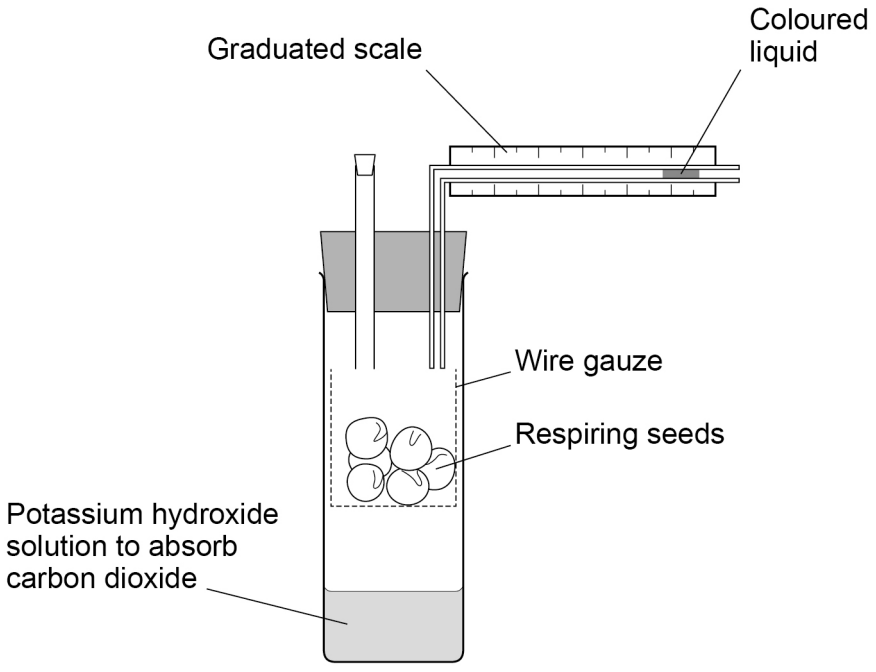
Reduction of NAD ☐

Reduction of pyruvate ☐

Substrate-level phosphorylation ☐

A student used the apparatus shown in **Figure 1** to measure the rate of aerobic respiration of seeds for 48 hours.

Figure 1



Do not write outside the box

0 4 . 2 During the 48 hours, the coloured liquid moved to the left.

Explain why.

[3 marks]

0 4 . 3 Apart from time, give **two** measurements the student would have to make to determine the rate of aerobic respiration of these seeds in cm^3 $hour^{-1}$

[2 marks]

1 _____

_____

2 _____

_____

Question 4 continues on the next page

Do not write outside the box

0 4 . 4 The student used the same apparatus to determine the volume of carbon dioxide the seeds produced during 48 hours.

Give the change the student would need to make to the contents of the apparatus **and** describe how he could calculate the volume of carbon dioxide produced.

[3 marks]

0 4 . 5 The student calculated that during the 48 hours, 6.2×10^{-4} cm^3 of oxygen was absorbed by 40 g of seeds.

Calculate the oxygen uptake in $cm^3\,g^{-1}\,hour^{-1}$

[1 mark]

Answer _____ $cm^3\,g^{-1}\,hour^{-1}$

10

Do not write outside the box

Turn over for the next question

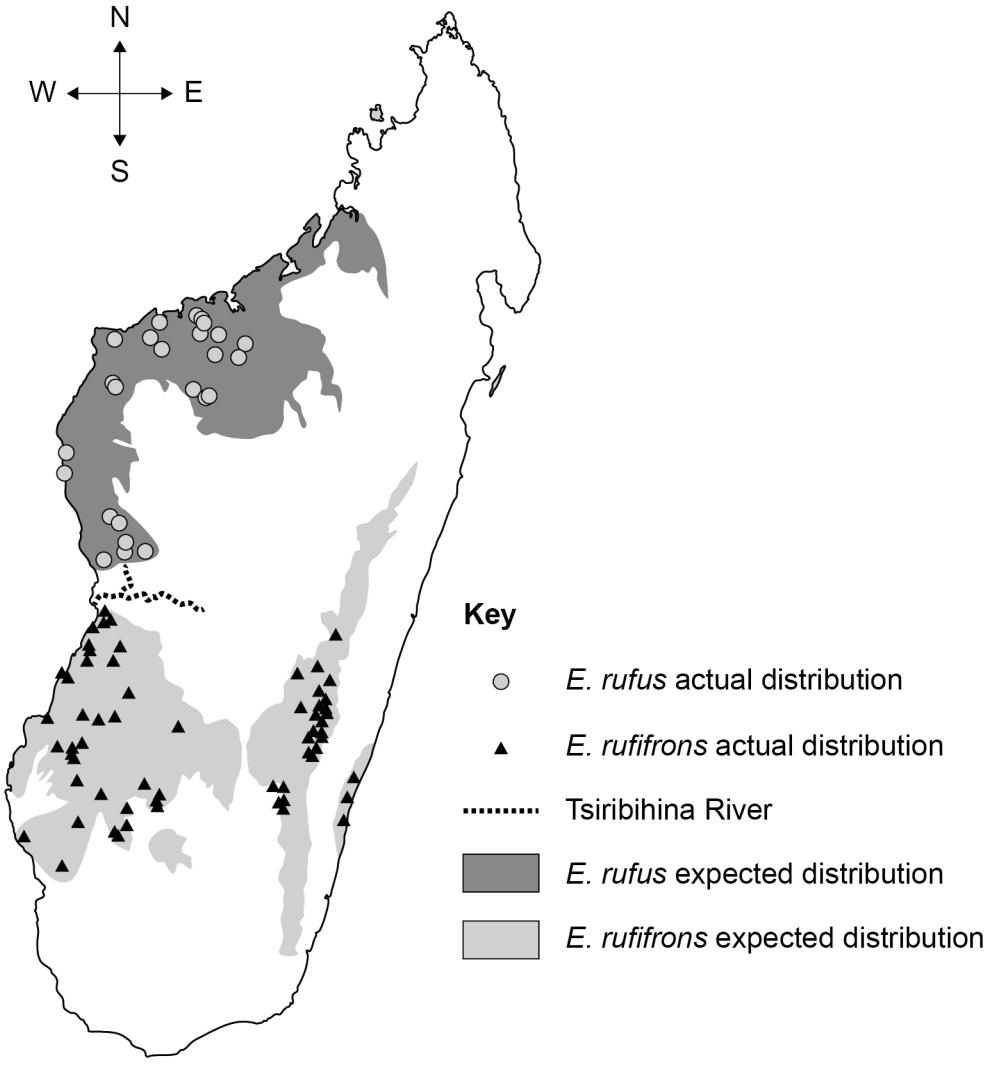
DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 5 Lemurs are small mammals. Lemurs live in trees and feed on leaves and fruit. Scientists used a computer program to predict the expected distribution of two species of lemur, *Eulemur rufus* and *Eulemur rufifrons,* on the island of Madagascar. These predictions were based on the environmental needs of each species.
Then, the scientists determined the actual distribution of these two species of lemur on the island of Madagascar.

Figure 2 shows the scientists' results.

Figure 2



Do not write outside the box

0 5 . 1 Using **Figure 2**, give **three** conclusions you can make about the distribution of these lemur species.

[3 marks]

1 _____

2 _____

3 _____

0 5 . 2 Using all the information, suggest how speciation happened to produce two species of lemur.

[5 marks]

Question 5 continues on the next page

Do not write outside the box

The scientists used the mark-release-recapture method to determine the number of lemurs in one area of forest. They captured, marked and released a first sample of 30 lemurs. A week later, they captured a second sample of 25 lemurs from the same area of forest. The scientists calculated that there were 250 lemurs in that area of forest.

0 5 . 3 Suggest **one** precaution needed when marking the lemurs to make sure the estimate of the number of lemurs is valid.

[1 mark]

0 5 . 4 Using the information provided, calculate how many lemurs in the second sample were marked.

[1 mark]

Answer _____

10

Do not write outside the box

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 6 In humans, the ABO blood groups and Rhesus blood groups are under genetic control. The inheritance of the ABO blood groups is controlled by three alleles of a single gene, I^A, I^B and I^O. The alleles I^A and I^B are codominant, and the allele I^O is recessive to I^A and recessive to I^B.

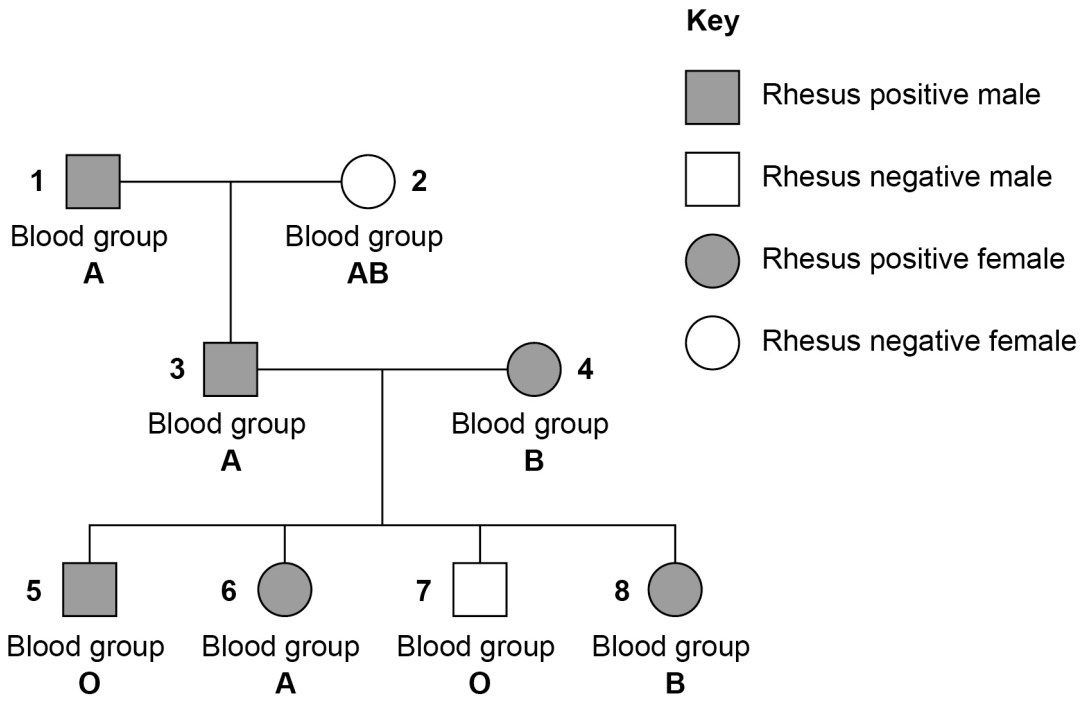
There are four ABO phenotypes, **A**, **B**, **AB** and **O**.

The gene for the Rhesus blood groups has two alleles. The allele for Rhesus positive, **R**, is dominant to the allele for Rhesus negative, **r**.

The genes for the ABO and Rhesus blood groups are **not** sex-linked and are **not** on the same chromosome.

Figure 3 shows the phenotypes in a family tree for the ABO and Rhesus blood groups.

Figure 3



0 6 . 1 Give the genotypes of the ABO blood groups for individuals **1** and **2**.

Do **not** include the genotypes for the Rhesus blood groups in your answer.

[1 mark]

1 _____

2 _____

Do not write outside the box

0 6 . 2 Explain **one** piece of evidence from **Figure 3** that the allele for Rhesus positive is dominant.

[2 marks]

0 6 . 3 Calculate the probability of individuals **1** and **2** producing a Rhesus positive son with blood group **A** (individual **3**). You can assume that individual **1** is heterozygous for the Rhesus blood group.

Show your working.

[2 marks]

Probability _____

Scientists determined the frequencies of the ABO alleles and ABO phenotypes in a large population. They then used a statistical test to determine if the frequencies of the four phenotypes differed significantly from the frequencies expected according to the Hardy–Weinberg equation.

0 6 . 4 The frequencies of the I^A and I^O alleles were 0.15 and 0.65. What is the frequency of the I^B allele?

[1 mark]

Frequency of I^B allele _____

Do not write outside the box

0 6 . 5 Name the statistical test you should use to determine if the observed frequencies of the four phenotypes differed significantly from the frequencies expected according to the Hardy–Weinberg equation.

State how many degrees of freedom should apply.

[2 marks]

Statistical test _____

Number of degrees of freedom _____

0 6 . 6 The scientists concluded that the observed frequencies of the four phenotypes differed significantly from the expected frequencies. Use your knowledge of the Hardy–Weinberg principle to suggest **two** reasons why.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

10

Do not write outside the box

0 7 . 1 Give **two** reasons why transmission across a cholinergic synapse is unidirectional.

[2 marks]

1 _____

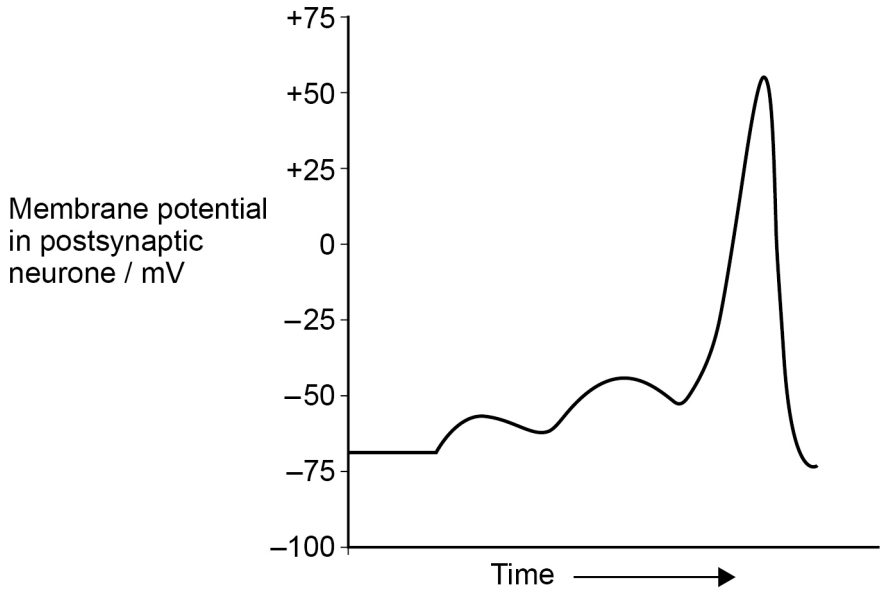
_____

2 _____

_____

Figure 4 shows the changes in membrane potential in a postsynaptic neurone after repeated stimulation from a single presynaptic neurone.

Figure 4



0 7 . 2 Name and explain the type of summation shown in **Figure 4**.

[2 marks]

Type of summation _____

Explanation _____

_____

_____

Question 7 continues on the next page

Do not write outside the box

Myasthenia gravis (MG) is an autoimmune disease caused when antibodies bind to the sarcolemma (postsynaptic membrane) of neuromuscular junctions. This can weaken contraction of muscles.

Mestinon is a drug that inhibits the enzyme acetylcholinesterase. Mestinon can help in the treatment of MG.

0 7 . 3 Suggest and explain how MG can weaken contraction of muscles.

Do **not** include details of myofibril or muscle contraction in your answer.

[2 marks]

0 7 . 4 Mestinon can help in the treatment of MG. Explain how.

[3 marks]

9

Do not write outside the box

0 8 Scientists investigated the production of laboratory rats with the characteristics of type II diabetes. The scientists used the following method.

- They divided the rats into two groups, **A** and **B**, and fed them different diets for 2 weeks.
- They fed the rats in group **A** the normal diet containing 12% fat.
- They fed the rats in group **B** a high-fat diet containing 56% fat.
- After 2 weeks, they injected both groups of rats with 35 mg kg^{-1} of the drug streptozotocin (STZ) to induce diabetes.
- 1 week later, the scientists determined the mean body mass and mean blood glucose concentration for each group.

Table 3 shows the results.

Table 3

A value of ± 2 × SD from the mean includes over 95% of the data.

Group	Mean body mass / g (± 2 × SD)	Mean blood glucose concentration / mg dm^{-3} (± 2 × SD)
A	221.07 (± 3.28)	129.41 (± 8.34)
B	233.34 (± 5.73)	385.02 (± 7.75)

0 8 . 1 Calculate how many grams of STZ should be injected into a rat with a mass of 230.45 g. Show your working.

Give your answer in standard form.

[2 marks]

Answer _____ g

0 8 . 2 Suggest and explain why STZ was injected per unit of body mass.

[1 mark]

_____

_____

_____

Turn over ►

Do not write outside the box

0 8 . 3 The scientists concluded that group **B** rats could be used for studying type II diabetes in humans.

Use all the information and your knowledge of type II diabetes to evaluate this conclusion.

[5 marks]

Do not write outside the box

0 8 . 4 The scientists repeated the investigation using much higher doses of STZ. This led to destruction of pancreatic cells. The scientists concluded that these rats would **not** be suitable for studying type II diabetes.

Give **two** reasons why the scientists made this conclusion.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

10

Turn over for the next question

Do not write outside the box

0 9 . 1 Name the part of the body which releases antidiuretic hormone (ADH) into the blood.

[1 mark]

0 9 . 2 Alcohol decreases the release of ADH into the blood.

Suggest **two** signs or symptoms which may result from a decrease in ADH.

[2 marks]

1

2

0 9 . 3 Describe the effect of ADH on the collecting ducts in kidneys.

[3 marks]

6

Do not write outside the box

1 0 Read the following passage.

BRCA1 and *BRCA2* are human genes that code for tumour suppressor proteins. Mutations in *BRCA1* and *BRCA2* can cause cancer. Specific inherited mutations in these genes increase the risk of female breast cancers and ovarian cancers and have been associated with increased risks of several other types of cancer. Genetic testing, using DNA from saliva, can screen for all known harmful mutations in both genes.

ER-positive breast cancers have receptors for the hormone oestrogen. These cancers develop as a result of increased oestrogen concentrations in the blood. Effective treatment of ER-positive breast cancers often involves the use of drugs which have a similar structure to oestrogen.

Blood tests can be used to test for cancers. Men with prostate cancer have a high concentration of prostate-specific antigen (PSA) in their blood. Urinary infections and a naturally enlarged prostate can also increase concentrations of PSA.

Recent research has indicated that several cancers result from epigenetic abnormalities. Treatment with drugs might be able to reverse the epigenetic changes that cause cancers.

Use the information in the passage and your own knowledge to answer the following questions.

1 0 . 1 *BRCA1* and *BRCA2* are human genes that code for tumour suppressor proteins. Mutations in *BRCA1* and *BRCA2* can cause cancer (lines 1–2). Explain how.

[3 marks]

Question 10 continues on the next page

Do not write outside the box

1 0 . 2 Genetic testing, using DNA from saliva, can screen for all known harmful mutations in both genes (lines 5–6). Describe how this DNA could be screened for all known harmful mutations in both genes.

[4 marks]

1 0 . 3 Effective treatment of ER-positive breast cancers often involves the use of drugs which have a similar structure to oestrogen (lines 9–10).

Suggest and explain how these drugs are an effective treatment of ER-positive breast cancers.

[3 marks]

Do not write outside the box

1 0 . 4 Blood tests can be used to test for cancers (line 11). However, the results of blood tests may **not** be conclusive when testing for prostate cancer. Explain why.

[2 marks]

1 0 . 5 Treatment with drugs might be able to reverse the epigenetic changes that cause cancers (lines 16–17). Suggest and explain how.

[3 marks]

15

END OF QUESTIONS

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

Do not write outside the box

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

Copyright information

For confidentiality purposes, all acknowledgements of third-party copyright material are published in a separate booklet. This booklet is published after each live examination series and is available for free download from www.aqa.org.uk.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team.

Copyright © 2022 AQA and its licensors. All rights reserved.