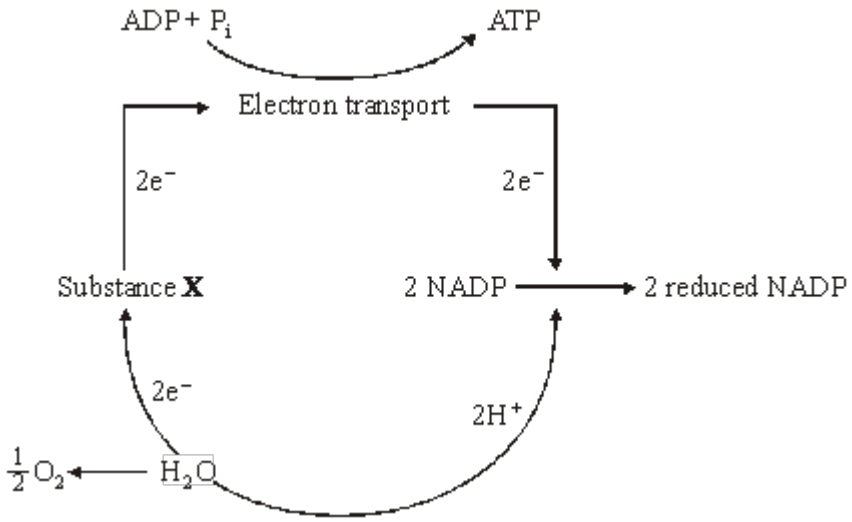
5.1 Energy transfers in and between organisms (A-Level Only) – Respiration 2– Questions

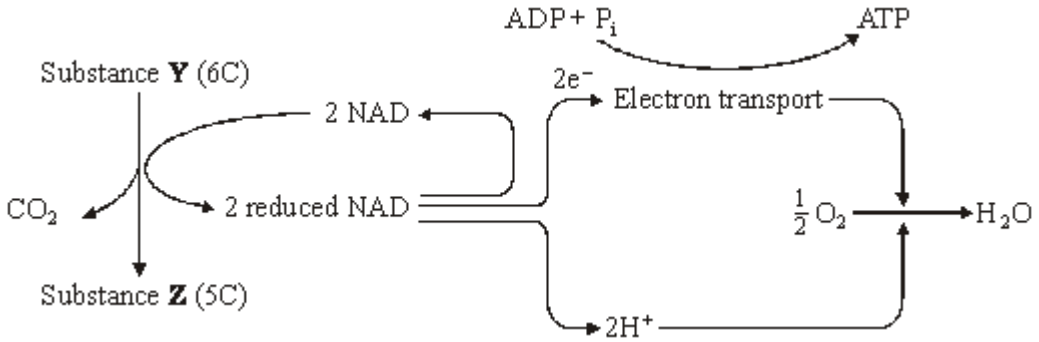
Q1.

The diagram shows some of the stages in two processes that produce ATP.

Process 1



Process 2



(a) In **Process 1**, what causes substance **X** to lose electrons (e^-)?

_____

_____

(1)

(b) Where precisely, within a cell, does electron transport take place in **Process 2**?

_____

_____

(1)

(Total 2 marks)

Q2.

(a) The table contains some statements relating to biochemical processes in a plant cell. Complete the table with a tick if the statement is true or a cross if it is not true for each biochemical process.

Statement	Glycolysis	Krebs cycle	Light-dependent reaction of photosynthesis
NAD is reduced			
NADP is reduced			
ATP is produced			
ATP is required			

(4)

(b) An investigation was carried out into the production of ATP by mitochondria. ADP, phosphate, excess substrate and oxygen were added to a suspension of isolated mitochondria.

(i) Suggest the substrate used for this investigation.

_____

(1)

(ii) Explain why the concentration of oxygen and amount of ADP fell during the investigation.

_____

_____

_____

_____

(2)

(iii) A further investigation was carried out into the effect of three inhibitors, **A**, **B** and **C**, on the electron transport chain in these mitochondria. In each of three experiments, a different inhibitor was added. The table shows the state of the electron carriers, **W–Z**, after the addition of inhibitor.

Inhibitor added	Electron carrier			
	W	**X**	**Y**	**Z**
A	oxidised	reduced	reduced	oxidised
B	oxidised	oxidised	reduced	oxidised
C	reduced	reduced	reduced	oxidised

Give the order of the electron carriers in this electron transport chain. Explain your answer.

Order _____ _____ _____ _____

Explanation _____

_____

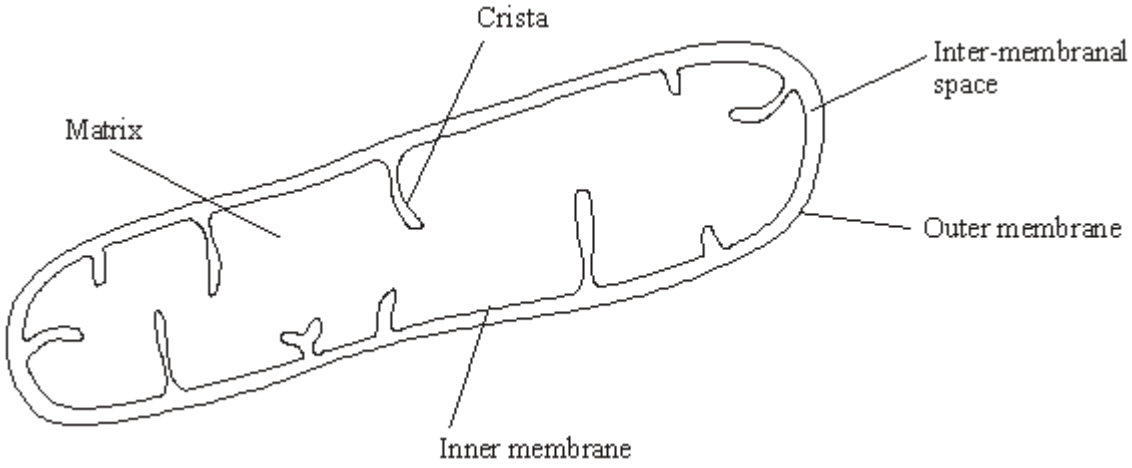
_____

(2)

(Total 9 marks)

Q3.

The diagram shows the structure of a mitochondrion.



(a) In which part of the mitochondrion does the Krebs cycle take place?

_____

(1)

(b) Name **two** substances for which there would be net movement into the mitochondrion.

1. _____

2. _____

(2)

(c) The mitochondria in muscles contain many cristae. Explain the advantage of this.

_____

_____

_____

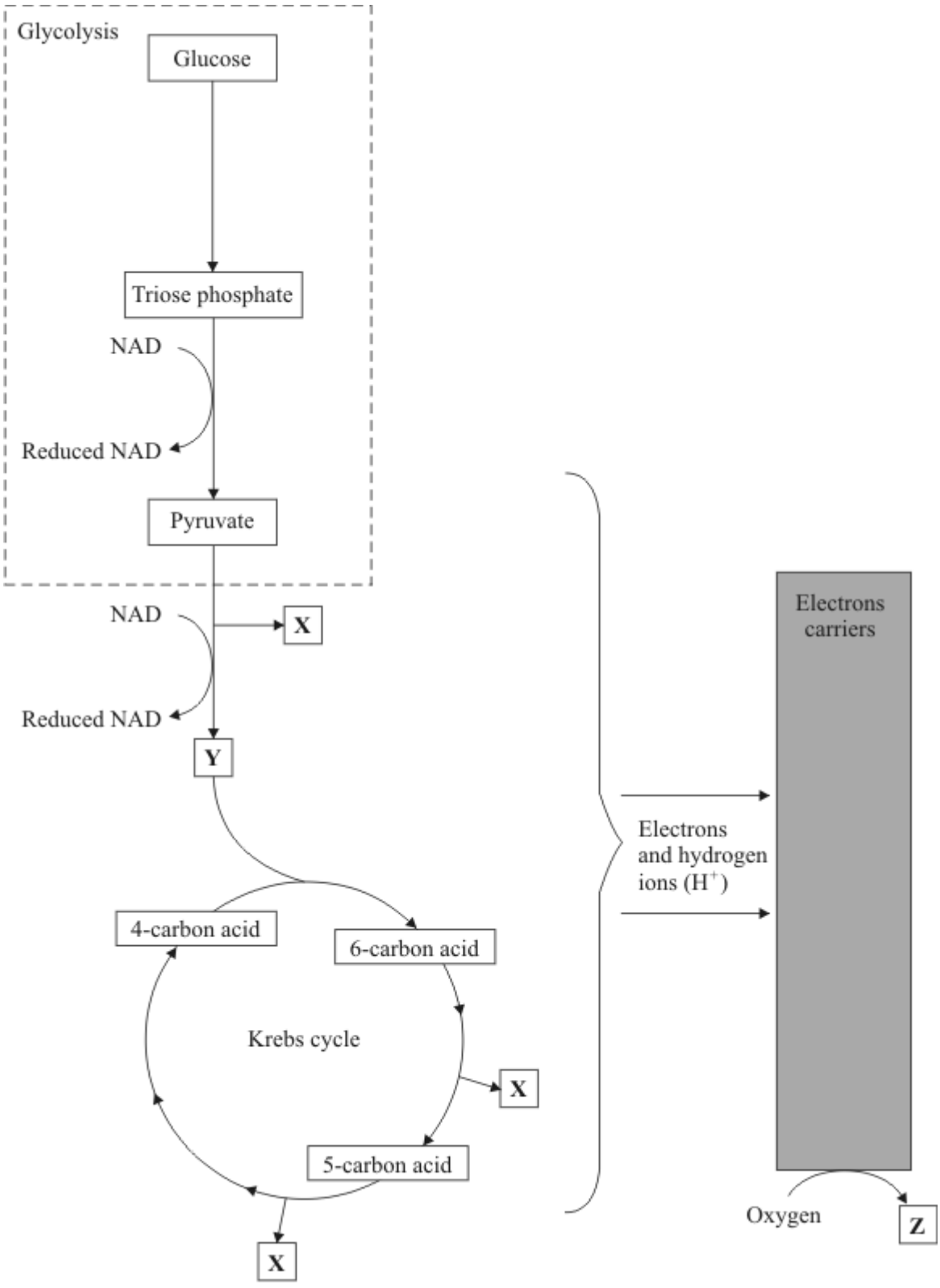
_____

(2)

(Total 5 marks)

Q4.

The diagram gives an outline of the process of aerobic respiration.



(a) Name substances **X**, **Y** and **Z**.

X _____

Y _____

Z _____

(3)

(b) Give the location of each of the following in a liver cell.

(i) Glycolysis _____

(ii) The Krebs cycle _____

(2)

(c) (i) Write the letter **A** on the diagram to show **one** step where ATP is used.

(ii) Write the letter **B** on the diagram at **two** steps where ATP is produced.

(3)

(d) Apart from respiration, give **three** uses of ATP in a liver cell.

1. _____

2. _____

3. _____

(3)

(e) Human skeletal muscle can respire both aerobically and anaerobically. Describe what happens to pyruvate in anaerobic conditions and explain why anaerobic respiration is advantageous to human skeletal muscle.

_____

_____

_____

_____

_____

_____

_____

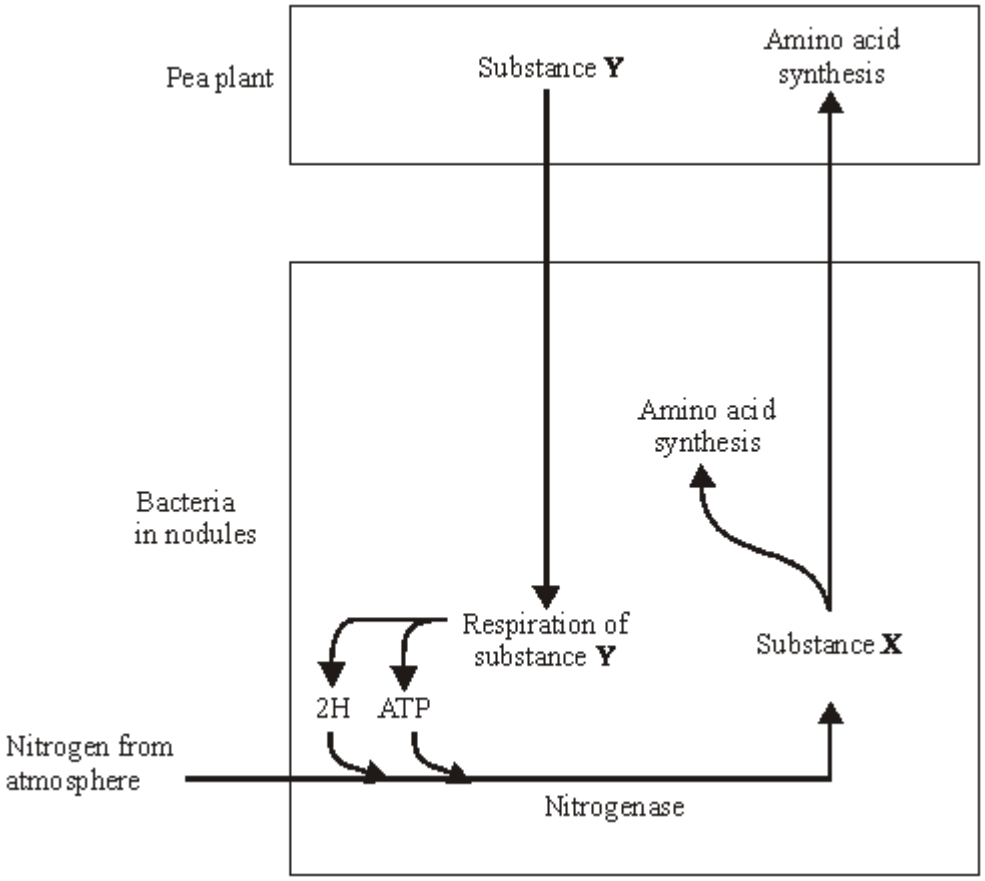
_____

(4)

(Total 15 marks)

Q5.

Pea plants are leguminous and have nodules on their roots which contain bacteria that are able to fix nitrogen. The diagram shows some of the processes involved in nitrogen fixation by these bacteria.



(a) Name

(i) substance **X**;

_____

(1)

(ii) substance **Y**.

_____

(1)

(b) Pea plants respire aerobically, producing ATP which can be used for amino acid synthesis. Describe the role of oxygen in aerobic respiration.

_____

_____

_____

_____

(2)

(c) The bacteria respire anaerobically. This produces hydrogen and ATP used in nitrogen fixation. The hydrogen comes from reduced NAD. Explain how the regeneration of NAD in this way allows ATP production to continue.

_____

(2)

(d) The enzyme nitrogenase is specific to the reaction shown. Explain how **one** feature of the enzyme would contribute to this specificity.

Feature

Explanation

(2)

(e) Sodium ions act as a non-competitive inhibitor of the enzyme nitrogenase. Explain how the presence of a non-competitive inhibitor can alter the rate of the reaction catalysed by nitrogenase.

(3)

(Total 11 marks)

Q6.

When one mole of glucose is burned, 2800 kJ of energy are released. However, when one mole of glucose is respired aerobically, only 40% of the energy released is incorporated into ATP. Each mole of glucose respired aerobically produces 38 moles of ATP.

(a) (i) Calculate how much energy is incorporated into each mole of ATP. Show your working.

Answer _____ kJ

(2)

(ii) When glucose is respired what happens to the energy which is **not** incorporated into ATP?

_____

(1)

(b) (i) When one mole of glucose is respired anaerobically, only 2 moles of ATP are produced. Explain why less energy is released in anaerobic respiration.

_____

_____

(1)

(ii) At the end of a sprint race, a runner continues to breathe rapidly for some time. Explain the advantage of this.

_____

_____

_____

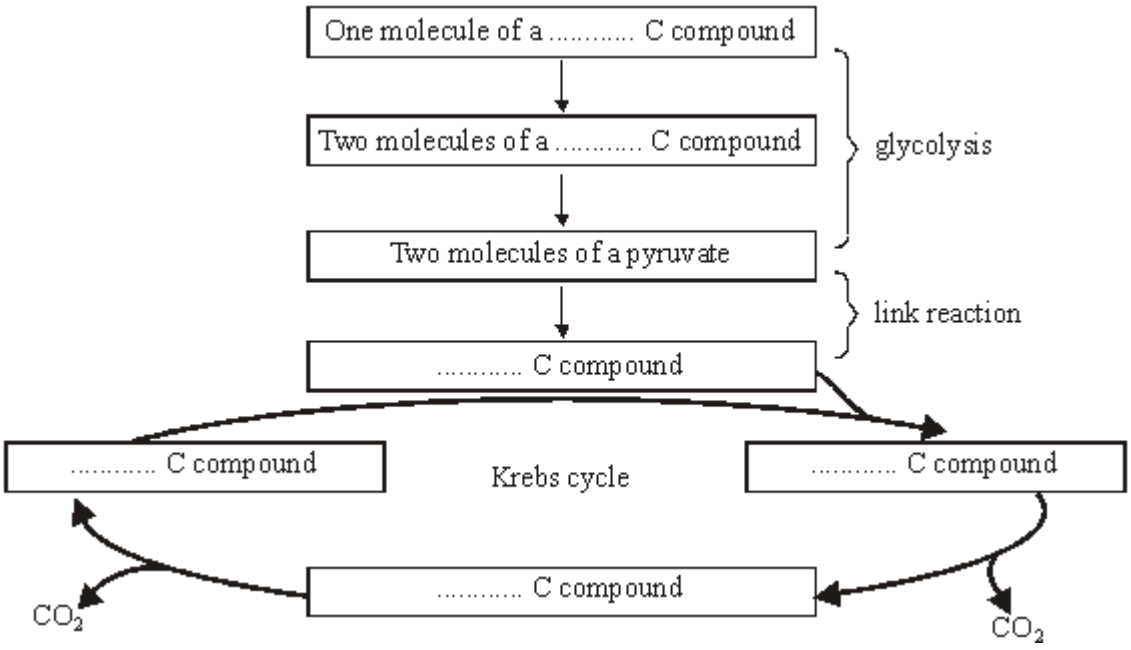
_____

(2)

(Total 6 marks)

Q7.

The boxes in the diagram represent substances in glycolysis, the link reaction and the Krebs cycle.



(a) Complete the diagram to show the number of carbon atoms present in **one** molecule of each compound.

(2)

(b) Other substances are produced in the Krebs cycle in addition to the carbon compounds shown in the diagram. Name **three** of these other products.

1. _____

2. _____

3. _____

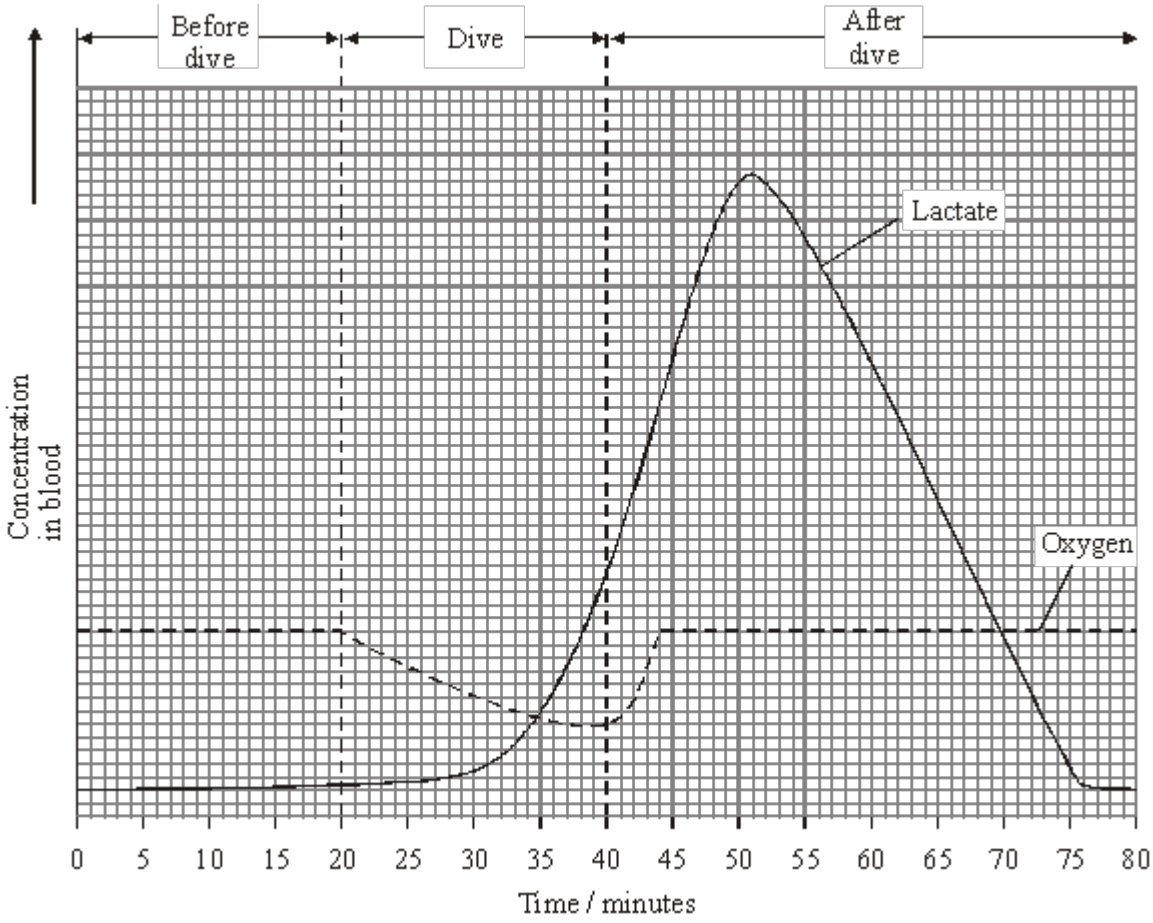
(3)

(Total 5 marks)

Q8.

Seals are aquatic mammals. They use lungs as organs of gas exchange so they do not breathe when they are under water during a dive.

The graph shows changes in oxygen and lactate concentration in the blood of a seal before, during and after a dive.



(a) The concentration of oxygen in the blood fell during the dive. Explain why.

_____

_____

(1)

(b) Use information in the graph to calculate how long it took from the end of the dive for the seal to recover fully.

Answer _____ minutes

(1)

(c) Explain what causes the concentration of blood lactate to fall after a dive.

_____

_____

_____

_____

(2)

(d) Reducing the volume of blood pumped out by the heart reduces the rate of blood flow to the diaphragm muscles.

(i) Give **one** other way in which blood flow into the diaphragm muscles may be reduced.

_____

_____

(1)

(ii) During a dive, blood flow to the diaphragm muscles of a seal is reduced. Suggest the advantage to the seal of maintaining some blood supply to the diaphragm muscles during a dive.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q9.

In an investigation, the effects of caffeine on performance during exercise were measured. One group of athletes (**A**) was given a drink of decaffeinated coffee. Another group (**B**) was given a drink of decaffeinated coffee with caffeine added. One hour later the athletes

started riding an exercise bike and continued until too exhausted to carry on. Three days later the same athletes repeated the experiment, with the drinks exchanged.

(a) (i) The researchers added caffeine to decaffeinated coffee. Explain why they did not just use normal coffee.

_____

_____

(1)

(ii) The performance of the athletes might have been influenced by how they expected the caffeine to affect them. How could the researchers avoid this possibility?

_____

_____

(1)

During the exercise the concentrations of glycerol and fatty acids in the blood plasma were measured. The results are shown in the table.

Drink	**Mean time to exhaustion /minutes**	**Mean concentration of blood glycerol/ mmol dm^{-3}**	**Mean concentration of blood fatty acids/ mmol dm^{-3}**
With caffeine	90.2	0.20	0.53
Without caffeine	75.5	0.09	0.31

(b) (i) Describe the effect of caffeine on exercise performance.

_____

_____

(1)

(ii) Suggest **one** explanation for the higher glycerol and fatty acid concentrations in the blood plasma of the athletes after they were given caffeine.

_____

_____

_____

_____

(2)

(c) The researchers measured the volumes of carbon dioxide exhaled and oxygen inhaled during the exercise. From the results they calculated the respiratory quotient (RQ), using the formula

$$RQ = \frac{\text{volume of carbon dioxide exhaled per minute}}{\text{volume of oxygen inhaled per minute}}$$

When a person is respiring carbohydrate only, RQ = 1.0

When a person is respiring fatty acids only, RQ = 0.7

(i) The basic equation for the respiration of glucose is

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

Explain why the RQ for glucose is 1.0.

_____

_____

_____

_____

(2)

(ii) The researchers found that, when the athletes were given the drink containing caffeine, their mean RQ was 0.85. When given the drink without caffeine their mean RQ was 0.92.

The researchers concluded that when the athletes had caffeine they used glycogen more slowly than when they did not have caffeine, and that the store of glycogen in their muscles was used up less quickly during the exercise.

Explain the evidence from the information above and from the table which supports these conclusions.

_____

_____

_____

_____

_____

_____

(3)

(Total 10 marks)

Q10.

(a) In respiration in cells,

(i) where does glycolysis take place

_____

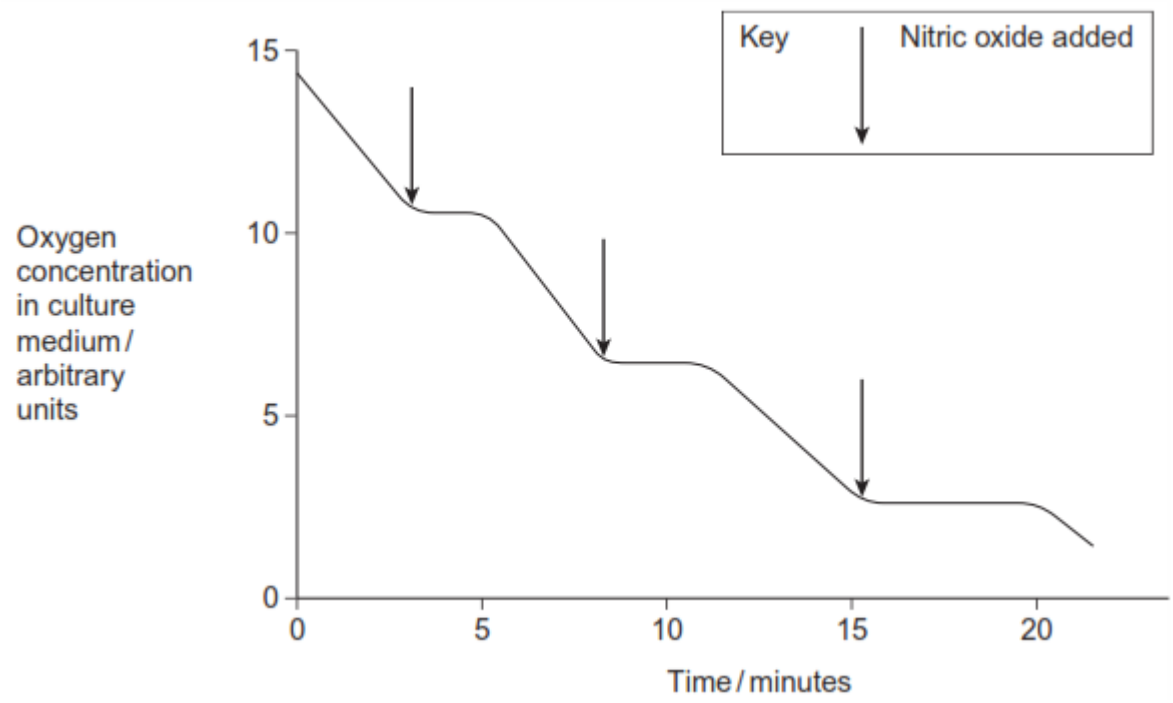
(1)

(ii) where, exactly, is the electron transfer chain found?

(1)

(b) Scientists kept kidney cells in a liquid culture. They investigated the effect of the gas nitric oxide on oxygen consumption by these cells. They recorded the oxygen concentration in the culture medium over a period of time. At intervals they added a small volume of nitric oxide to the culture medium. Nitric oxide affects the functioning of a protein in the electron transport chain.

The graph shows their results.



Explain the effect of nitric oxide.

(Extra space)

(3)

(Total 5 marks)

Q11.

(a) Mitochondria in muscle cells have more cristae than mitochondria in skin cells. Explain the advantage of mitochondria in muscle cells having more cristae.

_____

_____

_____

_____

(2)

(b) Substance **X** enters the mitochondrion from the cytoplasm. Each molecule of substance **X** has three carbon atoms.

(i) Name substance **X**.

_____

(1)

(ii) In the link reaction substance **X** is converted to a substance with molecules effectively containing only two carbon atoms. Describe what happens in this process.

_____

_____

_____

_____

(2)

(c) The Krebs cycle, which takes place in the matrix, releases hydrogen ions. These hydrogen ions provide a source of energy for the synthesis of ATP, using coenzymes and carrier proteins in the inner membrane of the mitochondrion.

Describe the roles of the coenzymes and carrier proteins in the synthesis of ATP.

_____

_____

_____

_____

_____

_____

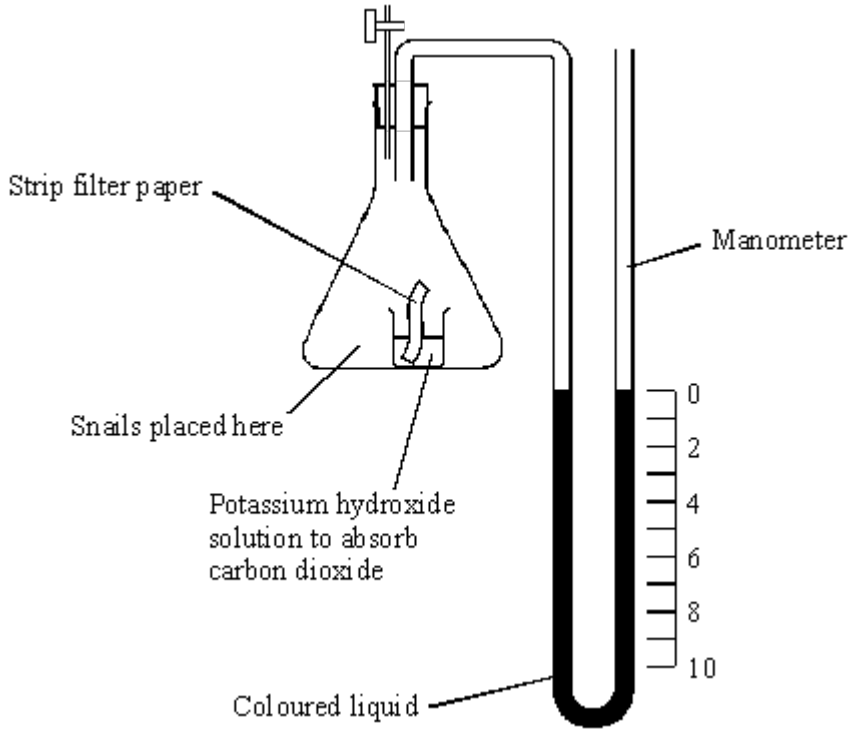
(3)

(Total 8 marks)

Q12.

The diagram shows apparatus used to measure the oxygen uptake of snails that live on

the seashore. The apparatus was kept at a constant temperature.



(a) (i) Explain the purpose of the strip of filter paper in the potassium hydroxide solution.

_____

_____

(1)

(ii) The level of liquid in the right-hand side of the manometer went down during the experiment. Explain why.

_____

_____

_____

_____

(2)

(iii) What measurements are needed to calculate the rate of oxygen uptake by the snails in $mm^3\ g^{-1}\ h^{-1}$?

_____

_____

_____

(3)

(b) Two experiments were carried out using the apparatus shown in the diagram.

1 The oxygen uptake of batches of 10 seashore snails kept in moist air was

measured at temperatures between 5 °C and 35 °C.

2 Experiment 1 was repeated but with batches of 10 seashore snails covered by aerated seawater.

The experiments were repeated several times and means and standard deviations calculated. The results are shown in the table. The values given are means plus or minus one standard deviation.

Temperature / °C	**Oxygen uptake of snails kept in moist air / $mm^3\ g^{-1}\ h^{-1}$**	**Oxygen uptake of snails kept in seawater / $mm^3\ g^{-1}\ h^{-1}$**
5	35 ± 2	28 ± 8
10	34 ± 6	32 ± 3
15	36 ± 3	35 ± 3
20	86 ± 8	52 ± 10
25	141 ± 13	96 ± 15
30	132 ± 14	108 ± 9
35	120 ± 16	79 ± 21

(i) Describe **one** similarity and **one** difference between the pattern of mean oxygen uptake of the snails kept in moist air and those covered by seawater.

_____

_____

_____

_____

(2)

(ii) Explain why valid conclusions cannot be drawn about the trends in oxygen uptake at temperatures of 25 °C and above.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q13.

(a) During respiration where, exactly, in a cell does each of the following occur?

(i) Glycolysis

_____

(1)

(ii) Electron transfer chain

_____

(1)

(b) Without oxygen, less ATP is produced by respiration. Explain why.

_____

_____

_____

_____

(2)

(Total 4 marks)