Helicate

HELICATE · AS AND A-LEVEL BIOLOGY · TOPIC BANK

3.1.6 ATP

Topic question bank

Version 3 · 9 October 2026

Name

Date

QUESTIONS	TOTAL MARKS	TIME	YOUR SCORE
8	51	No time limit	/ 51

Contents

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Total		**51**

Instructions

- Answer the questions in the spaces provided. Show all your working.
- The marks for each question are shown in brackets. Use them to judge how much detail to give.
- Work through a subtopic at a time, then mark your answers with the matching mark scheme.

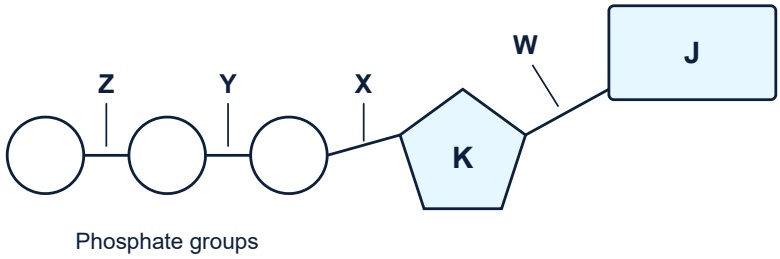
Original questions by Helicate for AQA AS and A-level Biology (7401/7402), specification section 3.1.6. Not affiliated with or endorsed by AQA.

Do not write outside the box

Structure of ATP 3.1.6

Figure 1 is a simple diagram of one ATP molecule. Two of its components are labelled **J** and **K**. Four bonds are labelled **W**, **X**, **Y** and **Z**.

Figure 1



0 1 . 1 Name components **J** and **K**.

[2 marks]

J .....

K .....

0 1 . 2 ATP hydrolase converts ATP into ADP and inorganic phosphate (Pi).
Which bond in Figure 1 is broken in this reaction?
Tick (✓) one box.

[1 mark]

W ☐

X ☐

Y ☐

Z ☐

Question 1 continues on the next page

Do not write outside the box

0 1 . 3 ATP is described as a nucleotide derivative.
Give **two** ways in which the structure of a molecule of ATP is different from the structure of a DNA nucleotide that contains adenine.

[2 marks]

1 .....

.....

2 .....

.....

An adult human contains about 50 g of ATP at any one time. During one day, the same person hydrolyses about 60 kg of ATP. The mass of ATP in the body stays about the same during the day.

0 1 . 4 Calculate the mean number of times each molecule of ATP is resynthesised from ADP and Pi in one hour.

[2 marks]

.....

.....

.....

.....

Answer ..... **times per hour**

7

Turn over for the next question

Do not write outside the box

Hydrolysis of ATP, coupling and phosphorylation 3.1.6

Cells make the amino acid glutamine from glutamate and ammonia. This reaction requires energy.

In cells, enzyme G catalyses the formation of glutamine and couples it to the hydrolysis of ATP. The reaction takes place in two steps.

Step 1 glutamate + ATP → glutamyl phosphate + ADP
Step 2 glutamyl phosphate + ammonia → glutamine + Pi

In step 1, a phosphate group from ATP is attached to glutamate.

0 2 . 1 Which statement describes what is meant by coupling the formation of glutamine to the hydrolysis of ATP?
Tick (✓) one box.

[1 mark]

Energy released by the hydrolysis of ATP is used in the energy-requiring formation of glutamine. ☐

Energy released by the formation of glutamine is used to resynthesise ATP from ADP and Pi. ☐

ATP is hydrolysed and resynthesised during the same reaction. ☐

Glutamine is formed by the hydrolysis of glutamate and ammonia. ☐

0 2 . 2 Explain how step 1 helps glutamine to form in step 2.

[2 marks]

Question 2 continues on the next page

Do not write outside the box

Under standard conditions:

- hydrolysis of 1 mol of ATP releases 30.5 kJ of energy
- formation of 1 mol of glutamine from glutamate and ammonia requires 14.2 kJ of energy.

0 2 . 3 Calculate the percentage of the energy released by the hydrolysis of ATP that is used to form glutamine.
Give your answer to **two** significant figures.

[2 marks]

.....

.....

.....

.....

Answer ..... **%**

5

Turn over for the next question

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Enzyme M is found in liver cells. Scientists investigated how enzyme M is switched on. They incubated enzyme M for 10 minutes in four tubes, **A** to **D**, then measured its activity. Enzyme T is another enzyme from liver cells.

Table 1 shows their results.

Table 1

Tube	Contents	Activity of enzyme M / arbitrary units
A	Enzyme M + enzyme T + ADP	4
B	Enzyme M + enzyme T + ATP	96
C	Enzyme M + ATP	5
D	Altered enzyme M + enzyme T + ATP (one particular amino acid replaced by an amino acid that phosphate cannot attach to)	6

When a phosphate group is attached to a protein, the phosphate group carries a negative charge.

0 3 Use Table 1 and your knowledge of ATP and of enzymes to explain the results.

[5 marks]

5

Turn over for the next question

Do not write outside the box

Donated blood is stored at 4 °C for up to 42 days before it is used. The storage solution contains glucose.

Red blood cells have no mitochondria. They resynthesise ATP by anaerobic respiration of glucose in the cytoplasm.

Red blood cells keep a higher concentration of potassium ions inside the cell than outside. They do this using a carrier protein in the cell-surface membrane. This carrier protein is also an ATP hydrolase.

Scientists measured the concentration of ATP in stored red blood cells, and the concentration of potassium ions in the storage solution. Table 2 shows their results.

Table 2

Storage time / days	ATP in red blood cells / μmol g^{-1} haemoglobin	Potassium ions in storage solution / mmol dm^{-3}
0	4.4	1.2
7	4.6	12.4
14	4.3	21.9
21	3.9	29.6
28	3.4	35.8
35	3.0	41.0
42	2.6	45.3

0 4 . 1 Explain how the carrier protein keeps the concentration of potassium ions inside fresh red blood cells higher than in the solution around them.

[4 marks]

Question 4 continues on the next page

Do not write outside the box

0 4 . 2 Calculate the mean rate of increase in the concentration of potassium ions in the storage solution during the first 7 days of storage.
Give your answer to **two** significant figures and give the unit.

[2 marks]

Answer .....

Unit .....

0 4 . 3 A scientist concluded that the fall in ATP concentration in the red blood cells causes the increase in the concentration of potassium ions in the storage solution.
Evaluate this conclusion.

[3 marks]

9

Turn over for the next question

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Resynthesis of ATP 3.1.6

0 5 Complete Table 3 to compare the hydrolysis of ATP with the resynthesis of ATP.

[3 marks]

Table 3

	ATP → ADP + Pi	**ADP + Pi → ATP**
Type of reaction		
Name of enzyme		
Water used or released?		

3

Turn over for the next question

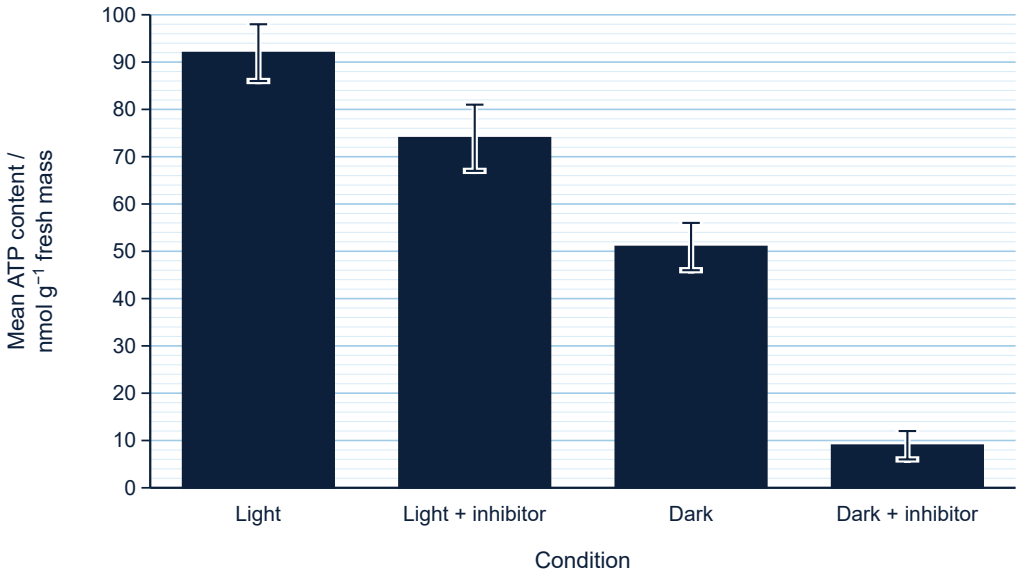
Do not write outside the box

Scientists cut discs from the leaves of pea plants and placed them in a buffer solution. They divided the discs into four groups. They kept each group for 30 minutes in one of these conditions:

- light
- light, with a respiratory inhibitor added
- dark
- dark, with a respiratory inhibitor added.

They then extracted the ATP from 5 samples of discs from each group and calculated the mean ATP content. Figure 2 shows their results. The error bars show ± 1 standard deviation.

Figure 2



0 6 . 1 Explain why the leaf discs kept in the dark with the respiratory inhibitor had the lowest ATP content.

[2 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 2 Calculate the percentage decrease in the ATP content of leaf discs in the light caused by the respiratory inhibitor.

[2 marks]

Answer ..... **%**

The scientists dissolved the respiratory inhibitor in a small volume of ethanol before adding it to the buffer solution.

0 6 . 3 Describe a control the scientists should use for the effect of the inhibitor.

[1 mark]

0 6 . 4 A student concluded that, in the light, most of the ATP in leaf cells is resynthesised during photosynthesis rather than during respiration. Evaluate this conclusion.

[3 marks]

8

Turn over for the next question

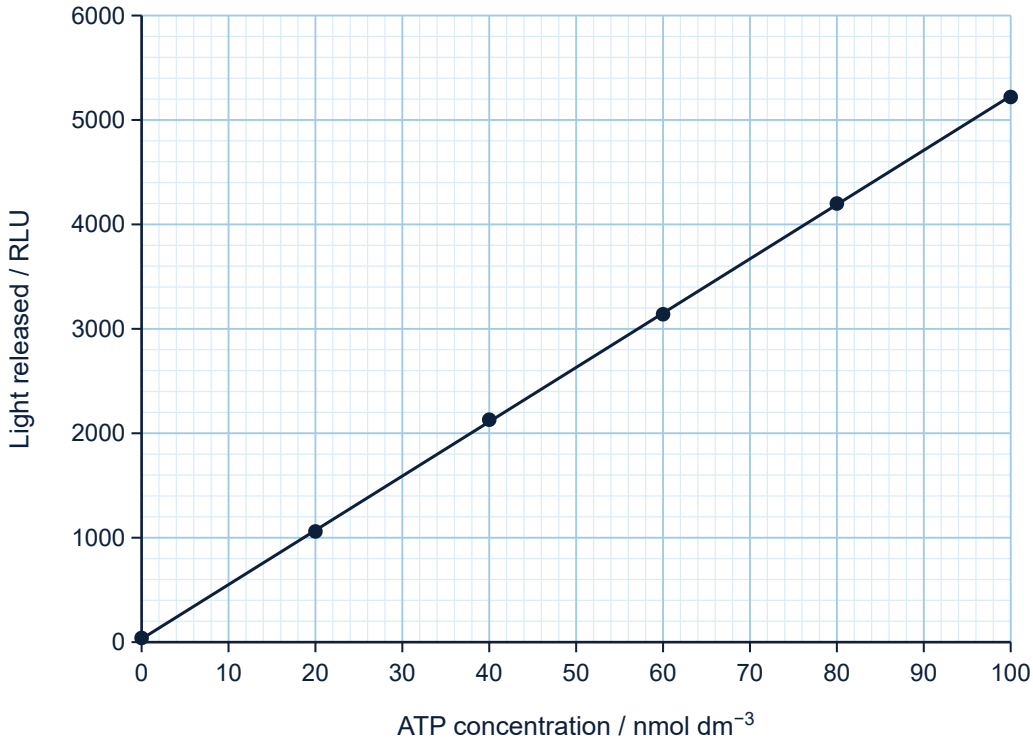
Do not write outside the box

Measuring ATP: an unfamiliar practical 3.1.6 (PS 1.2, 2.4)

Luciferase is an enzyme from fireflies. It catalyses a reaction between ATP and a substrate called luciferin. This reaction releases light. A luminometer measures the light released in relative light units (RLU).

A student added luciferase and luciferin, both in excess, to standard solutions of ATP of known concentrations. She measured the light released at 25 °C. Figure 3 shows her results and a line of best fit.

Figure 3



0 7 . 1 Explain why the student added luciferase and luciferin in excess.

[2 marks]

Question 7 continues on the next page

Do not write outside the box

The student then measured the ATP concentration in yeast cells. She:

- added a sample of yeast suspension to boiling water for 2 minutes
- cooled and filtered the mixture to give an extract
- diluted the extract by mixing 1 cm^3 of extract with 19 cm^3 of distilled water
- added excess luciferase and luciferin to the diluted extract at 25 °C.

The light released from the diluted extract was 2630 RLU.

0 7 . 2 Use Figure 3 to calculate the concentration of ATP in the undiluted extract.
Give your answer in mol dm^{-3} in standard form.

[3 marks]

Answer ..... **mol dm^{-3}**

0 7 . 3 Boiling water denatures enzymes.
Suggest why this step is important when measuring the ATP concentration of yeast cells.

[1 mark]

0 7 . 4 Suggest why the student diluted the extract before measuring the light released.

[1 mark]

Question 7 continues on the next page

Do not write outside the box

0 7 . 5 Suggest why the student measured the light released from the standard solutions and from the diluted extract at the same temperature.

[1 mark]

.....

.....

.....

8

Turn over for the next question

Do not write outside the box

The student wanted to use the luciferase method to investigate the effect of temperature on the activity of ATP hydrolase.

She was given:

- ATP solution
- ATP hydrolase solution
- buffer solution
- luciferase and luciferin
- a luminometer and her calibration curve.

0 8 Describe how the student could carry out this investigation.
Include how she would process her results to compare the activity of ATP hydrolase at different temperatures.

[6 marks]

6

END OF QUESTIONS

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