Model Answers: Medium

1a

a) Calculating the percentage energy transfer between primary and secondary consumers:

- (60 ÷ 630) x 100; [1 mark]
- 10(%); [1 mark]

Full marks awarded for the correct answer only.

[Total: 2 marks]

The amount of energy transferred to the primary consumers can be calculated as follows:

$350 + 280 = 630$

The amount of energy transfered to the Secondary Consumers is:

$32 + 25 + 3 = 60$

Calculating the percentage energy transfer:

$$\frac{\text{Energy transfered to sec. consumers}}{\text{Energy transferred to prim. consumers}} \times \frac{100}{1}$$

$$= \frac{60}{630} \times \frac{100}{1} \quad [1 \text{ mark}]$$

$$= 10\% \quad [1 \text{ mark}]$$

1b

b) The energy conversion between the sun and the primary consumers is....

- Light energy to chemical (potential) energy; [1 mark]

[Total: 1 mark]

1c

c) The need for energy in living organisms is because....

Any **five** of the following:

- Organisms require energy for metabolic processes / metabolism; [1 mark]
- (Energy is required for) the synthesis of ATP; [1 mark]
- ATP is the (universal) energy currency (in all living organisms); [1 mark]
- Light energy is required for photosynthesis to occur; [1 mark]
- (Energy is) required during the light dependent stage to split water by photolysis and synthesise ATP; [1 mark]
- (ATP is) used to convert carbon dioxide to carbohydrates during the Calvin cycle / light independent stage; [1 mark]
- Anabolic reactions require energy (to form more complex molecules from simpler ones); [1 mark]
- Named anabolic reaction, e.g. protein synthesis, starch or glycogen formation, synthesis of lipids; [1 mark]

- (Needed for) the activation of glucose (though phosphorylation) in glycolysis; [1 mark]
- Active transport requires energy to move molecules against their concentration gradient / from area of lower concentration to an area of higher concentration; [1 mark]
- Mechanical movement (such as muscle contraction) requires ATP; [1 mark]
- Organisms require energy for regulating (body) temperature; [1 mark]

[Total: 5 marks]

This question has quite a wide range of answers, so there is plenty for you to choose from when trying to come up with examples of why energy is important to living organisms.

1d

d) The role of photosynthesis and respiration in the transfer of energy between autotrophs and heterotrophs:

Any **three** of the following:

- Autotrophs/cacti/grasses can synthesise (usable) carbon compounds / glucose from (atmospheric) carbon dioxide (during photosynthesis); [1 mark]
- Heterotrophs/kangaroo rat/grasshopper/Saharan silver ant consume these carbon compounds / glucose (as they cannot photosynthesise) as a source of energy; [1 mark]
- These carbon compounds are broken down during respiration to release energy; [1 mark]
- Carbon dioxide is released (during respiration) into the atmosphere (needed for photosynthesis); [1 mark]

[Total: 3 marks]

The chemical potential energy that is stored in the carbon compounds produced during photosynthesis serves as an energy source for heterotrophs. This energy is released during respiration when these compounds are broken down and the energy can be used by the organism for a variety of functions or can serve as an energy source for secondary and tertiary consumers. Carbon dioxide is released as a waste product of respiration and serves as one of the raw materials for photosynthesis.

2a

a) Part **X** of the ATP molecule in Fig. 1 is:

- **X** = adenosine; [1 mark]

[Total: 1 mark]

2b

b) ATP can be described as a 'universal energy currency' for cells because:

- It is used (as a short term store of chemical energy) in all living organisms (making it universal); [1 mark]
- It can be used for different reactions/purposes and can be reused (just like a currency); [1 mark]

[Total: 2 marks]

2c

c) The main benefits of ATP as an energy currency in living organisms include:

Any **four** of the following:

- ATP hydrolysis can occur quickly and easily (when energy is needed) and requires just one type of enzyme/ATPase; [1 mark]
- An adequate/useful/sufficient amount of energy is released (from ATP hydrolysis) which reduces waste and drives metabolic reactions; [1 mark]
- (ATP is) relatively stable at the pH level of the cell; [1 mark]
- It is soluble for easy transport around the cell; [1 mark]
- The breakdown of ATP is reversible, it can therefore be recycled/reused; [1 mark]

[Total: 4 marks]

The characteristics of ATP mentioned above are the main reasons why the molecule is so useful as an energy currency in living organisms. It is easily broken down, yet stable in the conditions found within cells, which reduces energy wastage. It solubility enables it to be transported to parts of the cell that requires energy. ATP can be reformed by adding an inorganic phosphate group to ADP, meaning the same ATP molecule can be reused in different chemical reactions.

2d

d) i) The type of reaction catalysed by ATPases:

- Hydrolysis **OR** dephosphorylation; [1 mark]

d) ii) The products of the hydrolysis of ATP is:

- ADP/adenosine diphosphate **AND** inorganic phosphate/P_i /H_3PO_4; [1 mark]

[Total: 2 marks]

3a

a) i) The control in this experiment is:

- The tube containing the glass beads; [1 mark]

a) ii) The purpose of the potassium hydroxide solution is...

- To absorb carbon dioxide produced by respiring woodlice; [1 mark]

[Total: 2 marks]

3b

b) The movement of the liquid in the manometer can be explained as follows:

- The woodlice consumed/used oxygen for (aerobic) respiration; [1 mark]
- The carbon dioxide produced by the woodlice / during respiration was absorbed by the potassium hydroxide solution; [1 mark]
- (This caused a) decrease in pressure on the woodlice side of the capillary u-tube / manometer; [1 mark]

[Total: 3 marks]

The pressure difference in the manometer will cause the coloured liquid to move upward in the capillary tube on the side of the woodlice, as this side will have a lower pressure than the side of the glass beads.

3c

c) The volume of oxygen consumed can be calculated as follows:

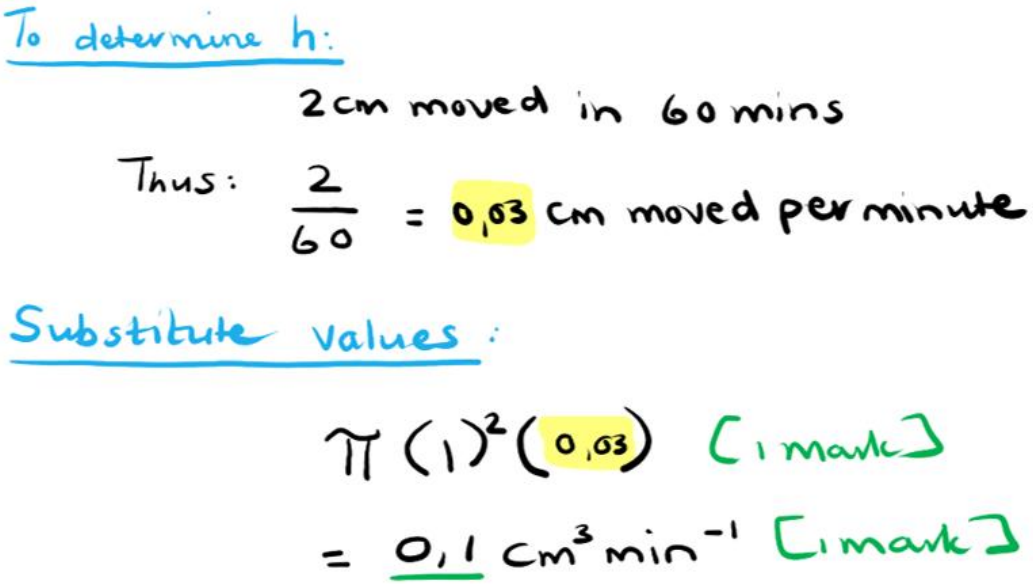
- $\pi(1)^2(0.03)$; [1 mark]
- 0.1 (cm^3min^{-1}); [1 mark]

Full marks awarded for the correct answer only.

[Total: 2 marks]

Make sure that you use the radius (1 cm) in your calculations here rather than the diameter

(2 cm). In order to get the radius, you simply divide the diameter by 2.



3d

d) The deductions that can be made from an RQ value of 0.8 is:

- Both lipids and proteins were used as respiratory substrates by the woodlice **OR** a mixture of substrates were respired/used by the woodlice; [1 mark]
- This is because the RQ for lipids is 0.7 and the the RQ for protein is 0.9 (which will give an average value of 0.8); [1 mark]

[Total: 2 marks]

RQ values can give a variety of information to an investigator. It can indicate the respiratory substrate that an organism used, or it may also indicate whether an organism is overfed or underfed.

4a

a) Carbohydrates, lipids and proteins have different relative energy values as substrates in respiration in aerobic conditions because...

Any **six** of the following:

- Different substrates have different numbers of hydrogens/C-H bonds; [1 mark]
- Lipids have (relatively) more hydrogens/C-H bonds (than carbohydrates or proteins); [1 mark]
- Hydrogens/C-H bonds located in fatty acid (tails of lipids); [1 mark]
- Breakdown/oxidation of substrate provides hydrogen (atoms); [1 mark]
- For reduction of NAD/FAD; [1 mark]
- (Reduced NAD/FAD) provides/releases hydrogen to ETC; [1 mark]
- Hydrogen (dissociates) into protons and electrons; [1 mark]
- Energy used to set up proton gradient; [1 mark]
- Chemiosmosis / oxidative phosphorylation; [1 mark]
- (So) more ATP/energy from lipids per unit mass (than carbohydrates/proteins) **OR** lipids more energy dense / have higher (relative) energy value; [1 mark]

[Total: 6 marks]

4b

b) The definition of respiratory quotient is...

- (Ratio of) carbon dioxide given out divided by oxygen taken in; [1 mark]
- Volume / moles *(reject amount); [1 mark]*
- Per unit time; [1 mark]

An investigation determine the RQ of germinating barley seeds would be...

Up to **eight** of the following:

- Use respirometer; [1 mark]
- Seeds placed on mesh/gauze; [1 mark]
- KOH/NaOH/sodalime to absorb carbon dioxide; [1 mark]
- Manometer / capillary tube / syringe; [1 mark]
- Movement of fluid (in manometer/capillary tube/syringe) = uptake of oxygen; [1 mark]
- Keep temperature/air pressure constant; [1 mark]
- Measure oxygen uptake after certain time; [1 mark]
- Repeat without KOH/NaOH/sodalime; [1 mark]
- Difference in manometer readings due to carbon dioxide given out; [1 mark]

[Total: 9 marks]

Take the time to review the revision note and make sure you've memorised the typical set up for a respirometer. A good way to revise this would be to practice drawing and labelling a diagram of the equipment.