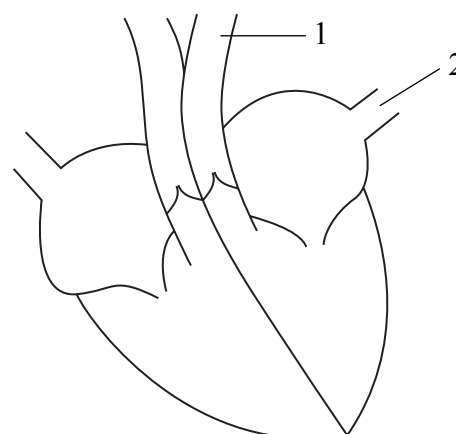
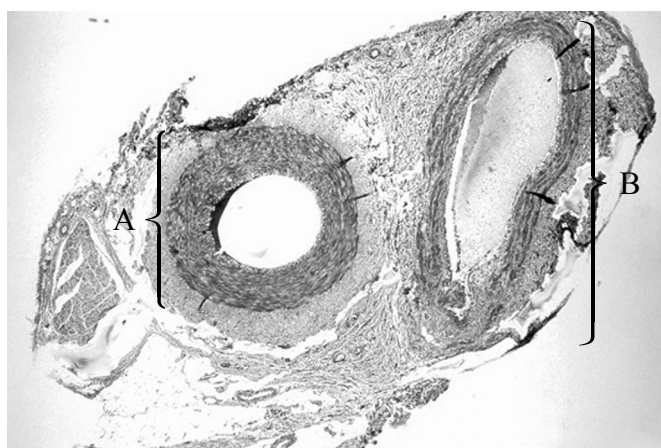


Answer ALL questions.

1. The photograph (below left) shows sections of two blood vessels labelled A and B. The diagram (below right) shows a human heart with two of the blood vessels numbered 1 and 2.



CNRI/Science photo library

- (a) Two of these vessels are arteries and two are veins. Place a tick in the box on the right of the table below that correctly identifies the row showing which two vessels are arteries and which two are veins.

Arteries	Veins	
A and 1	B and 2	<input type="checkbox"/>
A and 2	B and 1	<input type="checkbox"/>
B and 1	A and 2	<input type="checkbox"/>
B and 2	A and 1	<input type="checkbox"/>

(1)



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blank

(b) Blood moves towards the heart in veins. Describe how blood is moved through veins.

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(3)

(c) Capillaries are involved in the exchange of materials between the blood and the surrounding body tissues. Give **two** structural features of a capillary that enable it to exchange materials rapidly between the blood and the surrounding body tissues.

1

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2

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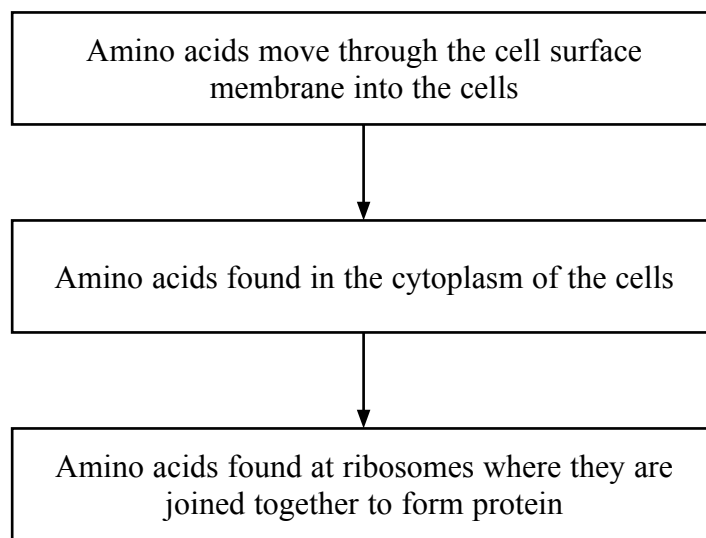
(2)

Q1

(Total 6 marks)



2. Some cells from the small intestine were placed in a solution containing amino acids. The diagram below shows the movement of these amino acids over a 15 minute period.



(a) (i) Name **two** mechanisms by which amino acids can move through the cell surface membrane.

- 1
- 2 **(2)**

(ii) Name the stage of protein synthesis that occurs at the ribosomes.
..... **(1)**

(b) (i) If a protein formed at a ribosome is 300 amino acids long, state how many water molecules would be released during its synthesis.

..... **(1)**

(ii) Assuming that the start codon on mRNA is three bases long and the stop codon is also three bases long, calculate the minimum number of bases in the mRNA needed to code for a protein that is 300 amino acids long.
..... **(1)**



(c) Suggest **two** molecules, other than amino acids and water, that may be found at the ribosomes and that are involved in protein synthesis.

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(2)

(Total 7 marks)

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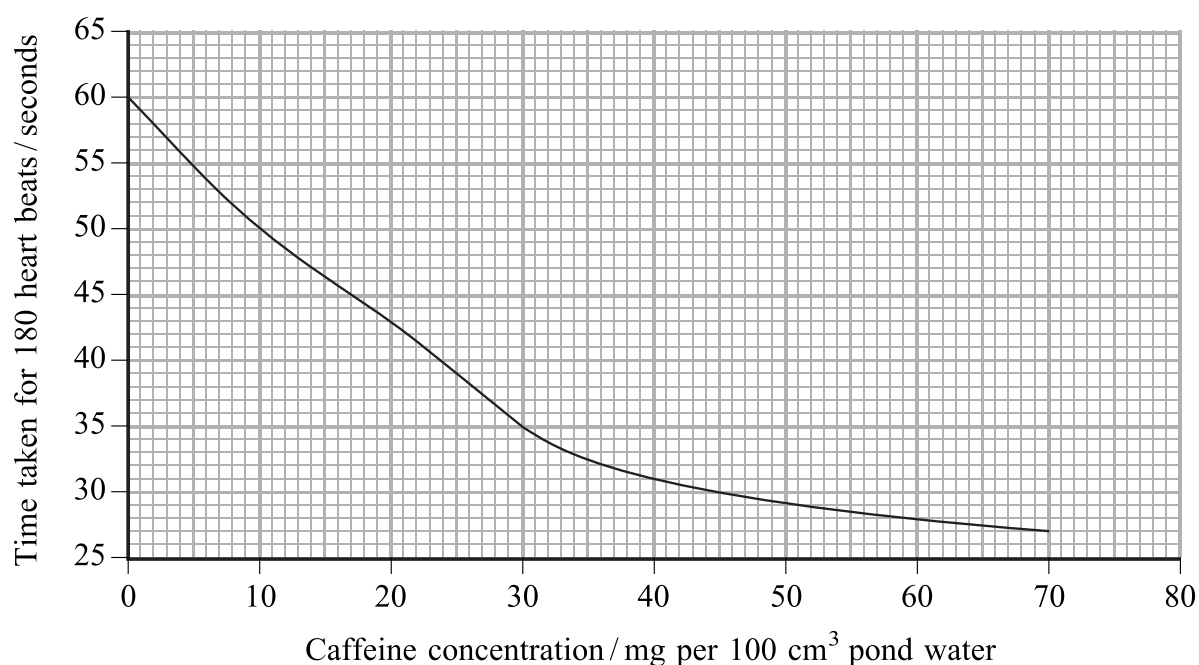
Q2



3. (a) *Daphnia* heart rate increases when *Daphnia* are given the stimulant, caffeine. A student used this knowledge to estimate the caffeine content of three drinks.

To do this she set up a calibration curve. Initially, she placed one *Daphnia* in pond water with no caffeine and counted the number of its heart beats in one minute. She found this to be 180.

She then placed the *Daphnia* in pond water with 10 mg of caffeine per 100 cm³ of pond water and recorded the time taken for 180 heart beats. This was repeated for several different caffeine concentrations and the results are shown in the calibration curve below. All measurements were taken at 15 °C.



The student now repeated the study, using the same *Daphnia* and keeping the temperature at 15 °C throughout, but with instant coffee as the source of caffeine. She recorded the time taken for 180 heart beats to occur. She then repeated this using the two other drinks. The results are shown in the table below. Use the calibration curve to complete the third column of the table.

Drink	Time taken for 180 heart beats / seconds	Caffeine concentration / mg per 100 cm ³
Instant coffee	33	
Filter coffee	28	
Tea	35	

(3)



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- (b) By using the same *Daphnia* throughout the investigation, the student was able to control certain variables that could have affected her results.

Give **three** variables that the student controlled by using the same *Daphnia*.

1

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2

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3

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(3)

- (c) At the end of the investigation the student removed the *Daphnia* from the tea and placed it in pond water. She then recorded its heart rate and found it to be 190 beats per minute.

Suggest **two** reasons why the *Daphnia* heart rate was higher at the end of the investigation compared to the 180 beats per minute at the start.

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(2)

Q3

(Total 8 marks)



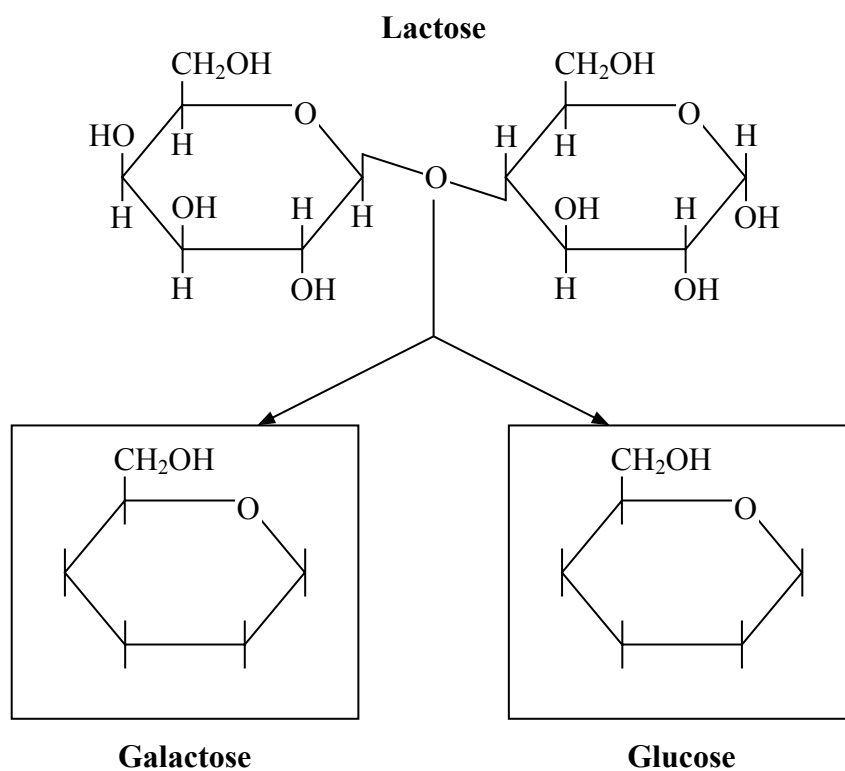
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4. Lactose is a sugar found in human milk.

(a) Lactose is a disaccharide that can be hydrolysed to its two monosaccharides, galactose and glucose.

(i) The diagram below shows lactose being hydrolysed. Complete the diagram by drawing the missing components of the monosaccharide galactose in the left-hand box and the monosaccharide glucose in the right-hand box.



(2)

(ii) Explain the term **hydrolysis**.

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(2)



(b) Galactosaemia is a rare and potentially serious inherited condition. It is caused by a recessive allele that reduces the ability of the body to break down galactose.

A couple is expecting a second child. Neither parent has galactosaemia but their first child does have galactosaemia.

(i) Using the symbols G and g, complete the genetic diagram below to show the probability of the couple's second child **not** having galactosaemia.

Parents' genotypes

Parents' gametes



Possible genotypes of second child

Probability of their second child **not** having galactosaemia **(3)**

(ii) The couple wanted confirmation that their second unborn child did not have galactosaemia. To do this, fetal cells were taken, the DNA extracted and the alleles associated with galactosaemia were sequenced.

A mutation was found in one of these alleles but the protein produced by this allele was the same as the protein produced by the normal allele. The couple were told this could be explained by the degenerate nature of the genetic code.

Explain how the degenerate nature of the genetic code could allow the mutated allele to produce the same protein as a normal allele.

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(2)



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(iii) Outline the ethical issues related to genetic screening of a fetus for inherited disorders such as galactosaemia.

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(3)

Q4

(Total 12 marks)

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N 3 1 0 5 8 A 0 1 1 2 0

5. (a) During ventricular systole, blood is forced out of the heart.

Place a tick in the box (✓) below the column that correctly identifies three features that occur during ventricular systole.

Three features				
Atrioventricular valves	closed	open	open	closed
SAN pacemaker	active	not active	active	not active
Ventricular blood pressure	lower than atria	lower than atria	higher than atria	higher than atria

Place your tick in one of these four boxes

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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(1)

(b) (i) When a doctor takes the blood pressure of a patient, two values are found, such as 110/75 (110 over 75). Which value is the systolic pressure?

.....

(1)

(ii) Hypertension is a consistently and abnormally high blood pressure. Give **two** factors that increase the risk of having hypertension.

1

2

(2)

(c) It has been shown that, for men aged 40 to 50 years old, each rise of 10 units in their systolic blood pressure increases the risk of heart disease by 20%.

(i) Calculate the increased risk of heart disease in a 40 year old man with a systolic blood pressure 50 units higher than the average for his age.

Answer

(1)

(ii) Explain the meaning of the figure you have calculated in (c)(i).

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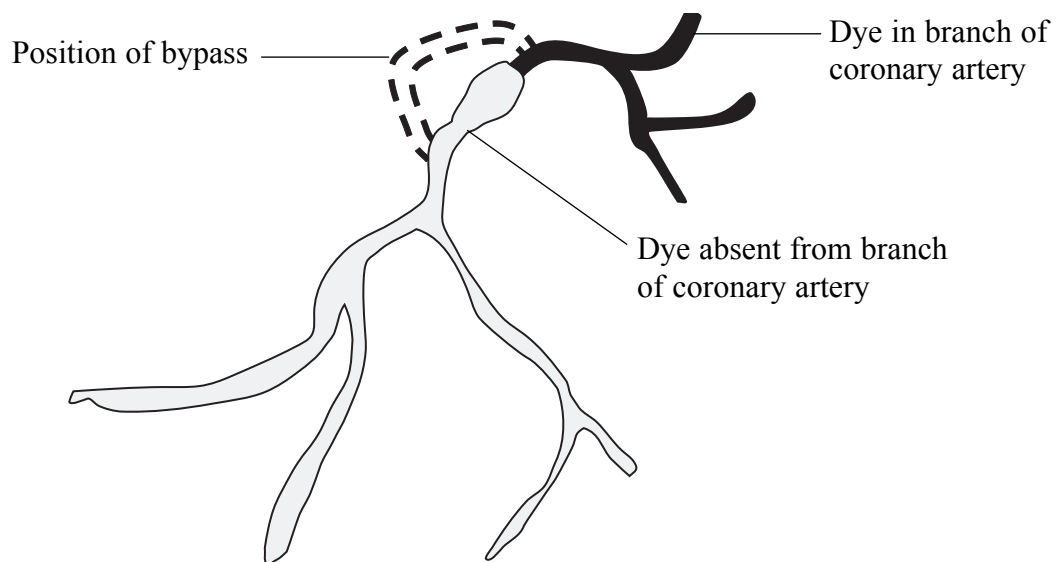
(1)



(d) A man had complained of a crushing pain in his chest. An angiogram was taken to discover if a blockage had occurred in one of his coronary arteries.

In this technique, a dye is injected into his blood circulation. The dye shows up on an X-ray as black.

The diagram below shows the results of the angiogram and identifies a blockage.



(i) Name **one** substance that may be causing the blockage.

..... (1)

(ii) The man had a coronary bypass operation. In this operation a piece of blood vessel from another part of the body is used to bypass the blockage. The position of the bypass is shown on the diagram.

Explain how a coronary bypass could restore normal heart function.

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..... (3)

(Total 10 marks)

Q5

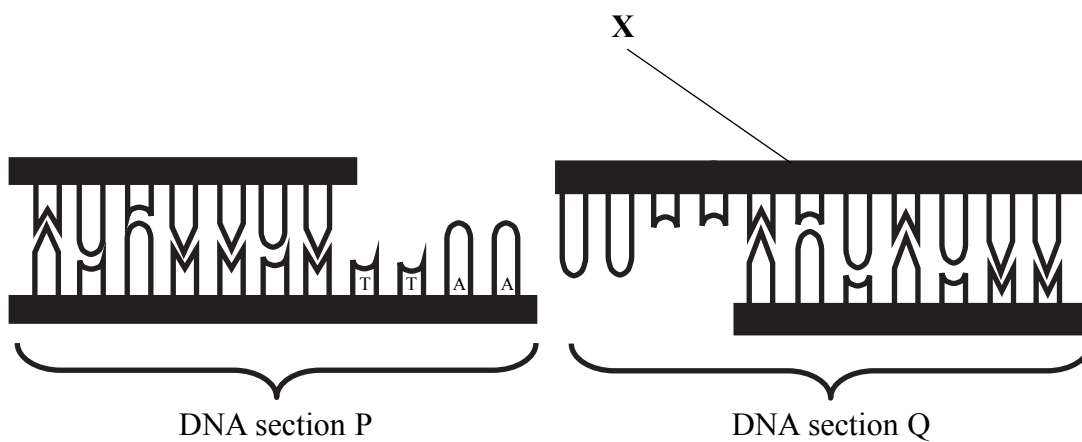


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6. EcoR1 is a restriction enzyme that will cut DNA at a certain base sequence to make DNA fragments suitable for gel electrophoresis.

(a) Below is a diagram showing part of a DNA molecule that has been cut with EcoR1 into two sections called P and Q. The four bases at the cut (sticky) end of section P have been labelled.



(i) Name a component of the DNA molecule found in the part labelled X.

..... (1)

(ii) State the letter of the four complementary bases for the sticky end of section P.

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..... (2)

(iii) Name the base T.

..... (1)



(b) EcoR1 cut a piece of DNA which is shown below.

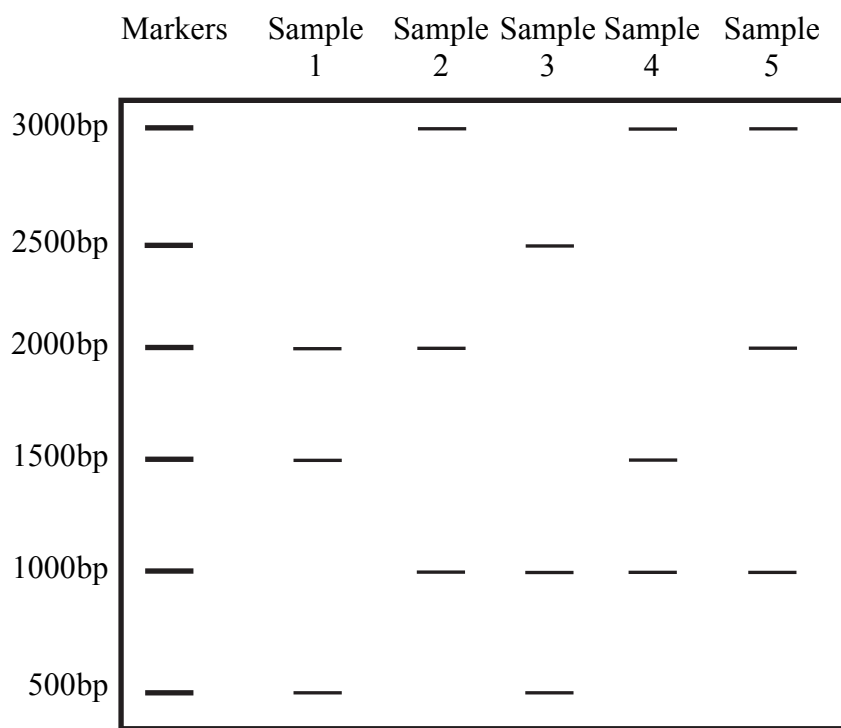


(i) The letters **bp** stand for base pairs when referring to DNA. Name the type of bond that joins two bases together to form a base pair.

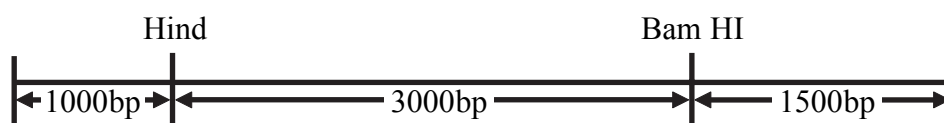
..... (1)

(ii) A gel electrophoresis study was undertaken with 5 samples of DNA. Each sample was made up of a 5500bp section of DNA that had been mixed with two restriction enzymes. These enzymes cut the DNA section into smaller fragments. The restriction enzymes were different in each of the five samples.

The results of the study are shown in the diagram of the gel electrophoresis plate below.



In one sample the restriction enzymes used were Hind and Bam HI. These enzymes cut the DNA section as shown below.



Use both pieces of information to choose the sample that correctly represents the DNA mixed with Hind and Bam HI.

Sample number:

(1)

(Total 6 marks)

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Q6



N 3 1 0 5 8 A 0 1 7 2 0

7. Animals have evolved a heart and a circulation system as a mechanism which overcomes the limitations of diffusion. However, diffusion is still important in animals. For example, calcium (Ca^{2+}) ions can be absorbed by facilitated diffusion from the bloodstream into muscle cells.

(a) Describe how ions such as Ca^{2+} pass through the cell surface membrane by facilitated diffusion.

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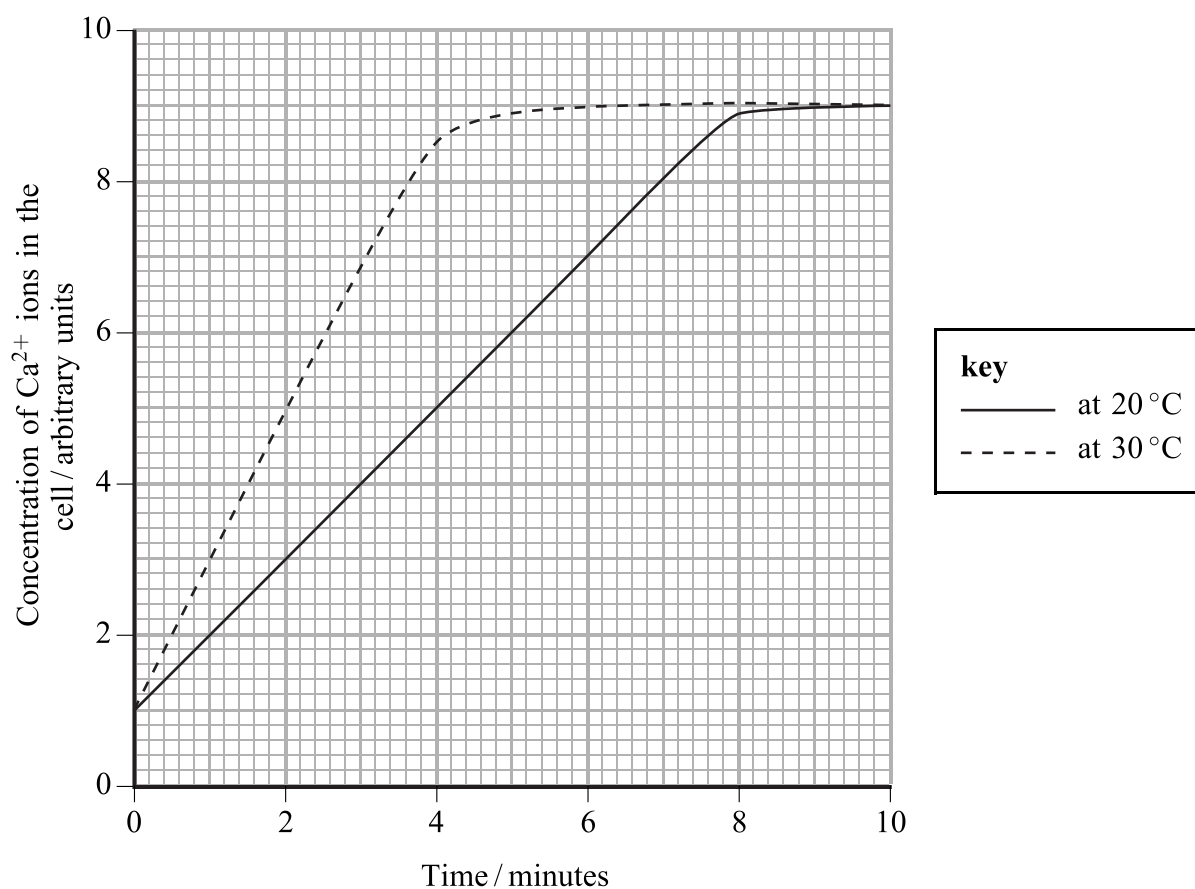
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(4)

(b) The graph below shows the diffusion of Ca^{2+} ions into a cell at two different temperatures over a 10 minute time period.



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(i) Describe the uptake of Ca^{2+} ions by the cell over the 10 minute period at $30\text{ }^{\circ}\text{C}$.

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(3)

(ii) Use the graph to describe the effect of a $10\text{ }^{\circ}\text{C}$ temperature rise (from $20\text{ }^{\circ}\text{C}$ to $30\text{ }^{\circ}\text{C}$) on the uptake of Ca^{2+} ions into this cell.

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(2)

(iii) Suggest an explanation for the effect you have described in part (ii).

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(2)

Q7

(Total 11 marks)

TOTAL FOR PAPER: 60 MARKS

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