A

AQA

Surname _____

Other Names _____

Centre Number _____

Candidate Number _____

Candidate Signature _____

A-level
BIOLOGY

Paper 3

7402/3

Monday 17 June 2019 **Morning**

Time allowed: 2 hours

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

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

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INSTRUCTIONS

- **Use black ink or black ball-point pen.**
- **Answer ALL questions in SECTION A.**
- **Answer ONE question from SECTION B.**
- **You must answer the questions in the spaces provided. Do not write on blank pages.**
- **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 78.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

SECTION A

Answer ALL questions in this section.

You are advised to spend no more than one hour and 15 minutes on this section.

0 1 . 1 Describe how ultrafiltration occurs in a glomerulus. [3 marks]

[Turn over]

0 1 . 2 Glucose and water are reabsorbed by the proximal convoluted tubule of a nephron.

Put a tick (✓) in the box next to the correct ways in which glucose and water are reabsorbed. [1 mark]

- ☐ **Glucose by active transport and water against a water potential gradient**
- ☐ **Glucose by diffusion and water down a water potential gradient**
- ☐ **Glucose by facilitated diffusion and active transport and water against a water potential gradient**
- ☐ **Glucose by facilitated diffusion and active transport and water down a water potential gradient**

0 1 . 3 **The equation shows the relationship between urine concentration in arbitrary units (y) and mean length of the loop of Henle in mm (x).**

$$y = 0.72x + 4$$

Calculate the mean length of the loop of Henle in an organism that produces urine with a concentration of 16.56 arbitrary units. [1 mark]

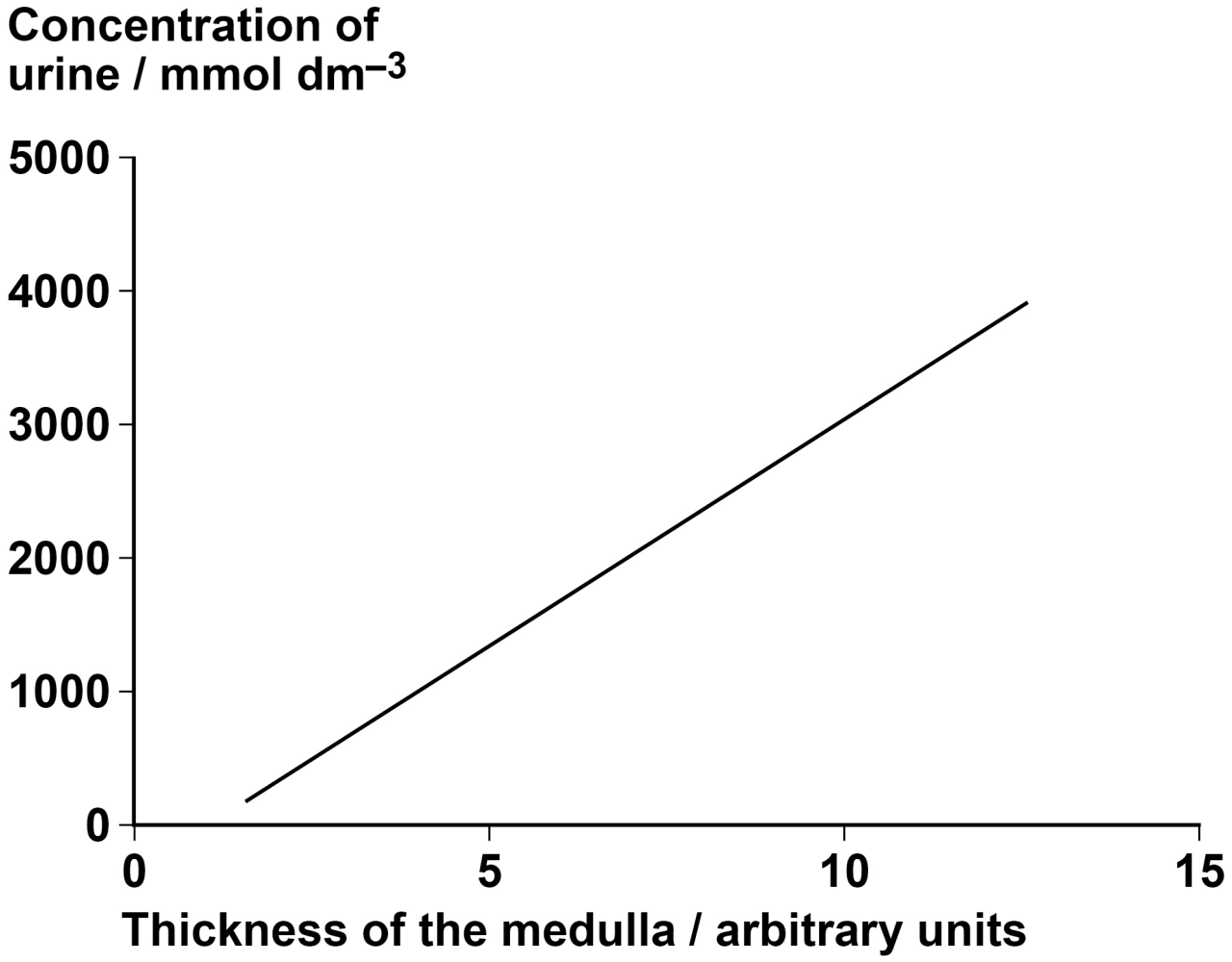
Answer = _____ mm

[Turn over]

0 1 . 4 **Scientists investigated the relationship between the thickness of the kidney medulla of different species of mammals and the concentration of their urine.**

FIGURE 1 shows their results.

FIGURE 1



Explain the pattern shown by the results in FIGURE 1. [3 marks]

8

0 2 . 1 **Describe the role of saprobionts in the nitrogen cycle. [2 marks]**

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[Turn over]

0 2 . 2 **One environmental issue arising from the use of fertilisers is eutrophication.**
Eutrophication can cause water to become cloudy.

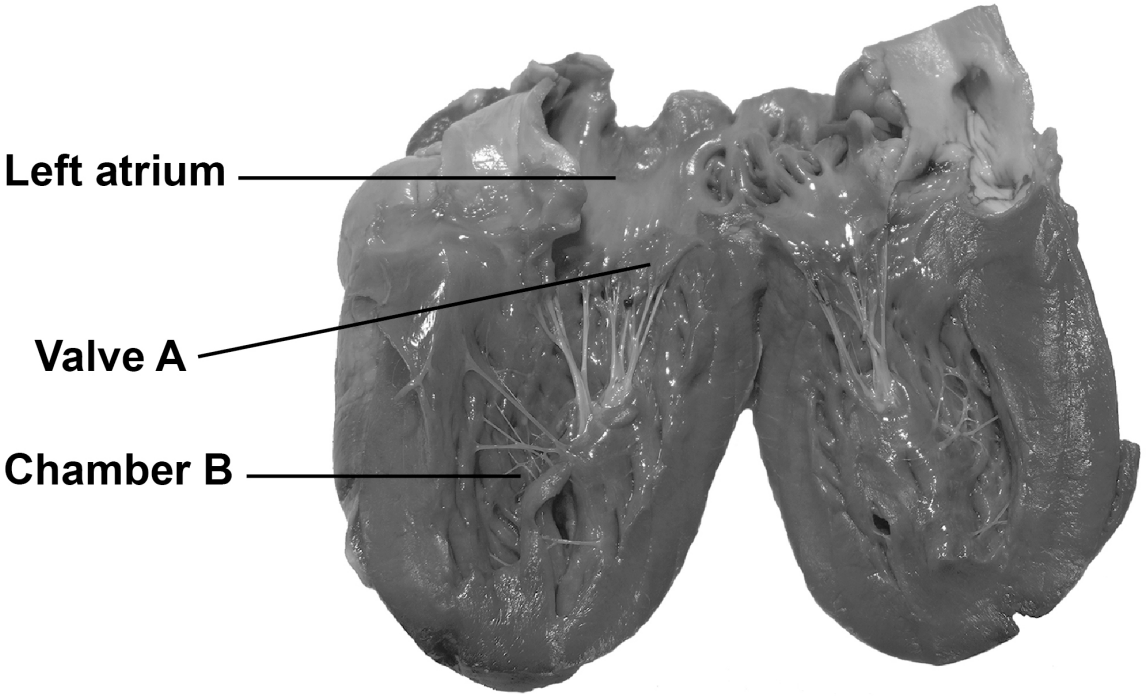
You are given samples of water from three different rivers.

Describe how you would obtain a quantitative measurement of their cloudiness. [3 marks]

5

0 3 **FIGURE 2 shows a photograph of a dissected heart.**

FIGURE 2



0 3 . 1 **Name valve A and chamber B. [1 mark]**

Valve A

Chamber B

0 3 . 2 **Give TWO safety precautions that should be followed when dissecting a heart. [1 mark]**

1 _____

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2 _____

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[Turn over]

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0 3 . 3 **Explain how valve A in FIGURE 2, on page 14, maintains a unidirectional flow of blood.**
[2 marks]

A research scientist investigated the effect of caffeine on heart rate in human volunteers.

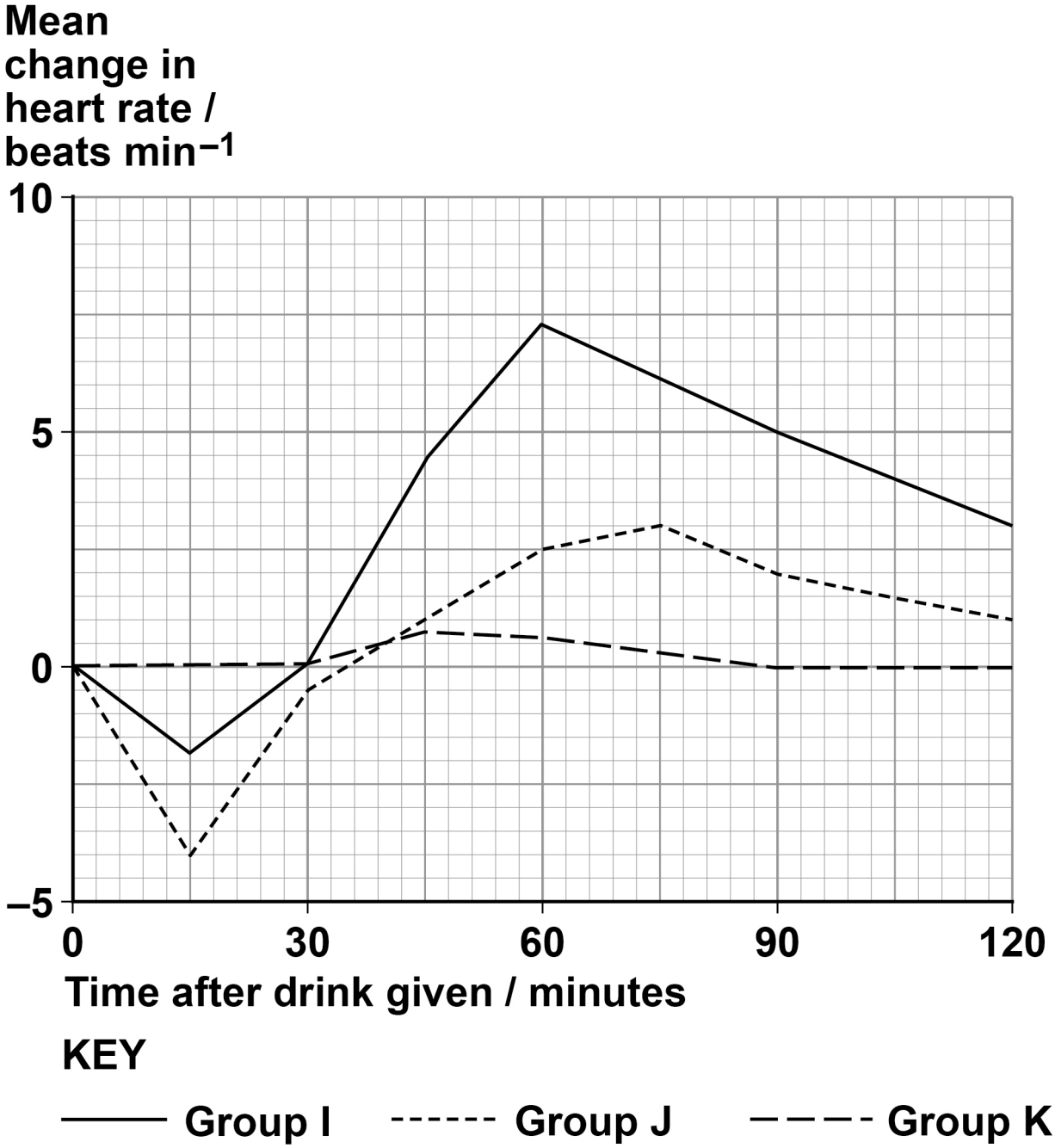
The scientist divided volunteers into three groups. Each group was given the same volume of fluid.

- **Each member of Group I was given a sports drink containing caffeine and sugar.**
- **Each member of Group J was given a sports drink containing caffeine and no sugar.**
- **Each member of Group K was given water.**

The scientist recorded the volunteers' heart rate before the drink was given and for 120 minutes after the drink was given.

Her results can be seen in FIGURE 3.

FIGURE 3



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0 3 . 4 **Caffeine affects the autonomic nervous system.**

Suggest how caffeine could account for the results of Group I in FIGURE 3, on page 19, at 60 minutes. [2 marks]

0 3 . 5 **Before taking the drink, the mean heart rate of Group J was 68 beats per minute.**

Fifteen minutes after taking the drink, the mean volume of blood leaving the hearts of Group J was 4700 cm^3 per minute.

Calculate the mean volume of blood leaving the heart at each beat fifteen minutes after taking the drink. [1 mark]

Answer = _____ cm^3

0 3 . 6 **The increase seen in Group I could be due to the combination of caffeine and sugar.**

Suggest ONE drink to be given to an ADDITIONAL group that should be investigated to find out if this is true.

Give a reason for your answer. [2 marks]

Group to be given _____

Reason _____

0 4 **Mitochondrial DNA (mtDNA) is a small circular DNA molecule located in mitochondria. It is 16 569 nucleotides long and contains 37 genes and a control region.**

Sports scientists investigated whether a mutation in the control region of mtDNA in human males was related to an ability to exercise for longer.

- **The males in Group T had thymine at nucleotide position 16 519**
- **The males in Group C had a mutation resulting in cytosine at nucleotide position 16 519**

0 4 . 1 **The control regions of Group T and Group C were the same length.**

Name the type of gene mutation that is most likely to have occurred at nucleotide position 16 519 [1 mark]

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[Turn over]

Group T and Group C completed the same 8-week training programme. The following measurements were taken at the start of the 8-week programme, and again at the end.

1. **$VO_{2\ max}$ (a measure of maximal oxygen uptake).**
2. **Citrate synthase (CS) activity (CS is an enzyme involved in the Krebs cycle).**

The scientists then calculated the percentage increase in each measurement in both groups.

FIGURE 4 and FIGURE 5 show their results.

FIGURE 4

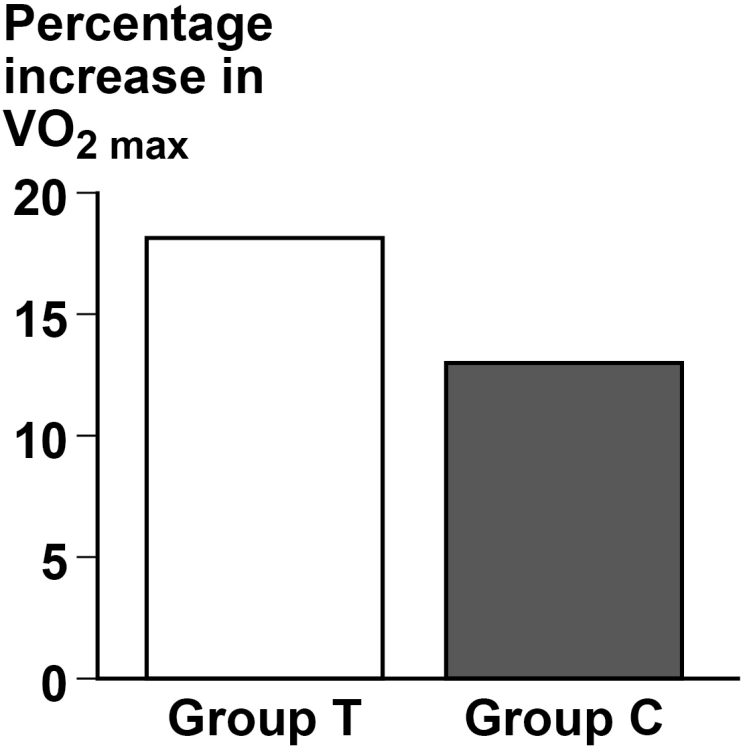
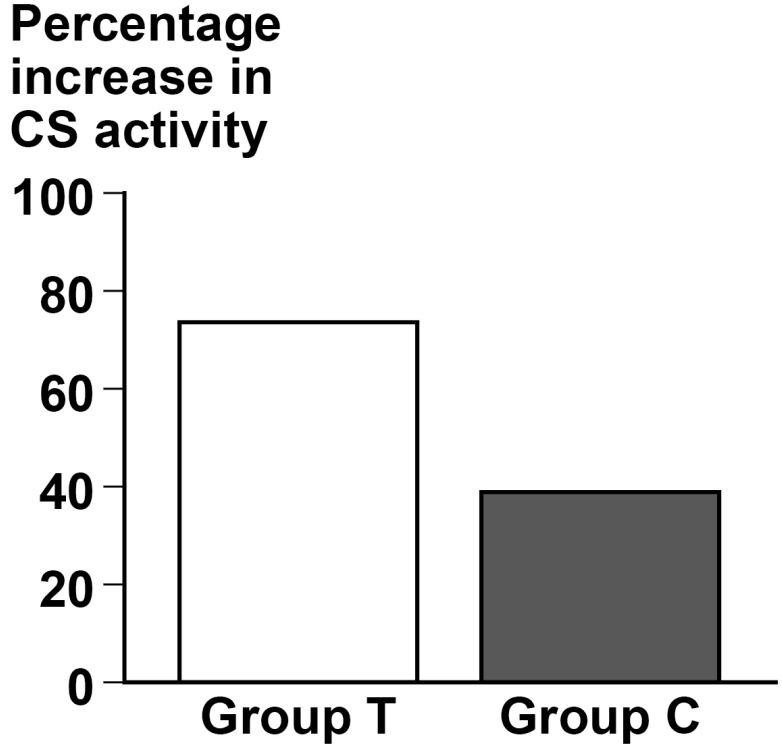


FIGURE 5



0 4 . 2 **A student concluded from FIGURE 4 and FIGURE 5 that training has a positive effect on $VO_{2\ max}$ and CS activity.**

Evaluate the student's conclusion. [3 marks]

0 4 . 3 **The mitochondrial DNA (mtDNA) control region is an area of mtDNA that is non-coding. This region stimulates the synthesis of both mtDNA and mitochondrial messenger RNA.**

Use this information to suggest TWO reasons why the mutation at nucleotide position 16 519 could lead to the differences seen in FIGURE 5, on page 27. [2 marks]

1 _____

_____

_____

_____

_____

2 _____

_____

_____

_____

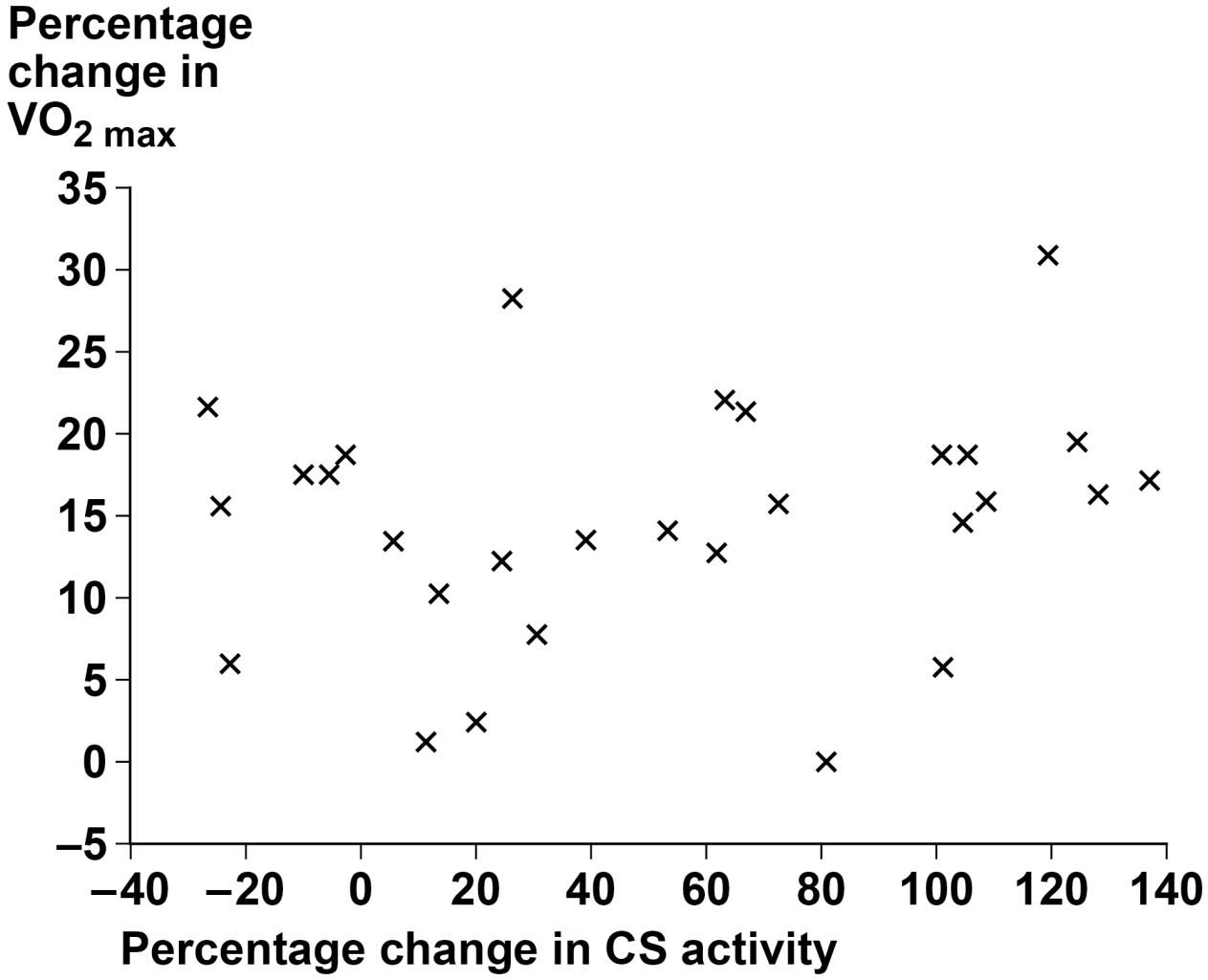
_____

[Turn over]

The sports scientists investigated whether there was a correlation between the percentage change in $VO_{2\ max}$ and percentage change in CS activity in Group T.

FIGURE 6 shows their results.

FIGURE 6



0 4 . 4 **‘Having thymine at nucleotide position 16 519 in Group T causes an increase in ability to exercise for longer.’**

Evaluate this conclusion.

Use ALL the data in this question. [3 marks]

9

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[Turn over]

0 5 **The crown-of-thorns starfish (COTS) is one of the main causes of the decline of the world's coral reefs.**

Marine biologists used a choice chamber to investigate the effects of flashing and constant light on the behaviour of COTS.

TABLE 1 shows their results as they presented them. The P values show results from a statistical test.

TABLE 1

Behaviour of COTS	Type of light used in choice chamber	
	Flashing	Constant
COTS moving towards the stimulus	22	12
COTS moving away from the stimulus	28	38
P value	0.69	0.02

0 5 . 1 **State a null hypothesis the marine biologists tested in this investigation. [1 mark]**

0 5 . 2 **The natural habitat of COTS is coral reefs of tropical oceans.**

Suggest TWO factors that should be kept constant in the choice chambers so that COTS display normal behaviour. [1 mark]

1

2

[Turn over]

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0 5 . 3 **A journalist studying TABLE 1, on page 34, suggested that EITHER type of light could be used to cause COTS to move away from coral reefs.**

Evaluate the journalist's suggestion. [3 marks]

0 5 . 4 One of the reasons COTS can destroy coral reefs in a short time is because COTS move quickly, allowing them to move from one reef to another.

TABLE 2 shows the maximum speeds recorded of COTS in constant light.

TABLE 2

Response to light	Maximum speed / mm min^{-1}
COTS moving towards constant light	259
COTS moving away from constant light	564

Calculate the shortest time one COTS would take to move up a coral reef from 66 m under water to 18 m under water in hours of daylight.

Give your answer to the nearest hour.
[2 marks]

Answer = _____ hours

[Turn over]

7

0 6 **Uncontrolled cell division can cause tumours to form.**

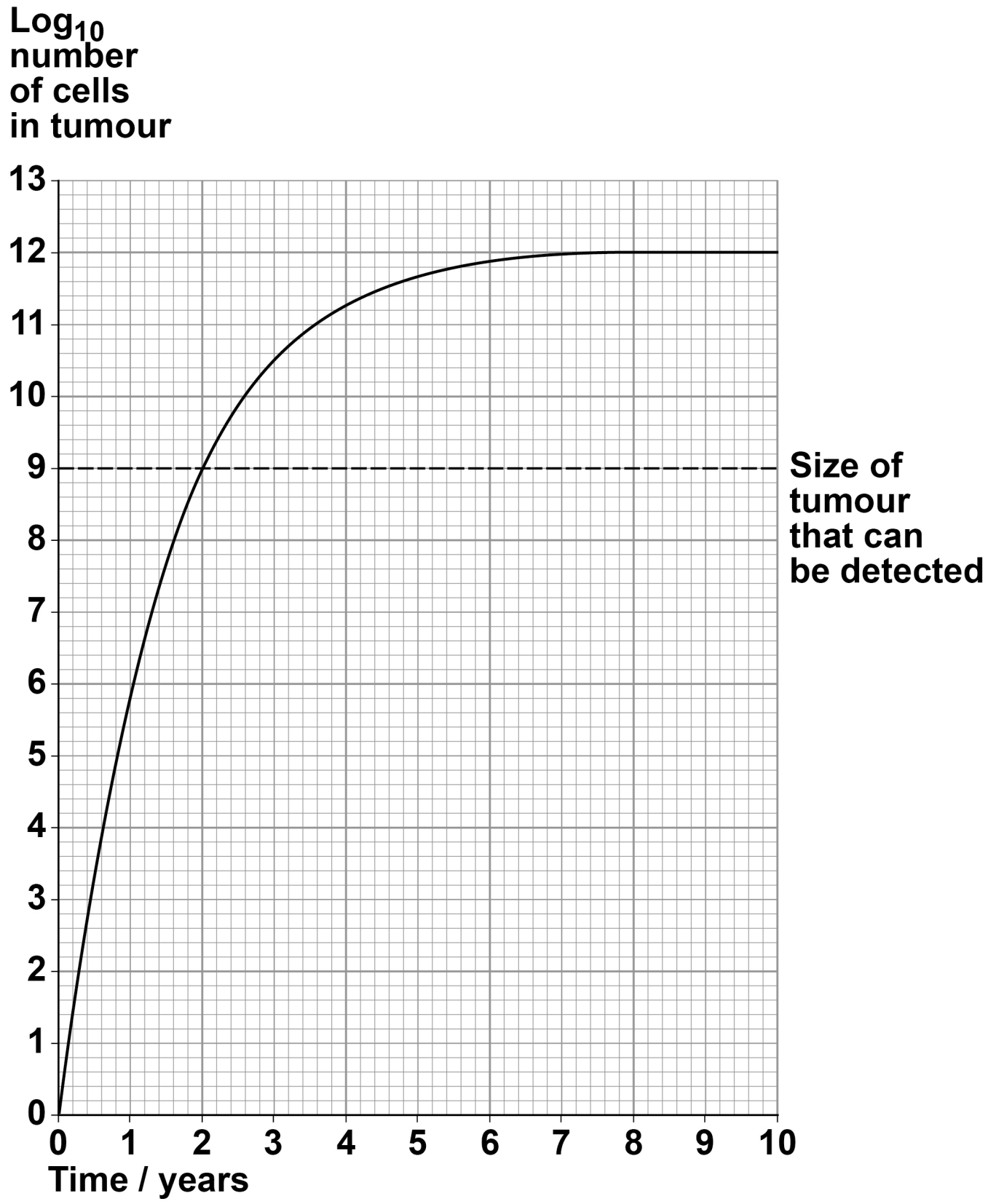
FIGURE 7, on the opposite page, shows the growth pattern followed by a type of tumour.

0 6 . 1 **Use FIGURE 7 to calculate the percentage of maximum growth this type of tumour reaches before it can be detected.**

You will need to use the 10^x button on your calculator. [1 mark]

Answer = _____ %

FIGURE 7


Log10 number of cells in tumour
13
12
11
10
9
8
7
6
5
4
3
2
1
0
0 1 2 3 4 5 6 7 8 9 10
Time / years
Size of tumour that can be detected

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0 6 . 2 **FIGURE 7, on page 41, can also be used to calculate the age of this type of tumour.**

At diagnosis, a patient had a tumour of 3.98×10^{11} cells. Calculate the age of the tumour.

You will need to use the $\log_{10}$ button on your calculator. [1 mark]

Answer = _____ years

[Turn over]

Trexall is a drug that can be used to slow the development of various forms of cancer.

Trexall slows cell division by interacting with an enzyme called dihydrofolate reductase (DR).

DR is involved in making nucleotides; the substrate for DR is folic acid.

FIGURE 8 shows the chemical structure of Trexall.

FIGURE 9, on the opposite page, shows the chemical structure of folic acid.

FIGURE 8

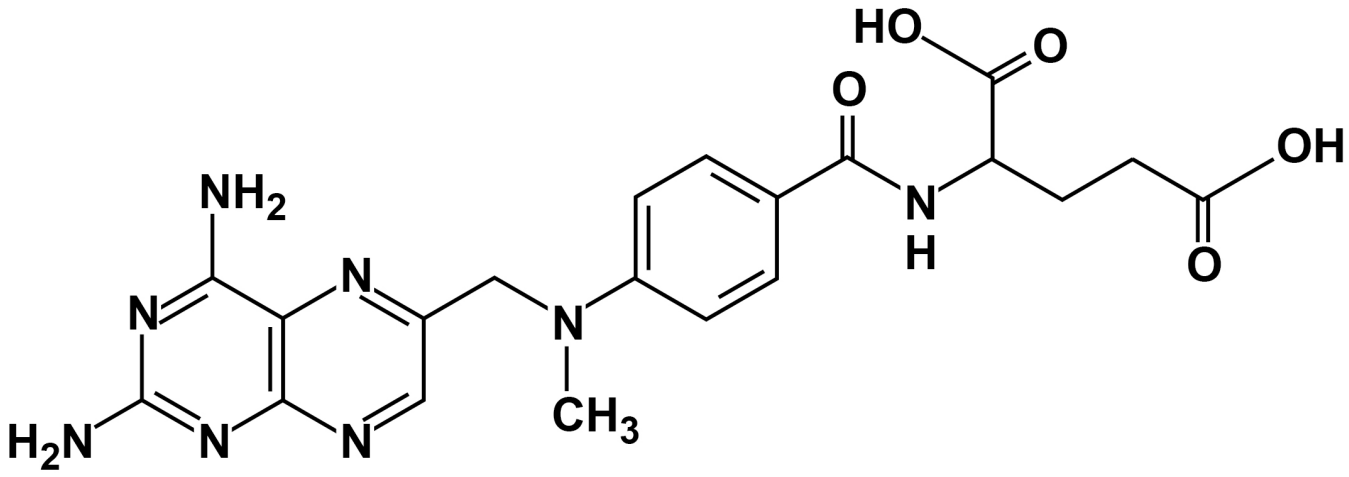
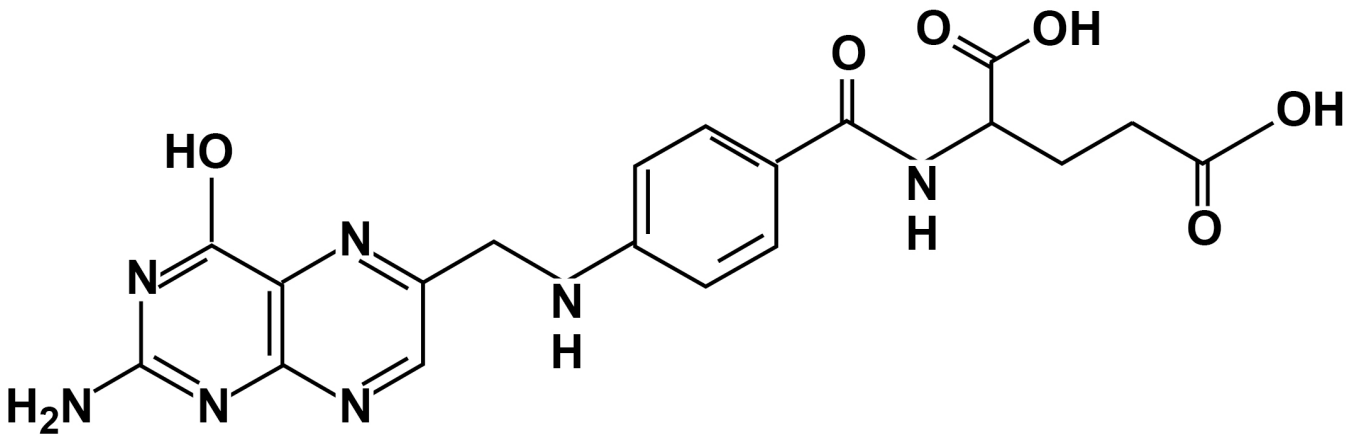


FIGURE 9



[Turn over]

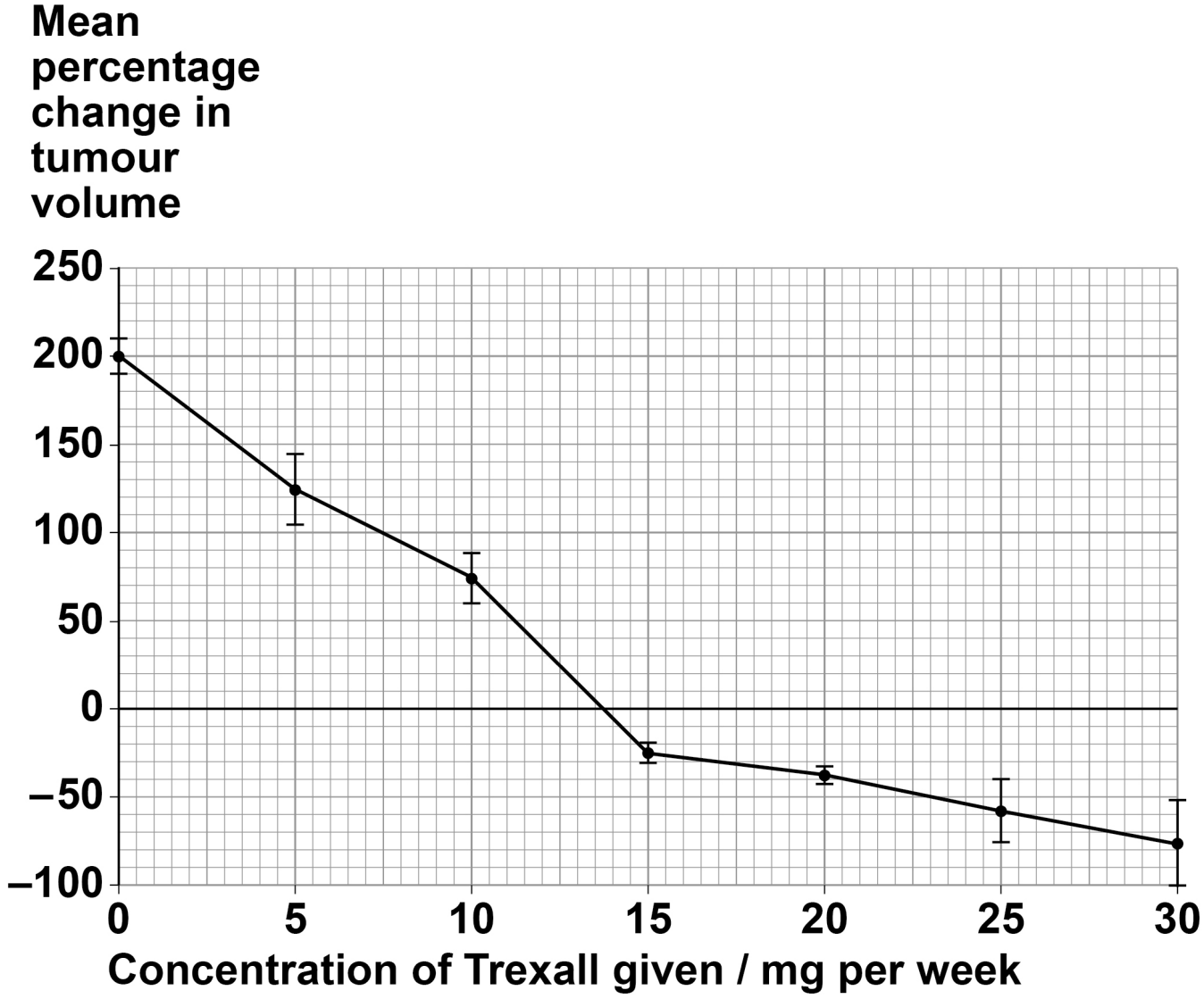
0 6 . 3 **Use the information provided to suggest how Trexall slows cell division. [3 marks]**

[Turn over]

Doctors investigated how the concentration of Trexall given to patients affected the growth of lung tumours. The doctors measured the volume of tumours at the beginning of the study and after 8 months.

FIGURE 10 shows the results of this investigation. The bars represent ± 2 standard deviations. A value of ± 2 standard deviations from the mean includes over 95% of the data.

FIGURE 10



0 6 . 4 **The scientists measured the percentage change in tumour volume.**

Suggest why they recorded both percentage change AND tumour volume. [2 marks]

Percentage change _____

_____

_____

_____

_____

_____

Tumour volume _____

_____

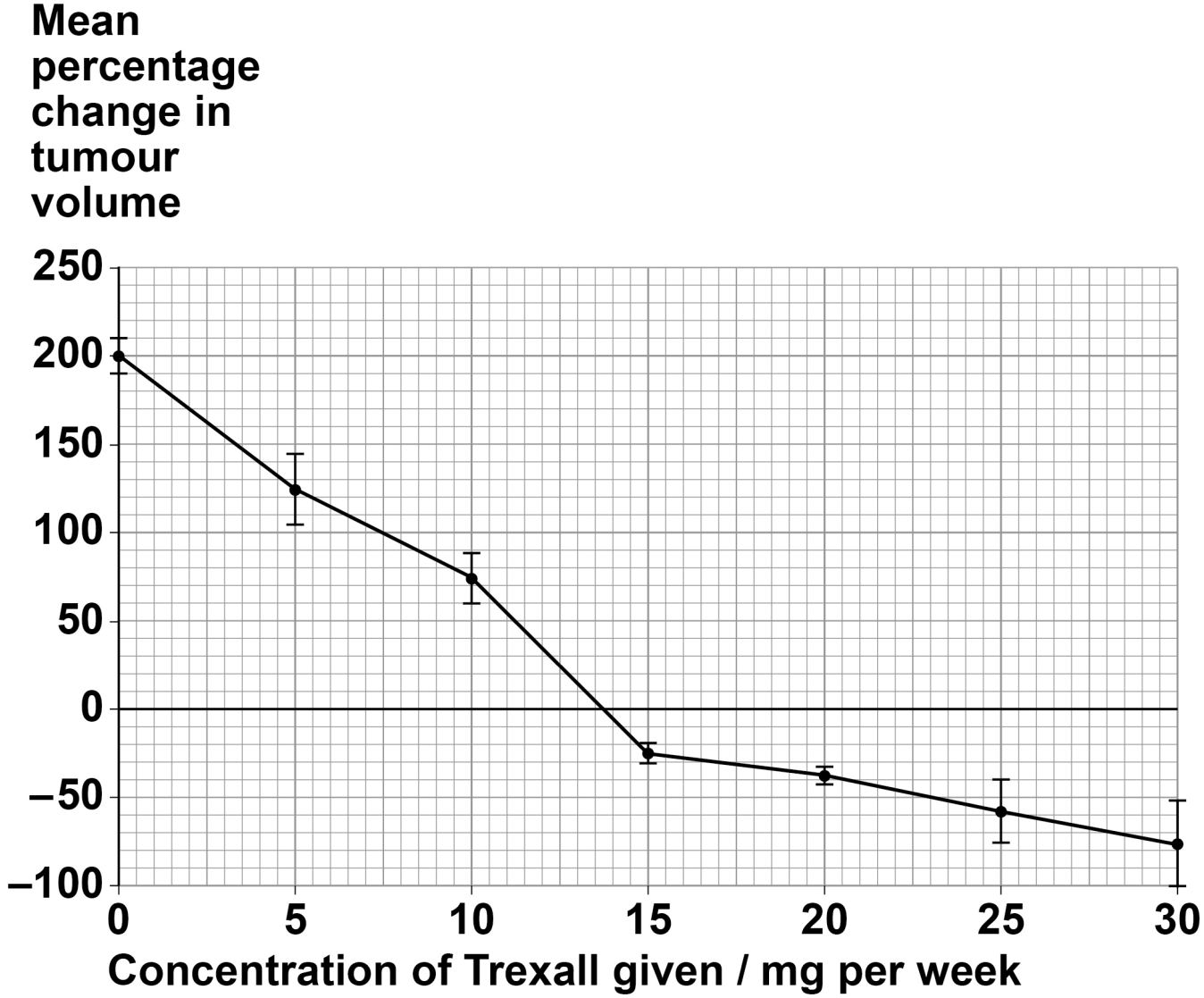
_____

_____

_____

_____

Repeat of FIGURE 10



0 6 . 5 **A lung cancer patient received 15 mg of Trexall per week. After treatment, the diameter of his lung tumour was 35.8 mm**

Assuming the tumour was spherical, use the mean percentage change in tumour volume shown in FIGURE 10 to calculate the volume of the patient's tumour BEFORE TREATMENT with Trexall.

The formula for the volume of a sphere is $\frac{4}{3}\pi r^3$ where π = 3.14 [2 marks]

Answer = _____ mm^3

[Turn over]

0 6 . 6 **To reduce the size of tumours, would it be better to use 30 mg of Trexall per week, or 20 mg of Trexall per week?**

Explain your answer. [2 marks]

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[Turn over]

Trexall can also be used to slow the development of rheumatoid arthritis (a pain-causing joint disease).

Scientists investigated the effectiveness of Trexall as a pain relief treatment in 12 rheumatoid arthritis patients. All of the patients were female. They randomly divided the patients into two groups:

- **Group R received Trexall tablets for 35 days**
- **Group S was a control group.**

They asked both groups to rate their pain on a scale of 0–10 (0 being no pain and 10 being the worst pain possible) at the start and then every 7 days for 35 days. They calculated mean scores for each group.

Their results can be seen in TABLE 3.

TABLE 3

Number of days of treatment	Mean score for severity of pain (scale 0–10)	
	Group R	Group S
0	9.7	9.8
7	8.2	9.1
14	8.4	8.6
21	7.6	7.2
28	6.3	7.5
35	5.1	7.8

0 6 . 7 **Apart from age and general health, give TWO important factors when choosing patients for this investigation. [1 mark]**

1 _____

_____

2 _____

_____

[Turn over]

0 6 . 8 **A student analysed TABLE 3, on page 54, and concluded that Trexall was effective in reducing pain in arthritis patients.**

Evaluate the student's conclusion. [3 marks]

[Turn over]

15

SECTION B

Answer ONE question.

You are advised to spend no more than 45 minutes on this section.

0 7 **Write an essay on ONE of the topics below.**

EITHER

0 7 . 1 **The importance of DNA as an information-carrying molecule AND its use in gene technologies. [25 marks]**

OR

0 7 . 2 **The importance of bonds and bonding in organisms. [25 marks]**

END OF QUESTIONS

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For Examiner's Use	
Question	Mark
1	
2	
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TOTAL	

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