Q1.

(a) Describe how acetylcoenzyme A is formed in the link reaction.

____

____

____

____

____

(2)

(b) In the Krebs cycle, acetylcoenzyme A combines with four-carbon oxaloacetate to form six-carbon citrate. This reaction is catalysed by the enzyme citrate synthase.

(i) Oxaloacetate is the first substrate to bind with the enzyme citrate synthase. This induces a change in the enzyme, which enables the acetylcoenzyme A to bind.

Explain how oxaloacetate enables the acetylcoenzyme A to then bind to the enzyme.

____

____

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(2)

(ii) Another substance in the Krebs cycle is called succinyl coenzyme A. This substance has a very similar shape to acetylcoenzyme A.

Suggest how production of succinyl coenzyme A could control the rate of the reaction catalysed by citrate synthase.

____

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____

(2)

(c) In muscles, pyruvate is converted to lactate during anaerobic respiration.

(i) Explain why converting pyruvate to lactate allows the continued production of ATP during anaerobic respiration.

____

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(2)

(ii) In muscles, some of the lactate is converted back to pyruvate when they are well supplied with oxygen. Suggest **one** advantage of this.

____

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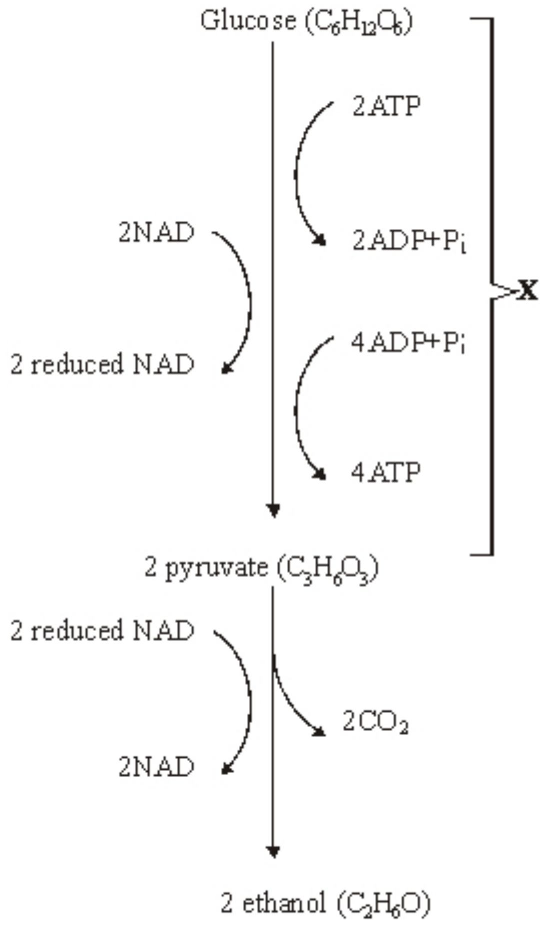
(1)

(Total 9 marks)

Q2.

(a) The main stages in anaerobic respiration in yeast are shown in the diagram.



(i) Name process **X**.

____ **(1)**

(ii) Give **one** piece of evidence from the diagram which suggests that the conversion of pyruvate to ethanol involves reduction.

____

____ **(1)**

(iii) Explain why converting pyruvate to ethanol is important in allowing the continued production of ATP in anaerobic respiration.

____

____

____

____ **(2)**

(b) Give **two** ways in which anaerobic respiration of glucose in yeast is

(i) similar to anaerobic respiration of glucose in a muscle cell;

1. ____

____

2. ____

____

(2)

(ii) different from anaerobic respiration of glucose in a muscle cell.

1. ____

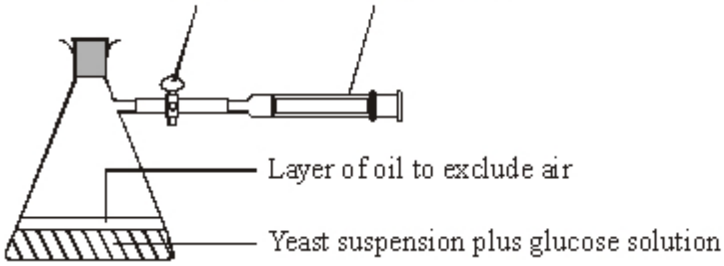
____

2. ____

____

(2)

(c) Some students investigated the effect of temperature on the rate of anaerobic respiration in yeast. The apparatus they used is shown in the diagram. The yeast suspension was mixed with glucose solution and the volume of gas collected in five minutes was recorded.



(i) Each student repeated the experiment and the results were pooled. Explain the advantages of collecting a large number of results.

____

____

____

____

(2)

(ii) At 30 °C, one student obtained the following results.

	Result 1	Result 2	Result 3
Volume of gas collected in 5 minutes / cm^3	38.3	27.6	29.4

Calculate the mean rate of gas production. Give your answer in $cm^3\ s^{-1}$.

Answer ____________________ $cm^3\ s^{-1}$

(2)

(iii) If aerobic respiration had been investigated rather than anaerobic respiration, how would you expect the volumes of gas collected at 30°C to differ from these results?

Explain your answer.

____

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____

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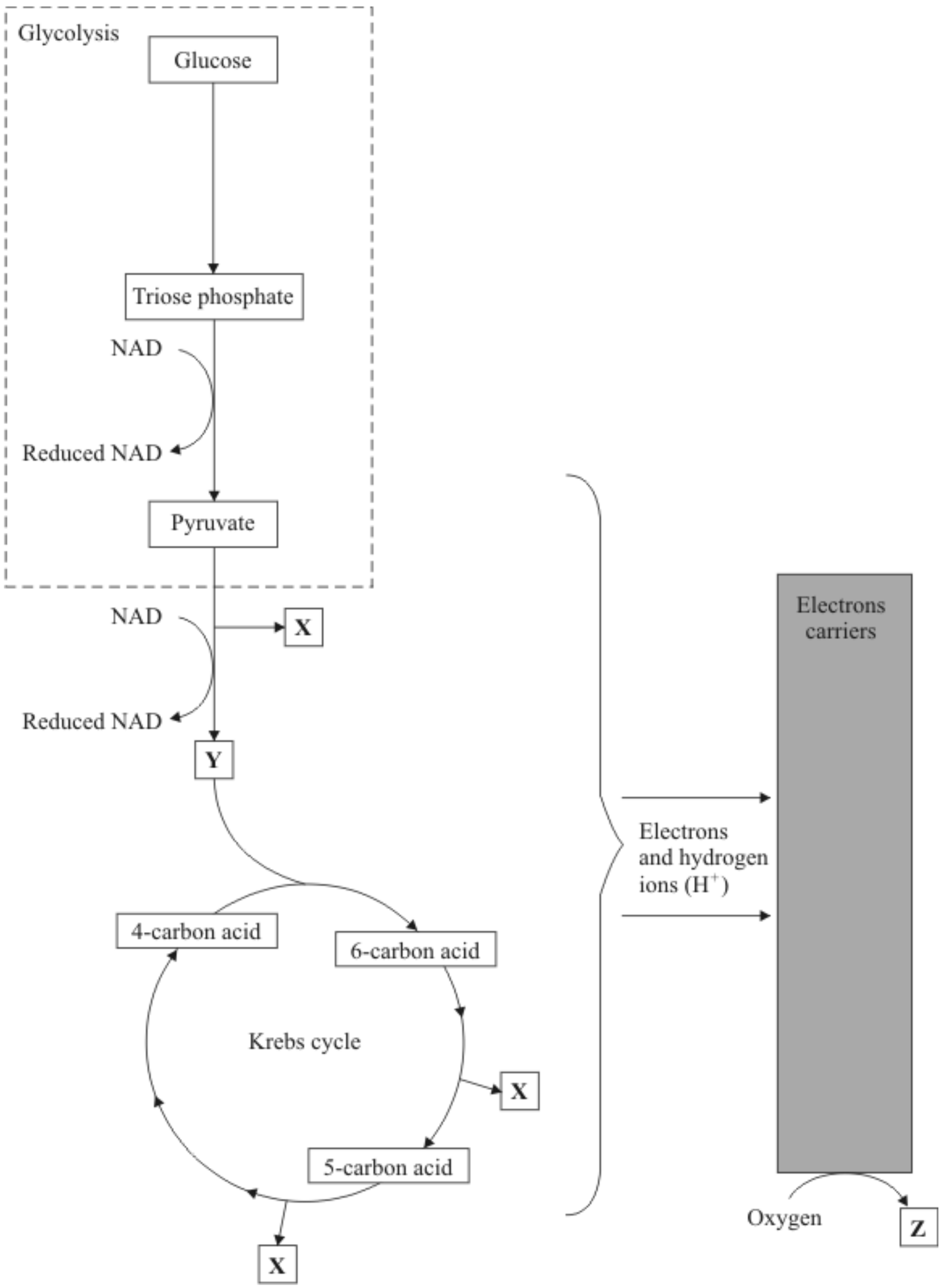
____

____

(3)

(Total 15 marks)

Q3.
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.

____

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____

____

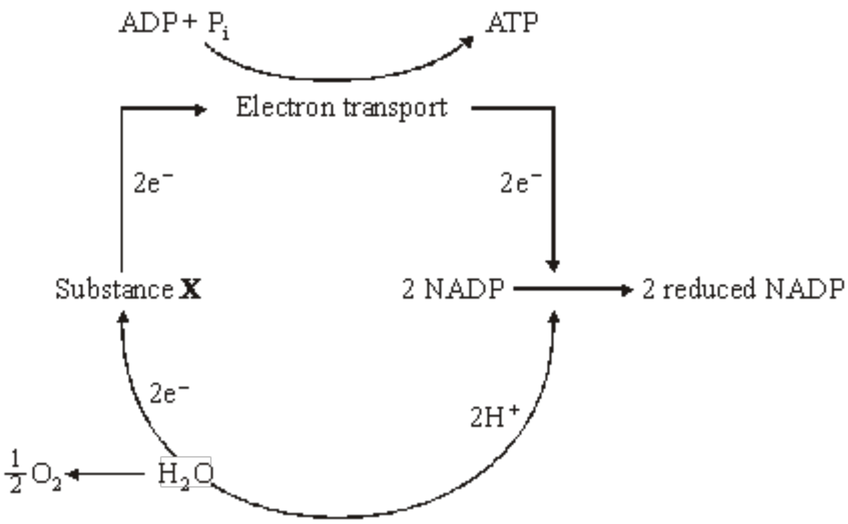
(4)

(Total 15 marks)

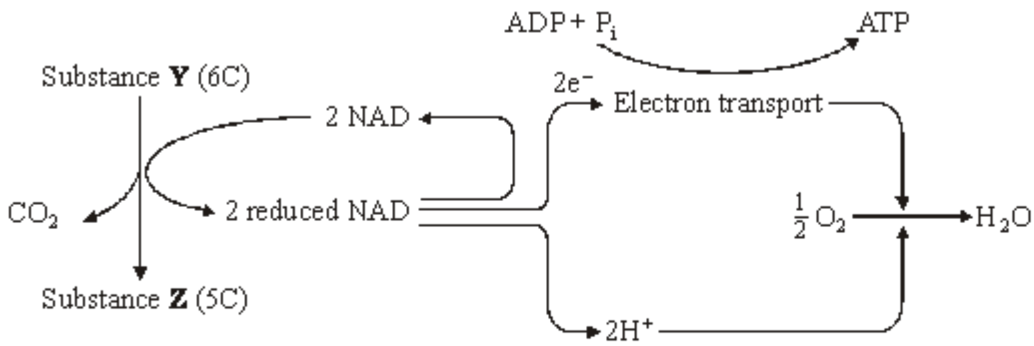
Q4.

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**?

____

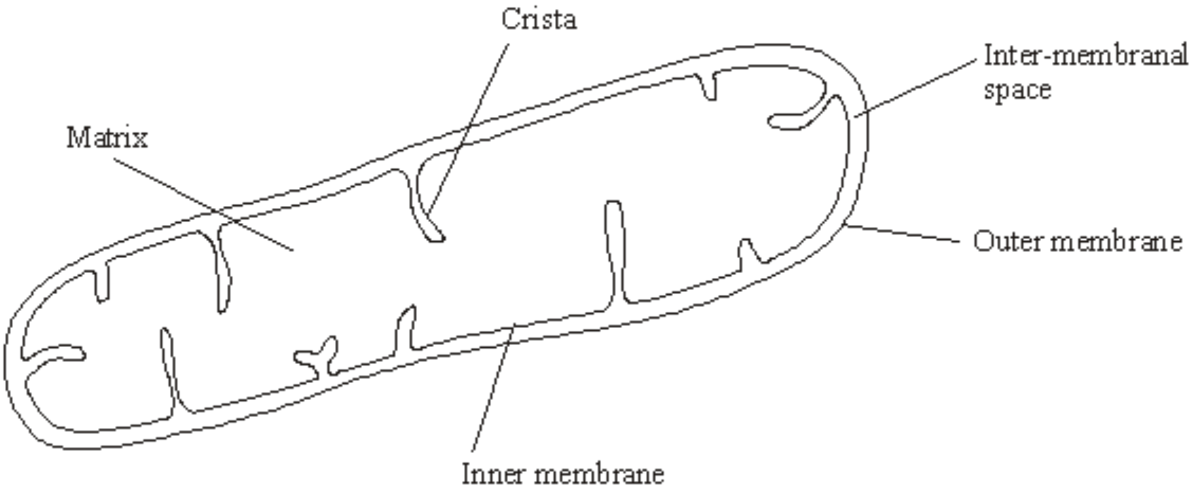
____

(1)

(Total 2 marks)

Q5.

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)

(d) 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)

(e) 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.

____

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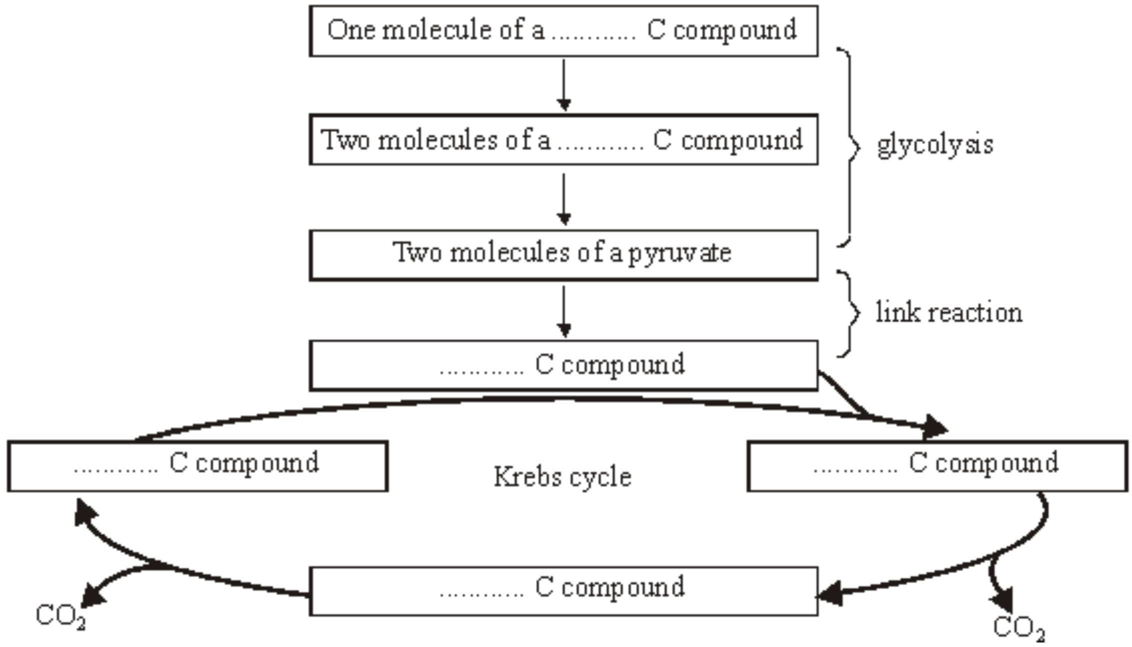
____

(3)
(Total 11 marks)

Q6.

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. ____

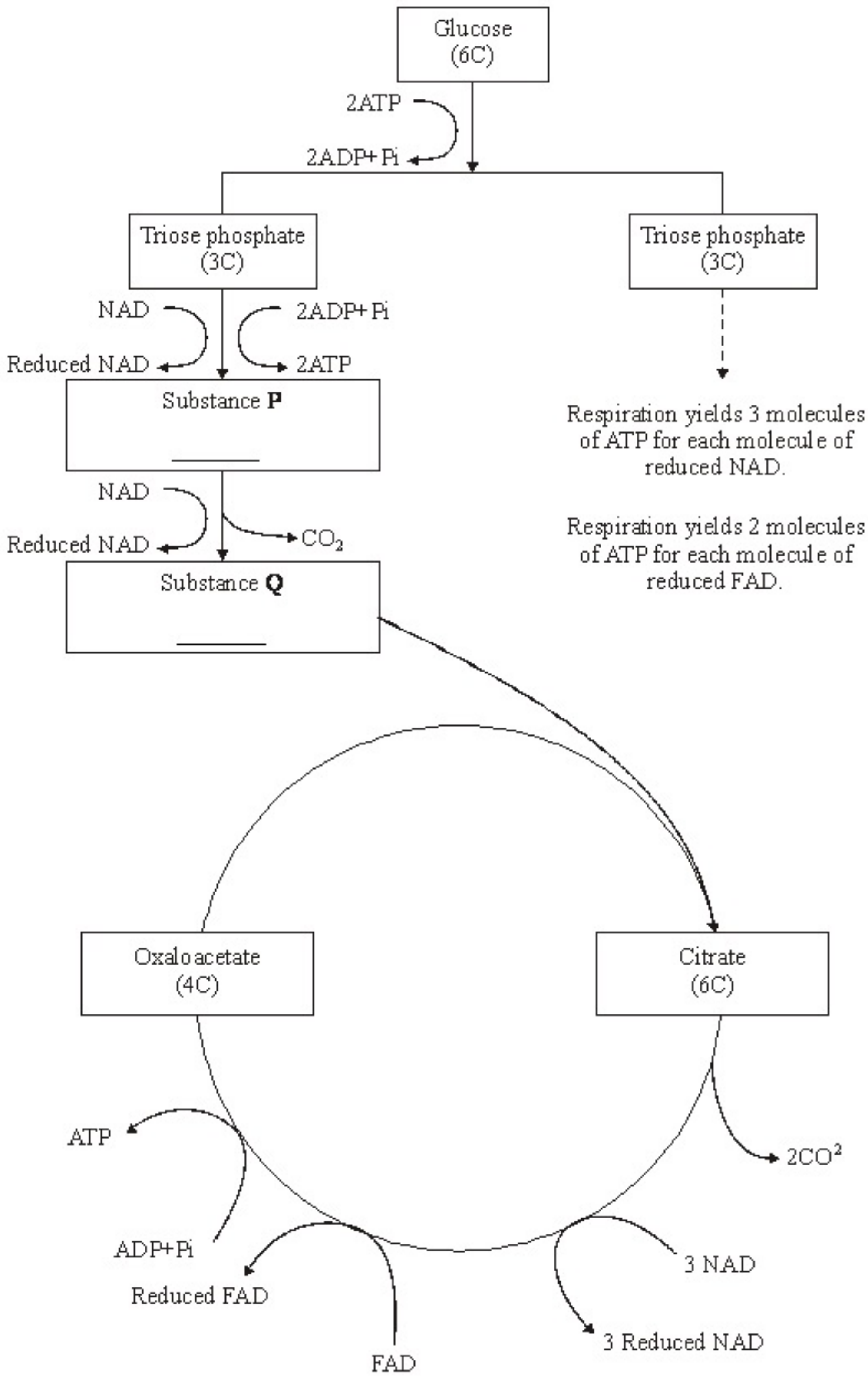
2. ____

3. ____

(3)
(Total 5 marks)

Q7.

(a) The flow chart shows the main stages in aerobic respiration.



(i) Complete the flow chart by writing, in the appropriate boxes, the number of carbon atoms in substance **P** and the name of substance **Q**.

(2)

(ii) Some ATP is formed in the cytoplasm and some in the mitochondria. Use the information given to calculate the number of molecules of ATP formed in a mitochondrion from one molecule of glucose in aerobic respiration. Show how you arrived at your answer.

Answer____________________

(2)

(iii) In the presence of oxygen, respiration yields more ATP per molecule of glucose than it does in the absence of oxygen. Explain why.

____

____

____

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____

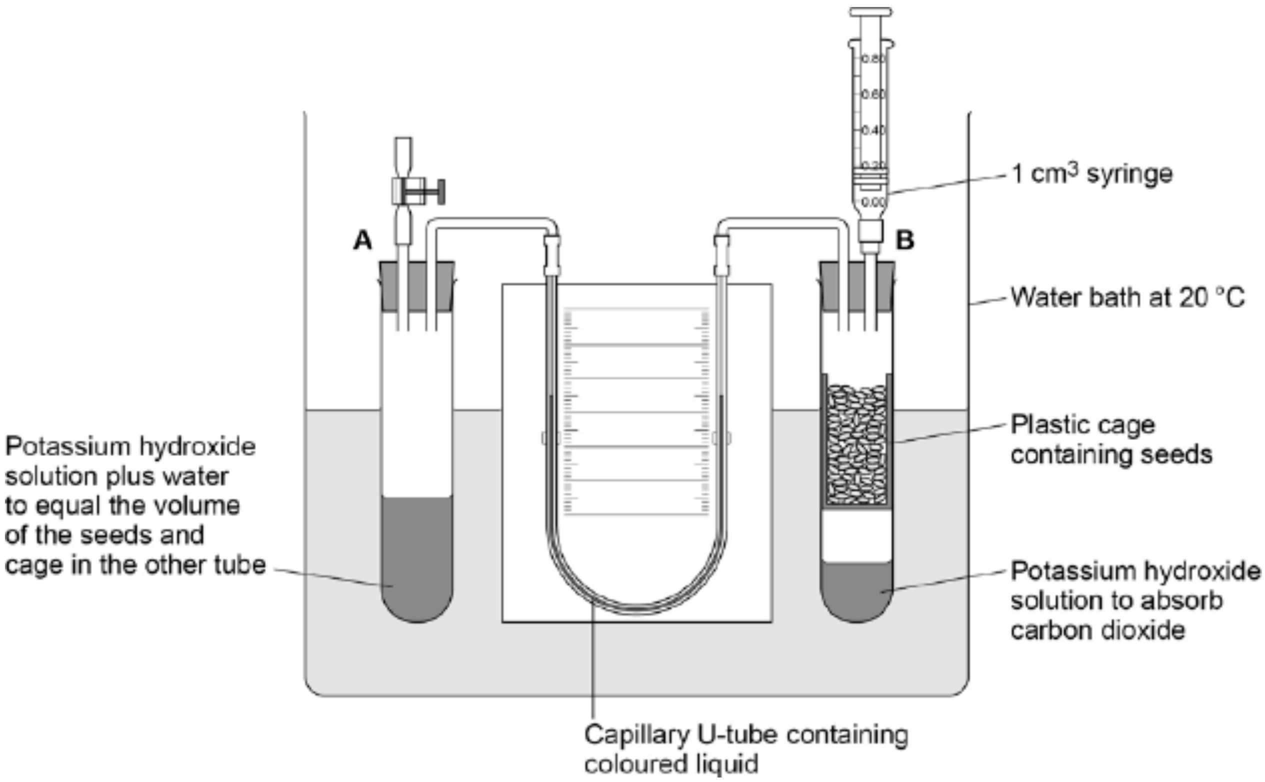
____

(3)

(Total 7 marks)

Q8.

The figure below shows the apparatus used for measuring the rate of oxygen consumption in aerobic respiration by seeds.



(a) For the first 10 minutes, the tap attached to tube **A** was left open and the syringe from tube **B** was removed.

Suggest **three** reasons why the apparatus was left for 10 minutes.

1. ____

____

2. ____

____

3. ____

____

(3)

(b) Suggest and explain why the chosen temperature was 20 °C for this experiment.

____

____

____

____

(2)

After 10 minutes, the tap attached to tube **A** was closed and the syringe was attached to tube **B**. Every minute, the syringe plunger was moved until the levels in the U-tube were the same. The reading on the syringe volume scale was then recorded.

The results are shown in the table below.

Time / minutes	Reading on syringe volume scale / cm^3
0	0.84
1	0.81
2	0.79
3	0.76
4	0.73
5	0.70
6	0.68
7	0.66
8	0.63
9	0.62
10	0.58

(c) During the experiment, the coloured liquid in the tubing moved towards tube **B**. Explain what caused this.

____

____

____

____

____

____

____

(3)

(d) The mass of the seeds was 1.6 g. Use the information in the table above to calculate the rate of oxygen consumption in $cm^3\ g^{-1}\ hour^{-1}$ by the seeds.

Show your working.

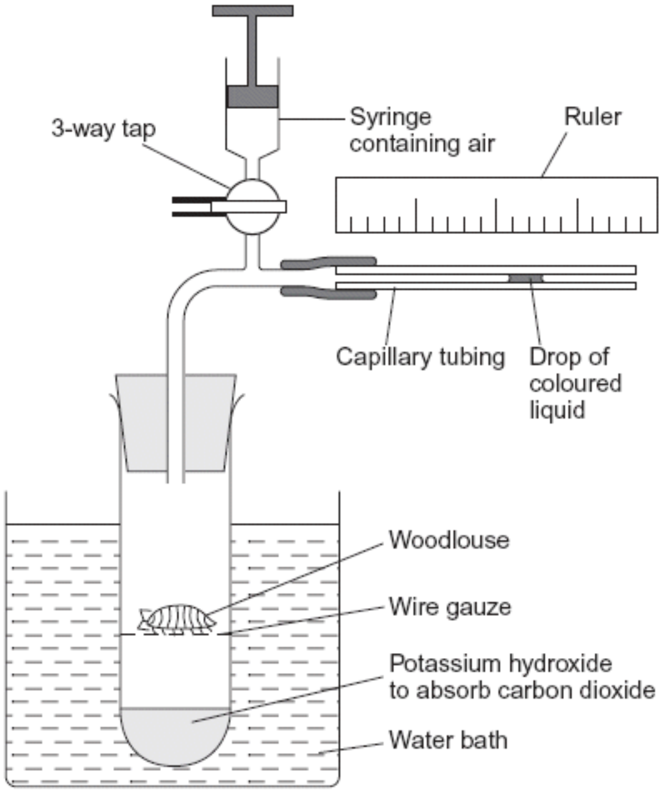
Rate = ____________________ $cm^3\ g^{-1}\ hour^{-1}$

(2)

(Total 10 marks)

Q9.

(a) A student measured the rate of aerobic respiration of a woodlouse using the apparatus shown in the diagram.



(i) The student closed the tap. After thirty minutes the drop of coloured liquid had moved to the left. Explain why the drop of coloured liquid moved to the left.

____

____

____

____

____

____

(3)

(ii) What measurements should the student have taken to calculate the rate of aerobic respiration in mm^3 of oxygen g^{-1} h^{-1}?

____

____

____

____

____

(3)

(b) DNP inhibits respiration by preventing a proton gradient being maintained across membranes. When DNP was added to isolated mitochondria the following changes were observed

- less ATP was produced
- more heat was produced
- the uptake of oxygen remained constant.

Explain how DNP caused these changes.

____

____

____

____

____

____

(3)
(Total 9 marks)

Q10.

(a) Pyruvate is formed in the breakdown of glucose during respiration. When there is sufficient oxygen, this pyruvate is fully broken down. Name **two** substances formed from the pyruvate.

1. ____

2. ____

(1)

(b) (i) If there is a shortage of oxygen in muscle cells during exercise, some pyruvate is converted into lactate. Explain why muscles become fatigued when insufficient oxygen is available.

____

____

____

____

(2)

(ii) Some of the lactate is oxidised to pyruvate by muscles when they are well-supplied with oxygen. Suggest an advantage of the lactate being oxidised in the muscles.

____

____

____

____

(2)

(Total 5 marks)

Mark scheme

Q1.

(a) 1. Oxidation of / hydrogen removed from pyruvate <u>and</u> carbon dioxide released;

2. Addition of coenzyme A.

Accept: NAD reduced for oxidation

2

(b) (i) 1. Change (in shape) of active site / active site moulds around the substrate;

Reject: reference to inhibitor

Accept: change in tertiary structure affecting active site

2. (Substrate / active site) now <u>complementary</u>.

Neutral: references to two active sites

2

(ii) 1. Is a competitive inhibitor / attaches to active site;

Neutral: reference to inhibitor forming an enzyme-substrate complex

2. Reduces / prevents enzyme-substrate / E-S complex forming.

Accept: Reduces / prevents acetylcoenzyme A binding to enzyme / citrate synthase

2

(c) (i) 1. Regenerates / produces NAD / oxidises reduced NAD;

2. (NAD used) in glycolysis.

Accept: description of glycolysis

Accept: glycolysis can continue / begin

2

(ii) (Pyruvate used) in aerobic respiration / (lactate / lactic acid) is toxic / harmful / causes cramp / (muscle) fatigue.

Accept: (pyruvate) can enter link reaction

Accept: reduces cramp / (muscle) fatigue

Neutral: 'reduces muscle aches'

1

[9]

Q2.

(a) (i) glycolysis;

1

(ii) oxygen removed from pyruvate / reduced NAD is oxidised / donates hydrogen / donates electrons;

1

(iii) allows NAD to be recycled / re-formed;
so that glycolysis / described / candidates answer to (i) can proceed / so that (more) glucose can be converted to pyruvate / so that process X can continue;

2

(b) (i) ATP formed / used;
pyruvate formed / reduced;
NAD / reduced NAD;
glycolysis involved / two stage process;

2 max

(ii) ethanol / alcohol formed by yeast, lactate (*allow lactic acid*) by muscle cell; CO_2 released by yeast but not by muscle cell;
(note: need both parts of the comparison for the mark)

2

(c) (i) allows anomalies to be identified / increases reliability (of means / averages / results);
allows use of statistical test;

2

(ii) $\frac{38.3 + 27.6 + 29.4}{3}$ = 31.8 / 31.76 / 31.77;
(units not required)

÷ (5 × 60) = 0.106 / 0.11 / 0.1;
(correct answer scores two marks, however derived.)
(correct mean volume (31.8 cm^3) however derived scores 1 mark)

2

(iii) Volume(s) less / no gas evolved;
So (volume) CO_2 evolved = (volume of) O_2 taken in;

3

[15]

Q3.

(a) X = Carbon dioxide;
Y = Acetyl coenzyme A;
(ACCEPT Acetyl CoA)

Z = Water;

3

(b) (i) Cytoplasm;

1

(ii) Mitochondrion;
(IGNORE named part)

1

(c) <u>On the diagram:</u>

(i) '**A**' (ATP used) – <u>between</u> glucose and triose phosphate;

1

(ii) '**B**' <u>Any **two** from</u>:

(ATP produced) – between triose phosphate and pyruvate;
in Krebs cycle;
from electron carriers
(to right of bracket & not below grey box);

max 2

(d) <u>Any **three** from</u>:

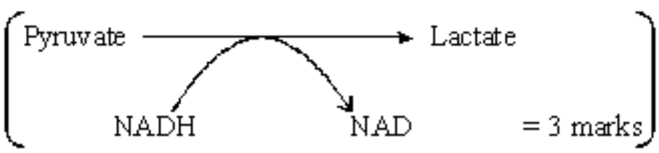
Source of energy / of phosphate;
Active transport;
Phagocytosis / endo- / exocytosis / pinocytosis;
Bile production;
Cell division / mitosis;
Synthesis of: glycogen;
protein / enzymes;
DNA / RNA;
lipid / cholesterol;
urea;

max 3

(e) <u>Any **four** from</u>:
Forms lactate; [extras – C_2H_5OH / CO_2 – *CANCEL*]

Use of reduced NAD / NADH;

Regenerates NAD;



NAD can be re-used to oxidise more respiratory substrate / correct e.g. / allows glycolysis to continue;
Can still release energy / form ATP
<u>when oxygen in short supply</u> / <u>when no oxygen</u>;

max 4

[15]

Q4.

(a) (Absorption of) light; **1**

(b) Inner membrane / cristae / stalked particles of mitochondria; **1**

[2]

Q5.

(a) matrix; **1**

(b) pyruvate;
ADP;
P / inorganic phosphate;
reduced NAD;
oxygen;
2 max

(c) larger surface area for electron carrier system / oxidative phosphorylation; provide ATP / energy for contraction; **2**

(d) (i) pyruvate; **1**

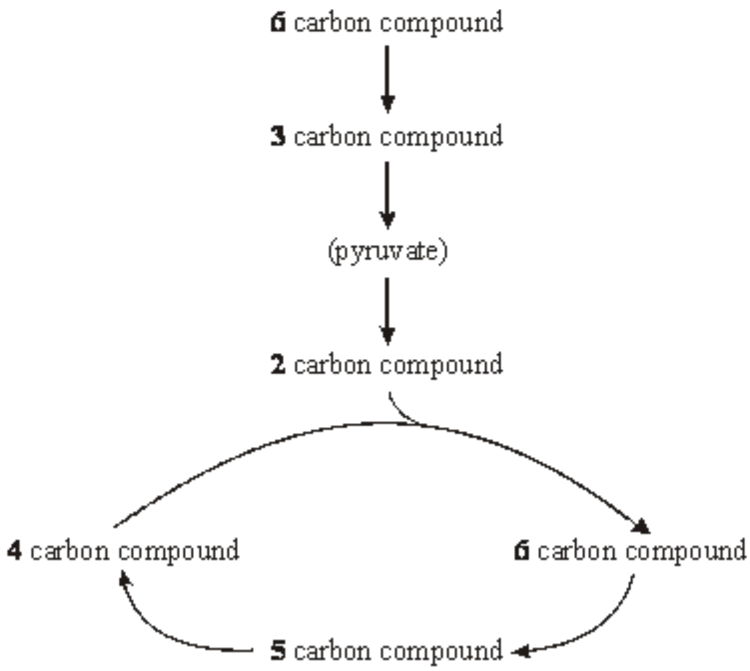
(ii) carbon dioxide formed / decarboxylation;
hydrogen released / reduced NAD formed;
acetyl coenzyme A produced;
2 max

(e) NAD / FAD reduced / hydrogen attached to NAD / FAD;
H^+ ions / electrons transferred from coenzyme to coenzyme / carrier to carrier / series of redox reactions;
energy made available as electrons passed on;
energy used to synthesise ATP from ADP and phosphate / using ATPase;
H^+ / protons passed into intermembrane space;
H^+ / protons flow back through stalked particles / enzyme;
3 max

[11]

Q6.

(a)



(1 mark for three correct answers)
(2 marks for six correct answers)

2

(b) reduced NAD / NADH / $NADH_2$;
reduced FAD / FADH / $FADH_2$;
ATP;

3

[5]

Q7.

(a) (i) **P** = 3;
Q = acetylcoenzyme A;

2

(ii) 36 ATP, however derived = 2 marks
30 ATP, however derived = 1 mark

2

(iii) *Correct statement in the context of aerobic respiration or anaerobic respiration concerning:*
Oxygen as terminal hydrogen / electron acceptor allowing operation of electron transport chain / oxidative phosphorylation;
Fate of pyruvate;
Significance of ATP formed in glycolysis;

3

[7]

Q8.

(a) 1. Equilibrium reached.

Accept equilibrate

2. Allow for expansion / pressure change in apparatus;
3. Allow respiration rate of seeds to stabilise.

Ignore seeds acclimatise

3

(b) 1. Optimum temperature / temperature for normal growth of seeds;
2. (Optimum temperature) for enzymes involved in respiration.

2

(c) 1. Oxygen taken up / used by seeds;
2. CO_2 given out is absorbed by KOH (solution);
3. Volume / pressure (in **B**) decreases.

3

(d) 0.975 / 0.98.

If incorrect,
0.26 × 6 / or incorrect numbers divided by 1.6 for 1 mark

2

[10]

Q9.

(a) (i) 1. Oxygen taken up / used (by woodlouse);

2. Carbon dioxide (given out) is absorbed by solution / potassium hydroxide;

3. Decrease / change in pressure;

Reference to vacuum negates last marking point
Reject reference to pressure increasing inside tube

3

(ii) 1. Distance (drop moves) and time;

2. Mass of woodlouse;

3. Diameter / radius / bore of tubing / lumen / cross-sectional area;

If answer refers to measuring volume using the syringe allow 2 max –
one mark for measuring volume;
one mark for mass of woodlouse;

3

(b) 1. Less / no proton / H^+ movement so less / no ATP produced;

2. Heat released from electron transport / redox reactions / energy not used to produce ATP is released as heat;

3. Oxygen used as final electron acceptor / combines with electrons (and protons);

3

[9]

Q10.

(a) CO_2, water, ATP, reduced NAD / FAD;

(accept creatine phosphate)(any 2 - one tick)

1

(b) (i) build up / increased concentration of lactate lowers
pH / increases H^+ / increases acidity;
enzymes / named protein inhibited*(not denatured);*

2

(ii) lactate / pyruvate is an energy source;
muscles have increased / immediate energy or ATP supply;
(accept lactate replenishes glycogen or glucose)
restores pH levels;

2 max

[5]