Unit 4 · Ecology

HARDER PRACTICE QUESTIONS · ANSWER KEY

Full marks 52

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Spot the error

ANSWER U · 2

The power is $n - 1$, the number of **steps**, not the level. From level 1 to level 4 is 3 steps: $6{,}000 \times (0.1)^3 = \mathbf{6\ kJ}$.

MARKING SCHEME

✓ The power is the number of steps, 3, not the level.
✓ 6 kJ.

2 Which can't be real?

ANSWER A · 4

P: spindle-shaped, inverted at the base (a tree with its insects and birds). **Q:** inverted, as in some seas: a snapshot of biomass. **R:** upright.
S can't be real. It is a pyramid of energy with a wider second bar. Primary consumers get all their energy from the producers, so they can't take in more than the producers took in.

MARKING SCHEME

✓ P is spindle-shaped.
✓ Q is inverted.
✓ R is upright.
✓ S can't be real: energy can't be more than the level below had.

3 Read the measurements

ANSWER A · 4

i. $14{,}100 \div 87{,}100 = \mathbf{16.2\%}$; $1{,}600 \div 14{,}100 = \mathbf{11.3\%}$; $88 \div 1{,}600 = \mathbf{5.5\%}$.
ii. $88 \div 87{,}100 \times 100\% = \mathbf{0.10\%}$.
iii. $87{,}100 \times (0.1)^3 = \mathbf{87.1\ kJ}$, against a real 88 kJ.
iv. The steps above 10% and the step below it cancel: $0.162 \times 0.113 \times 0.055 \approx 0.001$, the same as $0.1 \times 0.1 \times 0.1$. This won't happen in every ecosystem.

MARKING SCHEME

✓ 16.2%, 11.3% and 5.5%.
✓ 0.10%.
✓ 87.1 kJ.
✓ The high and low steps cancel, multiplying to about 0.001.

4 Start from the top

ANSWER A · 3

The plants must store $30 \div (0.1)^3 = 30 \times 1{,}000 = \mathbf{30{,}000\ kJ}$.
Sunlight $= 30{,}000 \div 0.015 = \mathbf{2{,}000{,}000\ kJ}$.

MARKING SCHEME

✓ Three steps down the chain.
✓ The plants store 30,000 kJ.
✓ 2,000,000 kJ of sunlight.

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5 Estimate it

ANSWER A · 3

Each tiger needs about 3,000 × 10 = 30,000 kg of grass a year. 429 tigers: 429 × 30,000 = 12,870,000 kg. Land: 12,870,000 ÷ 5,000 ≈ 2,570 hectares, **about 26 km²**, if the deer ate all of it and only the tigers ate the deer. The real land needed is much larger.

MARKING SCHEME

- ✓ 30,000 kg of grass for each tiger.
- ✓ About 12.9 million kg in all.
- ✓ About 2,570 hectares, or 26 km^2.

6 Maize or chicken?

ANSWER A · 3

i. 3,000,000 ÷ 10,000 = **300 days**.
ii. The chickens hold about 10%, 300,000 kJ: **30 days**.
iii. 150 + 15 = **165 days**.

MARKING SCHEME

- ✓ 300 days.
- ✓ 30 days.
- ✓ 165 days.

7 Trace an atom

ANSWER U · 5

1. **Fixation:** *Rhizobium* in the root nodules turns N_2 into ammonia.
2. **Assimilation:** the plant builds it into proteins; the person eats them.
3. **Ammonification:** decomposers such as *Bacillus* turn the urea of the urine into ammonia or ammonium.
4. **Nitrification:** *Nitrosomonas* turns ammonium into nitrite, and *Nitrobacter* nitrite into nitrate.
5. **Denitrification:** in the flooded field, bacteria such as *Pseudomonas* turn the nitrate into N_2.

MARKING SCHEME

- ✓ Fixation by *Rhizobium*.
- ✓ Assimilation, then passing on by eating.
- ✓ Ammonification by decomposers.
- ✓ Nitrification by *Nitrosomonas* and *Nitrobacter*.
- ✓ Denitrification by *Pseudomonas*.

8 Predict, then explain

MARKING SCHEME A · 3

- ✓ The flooded field.
- ✓ Denitrifying bacteria use nitrate in place of oxygen, and give off nitrogen gas.
- ✓ Little new nitrate, as nitrification needs oxygen.

9 Which explanation fits the evidence?

ANSWER HA · 4

i. Rabin: only **half** of the gas is heavy. "All from water": **all** of it as heavy as the water's oxygen.
ii. **All from water.**
iii. $6CO_2 + 12H_2O \rightarrow C_6H_{12}O_6 + 6O_2 + 6H_2O$. Left: 12 + 12 = **24**. Right: 6 + 12 + 6 = **24**. The 12 water molecules hold the 12 atoms of the gas.

MARKING SCHEME

- ✓ Rabin predicts half heavy, the other idea all heavy.
- ✓ The result fits "all from water".
- ✓ The equation with $12H_2O$ split and $6H_2O$ made.
- ✓ 24 oxygen atoms on each side.

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10 Design a fair test

ANSWER A · 4

Change: one plot grows lentils between the rice crops; the other is left bare.
Keep the same: the size of the plots, the soil, the water, the rice seed and the urea (none, or the same small amount on both).
Measure: the mass of rice each plot gives.
More reliable: several plots of each kind, side by side, for more than one season.

MARKING SCHEME

- ✓ Changes only lentils or no lentils.
- ✓ Keeps plot size, soil, water, seed and urea the same.
- ✓ Measures the next rice crop.
- ✓ Repeats with several plots or seasons.

11 What if?

ANSWER HA · 3

Fixation would go on taking nitrogen from the air, and almost nothing would return it, so nitrogen gas would slowly fall. Nitrate would build up in soil and wash into lakes and wells, feeding algae whose decay kills fish. The cycle would no longer close: nitrogen would go only one way, out of the air.

MARKING SCHEME

- ✓ Nitrogen in the air slowly falls, as fixation goes on.
- ✓ Nitrate builds up, with more leaching and algae in lakes.
- ✓ The cycle no longer closes.

12 Draw

MARKING SCHEME A · 3

- ✓ Bars of 0.8 cm and 4.2 cm.
- ✓ Phytoplankton at the base, so it looks inverted.
- ✓ The pyramid of energy drawn upright.

13 Read the numbers

ANSWER A · 3

i. $427 \div 1{,}000{,}000 \times 100\% = \mathbf{0.0427\%}$.
ii. $(427 - 280) \div 280 \times 100\% = 147 \div 280 \times 100\% = \mathbf{52.5\%}$.
iii. Your carbon came from recent food, so from the air through photosynthesis not long ago: it goes round. Coal's carbon was buried for millions of years, and burning it adds carbon that was out of the cycle.

MARKING SCHEME

- ✓ 0.0427%.
- ✓ 52.5%.
- ✓ Breath returns carbon taken in recently; coal adds carbon locked away for millions of years.

14 Think

ANSWER HA · 3

i. $365 \div 3 \approx 122$ crops; $122 \times 4 \approx$ **490 g/m²** a year.
ii. About 10% of it: **about 49 g/m²** a year.
iii. The 4 g is only what is there at one moment. The food made over a year is far more than the 21 g of animals, and enough to build and keep it.

MARKING SCHEME

- ✓ About 490 g/m² a year.
- ✓ About 49 g/m² a year.
- ✓ 4 g is a snapshot; over a year the food is far more than 21 g.

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15 Correct the misconceptions

ANSWER U · 3

1. Decomposers recycle **matter**, not energy. Energy leaves as heat, so ecosystems need a steady supply of sunlight.
2. **Fixation** brings new nitrogen in from the air. Nitrification only changes ammonium already in the soil.
3. The oxygen comes from **water**, which the plant splits using light energy.

MARKING SCHEME

- ✓ Decomposers recycle matter, not energy.
- ✓ Fixation brings new nitrogen in; nitrification doesn't.
- ✓ The oxygen comes from water.

16 Make your own

ANSWER HA · 2

For example: "In the chain paddy → grasshopper → frog → snake, the snake takes in 8 kJ. How much must the paddy store?" Three steps down: $8 \times 1{,}000 = 8{,}000$ kJ.

MARKING SCHEME

- ✓ A problem with a chain of at least four levels.
- ✓ A correct answer, with working.

See it at Science Playground

Exhibits and plants at the center, Bhaktapur, that go with this unit. Book a class visit at science-playground.com/booking.

- **The Ecosystem Pond** (exhibit): Find the producers and a consumer: sunlight's energy, caught by the water plants and algae, passes to the guppies, with much lost on the way.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	0	10	30	12	**52**

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