



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

1 Key words

1. renewable

K • 4

2. helium

3. thermonuclear fusion

4. photovoltaic cells

5. briquette

6. methane

7. oxygen

8. hydroelectricity

Each carries 0.5 mark.

2 Label the diagram

1. mixing tank (dung + water)

2. inlet pipe

3. dome: biogas collects

4. digester: slurry decomposes without oxygen

5. compost pit

6. outlet chamber

K • 3

Each carries 0.5 mark.

3 Multiple choice

i. c. kerosene

K • 1

Kerosene is made from crude oil, which takes millions of years to form and runs out with use. Briquettes and biogas are made from biomass that keeps growing, and the wind keeps blowing.

ii. c. dung cake, biogas, alcohol, husk

U • 1

Dung cake, biogas, alcohol (made by fermenting crops) and husk all come from living things of today. Kerosene, coal and petrol are fossil fuels.

iii. d. water vapor, carbon dioxide, methane, hydrogen sulphide

K • 1

Biogas forms **without oxygen**, so the three groups with oxygen are wrong. The right group has its two main gases, **methane** and **carbon dioxide**, plus the water vapor and hydrogen sulphide that are always in it.

iv. b. Coal formed from ancient plants, which stored the Sun's energy by photosynthesis.

U • 1

Coal is the remains of plants that grew in swamps hundreds of millions of years ago. Those plants captured sunlight by photosynthesis and stored it as chemical energy. When you burn coal, you release sunlight that fell on the Earth before the dinosaurs.

v. c. the generator

U • 1

The turbine is spun by the water, but it only passes the motion on. The **generator**, turned by the turbine, is where a coil spins in a magnetic field and electricity is made. The transformer only changes the voltage of electricity that already exists, and the penstock is just the pipe.

4 Very short answers

a. MARKING SCHEME

K • 1

✓ A fuel made from living things or their wastes (plants, crop residue, dung).

b. MARKING SCHEME

K • 1

✓ Carbon monoxide.



- c. MARKING SCHEME U · 1
✓ Black absorbs the most sunlight (heat), so the air inside gets hotter.

5 Short answers

- a. MARKING SCHEME U · 2
✓ The Sun's heat drives the water cycle (rivers for hydroelectricity) and makes the wind.
✓ Its light, stored by plants in photosynthesis, gives food, wood and biomass and, over millions of years, fossil fuels.
- b. MARKING SCHEME U · 2
✓ Any one difference, e.g. a carbonized briquette is made from charcoal (charred biomass); a non-carbonized briquette from biomass that is not charred.
✓ Any second difference, e.g. a carbonized briquette gives very little smoke; a non-carbonized one (such as a dung cake) gives more.
- c. MARKING SCHEME A · 2
✓ Nepal has many snow-fed and rain-fed rivers falling steeply from great heights, ideal for hydropower.
✓ It is renewable, smokeless and cheap in the long run, and it can replace imported petroleum (and be sold abroad).
- d. MARKING SCHEME U · 2
✓ Hot water is less dense, so it rises from the tubes into the tank; cold, denser water sinks into the tubes.
✓ This flow by itself is convection, so no pump is needed.

6 Long answer

ANSWER

U · 4

In the Sun's core (about 15 million K, enormous pressure) hydrogen atoms lose their electrons, and the fast, crowded protons fuse in spite of repelling one another: thermonuclear fusion, in three steps. Two protons form deuterium and a positron; deuterium and a proton form helium-3 and a gamma ray; two helium-3 nuclei form helium-4 and free two protons. Overall, four hydrogen nuclei become one helium nucleus, which is slightly lighter; the lost mass is given out as energy (heat and light).

MARKING SCHEME

- ✓ At about 15 million K and enormous pressure, hydrogen atoms lose their electrons and the protons fuse (thermonuclear fusion).
- ✓ Step 1: ${}^1_1\text{H} + {}^1_1\text{H} \rightarrow {}^2_1\text{H} + {}^0_{+1}\text{e} + \text{energy}$.
- ✓ Step 2: ${}^2_1\text{H} + {}^1_1\text{H} \rightarrow {}^3_2\text{He} + \gamma$; step 3: ${}^3_2\text{He} + {}^3_2\text{He} \rightarrow {}^4_2\text{He} + 2 {}^1_1\text{H} + \text{energy}$.
- ✓ Overall $4 {}^1_1\text{H} \rightarrow {}^4_2\text{He} + 2 {}^0_{+1}\text{e} + \text{energy}$: the helium is slightly lighter, and the lost mass becomes the energy given out.

7 Numerical problem

ANSWER

A · 2

$$m = 0.2 \text{ g} = 2 \times 10^{-4} \text{ kg.}$$

$$E = mc^2 = 2 \times 10^{-4} \times (3 \times 10^8)^2 = 2 \times 10^{-4} \times 9 \times 10^{16} = 1.8 \times 10^{13} \text{ J.}$$

MARKING SCHEME

- ✓ $E = mc^2$ with $m = 2 \times 10^{-4} \text{ kg}$ (mass changed into kg).
- ✓ $E = 1.8 \times 10^{13} \text{ J.}$



8 Think

ANSWER

HA - 2

A few:

- **Nuclear energy** in a nuclear power station comes from uranium, which was made in exploding stars long before the Sun existed.
- **Geothermal energy** (the heat inside the Earth, which feeds hot springs like those at Tatopani) comes from the Earth's own heat, much of it from radioactive atoms in the rocks.
- **Tidal energy** comes mostly from the Moon's gravity pulling on the oceans.

Everything else (food, wood, dung, biogas, coal, oil, gas, wind, rivers, sunlight) is solar energy, fresh or stored.

MARKING SCHEME

- ✓ Any one, e.g. nuclear energy: from uranium, made in exploding stars before the Sun existed.
- ✓ Any second, e.g. geothermal energy (the Earth's own heat, as in the hot springs at Tatopani) or tidal energy (mostly the Moon's pull).

9 Activity: Hot water from the Sun

(not marked)

WHAT STUDENTS SHOULD FIND

The water in the black bottle gets warmer, often 10 °C or more above the clear one: black absorbs most of the light falling on it and turns it into heat, while a clear surface lets the light pass through. The same idea is used in the black inside of a solar dryer, the tubes of a solar water heater and the black pot of a solar cooker.

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.

- **Solar House Model** (exhibit): Follow the wires from the panels: sunlight becomes electricity, and a battery stores it.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	11	14	4	2	31

