



Energy transfers (food chain and pyramis)



105 minutes



105 marks

Q1. (a) One food chain in the wood is:

Hazel tree nuts → squirrels → owls

(i) What does this food chain tell us?

.....
.....

(2)

(ii) Which **one** of the organisms in the food chain is a producer?

.....

(1)

(iii) This year the hazel bushes have produced very few nuts.

Explain, as fully as you can, how this might affect the populations of:

1. squirrels;

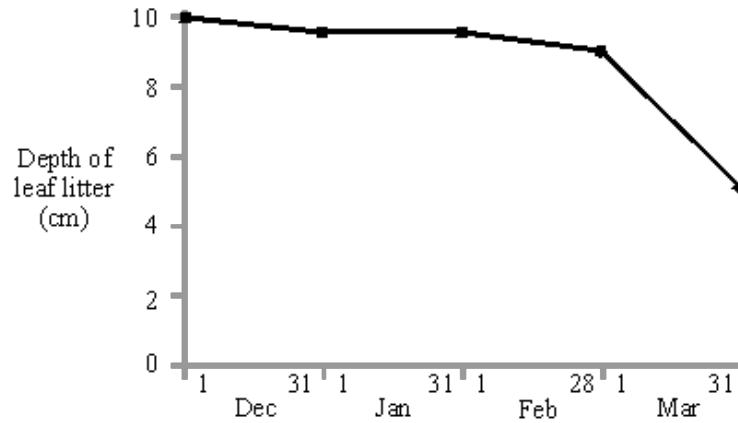
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2. owls.

.....
.....
.....
.....

(4)

- (b) An area of the floor of the wood 1 m² was fenced off so that animals could not reach it. The graph below shows the depth of leaf litter (dead leaves) inside the fence over the next few months.



Explain, as fully as you can,

- (i) why the depth of the leaf litter decreased;

.....

(1)

- (ii) how this decrease happened.

.....

(1)

- (iii) In which month does leaf litter disappear fastest? Explain why.

.....

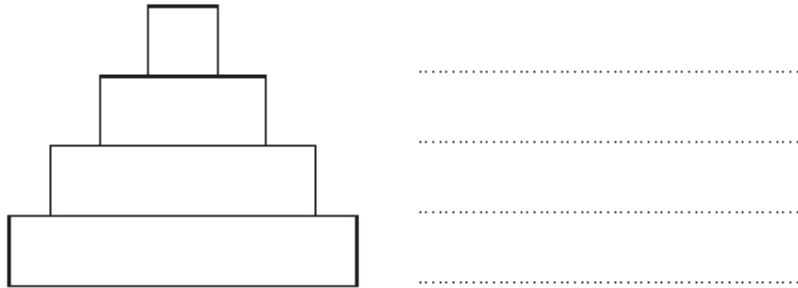
(2)

(Total 11 marks)

Q2. This is a simple food chain.

Lettuce plant → Slug → Frog → Heron

The diagram shows a pyramid of biomass for this food chain.



(a) Write the names of the organisms in the food chain on the correct lines next to the pyramid of biomass. (1)

(b) (i) The slug obtains its energy from the lettuce plant. What is the source of energy for the lettuce plant?
 (1)

(ii) What is the function of chlorophyll in a lettuce plant?
 (1)

(iii) The slugs ate some lettuce plants which contained 1620 kJ of energy. Only 10 per cent of this energy is used by the slugs for growth. Use the formula to calculate how much energy can be used by the slugs for growth. Show clearly how you work out your final answer.

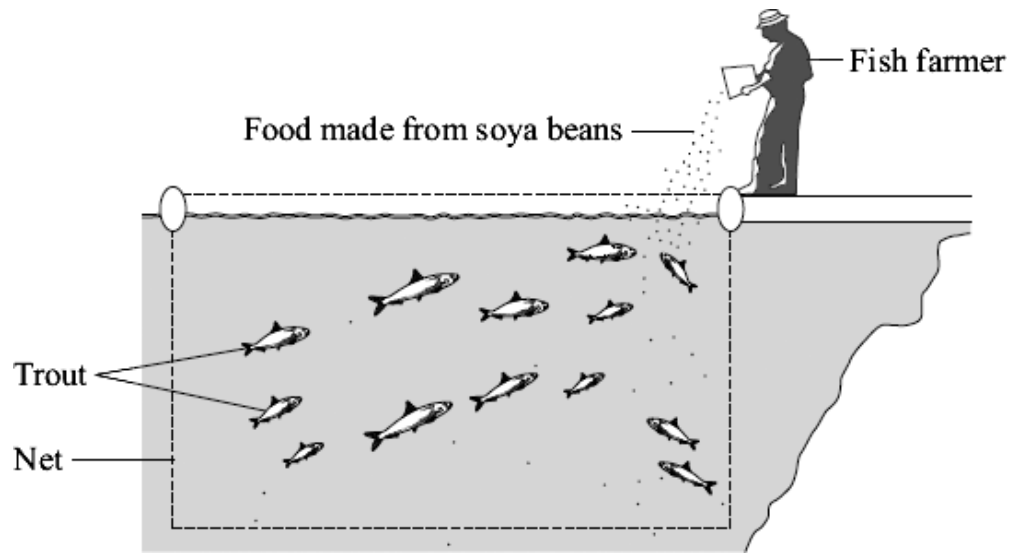
$$\text{Amount of energy} = \frac{(\text{Percentage of energy used by slugs}) \times (\text{Amount of energy in lettuce})}{100}$$

.....

Amount of energy = kJ

(2)
(Total 5 marks)

Q3. A fish farmer keeps trout in a large net in a lake.



The fish farmer feeds the trout on food made from soya beans.

When the trout are large enough the farmer sells them for food for people.

(a) Draw a pyramid of biomass for the three organisms in this food chain.

Label the pyramid.

(2)

(b) It would be more energy efficient if people ate the soya beans rather than eating the trout.

Which **two** of the following are reasons for this?

Tick (✓) **two** boxes.

Some people do not like eating animals such as trout.

The trout release energy when they respire.

Soya bean plants release energy when they respire.

Some energy will be lost in waste from the trout.

Soya bean plants absorb energy during photosynthesis.

(2)

(c) Suggest **one** advantage to the fish farmer of keeping the trout in a large net instead of letting them swim freely in the lake.

.....
.....

(1)

(d) Some trout die before they are large enough to be sold.
The dead trout contain carbon.

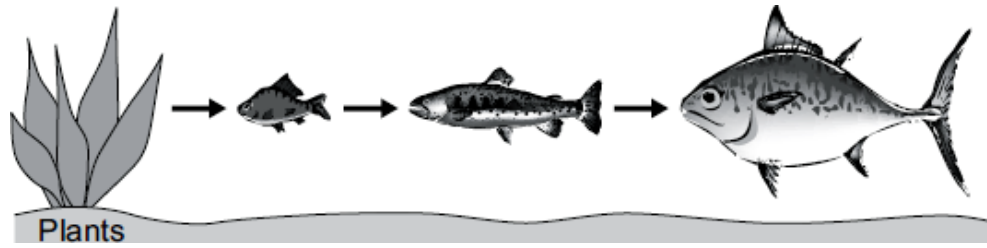
Use your knowledge of the carbon cycle to describe how this carbon is returned to the atmosphere after the trout die.

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(2)

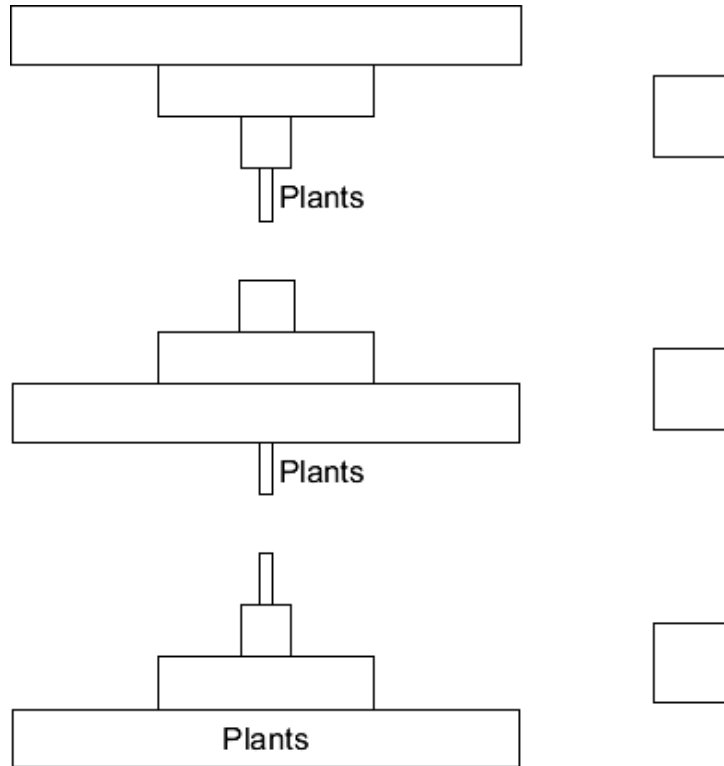
(Total 7 marks)

Q4. The picture shows a food chain.



(a) Which diagram shows a pyramid of biomass for the food chain in the picture?

Tick (✓) **one** box.



(1)

(b) The plants at the start of the food chain absorb energy.

Where does this energy come from?

Draw a ring around **one** answer.

the water

the sun

minerals

(1)

(c) Some energy is lost at each stage of the food chain.

Give **two** ways in which energy may be lost from the food chain.

- 1
-
- 2
-

(2)
(Total 4 marks)

Q5. Green plants are found at the start of all food chains.

(a) Complete the sentences.

(i) The source of energy for green plants is radiation from the

(1)

(ii) Green plants absorb some of the light energy that reaches them for a process called

(1)

(b) Draw a ring around the correct answer to complete each sentence.

(i) This process transfers light energy into

chemical
sound
electrical

 energy.

(1)

(ii) The process uses the gas

carbon dioxide.
oxygen.
water.

(1)

(iii) The process produces carbon-containing compounds called

carbohydrates.
minerals.
salts.

(1)

- (c) The amount of living material (biomass) at each stage in a food chain is less than at the previous stage.

The diagram shows a food chain.



Give **two** ways in which biomass is lost in this food chain.

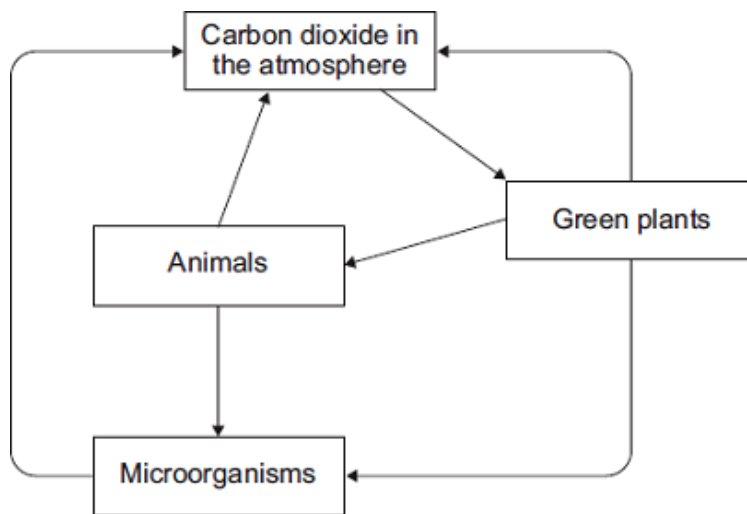
Tick (✓) **two** boxes.

- As carbon dioxide from the caterpillar
- As food eaten by the hawk
- As oxygen from the oak tree
- As faeces (droppings) from the blue-tit

(2)
(Total 7 marks)

- Q6.** *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The diagram shows part of the carbon cycle.



(b) The photographs show the two forms of peppered moth, on tree bark.



Tree bark covered with lichens

Tree bark made black by pollution

© Kim Taylor/Warren Photographic

(i) The dark form of the peppered moth was produced by a change in the genetic material of a pale moth.

Use **one** word from the box to complete the sentence.

characteristic	clone	mutation
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A change in genetic material is called a

(1)

(ii) In the 19th century, pollution made the bark of many trees go black.

Explain why:

- the population of the pale form of the moth in forests decreased
- the population of the dark form of the moth in forests increased.

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(3)

(c) (i) The larvae (young) of the peppered moths eat the leaves of birch trees.

The diagram shows the food chain:

birch trees → peppered moth larvae → birds

Draw a pyramid of biomass for this food chain.

Label the pyramid.

(2)

(ii) Which **two** reasons explain the shape of the pyramid you drew in part (c)(i)?

Tick (✓) **two** boxes.

Some material is lost in waste from the birds

The trees are much larger than peppered moth larvae

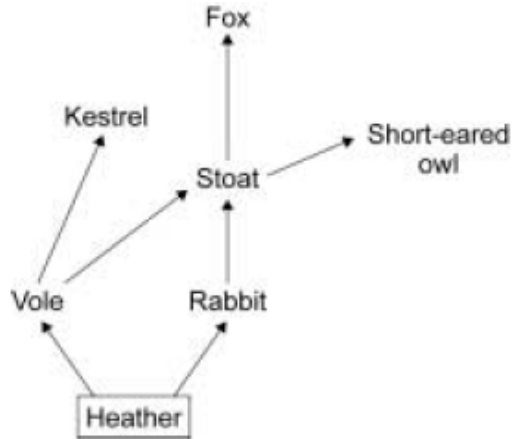
Peppered moth larvae do not eat all the leaves from the trees

The trees do not use all of the Sun's energy

(2)
(Total 9 marks)

Q8. In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The diagram below shows a food web for some of the organisms that live on moorland.



Only a small percentage of the Sun's energy captured by the heather is eventually incorporated into the body tissues of the fox.

Explain, as fully as you can, what happens to the rest of the energy captured by the heather.

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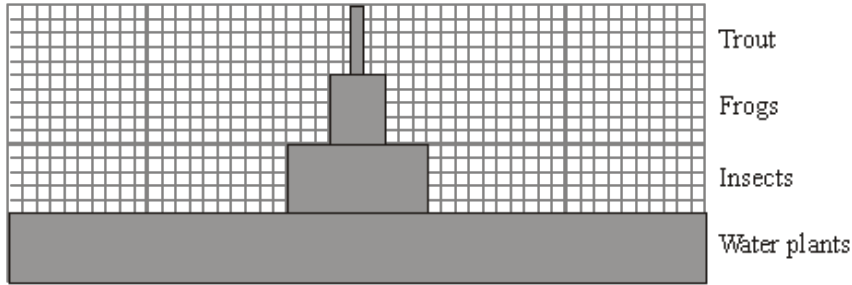
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(Total 6 marks)

Q9. The diagram shows a pyramid of biomass drawn to scale.



(a) What is the source of energy for the water plants?

.....

(1)

(b) The ratio of the biomass of water plants to the biomass of insects is 5 : 1.

Calculate the ratio of the biomass of insects to the biomass of frogs.

Show clearly how you work out your answer.

.....

.....

ratio = : 1

(2)

(c) Give **two** reasons why the biomass of the frog population is smaller than the biomass of the insect population.

1

.....

2

.....

(2)

(d) Some insects die.

Describe how the carbon in the dead insect bodies may be recycled.

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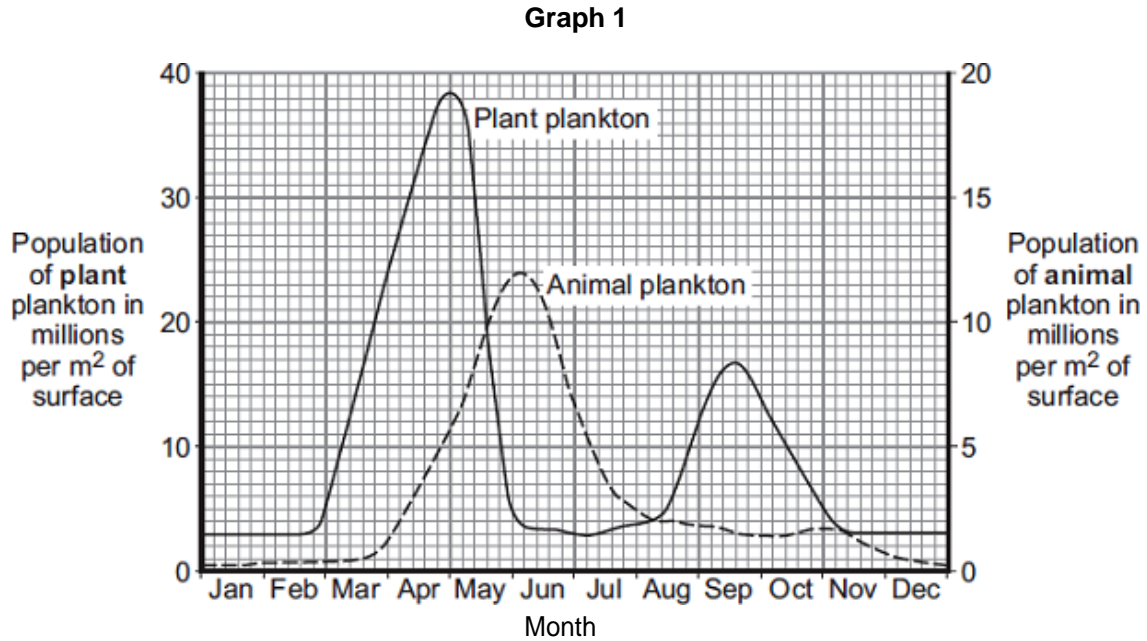
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(4)
(Total 9 marks)

Q10. Plankton live in the sea.
Animal plankton eat plant plankton.

Graph 1 shows how the populations of the plankton change through the year in the seas around the UK.

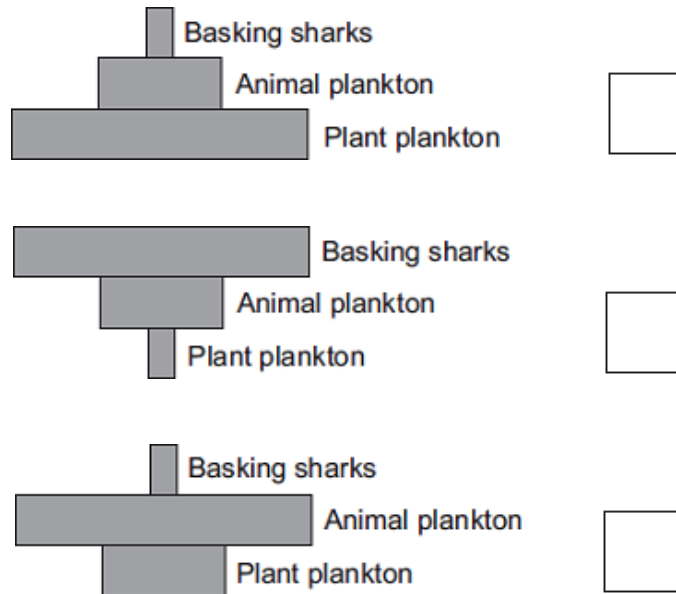


(a) Basking sharks eat animal plankton. Basking sharks grow up to 8 metres long.

Look at the diagram and **Graph 1**.

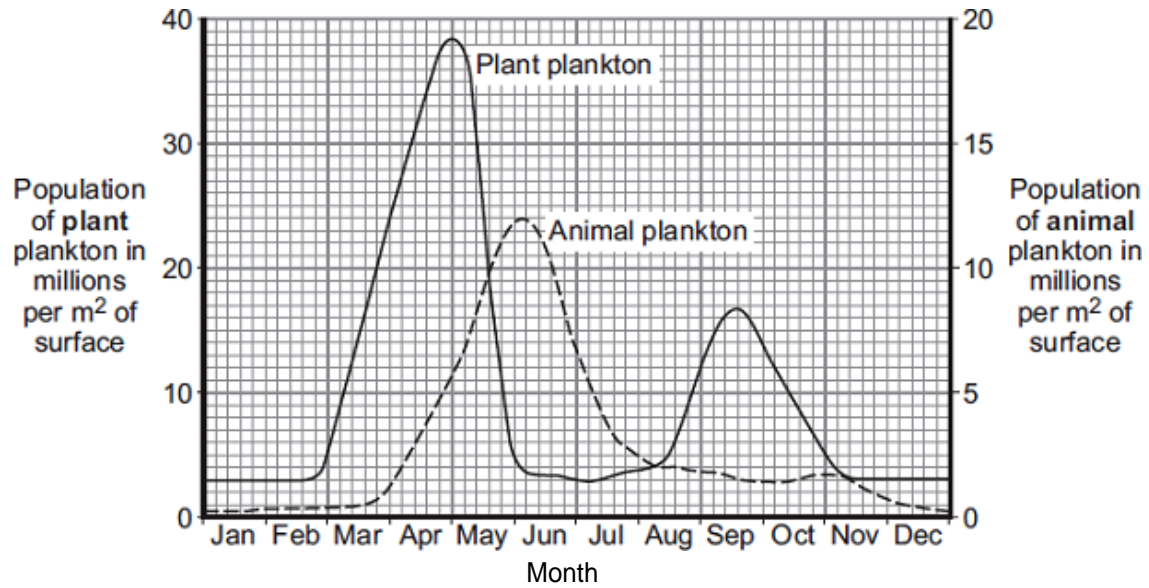
Which is the correct shape for the pyramid of biomass to show the relationship between plant plankton, animal plankton and basking sharks, in June?

Tick (✓) **one** box.

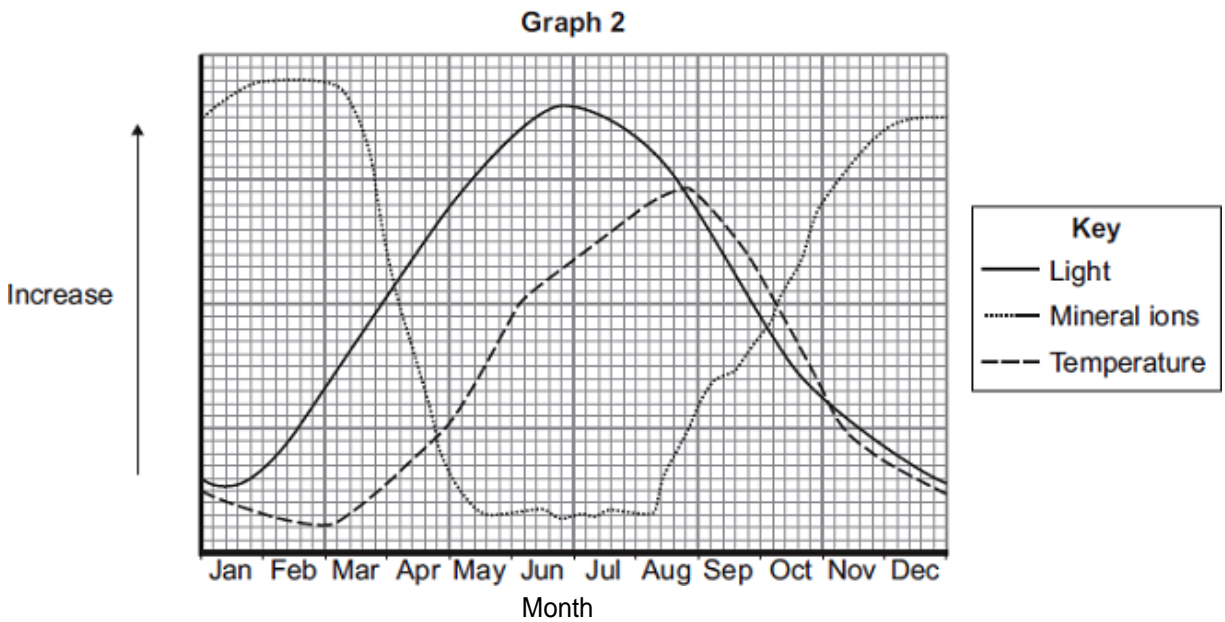


(1)

Graph 1 is repeated here to help you answer the following questions.



Graph 2 shows changes in some of the conditions in the upper layers of the sea around the UK.



(b) The population of plant plankton increases between February and April.

Suggest **one** reason for the increase.

Explain your answer.

.....

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.....

.....

(2)

(c) The population of animal plankton changes between April and July.

Suggest explanations for the changes.

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(2)

(d) The concentration of mineral ions changes between February and December.

Suggest explanations for the changes.

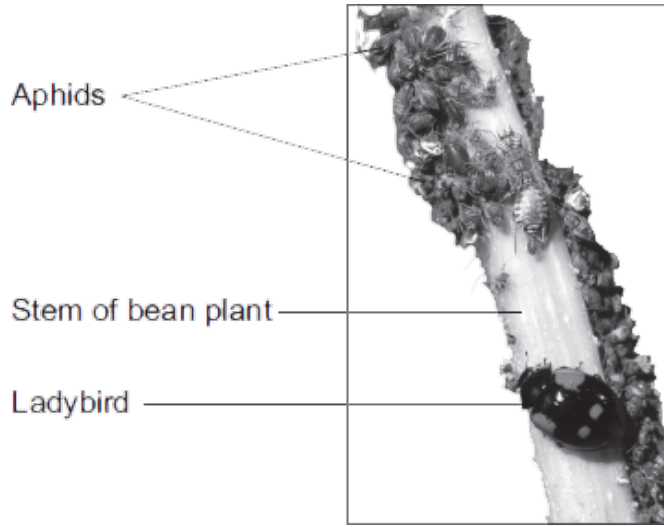
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(3)

(Total 8 marks)

Q11. Students investigated a food chain in a garden.

The students found 650 aphids feeding on one bean plant.
Five ladybirds were feeding on the aphids.



Photograph supplied by Hemera/Thinkstock

(a) (i) Draw a pyramid of biomass for this food chain.
Label the pyramid.

(2)

(ii) The biomass in the five ladybirds is less than the biomass in the bean plant.

Give **two** reasons why.

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(2)

- (b) The carbon in dead bean plants is returned to the atmosphere via the carbon cycle.

Describe this part of the carbon cycle.

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(4)
(Total 8 marks)

Q12. An oak wood contained the following:

200 oak trees

150 000 primary consumers

120 000 secondary consumers

- (a) Draw and label a pyramid of biomass for **this** wood. (Your pyramid does **not** have to be drawn to scale.)

(2)

- (b) A scientist estimated the total amount of energy flow through each level of the pyramid per year.

The results were:

Energy absorbed by oak trees 4 600 000 kJ per m² per year

Energy in sugar produced by trees 44 000 kJ per m² per year

Energy transferred to primary consumers 2 920 kJ per m² per year

Energy transferred to secondary consumers 700 kJ per m² per year

- (i) Calculate the percentage of the energy absorbed by the trees that is transferred to sugar by photosynthesis. Show your working.

Answer %

(2)

(ii) Suggest **two** reasons why a large proportion of the energy is not transferred to sugar.

1

.....

2

.....

(2)

(iii) Give **three** reasons why some of the energy in the primary consumers is not passed on to the secondary consumers.

1

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2

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3

.....

(3)

(Total 9 marks)

(a) Humans are removing large numbers of the cod.

Some scientists argue that this could lead to a decrease in the numbers of squid and penguins.

Others argue that the numbers of squid and penguins will stay the same.

Carefully explain each argument.

Why they might decrease.

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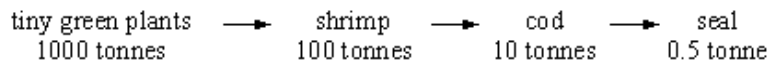
(1)

Why they might stay the same.

.....
.....
.....

(2)

(b) The following information is about the biomass of the organisms in one of the food chains in the web.



Draw and label a pyramid of biomass for this chain.

(2)

(c) Explain, as fully as you can, why the conversion of shrimp biomass into cod biomass is more efficient than that of cod biomass into seal biomass in the cold Antarctic Ocean.

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.....
.....
.....

(3)

(d) Boats from many countries fish the Antarctic Ocean. The cod are being overfished. If the numbers of cod are to increase, the population must be carefully managed.

(i) Suggest **two** control measures which would prevent a further drop in numbers,

.....
.....

(2)

(ii) Suggest why **one** of your control measures would be difficult to put into practice.

.....
.....

(1)

(Total 11 marks)

- M1.** (a) (i) squirrels eat nuts;
each for 1 mark
- owls eat squirrels
(2 marks for energy flow) 2
- (ii) hazel tree
gains 1 mark 1
- (iii) 1 squirrel population would decrease;
because fewer nuts available as food
each for 1 mark 2
- 2 owl population would decrease;
because fewer squirrels available as food
each for 1 mark 2
- (b) (i) digested/broken down;
- (ii) by microbes/reference to worm action;
each for 1 mark 2
- (iii) March
warmer/increased activity of worms/microbes;
each for 1 mark 2

[11]

- M2.** (a) In sequence:
- heron
frog
slug
lettuce 1

- (b) (i) light / sun
ignore photosynthesis / respiration
cancel mark if water / ions etc given
*do **not** accept heat* 1
- (ii) traps / absorbs light
accept energy for light
*do **not** accept collects / attracts*
*do **not** accept 'traps sun'* 1
- (iii) 162
if correct answer, ignore working / lack of working
- $$\frac{10 \times 1620}{100} \text{ for 1 mark}$$
- 2

[5]

- M3.** (a) three layer triangular pyramid
either way up (as blocks or triangle) 1
- (soya / beans / food – trout / fish – people / human (in sequence)
ignore reference to producers / herbivores / consumers
award 1 mark only for a correct food chain with 2 correct arrows
showing energy flow 1
- (b) the trout release energy when they respire 1
- some energy will be lost in waste from the trout 1
- (c) any **one** from eg
- easy / easier to catch / more caught
allow easy / easier to monitor
 - easy / easier to feed
allow control food
 - no / less predation
allow less fishing / poaching
 - less energy loss
allow grow faster
 - less movement
ignore less space to move
*do **not** allow easier to farm*
- 1

(d) any **two** from:

- microorganisms / bacteria /decomposers / microbes / fungi /detritus feeders
- decay / rot / decompose / digest /break down
ignore biodegrade
- (microorganisms) respire
*do **not** award this mark if response implies the trout respire*
- turned into fossil fuels / named fossil fuels
- carbon dioxide / CO₂ released

2

[7]

M4. (a) bottom / third pyramid ticked
extra box ticked cancels the mark

1

(b) the sun
extra ring drawn cancels the mark

1

(c) any **two** from:

- heat
ignore keeping warm
- movement / named example internal or external
ignore digestion
- respiration
*do **not** allow for respiration*
- faeces / not all digested
*allow waste for 1 mark if neither faeces nor excretion given (ie
waste + movement = 2 marks waste + faeces = 1 mark*
- excretion/ urine
- not all of animal / all parts eaten
*do **not** accept growth / reproduction*

2

[4]

M5. (a) (i) sun
*ignore light
apply list principle*

1

(ii) photosynthesis		
	<i>apply list principle</i>	
	<i>allow approximate spelling</i>	
	<i>do not accept phototropism</i>	1
(b) (i) chemical		1
(ii) carbon dioxide		1
(iii) carbohydrates		1
(c) As carbon dioxide from the caterpillar		
	<i>if more than 2 boxes ticked deduct one mark for each additional incorrect box</i>	
		1
As faeces (droppings) from the blue-tit		1

[7]

M6. Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the [Marking guidance](#).

0 marks

No relevant content.

Level 1 (1-2 marks)

For at least one process **either** the organism that carries it out **or** the carbon compound used **or** the carbon compound produced is described **or** for at least one organism **either** the carbon compound it uses **or** the carbon compound it produces is described **or** at least one process is named

Level 2 (3-4 marks)

For some processes (at least one of which is named) **either** the organisms involved **or** the carbon compounds used **or** the carbon compounds produced are described

Level 3 (5-6 marks)

For at least one named process an organism **and** either the carbon compound used for the process **or** the carbon compound produced by the process are described **and** for other processes (at least one of which is named) **either** the organism **or** the carbon compounds used **or** the carbon compounds produced are described (as in Level 2)

Examples of Biology points made in the response:

- (green) plants photosynthesise
- photosynthesis takes in carbon dioxide
- (green) plants use carbon to make carbohydrate / protein / fat / organic compounds / named (e.g. enzymes / cellulose)
- animals eat (green) plants (and other animals)
- (green) plants respire
- animals respire
- respiration releases carbon dioxide
- (green) plants and animals die
- microorganisms decay / decompose / rot / break down / feed on dead organisms
- microorganisms respire

[6]

M7.	(a)	sulfur dioxide	1	
	(b)	(i)	mutation	1
		(ii)	pale form now (more) easily seen (by predators) or dark form now less easily seen (by predators) <i>accept ref to camouflage</i>	1
			so pale form (more) likely to be eaten or dark form less likely to be eaten	1
			so dark form (more likely to) breed / pass on genes or pale form less likely to breed / pass on genes	1
	(c)	(i)	pyramid of three layers of diminishing size <i>either way up</i>	1
			three labels in food chain order <i>award 2 marks only if the pyramid is correctly labelled</i> <i>accept trees / birch</i> <i>accept (peppered) moth(s) / larvae</i>	1
		(ii)	some material is lost in waste from the birds	1

M8. Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.

No relevant content.

0 marks

There is a brief explanation of at least two ways in which the energy captured by the heather is transferred, which has little clarity and detail. Credit may be awarded either for references to general ways in which organisms transfer energy or to ways in which specific organisms in the food web transfer energy.

Level 1 (1–2 marks)

There is some explanation of a range of the ways in which the energy captured by the heather is transferred. Credit may be awarded either for references to general ways in which organisms transfer energy or to ways in which specific organisms in the food web transfer energy.

Level 2 (3–4 marks)

There is a clear, balanced and detailed explanation of a large variety of ways in which energy captured by the heather is transferred. Credit may be awarded either for references to general ways in which organisms transfer energy or to ways in which specific organisms in the food web transfer energy.

Level 3 (5–6 marks)

examples of biology points made in response

- respiration releases energy (allow this point even if given for named organism) NB: to gain full marks, candidates must gain this mark.
- some energy lost in animals / named animal's waste materials
- some energy used in maintenance / repair (allow this point if given for named organism)
- some energy used for movement (allow this point if given for named animal)
- energy lost as heat to surroundings (allow this point if given for named organism)
- some organisms die (rather than being eaten) (allow this point if given for named organism)
- reference to detritivores / microbes

[6]

M9. (a) the sun / light / sunshine / solar
allow radiation from the sun
ignore photosynthesis / respiration
apply list principle
*do **not** allow water / minerals / heat*

1

(b) 2.5 (:1)

correct answer with or without working

ignore rounding with correct working

*do **not** allow other equivalent ratios for both marks*

*evidence of selection of 10(insects) **and** 4(frogs) **or** 50 **and** 20 **or** 1 **and** 0.4 for 1 mark*

if no other working allow 1 mark for 0.4:(1) on answer line

2

(c) any **two** from:

*allow for insects **or** frogs*

allow energy for biomass

- some parts indigestible / faeces
- waste / examples of waste eg urea / nitrogenous compounds / urine / excretion
- movement / eg of movement
allow keeping warm
- heat
- not all eaten / eg of not all eaten
- respiration
do not accept energy for respiration

2

(d) any **four** from:

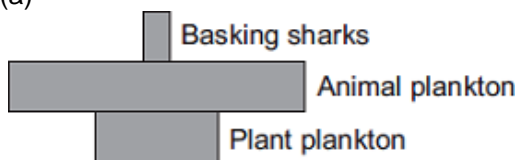
- (bodies) consumed by animals / named / scavengers / detritus feeders
- microorganisms / bacteria / fungi / decomposers
- reference to enzymes
- decay / breakdown / decompose / rot
ignore digest(ion)
- respiration
- carbon dioxide produced
- photosynthesis
- sugar / glucose produced
accept other organic molecules
- fossilisation / fossil fuels / named
- combustion / burning
must be linked with fossilisation / fossil fuels
- (burning) produces carbon dioxide
allow carbon dioxide produced once only

4

[9]

M10.

(a)



if more than one box is ticked award no mark

1

(b) increasing / higher light / temperature

*ignore references to months other than February – April
do **not** accept mineral / ions increase*

1

more / increased photosynthesis

*for both marks there must be a reference to 'more' at least once
(e.g. 'more light for photosynthesis' gains 2 marks)
allow 1 mark for reference to light **and** photosynthesis without an
idea of 'more'*

1

(c) increase due to increase in plant plankton / food

ignore references to months other than April – July

1

decrease due to fall in plant plankton / food **or** decrease as eaten by (basking) sharks

allow decrease as eaten by predators / animals / fish

1

(d) fall due to use / intake by plant (plankton)

ignore ref to no change section of graph

for fall allow March / April

ignore May / February

1

increase due to decay / decomposition / breakdown

for increase allow any month in range August to November

ignore December

1

of dead (plant / animal) plankton

allow of dead organisms / waste

1

[8]

M11. (a) (i) triangular pyramid with 3 layers
may be as blocks or as triangle
ignore food chains and arrows

1

layers appropriately labelled:
bean / plant

aphid,

ladybird

*labelled in food chain order must **not** contradict correct pyramid*

*allow correctly labelled inverted pyramid for **2** marks*

1

(ii) any **two** from:
(for aphid / ladybird)
ignore energy

• not all digested / faeces

• loss in urine

• loss of CO₂

ignore loss of CO₂ from bean plant

• not all eaten

*if none of first 3 points given then allow waste (materials) / excretion for **1** mark*

2

- (b) microorganisms / microbes / bacteria / fungi / decomposers / detritivores / named
do **not** accept germs
allow mould
ignore aphids
1
- decay / breakdown / digest / decompose / rot (bean plant)
ignore eat
1
- respiration (of microorganisms etc / aphids)
allow burning / combustion
1
- carbon dioxide released (from respiration of microorganisms etc / aphids)
allow carbon dioxide released / produced (from burning / combustion)
ignore other parts of the carbon cycle
ignore formation of fossil fuels
1

[8]

- M12.** (a) levels in correct order
sizes correct
for 1 mark each
2
- (b) (i) working
0.96% (correct answer = 2)
for 1 mark each
2
- (ii) 2 of e.g.
heat up leaves
absorbed by non-photosynthetic parts
transmitted through leaves
any 2 for 1 mark each
2
- (iii) 3 of e.g.
respiration of primary consumers
movement of p.c.
waste from p.c.
repair/growth of p.c.; heat losses to surroundings
any 3 for 1 mark each
3

[9]

M13. any **five** from:

- the amount of energy (in the biomass of organisms) is reduced at each successive stage in a food chain
- all of prey organism is not consumed
- energy is 'lost' as the organisms' waste materials
- energy is transferred / lost during respiration
- energy is transferred / lost as movement (kinetic energy)
- energy is transferred / lost as heat (thermal energy)
- energy is transferred / lost to the surroundings
- the only energy transferred to a higher level is that which the organisms have used in growing

statements about energy flow the wrong way are neutral

[5]

M14. (a) Decrease: seals will eat more squid and penguins
for 1 mark

1

Stay the same:

- more shrimp/food for squid and penguins

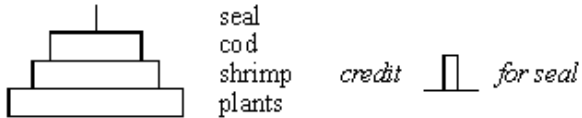
ideas that

- increase in squid and penguins balances the extra eaten by seals
- seals find other prey (allow start to eat shrimps)

any two for one mark each

2

(b)



allow



- correct shape (doesn't need to be to scale)
- correctly with organisms

*(if wholly correct but inverted then credit 1 mark)
each for 1 mark*

2

(c)

- seals are mammals
- *idea that seals have (to maintain) a constant body temperature*
[allow warm blooded]
- heat losses to cold seas
- more of food eaten used to replace heat loss

*(credit use of figures i.e. 95% loss compared to 90%
or 5% efficient compared to 10%
or 20 : 1 conversion ratio compared to 10 : 1
with 1 mark)*

any three for 1 mark each

3

(d) (i) *ideas that*

- reduce number of fishing boats allowed
- breed in captivity and then release
- agree quotas [not an unqualified 'ban']
- avoid breeding areas
- avoid breeding seasons
- increase size of net mesh/don't catch small fish
- limit catches of shrimps
- cull seals

*any two for 1 mark each
[allow any other reasonable answer]*

2

(ii)

- breeding areas closer to some countries than others
 - difficult to police/easy to cheat/'poach'
 - difficult to agree quotas
 - some countries eat more fish than others
 - best weather for fishing maybe in breeding seasons
 - fisherman/trawlers need employment
 - big demand for cod
- any one for 1 mark*
[allow any other sensible response]

1

[11]

