New GCSE

4781/03-A

SCIENCE B

UNIT 1: Space, Energy and Life

A.M. TUESDAY, 12 June 2012

Resource folder (Pre-Release Article)

For use with:

Section B of the Foundation Tier

Section A of the Higher Tier

Pre-Release Article - Feeding relationships and energy transfer in a food web

Feeding relationships and energy transfer in an ecosystem can be represented by food webs and pyramids. **Table 1** shows the living organisms present in a woodland habitat.

Food source	Eaten by
fruits and seeds	mice, badgers, blackbirds
leaves	aphids, rabbits
flowers	butterflies & bees
mice	kestrels & shrews
aphids	ladybirds
rabbits	badgers and stoats
butterflies	spiders
bees	spiders
ladybirds	spiders
blackbirds	stoats & kestrels
spiders	shrews
shrews	stoats & kestrels

Table 1: Living organisms in a woodland habitat

Badgers, kestrels & stoats have no natural predators.

Food chains vary in length from three trophic levels to four or more. A food chain consisting of fruits, mice and kestrels consists of three levels; whereas a food chain consisting of fruits, mice, shrews and finally a kestrel consists of four levels.

Diagrams of food webs only show qualitative information. Pyramids of numbers, biomass and energy provide us with quantitative information. **Table 2** shows the appearance of these ecological pyramids for two food chains, taken from a different habitat.

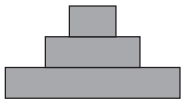
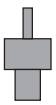
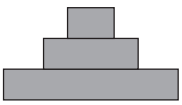
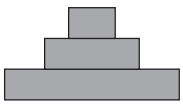
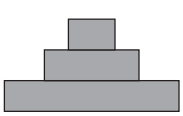
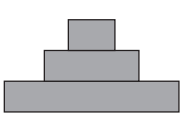
	Fox ↑ Rabbit ↑ Nettle plant	Two-spot ladybird ↑ Small nettle aphid ↑ Nettle plant
Pyramid of numbers compares the number of organisms at each trophic level		
Pyramid of biomass compares the mass of biological material at each trophic level		
Pyramid of energy compares the amount of energy passing through each trophic level over a period of time		

Table 2: Pyramids of numbers, biomass and energy for two food chains

Pyramid of numbers

Organisms are counted in a given area and grouped into trophic levels. The number of organisms is represented as a rectangle whose length is proportional to the number of organisms counted in the given area.

Usually there are decreasing numbers as you go through the trophic levels but there can be exceptions as shown in **Table 2**. The problems associated with pyramids of numbers are overcome if a pyramid of biomass is used.

Pyramid of biomass

A pyramid of biomass shows the dry mass of living tissue at each stage of the food chain at any one time. It is measured in units of mass per unit area e.g. grams per square metre. In water ecosystems it is measured in mass per unit volume. There is a smaller amount of biomass at each higher level of a food chain.

Pyramid of energy

The third type of pyramid is a pyramid of energy. An example of a pyramid of energy is shown in **Figure 1**. This shows the amount of energy at each trophic level of a food chain. Due to the energy losses between each stage of the food chain, a pyramid of energy is always pyramid-shaped. Each rectangle represents energy per unit area or volume per unit time. An example of a unit is kJ/m^2/yr. The idea of the transfer of energy allows us to consider the efficiency with which light energy is transferred to energy in producers, as well as the efficiency with which energy in the producers is then transferred from one trophic level to the next.

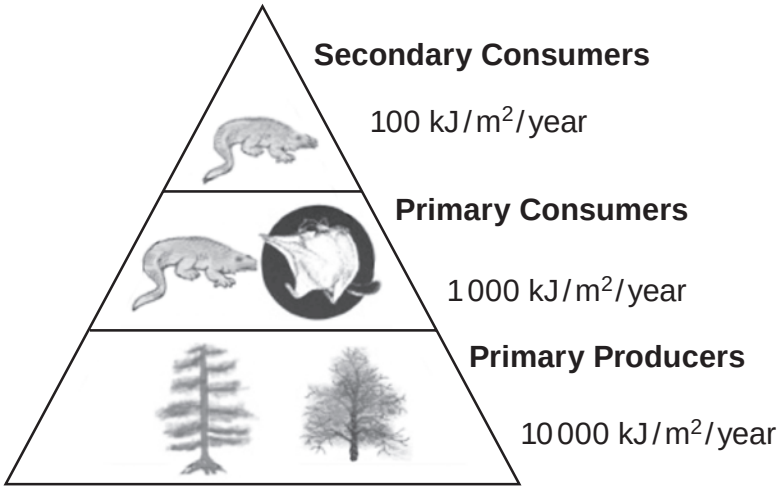


Figure 1 Pyramid of Energy

The efficiency of transferring energy between trophic levels can be calculated using the equation:

$$\textit{efficiency} = \frac{\textit{useful energy at next trophic level}}{\textit{available energy at previous trophic level}} \times 100$$

For example, the amount of energy at the primary consumer trophic level is 1000 kJ/m^2/yr and the energy at the producer level is 10000 kJ/m^2/yr.

$$\textit{efficiency} = \frac{1000}{10000} \times 100 = 10\%$$

Answer **all** *questions in the spaces provided.*

This section is based upon the Pre-Release Article which is found in the separate resource folder.

1. National Trust wardens monitor the wildlife living in woodland.

(a) Use the information in **Table 1** of the pre-release article to construct a **food web** below for the woodland habitat. [6]

Examiner only

(b) Give **one** example, from this food web, of a woodland organism that is: [6]

(i) at more than one trophic level; .....

(ii) a primary consumer; .....

(iii) a secondary consumer; .....

(iv) a tertiary consumer; .....

(v) a herbivore; .....

(vi) a carnivore. .....

(c) The government has announced that badger culls (killing) will be allowed. The Mammal Society is against this policy since badgers could disappear in certain areas. This would affect woodland habitats. Explain how the killing of badgers could affect the other organisms living in the woodland habitat shown in Table 1. [6] QWC

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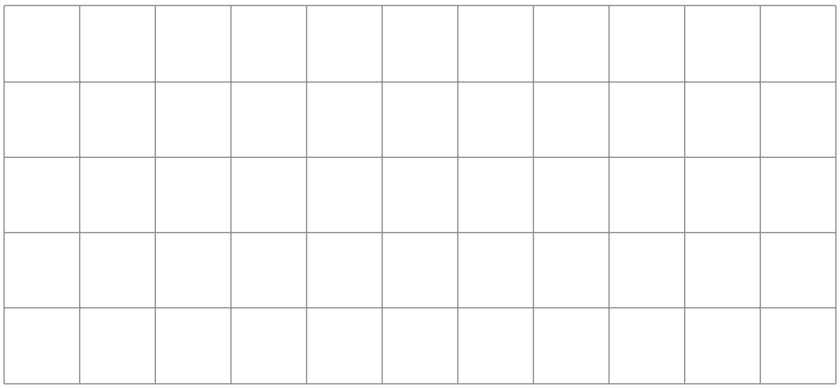
Turn over for next question.

Examiner only

(d) (i) Complete the table below for one food chain in the woodland habitat. [1]

Organism	Number in chain	Average mass of each organism (g)	Total mass (g)
Leaves	100	0.5	.....
Aphids	500	0.01	.....
Ladybirds	10	0.1	.....

(ii) Draw on the grid below, a pyramid of biomass to scale, for the food chain shown in the table above. [3]



(e) The table shows information about the energy transfer through the trophic levels of the woodland habitat.

Trophic level	Energy (J/m^2/year)	Efficiency of energy transfer to next level
1	25 000	15.0%
2	3 750	12.3%
3	460	.....
4	23	

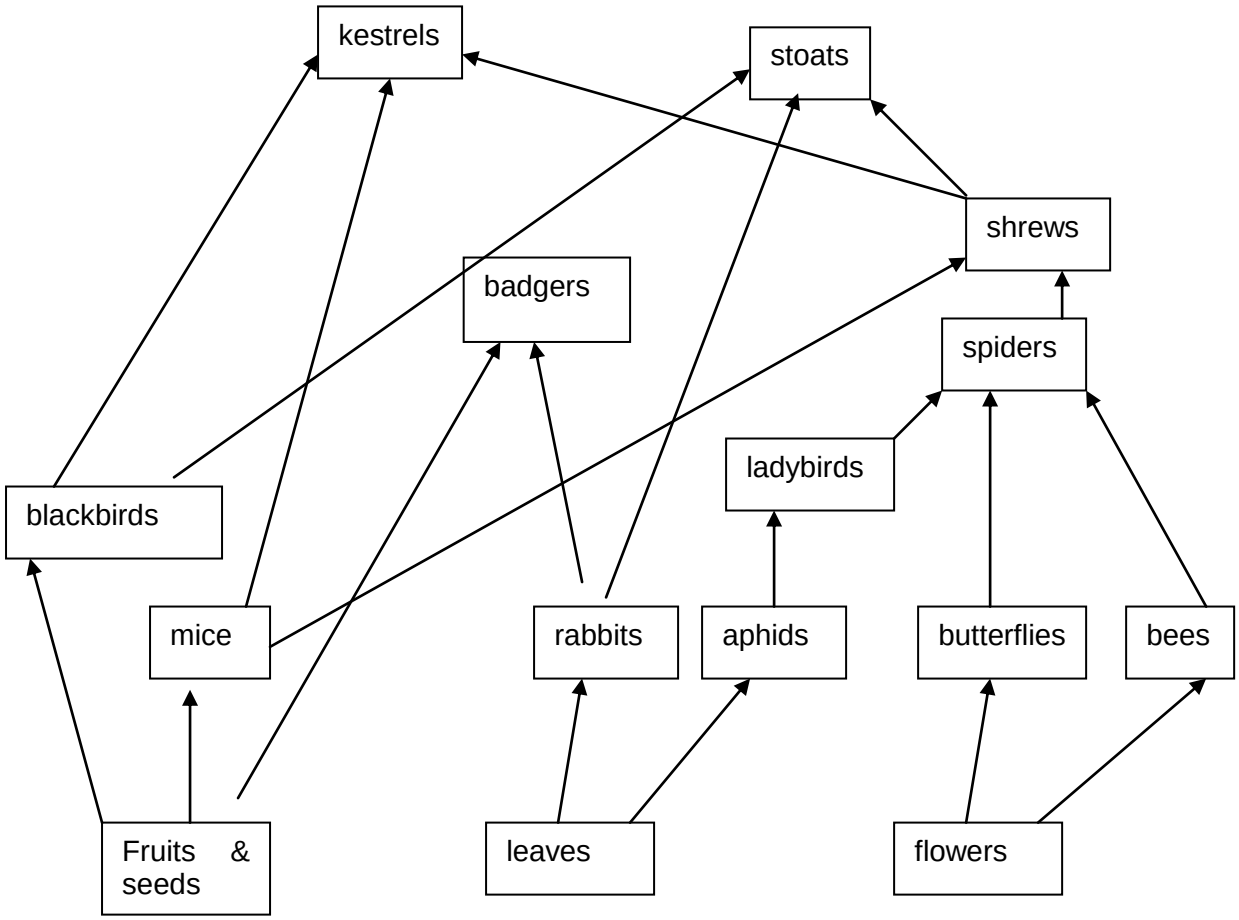
Calculate the value missing from the table. [2]

GCSE MARKING SCHEME

SCIENCE B

SUMMER 2012

Q.1 (a)



Producers at start of each chain within food web (1)
Badgers, kestrels & stoats at end of a chain within web (1)
Flowers to butterflies/bees to spiders to shrews to kestrels/stoats (1)
Leaves to aphids to ladybirds to spiders (1)
Leaves to rabbits to badgers/stoats (1)
Fruits & seeds to badgers (1)
Fruits & seeds mice to shrews/kestrel (1)
Fruits & seeds to blackbirds to kestrels/stoats (1)
Maximum of 5 if arrows not put in.

(b) (i) Badgers/spiders kestrels/stoats/spiders (1)

(ii) Blackbirds/mice/rabbits/aphids/butterflies/bees/badgers (1)

(iii) Kestrels/badgers/ladybirds/spiders/stoats (1)

(iv) Spiders/shrews (1)

(v) Blackbirds/mice/rabbits/aphids/butterflies/bees (1)

(vi) Kestrels/spiders/ladybirds/shrews/stoats (1)

(c) **Indicative Content**

Up to five of:

- Organisms that badgers feed on (rabbits, fruits & seeds) will become more plentiful
- more availability of fruits & seeds will cause an increase in herbivores that feed on them (mice & blackbirds)
- more food available for kestrels & stoats could increase their numbers
- rabbit population will increase lower supply of leaves so aphids may decrease
- result in decrease in ladybirds
- spiders will depend more on butterflies & bees so their numbers will decrease.

5 – 6 marks
The candidate constructs an articulate, integrated account correctly linking relevant points, such as those in the indicative content, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses appropriate scientific terminology and accurate spelling,
punctuation and grammar.

3 – 4 marks
The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate uses mainly appropriate scientific terminology and some accurate spelling, punctuation and grammar.

1 – 2 marks
The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate uses limited scientific terminology and inaccuracies in spelling, punctuation and grammar.

0 marks
The candidate does not make any attempt or give a relevant answer worthy of credit.

(d) (i) 50, 5, 1 all correct (1)

(ii) Correct height (1)
Correct shape (1)
Correct ratio (1) (50 – 5 – 1) (3)

(e) Substitution of values (23/460), answer 5% (2)