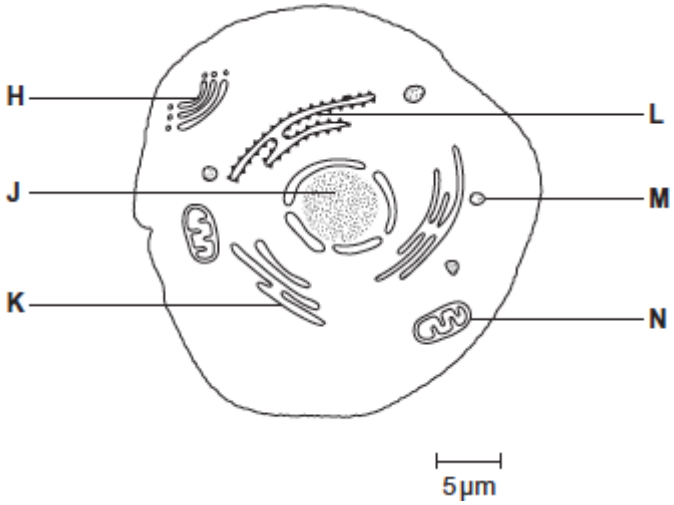
Q1.

The diagram shows a eukaryotic cell.



(a) Complete the table by giving the letter labelling the organelle that matches the function.

Function of organelle	**Letter**
Protein synthesis	
Modifies protein (for example, adds carbohydrate to protein)	
Aerobic respiration	

(3)

(b) Use the scale bar in the diagram above to calculate the magnification of the drawing. Show your working.

Answer = _____

(2)

(Total 5 marks)

Q2.

(a) What is a monomer?

_____

_____

_____

_____

_____

(1)

(b) Lactulose is a disaccharide formed from one molecule of galactose and one molecule of fructose.

Other than both being disaccharides, give one similarity and one difference between the structures of lactulose and lactose.

Similarity _____

_____

_____

_____

_____

Difference _____

_____

_____

_____

_____

(2)

(c) Following digestion and absorption of food, the undigested remains are processed to form faeces in the parts of the intestine below the ileum.

The faeces of people with constipation are dry and hard. Constipation can be treated by drinking lactulose. Lactulose is soluble, but is not digested or absorbed in the human intestine.

Use your knowledge of water potential to suggest why lactulose can be used to help people suffering from constipation.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(2)

(d) Lactulose can also be used to treat people who have too high a concentration of hydrogen ions (H^+) in their blood.

The normal range for blood H^+ concentration is 3.55×10^{-8} to 4.47×10^{-8} mol dm^{-3}

A patient was found to have a blood H^+ concentration of 2.82×10^{-7} mol dm^{-3}

Calculate the minimum percentage decrease required to bring the patient's blood H^+ concentration into the normal range.

Answer = _____

(2)

(Total 7 marks)

Q3.

(a) Draw **and** label a single DNA nucleotide.

(2)

(b) Give **two** features of DNA **and** explain how each one is important in the semi-conservative replication of DNA.

1. _____

_____

_____

2. _____

_____

_____

(2)

(c) Replication of mitochondrial DNA (mtDNA) is different from that of nuclear DNA.

The replication of the second strand of mtDNA **only** starts after two-thirds of the first strand of mtDNA has been copied.

A piece of mtDNA is 16 500 base pairs long and is replicated at a rate of 50 nucleotides per second.

Tick (✓) the box that shows how long it would take to copy this mtDNA.

A 330 seconds ☐

B 440 seconds ☐

C 550 seconds ☐

D 660 seconds ☐

(1)

(Total 5 marks)

Q4.

A scientist used grasshoppers to investigate the effect of composition of air on breathing rate in insects. He changed the composition of air they breathed in by varying the concentrations of oxygen and carbon dioxide.

The scientist collected 20 mature grasshoppers from a meadow. He placed the grasshoppers in a small chamber where he could adjust and control the composition of air surrounding them. The small chamber restricted the movement of the grasshoppers.

His results for three of the grasshoppers are shown in the table below in the form in which he presented them.

		Percentage of oxygen and carbon dioxide in different types of air breathed in by grasshoppers			
		A Air from atmosphere	**B Pure oxygen**	**C Gas mixture 1**	**D Gas mixture 2**
Gas	**Oxygen**	20.9	100.0	91.0	84.0
	Carbon dioxide	0.1	0.0	9.0	16.0
Breathing rate of grasshopper in different types of air / breaths per minute	**Grasshopper 1**	53	11	99	107
	Grasshopper 2	48	25	88	99
	Grasshopper 3	61	13	96	93

(a) The percentages of oxygen and carbon dioxide in Column **A** do **not** add up to 100% but in columns **C** and **D** they do.
Suggest **two** reasons for this difference.

1. _____

_____

2. _____

_____

(2)

(b) Use all the data to describe the effect of concentration of carbon dioxide on the breathing rate of grasshoppers.

_____

_____

_____

_____

_____

_____

(3)

(c) One of the different types of air was similar to the air in the meadow where the grasshoppers were collected. It provides data that might be used to calculate a mean breathing rate for grasshoppers in the meadow.

(i) Use the data to estimate the mean breathing rate of the three grasshoppers in the meadow. Show your working.

Mean breathing rate = _____ breaths per minute

(2)

(ii) The estimate does not provide a reliable value for the mean breathing rate of all insect species in the meadow.
Other than being an estimate, suggest and explain **three** reasons why this value would **not** be reliable.

1. _____

_____

_____

2. _____

_____

_____

3. _____

_____

_____

(3)
(Total 10 marks)

Q5.

Farmers use artificial fertilisers to maintain or increase yield from grain-producing crop plants such as wheat.

(a) Artificial fertiliser is used to replace mineral ions removed from the land when crops are harvested. One of the mineral ions is nitrate.

Give **two** examples of biological molecules containing nitrogen that would be removed when a crop is harvested.

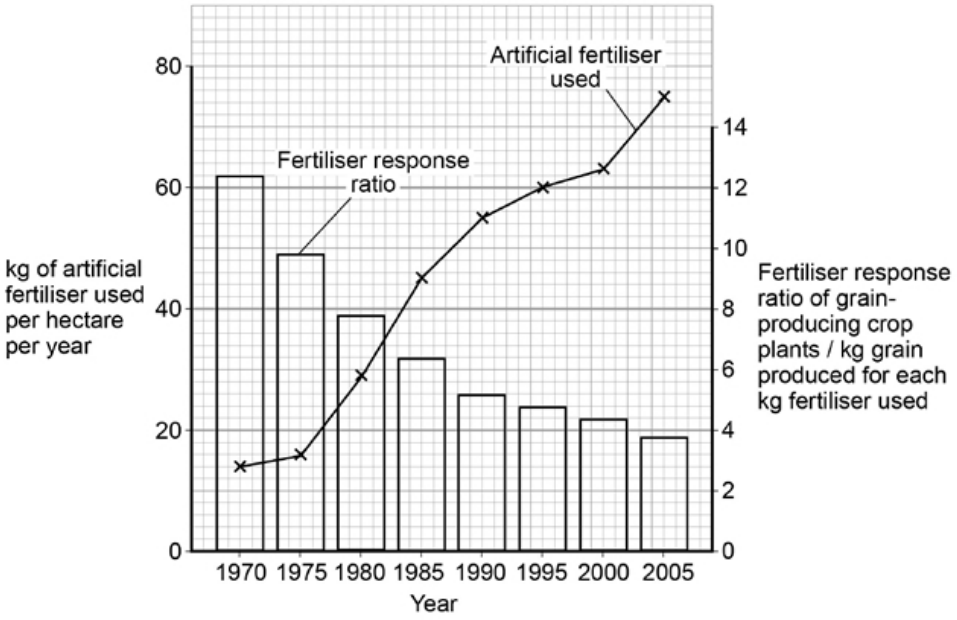
1. _____

2. _____

(2)

(b) Scientists investigated changes in the use of artificial fertiliser in India between 1970 and 2005. They also investigated changes in the **fertiliser response ratio**. This ratio shows how many kg of grain are produced for each kg of fertiliser used.

The graph shows their results in the form the scientists presented them. (A hectare is a unit of area commonly used in agriculture)



Use these data to calculate the difference in the mass of grain produced per hectare in 1970 compared with 2005.

Show your working.

Difference _____ kg hectare^{-1}

(2)

(c) Use the data in the graph above to evaluate the use of artificial fertilisers on grain-producing crops in India.

_____

_____

_____

_____

_____

_____

(2)
(Total 6 marks)

Q6.

(a) Describe the relationship between size and surface area to volume ratio of organisms.

_____

_____

_____

_____

_____

(1)

(b) A scientist calculated the surface area of a large number of frog eggs. He found that the mean surface area was 9.73 mm^2. Frog eggs are spherical.

The surface area of a sphere is calculated using this equation

Surface area = $4 \pi r^2$ (where r is the radius of a sphere) $\pi = 3.14$

Use this equation to calculate the mean diameter of a frog egg.

Show your working.

Diameter = _____ mm

(2)

The scientist calculated the ratio of surface area to mass for eggs, tadpoles and frogs. He also determined the mean rate of oxygen uptake by tadpoles and frogs.

His results are shown in the table.

Stage of frog development	Ratio of surface area to mass	Mean rate of oxygen uptake / μmol g^{-1} h^{-1}
Egg	2904 : 1	no information
Tadpole	336 : 1	5.7
Adult	166 : 1	1.3

(c) The scientist used units of μmol g^{-1} h^{-1} for the rate of oxygen uptake.

Suggest why he used μmol in these units.

_____

_____

_____

_____

_____

(1)

(d) The scientist decided to use the ratio of surface area to mass, rather than the ratio of surface area to volume. He made this decision for practical reasons.

Suggest **one** practical advantage of measuring the masses of frog eggs, tadpoles and adults, compared with measuring their volumes.

_____

_____

_____

_____

(1)

(e) Explain why oxygen uptake is a measure of metabolic rate in organisms.

_____

_____

_____

_____

_____

(f) A student who looked at these results said that they could not make a conclusion about the relationship between stage of development and metabolic rate.

Use information in the table to explain reasons why they were unable to make a conclusion.

_____

_____

_____

_____

_____

_____

_____

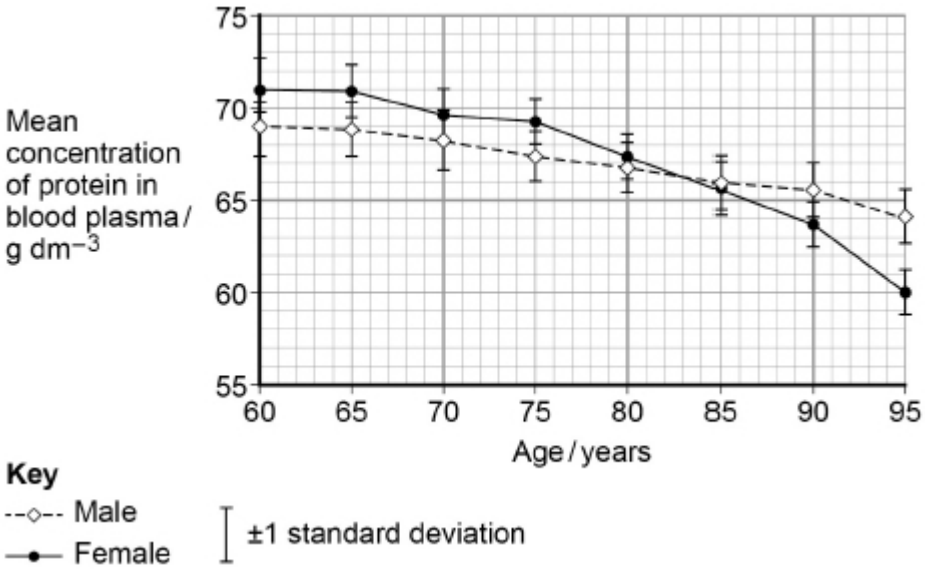
_____

(3)
(Total 9 marks)

Q7.

Scientists investigated how the concentration of protein in blood plasma changes in people between the ages of 60 and 95.

The graph shows the scientists' results. The bars show ±1 standard deviation.



(a) What is the difference between males and females in the fall in mean concentration of protein in blood plasma between 60 and 95 years?

Answer = _____ g dm^{-3}

(1)

(b) Use the graph above to calculate the rate of change of the mean concentration of protein in the blood plasma of males between the ages of 60 and 95.

Show your working.

Answer = _____ g dm^{-3} $year^{-1}$

(2)

(c) What can you conclude from the graph above about the effect of ageing on the mean concentration of protein in the blood plasma in males and females?

_____

_____

_____

_____

_____

_____

(2)

(d) The scientists measured the absorption of each sample of blood plasma using a colorimeter. They used a calibration curve to find the concentration of protein in samples of blood plasma.

Describe how the scientists could obtain data to produce a calibration curve and how they would use the calibration curve to find the concentration of protein in a sample of blood plasma.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

(e) Older people are more likely to suffer from infectious diseases.

Suggest how this may be linked to the decrease in the mean concentration of protein in the blood as people get older.

_____

_____

_____

(1)

(Total 9 marks)

Q8.

(a) Give **three** properties of water that are important in biology. **(NOT EDEXCEL)**

1. _____

_____

2. _____

_____

3. _____

(3)

A student investigated the effect of different concentrations of sucrose solution on "chips" cut from a potato. Each chip had the same dimensions.

The student:

- weighed each chip at the start
- placed each chip in a separate test tube, each containing 10 cm^3 of sucrose solution at a different concentration
- left the chips in the sucrose solution for 24 hours
- dried the surface of the chips and then weighed them again.

The table shows the student's results.

Concentration of sucrose solution / mol dm^{-3}	Initial mass of chip / g	Final mass of chip / g	Ratio of final mass to initial mass of chips
0.0	2.79	3.82	
0.2	2.75	2.97	
0.4	2.78	2.67	
0.6	2.69	2.31	
0.8	2.72	2.20	
1.0	2.77	1.99	

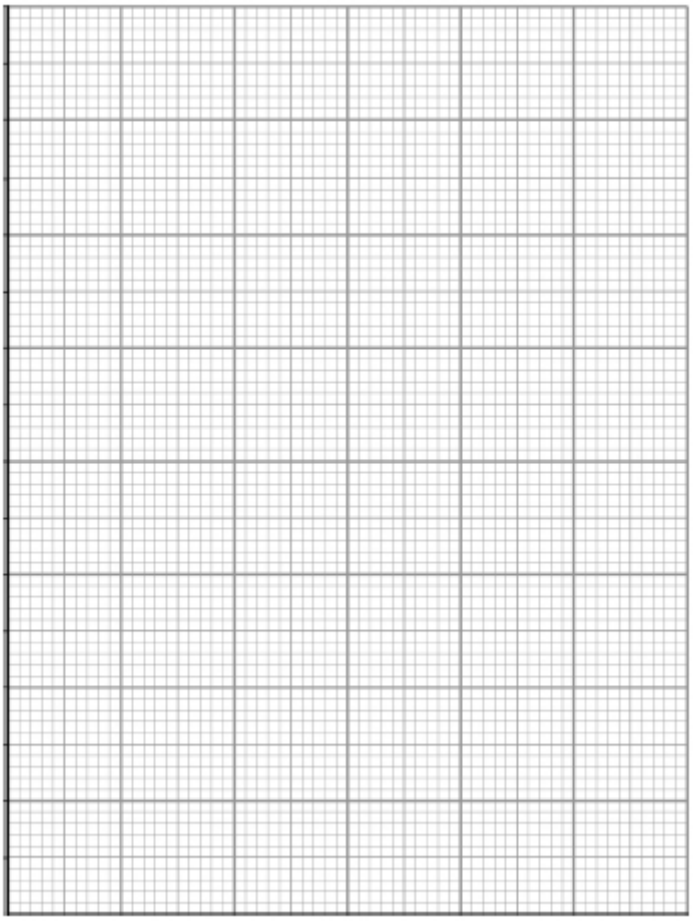
(b) The student produced the sucrose solutions with different concentrations from a concentrated sucrose solution.

Name the method she would have used to produce these sucrose solutions.

Name of method _____

(1)

(c) Calculate the ratio of final mass to initial mass of potato chips and plot a suitable graph of your processed data. Express the ratios in the table in part (a) as a single number (for example 5.26:1 would be expressed as 5.26).



(3)

(d) Explain the result for the chip in 0.8 mol dm^{-3} sucrose solution.

_____

_____

_____

_____

_____

_____

(2)
(Total 9 marks)

Q9.

(a) Describe the induced-fit model of enzyme action.

_____

_____

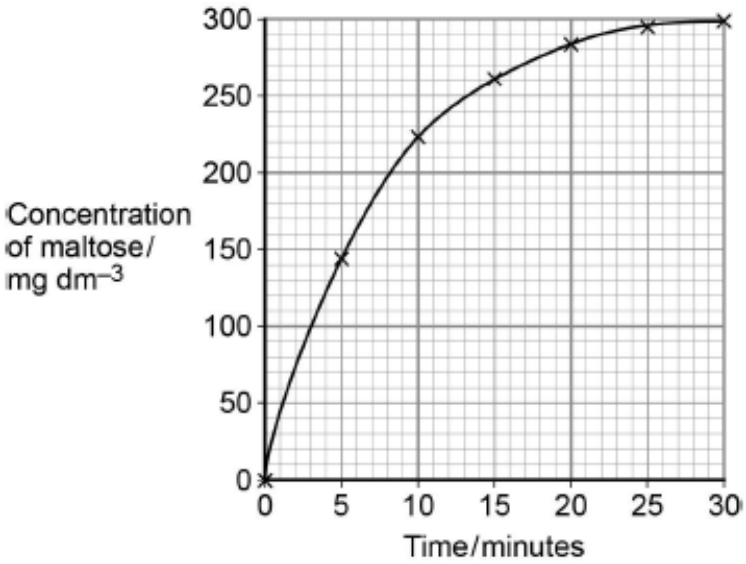
_____

_____

(2)

(b) A scientist investigated the hydrolysis of starch.
He added amylase to a suspension of starch and measured the concentration of maltose in the reaction mixture at regular intervals.

His results are shown in the graph below.



Determine the rate of the reaction **at** 10 minutes.
Show how you obtained your answer.

Rate of reaction _____ mg dm^{-3} min^{-1}

(2)

(c) Explain the results shown in the graph.

_____

_____

_____

_____

(2)

(d) A quantitative Benedict's test produces a colour whose intensity depends on the concentration of reducing sugar in a solution. A colorimeter can be used to measure the intensity of this colour.

The scientist used quantitative Benedict's tests to produce a calibration curve of colorimeter reading against concentration of maltose.

Describe how the scientist would have produced the calibration curve and used it to obtain the results in the graph.

Do **not** include details of how to perform a Benedict's test in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(3)
(Total 9 marks)

Mark schemes

Q1.

(a)

Protein synthesis	**L;**
Modifies protein	**H;**
Aerobic respiration	**N;**

3

(b) 1800–2200;

1.8, 2.0 or 2.2 in working or answer = 1 mark.

Ignore units in answer.

1 mark for an incorrect answer in which student clearly divides measured length by actual length (of scale).

Accept I / A or I / O for 1 mark but ignore triangle.

Accept approx 60mm divided by 30μm for 1 mark

2

[5]

Q2.

(a) (a monomer is a smaller / repeating) unit / molecule from which larger molecules / polymers are made;

Reject atoms / elements / 'building blocks' for units / molecules

Ignore examples

1

(b) **Similarity**

1. Both contain galactose / a glycosidic bond;

Ignore references to hydrolysis and / or condensation

Difference

2. Lactulose contains fructose, whereas lactose contains glucose;

Ignore alpha / beta prefix for glucose

Difference must be stated, not implied

2

(c) 1. (Lactulose) lowers the water potential of faeces / intestine / contents of the intestine;

Accept Ψ for water potential

2. Water retained / enters (due to osmosis) **and** softens the faeces;

Accept descriptions of soft faeces, eg faeces is less dry / less hard

2

(d) (-) 84.1(%);;

Accept (-) 84.15(%)
Allow 1 mark for
84
OR

$$\frac{2.82 \times 10^{-7} - 4.47 \times 10^{-8}}{2.82 \times 10^{-7}}$$

OR

$$\frac{2.37 \times 10^{-7}}{2.82 \times 10^{-7}}$$

2

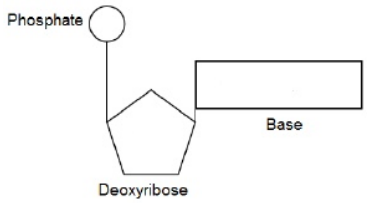
[7]

Q3.

(a) 1. Phosphate, deoxyribose and base correctly labelled;

Accept P in a circle / P_i / PO_4^{3-} for phosphate.
Do not accept phosphorus for phosphate.
*Do not accept **only** pentose for deoxyribose.*
Ignore references to sugar.
Accept a named base, (eg adenine, thymine, guanine, cytosine).
*Do not accept uracil or **only** letters (eg A, T, G or C).*
Ignore labelled bonds

2. Correct shapes **and** bonds in the correct positions (as shown below);



Accept correct shapes with incorrect labels
Accept any orientation of diagram, eg inverted / mirror image
Accept any pentagon for deoxyribose

2

(b) 1. Weak / easily broken hydrogen bonds between bases allow two strands to separate / unzip;

may appear in the same feature

2. Two strands, so both can act as templates;

may appear in the same feature

3. Complementary base pairing allows accurate replication;

Allow description of complementary base pairing and accurate replication.

2 max

(c) C. 550 seconds;

1

[5]

Q4.

(a) 1. Other gases / nitrogen / water vapour in atmosphere / **A**;
2. Only oxygen and carbon dioxide in gas mixtures / **C** and **D**;
3. Composition of / gases in **A** not controlled / composition of gas mixtures / **C** and **D** controlled.

2 max

(b) 1. Breathing rate *lowest* when no carbon dioxide / in (pure) oxygen / B;

Idea of 'lowest' must be stated.

2. (Generally) presence of carbon dioxide increases breathing rate / as concentration of carbon dioxide increases breathing rate increases / there is a positive correlation;

A general point incorporating all concentrations.

3. Breathing rate increases when (carbon dioxide) higher than 0.1% / concentration in atmosphere / A;

This MP requires a specific comparison to 0.1% or the atmospheric concentration.

Accept 'gas mixtures 1 and 2 / C and D' for 'higher carbon dioxide'.

4. Breathing rate of **grasshopper 3** falls in D / 16% / gas mixture 2 (whereas others increase).

Restating data alone is insufficient for any mark point.

3 max

(c) (i) 54;

OR

1. Correct data / column **A** chosen;

A correct answer of 54 gets 2 marks.

MP1 and MP2 allow a possible mark for an incorrect calculation or choice of wrong data.

2. Correct calculation of mean from data chosen;

Check – the three values must be from same column.

2 max

(ii) 1. Small sample / only 3 (grasshoppers)
so may not be representative (of all grasshoppers / insects);
2. Grasshoppers are not the only insects / species;
so genetic / behavioural / metabolic differences;
3. (Insects) not all mature / are at different stages of development / different sizes;
so different metabolic rates;
4. Movement not restricted / not at rest in meadow;
so (rate of) respiration higher;
5. (Naturally-occurring) carbon dioxide concentration lower in meadow;
so breathing rate lower;

Explanations required, therefore both parts of answer required for credit in each marking point.

Accept appropriate converse answers.

Accept 'respiration' for 'metabolism' and vice versa.

3 max

[10]

Q5.

(a) Two suitable examples;
Examples
1. amino acid / protein / polypeptide / peptide;
2. nucleic acid / nucleotide / base;
3. DNA;
4. RNA;
5. ATP / ADP;
6. NAD / NADP (reduced or not);
7. Cyclic AMP / cAMP;
8. Chlorophyll;

List rule applies

Reject for either point nitrates / nitrites / ammonia / ammonium / urea

4. Accept pre-mRNA / mRNA / rRNA / tRNA

2 max

(b) Correct answer in the range 90 to 133.2 scores 2 marks;
1 mark for answers where yield calculated correctly for 1970 **OR** 2005;
(1970 in range) 170.8 to 176.4
OR
(2005 in range) 266.4 to 304.0;

Accept positive or negative values

2

(c) 1. Using more but getting less response over time;
2. The graph shows correlation but doesn't prove changes in yield due to fertiliser / but there could be other factors;
3. Becomes less cost effective with time;

Idea of over time is important

1. accept fertiliser becomes less effective over time

1. Accept use of figures from graph

1. Accept the idea of less grain / crop over time

2. Ignore whether correlation is positive or negative

2 max

[6]

Q6.

(a) As size increases, ratio (of surface area to volume) decreases;

Accept converse.

Comparison required, e.g., smaller organisms have a larger ratio

1

(b) Two marks for correct answer in range of 1.75 to 1.76032;;

Accept for 1 mark, incorrect answer using radius 0.87 / 0.88 / 0.880 / 0.8802 / 0.88015;

OR

Accept for 1 mark, incorrect answer with correct rearranged equation, e.g.,

Radius = $\sqrt{(\text{surface area} \div 4\pi)}$

OR

= $\sqrt{9.73 \div 12.56}$

OR

= $\sqrt{0.77}$ / $\sqrt{0.774}$ / $\sqrt{0.775}$

OR

r^2 = *surface area* ÷ 4 π

OR

r^2 = *9.73* ÷ *12.56*

OR

r^2 = *0.77 / 0.774 / 0.775*

2

(c) (Measures) small uptake / amount / quantity / volume / concentration / rate (of oxygen uptake);

OR

Avoids use of powers of ten / standard form / many decimal places;

Ignore weight / accuracy

1

(d) More accurate / less error (in measuring mass);

OR

Causes less distress / damage to animal (to measure mass);

OR

Easier / quicker (to find mass) **because** irregular shapes;

OR

Fewer measurements / calculations;

*Ignore references to **human** error*

Accept converse if reference made to volume

Reject if comparison is made with surface area.

1

(e) (Oxygen used in) respiration, **which** provides energy / ATP;

OR

(Oxygen is used in) respiration, **which** is a metabolic process / chemical reaction;

Reject produces energy

Reject references to anaerobic respiration

1

(f) 1. No information about egg;

2. So cannot compare all stages (in Table 2);
Idea of comparing all three stages needed

3. No statistical information / test / t-test / comparison of standard deviations;
OR
No measure of significant differences;
Reject statements that "results" are not significant
Reject references to chi squared or correlation coefficient

3

[9]

Q7.

(a) 6 (g dm^{-3});

1

(b) Correct answer of (–)0.14;
1 mark for correct difference in concentration (5) divided by 35 / (69 – 64) ÷ 35 / 1 ÷ 7
Ignore +/- sign
Ignore additional d.p.
Accept 0.31(4) for 1 mark if female data used

2

(c) 1. Protein content decreases with age and decreases more in females;
2. Difference (between sexes) only significant at 95 years because SDs do not overlap;
OR
Differences not significant because 2 × SD would overlap;

2

(d) 1. Produce known concentrations of protein;
2. Measure absorbance of each concentration
OR
Measure each concentration with colorimeter;
3. Plot a graph of absorbance on y-axis against concentration (on x-axis) and draw curve;
4. Use absorbance of sample to find protein concentration from curve;
1. Idea of known concentrations required.
Accept % transmission / absorption for absorbance

3 max

(e) 1. (Lower plasma protein concentration suggests) fewer antibodies;
Ignore ref. to other proteins.
Reject answers which refer to white blood cells as proteins.

1

[9]

Q8.

(a) Accept any three suitable properties e.g.:

- Is a metabolite
- Is a solvent
- Has a (relatively) **high** heat capacity
- Has a (relatively) **large** latent heat of vaporisation / evaporation
- Has cohesion / hydrogen bonds between molecules;

No explanations are needed

However do not accept 'polar' unqualified

3 max

(b) Dilution series;

Accept serial dilution

1

(c) 1. Axes correct way round with linear scales;
2. Axes labelled with mol dm^{-3} and ratio without units;
3. Correct values correctly plotted and suitable curve drawn;

3. Accept point to point or smooth curve but no extrapolation

***NFP** – 3. Graph starts just below 1.4 and finishes just above 0.7 and looks right.*

3

(d) 1. (0.8 mol dm^{-3} sucrose) solution has a more negative / lower water potential than potato (cytoplasm);
OR
potato (cytoplasm) has a less negative / higher water potential than (0.8 mol dm^{-3} sucrose) solution;
2. (therefore) water moves out (of potato) into the (sucrose) solution by osmosis (so cells decrease in mass);

1. Accept sucrose solution is hypertonic / potato cytoplasm is hypotonic

*2. Accept water moves **down** a water potential gradient*

2

[9]

Q9.

(a) 1. (before reaction) active site not complementary to/does not fit substrate;

2. Shape of active site changes as substrate binds/as enzyme-substrate complex forms;

Note. Points 1 and 2 may be made in one statement and 'complementary' introduced at any point.

Points 1&2 – active site mentioned once applies for both points

Point 2 – Ignore references to how shape change is caused

3. Stressing/distorting/bending bonds (in substrate leading to reaction);

2 max

(b) 1. Tangent to curve drawn;

Tangent drawn at about 10 minutes

2. Value in range of 8 to 11;

1 mark only for correct answer

2

(c) 1. (Rate of) increase in concentration of maltose slows as substrate/starch is used up

OR

High initial rate as plenty of starch/substrate/more E-S complexes;

Reject ref. to amylase being used up

2. No increase after 25 minutes/at end/levels off because no substrate/starch left;

Accept 'little'

Ignore references to substrate a limiting factor

2

(d) 1. Make/use maltose solutions of known/different concentrations (and carry out quantitative Benedict's test on each);

2. (Use colorimeter to) measure colour/colorimeter value of each solution and plot calibration curve/graph described;

Axes must be correct if axes mentioned, concentration on x-axis and colorimeter reading on y-axis

3. Find concentration of sample from calibration curve;

3

[9]