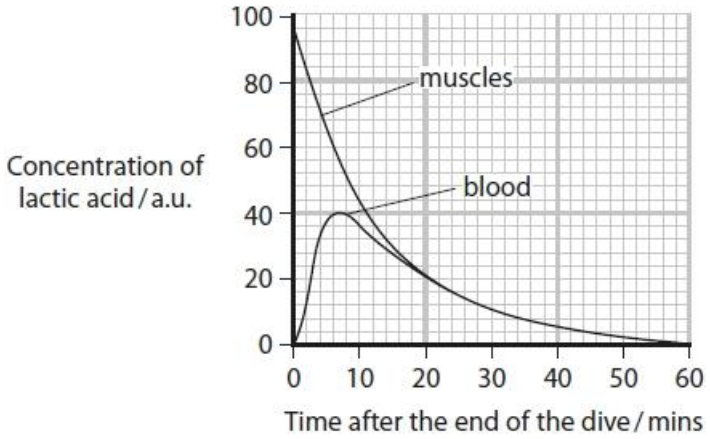
Questions

Q1.

Weddell seals spend a lot of their time swimming underwater, diving to find food and diving to avoid predators.

However, they do have to come to the surface to breathe.

The graph shows the changes in the lactic acid concentration in the muscles and blood of a Weddell seal, after a prolonged dive.



Explain the importance of these changes after the Weddell seal comes to the surface to breathe.

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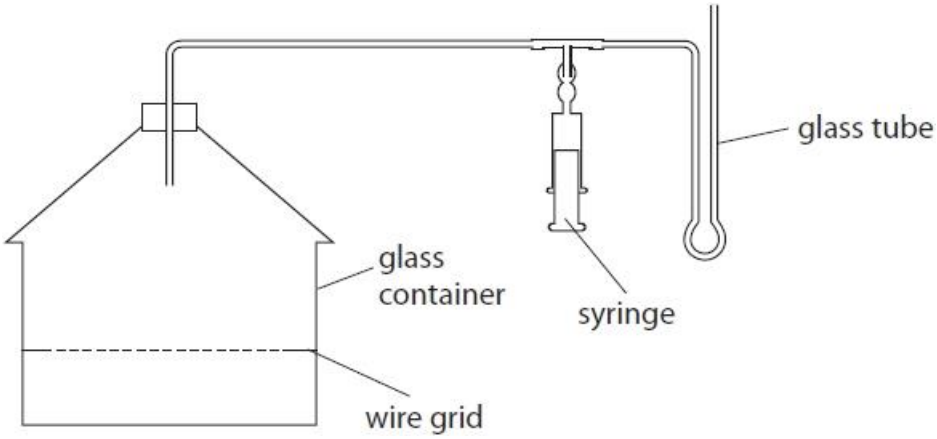
(Total for question = 3 marks)

Q2.

The diagram shows a respirometer.



Explain how a student could modify this respirometer and use it to measure the mean oxygen consumption of a rat.

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(Total for question = 4 marks)

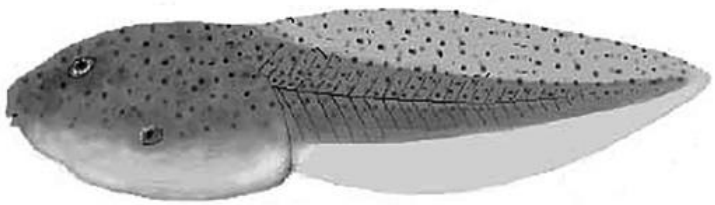
Q3.

The adult American bullfrog, *Rana catesbeiana*, can live in water or on land.

Adult frogs lay eggs in water where they are fertilised.

The fertilised eggs develop into tadpoles that live only in water.

The photograph shows a tadpole.



(i) Human activity can cause pollution that reduces the oxygen concentration in water.

Explain why a low oxygen concentration in the water would lower the pH of the blood of the tadpole.

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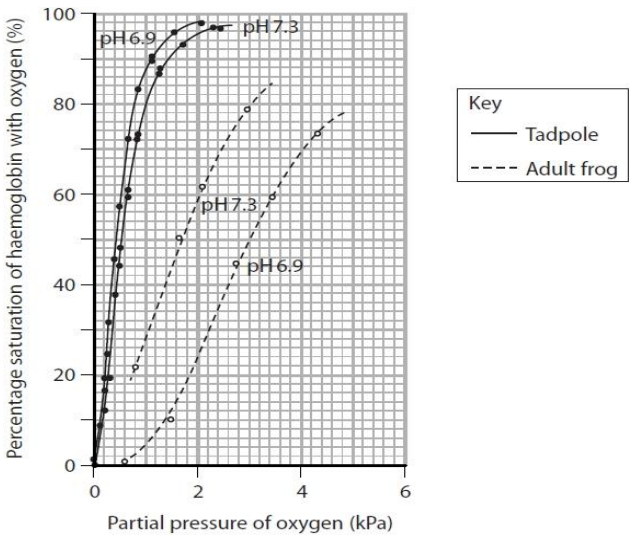
*(ii) The graph shows the effect of pH on the oxygen dissociation curves of haemoglobin for adult frog blood and tadpole blood.



The adult frog can either live on land or in water. The tadpole always lives in water. Discuss how the shape and position of the dissociation curves reflect the habitat in which these animals live.

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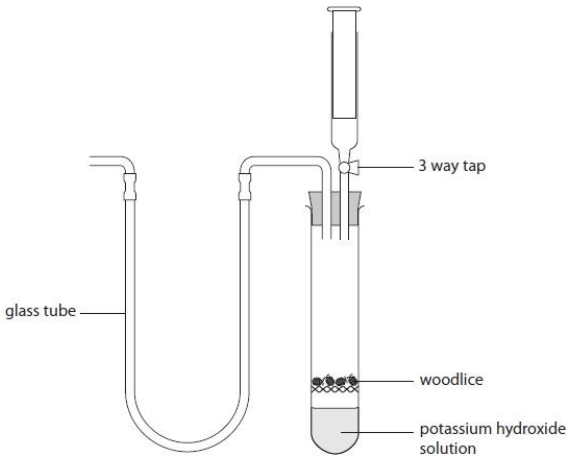
(Total for question = 12 marks)

Q4.

Fluoride ions reduce anaerobic respiration in yeast by inhibiting the action of the enzyme enolase.

Fluoride ions combine with magnesium ions and phosphate ions to resemble the substrate of enolase.

* The diagram shows some apparatus that can be used to measure the rate of respiration in small animals such as woodlice.



Discuss how you would modify this apparatus and use it to find out if fluoride ions have a significant effect on the rate of anaerobic respiration in yeast.

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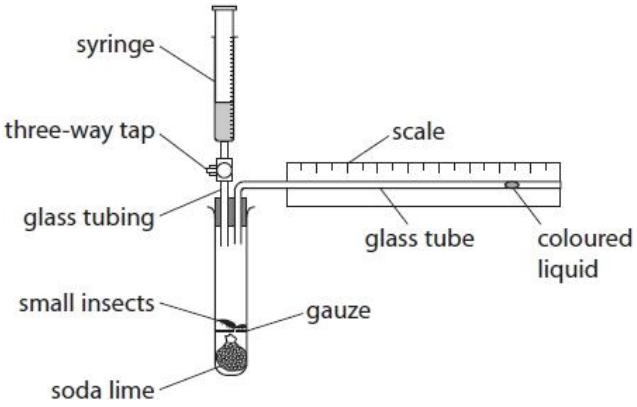
(Total for question = 9 marks)

Q5.

A respirometer was used to compare the rate of aerobic respiration of two species of insect.

The diagram shows the respirometer.



(i) Give the units for a valid comparison of the rate of respiration of these two species of insect.

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(ii) Other factors may affect the results from this respirometer.

Describe how one named factor could be controlled when using this respirometer.

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(iii) Explain why the soda lime in the tube must be replaced when the other species of insect is placed in the respirometer.

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(Total for question = 5 marks)

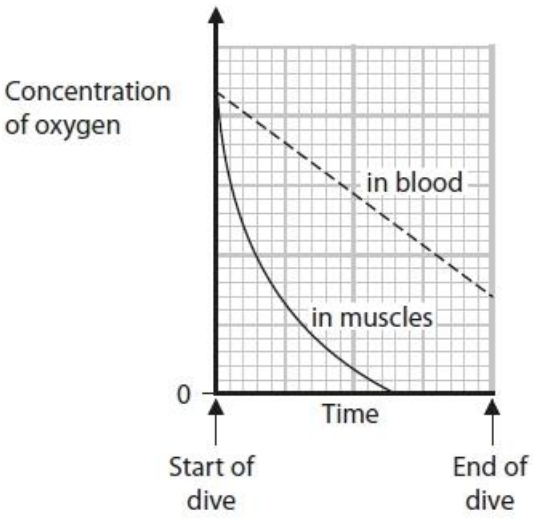
Q6.

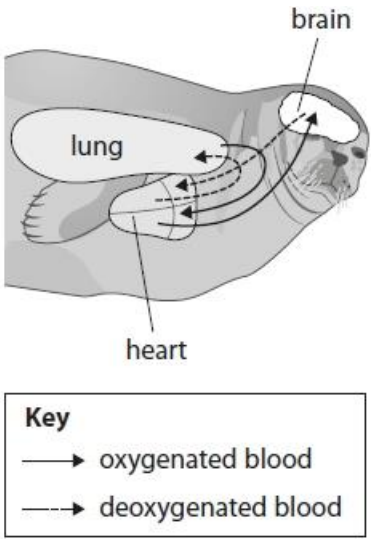
Weddell seals spend a lot of their time swimming underwater, diving to find food and diving to avoid predators.

However, they do have to come to the surface to breathe.

An investigation studied the change in the concentration of oxygen in the blood and muscles of a Weddell seal during a dive.

The graph shows the results of this investigation and the diagram shows part of the circulation of blood in the seal during the dive.





Analyse the data to explain these results.

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(Total for question = 3 marks)

Q7.

Hypoxia is an inadequate supply of oxygen to tissues and cells that restricts their function.

The body responds to hypoxia by releasing hypoxia-inducible transcription factors (HIF).

Investigations have shown that one effect of HIF is an increase in the rate of glycolysis in the affected cells.

(i) Explain how HIF could result in an increase in the rate of glycolysis.

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(ii) Explain why cells need to respond to hypoxia with an increase in the rate of glycolysis.

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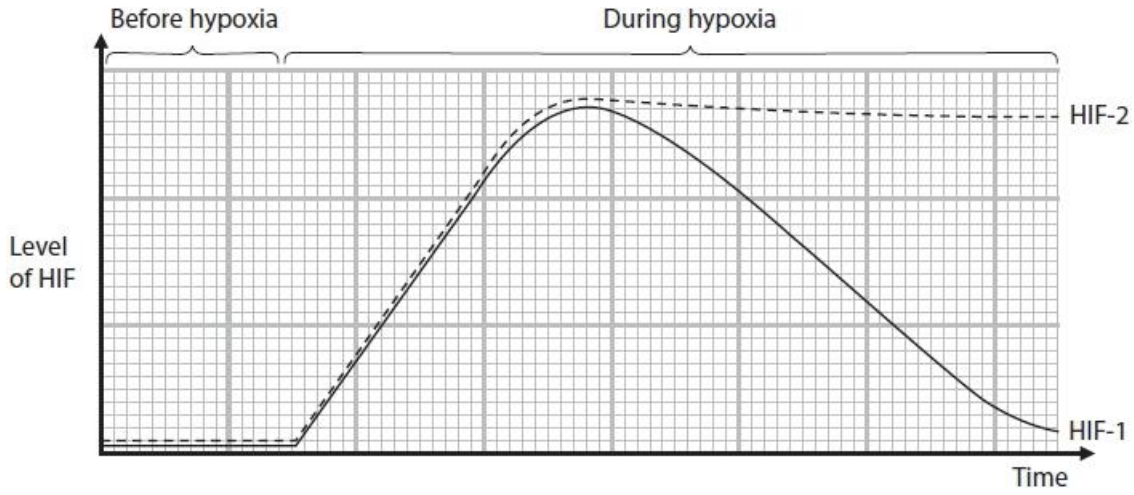
(iii) The graph shows the changes in levels of two HIFs, HIF-1 and HIF-2, before and during hypoxia.



Compare and contrast the changes in the levels of HIF-1 and HIF-2 during hypoxia.

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(iv) Explain the changes in levels of HIF-1 and HIF-2 during hypoxia.

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(Total for question = 10 marks)

Mark Scheme

Q1.

Question Number	Answer	Additional Guidance	Mark
	An explanation that makes reference to three of the following: • lactic acid (accumulation) in the muscles is toxic (1) • therefore it passes from the muscles into the blood (1) • lactic acid is taken from the muscles to the liver by the blood (1) • drop in pH (caused by lactic acid) will denature enzymes (in thecells / blood) (1)		(3)

Q2.

Question Number	Answer	Mark
	An explanation that makes reference to four of the following: • use {soda lime / KOH / NaOH} to absorb carbon dioxide (1) • put {water / dye / ink} (1) • use ruler / scale to measure distance (1) • use {syringe / cross sectional area multiplied by distance / use $\pi r^2 d$} to measure volume of oxygen (1) • use {syringe / 3-way tap} to reset / do repeats (1) • control temperature using water bath (1)	**(4)**

Q3.

Question Number	Answer	Mark
(i)	An explanation that makes reference the following: • anaerobic respiration takes place (1) • therefore {lactic acid / lactate} is produced (1) • because pyruvate reduced / NADH oxidised / NADH converted to NAD^+ / NADH donates H^+ or proton or e^- (1)	(3)

Question Number	Indicative content
*(ii)	Answers will be credited according to candidate's deployment of knowledge and understanding of material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Description: D** shape of curve is sigmoid / S-shaped tadpole curves are steeper tadpole curves are further to the left than frog curves lower pH moves curve to left in tadpole lower pH moves curve to the right in frog tadpole curves are closer together than frog curves reference to correct comparative % ONCE **Explanation: E** at higher ppO_2 blood more saturated / as ppO_2 increases saturation increases at lower ppO_2 blood less saturated / as ppO_2 decreases saturation decreases tadpole is more saturated at lower ppO_2 tadpole more dissociation with change in $pp0_2$ tadpole has higher % saturation than frog tadpole blood has greater affinity than blood movement lowers pH in blood Bohr shift in frog conformational change makes binding easier steep part of curve means small change in ppO_2 causes large change in percentage saturation top part of curve represents situation in gills or lungs bottom part of curve represents situation in tissues **Habitat: H** less oxygen in water than in air / ppO_2 in water lower than ppO_2 in air (lowering pH) tadpole is more able to obtain oxygen from polluted water (lowering pH) frog more able to release oxygen to tissues during exercise / activity / movement adaptations allow tadpole / frog to survive harder to move in water than on land

Level	Marks	
0	**0**	No awardable content
1	**1-3**	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. **1 to 3 from D, E or H**
2	**4-6**	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure. **1H and 4 to 6 in total**
3	**7-9**	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts.
		Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **2H and 7 to 9 plus in total**

Q4.

Question Number	Indicative content
*	Answers will be credited according to candidates' deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. <u>Modify:</u> - uses yeast - provide glucose to yeast - remove potassium hydroxide / remove gauze - coloured liquid put into tubing - scale / ruler - add oil on top of yeast / glucose mixture / use boiled glucose solution <u>'Use' Method:</u> - use apparatus to measure the carbon dioxide released - use range concentrations of fluoride / plus and minus fluoride - replication carried out - use of control - control species of yeast / mass of yeast / volume of mixture / temperature - allow yeast to acclimatise with the three-way tap open - wait for lag phase to finish before measuring rate of reaction <u>'Significant' - Analysis:</u> - use statistical analysis - t test - volume divided by time / distance divided by time - calculate volume from tube diameter - plot graph of respiration against fluoride concentration - use error bars / calculate standard deviation - calculate mean

Level	Marks	
0	0	No awardable content
1	1-3	Demonstrates isolated elements of biological knowledge and understanding to the given context with generalised comments made. Vague statements related to consequences are made with limited linkage to a range of scientific ideas, processes, techniques and procedures. The discussion will contain basic information with some attempt made to link knowledge and understanding to the given context. **Covers up to 3 ideas with no analysis** **Uses woodlice means Level 1 max**
2	4-6	Demonstrates adequate knowledge and understanding by selecting and applying some relevant biological facts/concepts. Consequences are discussed which are occasionally supported through linkage to a range of scientific ideas, processes, techniques and procedures. The discussion shows some linkages and lines of scientific reasoning with some structure. **Covers from 4 to 6 ideas including at least 1 analysis** **Inappropriate method eg. yeast and photosynthesis / aerobic respiration / Benedict's / keeping KOH means Level 2 and maximum of 5 marks**
3	7-9	Demonstrates comprehensive knowledge and understanding by selecting and applying relevant knowledge of biological facts/concepts. Consequences are discussed which are supported throughout by sustained linkage to a range of scientific ideas, processes, techniques or procedures. The discussion shows a well-developed and sustained line of scientific reasoning which is clear and logically structured. **Covers 7 or more ideas including at least 2 analysis** **Max 8 if no statistical analysis**

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	{mm/cm/mm^3/cm^3} min^{-1} g^{-1}		(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	A description that makes reference to the following: • named factor (1) • how controlled (1)	 e.g. temperature, {size / mass / age} of insect e.g. thermostatically controlled water bath / water bath set at a constant temperature / ac room choose equal { size / mass / age} of insect	(2)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to the following: • it has already absorbed the maximum amount of carbon dioxide / no more carbon dioxide can be absorbed (1) • (therefore) coloured liquid {would not move / would move less} / readings {are an underestimate / will not be valid} (1)	 Accept it is able to absorb less carbon dioxide (for the second insect) Accept (it is replaced) so that coloured liquid will move / so that readings will be valid	(2)

Q6.

Question Number	Answer	Additional Guidance	Mark
	An answer that makes reference to four of the following: • oxygen in blood decreases as it moves into {muscles / cells / named cell} for (aerobic) respiration (1) • blood retains some oxygen (even though the muscles are depleted) (1) • this is to supply oxygen to the brain so that the cells do not die(1) • oxygen decreases in muscles as it is used to generate ATP formuscle contraction (1)	**ACCEPT** energy	(3)

Q7.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to two of the following: • because HIF can switch on gene (expression) (1) • bind to a promotor region / stimulate transcription / stimulate protein synthesis} (1) • for {enzymes / proteins} involved in glycolysis (1)	**ACCEPT** increased gene expression **ACCEPT** increase rate of transcription **IGNORE** enzymes **ACCEPT** named {enzyme / protein} involved in glycolysis e.g. enzyme that makes NAD **IGNORE** NAD otherwise	(2) EXP
Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to the following: • (because if conditions are hypoxic) there is not much oxygen available to act as a terminal electron acceptor (1) • therefore the electron transport chain will not operate (1) • therefore ATP production by oxidative phosphorylation will be reduced (1)	**ACCEPT** no oxygen **IGNORE** numbers of ATP molecules produced	(4) EXP

	• ATP is produced (directly / SLP) during glycolysis (during these anaerobic conditions) (1)		

Question Number	Answer	Additional Guidance	Mark
(iii)	An answer that makes reference to the following: • both HIF-1 and HIF-2 increase (during hypoxia) (1) • levels of HIF-2 remain high (after a small decrease) but levels of HIF-1 fall (1)	**DO NOT PIECE TOGETHER** **IGNORE** any explanations given	(2) EXP

Question Number	Answer	Additional Guidance	Mark
(iv)	An explanation that makes reference to two of the following: • HIF-1 and HIF-2 switch on different genes (1) • {products / transcription of genes} resulting from the presence of both HIF-1 and HIF-2 are needed in the early stages of hypoxia (1) • {products / transcription of gene} resulting from the presence of HIF-2 are needed {for longer periods of hypoxia / to sustain glycolysis} (1)	**ACCEPT** bind to different promotor regions **ACCEPT** converse for HIF-1	(2) EXP