## Questions

**Q1.**

Climate change has been correlated with changing atmospheric carbon dioxide levels.

Scientists measured the productivity of two types of forest and recorded the mass of carbon taken up per square metre per year (gC $m^{-2}$ $y^{-1}$).

The table shows data on the mean net primary productivity (NPP) and mean gross primary productivity (GPP) of these two types of forest.

| Type of forest | Mean NPP / gC $m^{-2}$ $y^{-1}$ | Mean GPP / gC $m^{-2}$ $y^{-1}$ | Ratio of NPP to GPP |
|---|---|---|---|
| Boreal | 322 | 1013 | 0.32 |
| Temperate deciduous | 1301 | 2165 | 0.60 |

(i) Calculate the percentage increase in mass of carbon released due to respiration by temperate deciduous forests compared with that by boreal forests.

**(3)**

..... %

(ii) The ratio of net primary productivity to gross primary productivity is a measure of the ability of forests to transfer carbon from the atmosphere into biomass.

Scientists concluded that temperate deciduous forests would reduce levels of carbon dioxide in the atmosphere more than boreal forests.
Justify this conclusion.

**(3)**

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**(Total for question = 6 marks)**

**Q2.**

Tropical rainforests play a role in maintaining biodiversity and in storing carbon.

In a mature tropical rainforest, there is no net increase in biomass.

(i) Which statement describes the role of photosynthesis in the carbon cycle?

**(1)**

☒ **A** carbon dioxide is oxidised to form organic molecules

☒ **B** carbon dioxide is reduced to form organic molecules

☒ **C** organic molecules are combusted to produce carbon dioxide

☒ **D** organic molecules are decomposed to release carbon dioxide

(ii) The gross primary productivity (GPP) for one mature tropical rainforest was found to be 24 800 kJ $m^{-2}$ $year^{-1}$. It was estimated that 65% of GPP was used in respiration.

Calculate the energy transferred to the next trophic level.

**(2)**

..... kJ $m^{-2}$ $year^{-1}$

**(Total for question = 3 marks)**

**Q3.**

Photosynthesis contributes to the productivity of ecosystems.

(i) State what is meant by the term ecosystem.

**(1)**

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(ii) The table shows information about two types of ecosystem.

| Ecosystem | Gross productivity / g $m^{-2}$ $day^{-1}$ | Net productivity / g $m^{-2}$ $day^{-1}$ | Percentage of gross productivity used in respiration (%) | Total surface area of Earth occupied / $km^2$ |
|---|---|---|---|---|
| Tropical rainforest | 16.7 | 5.5 | 67.1 | $510 \times 10^6$ |
| Salt marsh | 10.5 | | 34.3 | $5.5 \times 10^4$ |

Calculate the net productivity of the salt marsh ecosystem.

**(2)**

..... g $m^{-2}$ $day^{-1}$

(iii) Comment on the impact of these different types of ecosystem on global warming.

**(3)**

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**(Total for question = 6 marks)**

**Q4.**

Explain why the value for GPP is lower than the light energy available to the ecosystem.

**(3)**

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**(Total for question = 3 marks)**

**Q5.**

Climate change has been linked to the release of carbon dioxide from some power stations.

Net primary productivity (NPP) is a measure of the increase in biomass of a plant.

Explain why respiration affects the production of biomass.

**(2)**

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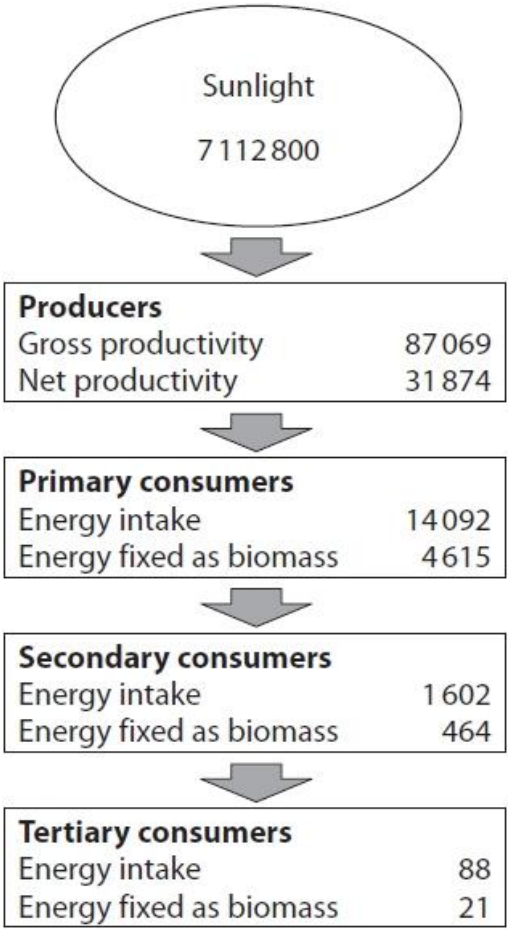
**(Total for question = 2 marks)**

**Q6.**

**Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.**

Silver Springs is a state park in Florida. The photograph shows one of the many waterways in this state park.

Energy flow through this ecosystem has been studied. The results are shown in the flow chart.
All values are given in kJ $m^{-2}$ $yr^{-1}$.




(i) Calculate how much energy is lost through respiration by the primary consumers.

**(1)**

Answer ..... kJ $m^{-2}$ $yr^{-1}$

(ii) The table gives details of energy transfers at the different trophic levels.

| Trophic level | Energy fixed as biomass / kJ $m^{-2}$ $yr^{-1}$ | Transfer efficiency (%) |
|---|---|---|
| Producers | 31 874 | |
| Primary consumers | 4615 | 14.5 |
| Secondary consumers | 464 | |
| Tertiary consumers | 21 | 4.5 |

Calculate the efficiency of energy transfer between primary consumers and secondary consumers.

**(1)**

..... %

(iii) The efficiency of photosynthesis can be measured as the percentage of energy from sunlight that is converted to gross primary productivity (GPP).
Which of the following shows the percentage efficiency of photosynthesis in this ecosystem?

**(1)**

- ☒ **A** 1.2%
- ☒ **B** 12%
- ☒ **C** 36.6%
- ☒ **D** 55.8%

**(Total for question = 3 marks)**

## Mark Scheme

Q1.

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (i) | • correct values for carbon released by boreal forest and deciduous forest respiration (1)<br><br>• correct use of values to calculate percentage increase (1)<br><br>• correct answer (1) | Example of calculation<br><br>1013 – 322 = 691 (Boreal)<br>2165 – 1301 = 864 (Deciduous)<br><br>= 173 ÷ 691<br><br>deciduous release 25% (25.04%) more than boreal<br><br>Correct answer with no working gains full marks | 3 |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | An answer that makes reference to the following:<br><br>• the ratio of NPP to GPP is higher in deciduous forests (1)<br><br>• NPP is higher / more of the carbon (fixed) is used to produce biomass (1)<br><br>• (in deciduous forests) more carbon (dioxide) removed (by photosynthesis) than returned by respirat ion (1) | ALLOW converse for boreal forests for all points | 3 |

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## Q2.

| Question Number | Answer | Mark |
|---|---|---|
| (i) | **B** - carbon dioxide is reduced to form organic molecules<br><br>*The only correct answer is **B***<br><br>***A** is incorrect because carbon dioxide is not oxidised to form organic molecules*<br><br>***C** is incorrect because organic molecules are not combusted in photosynthesis*<br><br>***D** is incorrect because organic molecules are not decomposed in photosynthesis* | **(1)** |

| Question Number | Answer | Additional Guidance | Mark |
|---|---|---|---|
| (ii) | • correct percentage transferred<br><br>• correct answer | Example of calculation<br><br>35 % / 0.35<br>= 8680 (kJ $m^{-2}$ $yr^{-1}$)<br><br>Correct answer without working gains full marks | **(2)** |

## Q3.

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| (i) | An answer that makes reference to the following:<br><br>• organisms and {non-living components / abiotic factors} (1) | | **(1)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| (ii) | Choose an item.<br><br>• correct value for respiration (1)<br><br>• respiration value calculated subtracted from gross productivity value (1) | Example of calculation<br><br>10.5 x (34.3 ÷ 100) = 3.6<br><br>10.5 – 3.6 = 6.9 (g $m^{-2}$ $day^{-1}$)<br><br>Correct answer with no working gains full marks | **(2)** |

| Question number | Answer | Additional guidance | Mark |
|---|---|---|---|
| (iii) | An answer that makes reference to three of the following:<br><br>• tropical rain forests use a greater percentage (of gross productivity) in respiration (1)<br><br>• tropical rain forests occupy a larger surface area (1)<br><br>• therefore (tropical rain forests) release more carbon dioxide (1)<br><br>• which is a greenhouse gas / making a greater contribution to global warming (1) | ALLOW converse arguments for salt marsh for mps 1, 2 and 3 | **(3)** |

**Q4.**

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to three of the following<br><br>• not all of the light falls on the { leaves / plants / producers } (1)<br><br>• some of the light is reflected (from the surface of the leaf) (1)<br><br>• some of the light misses the chloroplasts (and passes through leaf) (1)<br><br>• some of the light is { the wrong wavelength / not absorbed by the chlorophyll } (1) | ALLOW energy instead of light<br><br>ALLOW some of the light falls on { bark/parts of the plant that do not photosynthesise}<br><br>ALLOW chlorophyll / photosystem<br><br>ALLOW description of not all light wavelengths being absorbed | **(3)** |

## Q5.

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| | An explanation that makes reference to two of the following:<br>• GPP – R = NPP (1)<br>• {organic molecules / glucose} used in respiration to provideenergy (1)<br>• because the more {organic molecules / glucose } used inrespiration, the less is available for the production of biomass (1) | ALLOW word equation or rearranged equation<br>ALLOW more respiration results inless biomass | (2) |

## Q6.

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| (i) | • 9477 | Example of calculation<br>Gross productivity – net productivity<br>14092 - 4615 | (1) |

| Question Number | Answer | Additional guidance | Mark |
|---|---|---|---|
| (ii) | • calculation of energy fixed as biomass by secondary consumers as a percentage of the energy fixed by primary consumers | Example of calculation<br>(464 ÷ 4615) x 100 =<br>10.1 (same number of decimal places<br>as other values in table) | (1) |

| Question Number | Answer | Mark |
|---|---|---|
| (iii) | **The only correct answer is A - 1.2%**<br>***B*** *is incorrect because 12% has the decimal point in the incorrect place*<br>***C*** *is incorrect because 36.6% is NPP divided by GPP*<br>***D*** *is incorrect because 55.8% is (NPP of producers-energy intake of primary consumers) divided by NPP* | (1) |