

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

Trophic level	Energy fixed as biomass / $\text{kJ m}^{-2} \text{yr}^{-1}$	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)	<ul style="list-style-type: none"> correct values for carbon released by boreal forest and deciduous forest respiration (1) correct use of values to calculate percentage increase (1) correct answer (1) 	<p>Example of calculation</p> $1013 - 322 = 691$ (Boreal) $2165 - 1301 = 864$ (Deciduous) $= 173 \div 691$ deciduous release 25% (25.04%) more than boreal Correct answer with no working gains full marks	3
Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to the following: <ul style="list-style-type: none"> the ratio of NPP to GPP is higher in deciduous forests (1) NPP is higher / more of the carbon (fixed) is used to produce biomass (1) (in deciduous forests) more carbon (dioxide) removed (by photosynthesis) than returned by respiration (1) 	ALLOW converse for boreal forests for all points	3

Q2.

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

Question Number	Answer	Additional Guidance	Mark
(ii)	<ul style="list-style-type: none"> correct percentage transferred correct answer 	<p><u>Example of calculation</u></p> <p>35 % / 0.35 = 8680 (kJ m⁻² yr⁻¹)</p> <p>Correct answer without working gains full marks</p>	(2)

Q3.

Question number	Answer	Additional guidance	Mark
(i)	<p>An answer that makes reference to the following:</p> <ul style="list-style-type: none"> organisms and {non-living components / abiotic factors} (1) 		(1)

Question number	Answer	Additional guidance	Mark
(ii)	<p>Choose an item.</p> <ul style="list-style-type: none"> correct value for respiration (1) respiration value calculated subtracted from gross productivity value (1) 	<p><u>Example of calculation</u></p> <p>10.5 x (34.3 ÷ 100) = 3.6</p> <p>10.5 – 3.6 = 6.9 (g m⁻² day⁻¹)</p> <p>Correct answer with no working gains full marks</p>	(2)

Question number	Answer	Additional guidance	Mark
(iii)	<p>An answer that makes reference to three of the following:</p> <ul style="list-style-type: none"> tropical rain forests use a greater percentage (of gross productivity) in respiration (1) tropical rain forests occupy a larger surface area (1) therefore (tropical rain forests) release more carbon dioxide (1) 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
	<p>An explanation that makes reference to three of the following</p> <ul style="list-style-type: none"> not all of the light falls on the { leaves / plants / producers } (1) some of the light is reflected (from the surface of the leaf) (1) some of the light misses the chloroplasts (and passes through leaf) (1) some of the light is { the wrong wavelength / not absorbed by the chlorophyll } (1) 	<p>ALLOW energy instead of light</p> <p>ALLOW some of the light falls on { bark/parts of the plant that do not photosynthesise}</p> <p>ALLOW chlorophyll / photosystem</p> <p>ALLOW description of not all light wavelengths being absorbed</p>	(3)

Q5.

Question Number	Answer	Additional guidance	Mark
	<p>An explanation that makes reference to two of the following:</p> <ul style="list-style-type: none"> GPP - R = NPP (1) {organic molecules / glucose} used in respiration to provide energy (1) because the more {organic molecules / glucose} used in respiration, the less is available for the production of biomass (1) 	<p>ALLOW word equation or rearranged equation</p> <p>ALLOW more respiration results in less biomass</p>	(2)

Q6.

Question Number	Answer	Additional guidance	Mark
(i)	<ul style="list-style-type: none"> 9477 	<p><u>Example of calculation</u></p> <p>Gross productivity - net productivity 14092 - 4615</p>	(1)

Question Number	Answer	Additional guidance	Mark
(ii)	<ul style="list-style-type: none"> calculation of energy fixed as biomass by secondary consumers as a percentage of the energy fixed by primary consumers 	<p><u>Example of calculation</u></p> <p>$(464 \div 4615) \times 100 =$</p> <p>10.1 (same number of decimal places as other values in table)</p>	(1)

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