

Fuels, nuclear power, renewables and the climate

Grade 8 science (Year 9 · Class 8) · Worksheet answers

Compare your working with these model answers. Calculations give the formula, the substitution and the result in bold. For decision problems, notice that good answers weigh cost, CO₂ and reliability rather than naming one fact.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-ESS3-3

Problem 1 Renewable or not

1. Renewable: **wind, tidal, biomass**. Non-renewable: **coal, uranium, natural gas**.
2. The fossil fuels in the list are **coal and natural gas**.

Problem 2 How fossil fuels formed

1. They formed from the remains of **ancient plants and animals**.
2. It took **millions of years**.
3. We use them much faster than they form, so they will eventually run out.

Problem 3 Stages of a power station

1. A is the **fuel**, B the **boiler**, C the **turbine**, D the **generator** and E the **grid** (electricity).
2. The turbine is turned by **steam**.

Problem 4 Good and bad points

1. Wind: **wind**.
2. Nuclear: **nuclear**.
3. Solar: **solar**.
4. Coal: **coal**.

Problem 5 Greenhouse gases

1. **Carbon dioxide and methane**.
2. **Carbon dioxide (CO₂)**.
3. They absorb it and send some of it back towards the ground.

Problem 6 Simple efficiency

1. Efficiency = useful output ÷ total input × 100.

- $40 \div 200 \times 100 = \mathbf{20\%}$.
- $200 - 40 = \mathbf{160\text{ J}}$ wasted.

Problem 7 Power station efficiency

- Efficiency = $840 \div 2400 \times 100 = \mathbf{35\%}$.
- $2400 - 840 = \mathbf{1560\text{ MJ}}$.
- It goes to the surroundings as heat, for example from the cooling towers and flue gases.

Problem 8 Energy from a wind turbine

- $2.0\text{ MW} = \mathbf{2000\text{ kW}}$.
- $E = P \times t = 2000 \times 5.0 = \mathbf{10\,000\text{ kWh}}$.
- $10\,000 \div 10 = \mathbf{1000\text{ homes}}$.

Problem 9 Reading a Sankey diagram

- The useful band is half of the input: **50 units**.
- $100 - 50 = \mathbf{50\text{ units}}$ wasted.
- $50 \div 100 \times 100 = \mathbf{50\%}$.
- Gas: $0.50 \times 1000 = 500\text{ MJ}$. Coal: $0.35 \times 1000 = 350\text{ MJ}$. The gas station gives **150 MJ more**.

Problem 10 Solar panels at home

- $20 \times \$0.15 = \mathbf{\$3.00}$ a day.
- $30 \times \$3.00 = \mathbf{\$90}$.
- $\$3600 \div \$90 = \mathbf{40\text{ months}}$.

Problem 11 Carbon dioxide from two fuels

- $300 \times 0.90 = \mathbf{270\text{ kg}}$.
- $300 \times 0.40 = \mathbf{120\text{ kg}}$.
- $270 - 120 = \mathbf{150\text{ kg}}$ less with gas.

Problem 12 Wind and solar limits

- Solar panels give no output in darkness, and wind may be low at night.
- Both resources depend on the weather, so output may fall at the same time.
- Batteries or backup stations** (such as hydroelectric or gas) can cover the gap.

Problem 13 Greenhouse diagram

- A is **sunlight** (visible light) and B is **infrared** from the ground.
- C is the layer of **greenhouse gases**.

3. D is infrared **sent back down** to the ground.
4. Arrow **D** gets larger.

Problem 14 Spot the errors

1. Uranium is not burned. Its atoms are split in **nuclear fission**, which releases the heat.
2. Global warming is caused by **extra greenhouse gases** trapping infrared. The ozone layer blocks ultraviolet.

Problem 15 Carbon dioxide in the air

1. $413 - 317 = 96$ ppm.
2. $96 \div 317 \times 100 = 30.3\%$, so **30 %**.
3. 1960-1980: 22 ppm in two decades, which is 11 ppm per decade. 2000-2020: 44 ppm in two decades, which is 22 ppm per decade. The rate has **doubled**.

Problem 16 Hydroelectric dam

1. $E = m g h = 5.0 \times 10^6 \times 9.8 \times 80 = 3.92 \times 10^9 \text{ J} = \mathbf{3.9 \times 10^9 \text{ J}}$.
2. $0.85 \times 3.92 \times 10^9 = 3.33 \times 10^9 \text{ J}$, which is **$3.3 \times 10^9 \text{ J}$** .
3. $3.33 \times 10^9 \div 3.6 \times 10^6 = \mathbf{926 \text{ kWh}}$.

Problem 17 A wind farm

1. Rated power = $20 \times 3.0 = 60 \text{ MW}$, so average = $0.30 \times 60 = \mathbf{18 \text{ MW}}$.
2. $E = 18 \times 8760 = 157\,680 \text{ MWh}$, or **$1.6 \times 10^5 \text{ MWh}$** .
3. $157\,680 \text{ MWh} = 157\,680\,000 \text{ kWh}$, and $157\,680\,000 \div 4000 = 39\,420$, so about **39 000 homes**.

Problem 18 Uranium and coal

1. $8.0 \times 10^{13} \div 2.4 \times 10^7 = \mathbf{3.3 \times 10^6 \text{ times}}$.
2. The mass is $3.3 \times 10^6 \text{ kg}$, which is **3300 tonnes**.
3. Reasons include radioactive waste, high building cost and the risk of accidents.

Problem 19 Choosing power for a village

1. Diesel: fuel must be bought and delivered, it releases CO_2 , but it works on demand. Solar with batteries: no fuel costs and no CO_2 in use, works in the sunny climate, but batteries are expensive and need replacing. Small hydro: very cheap to run but fails in the dry season.
2. **Solar with batteries** is the best choice, because sunshine is plentiful and reliable, there is no fuel to transport and the village produces no CO_2 . A small generator could be kept as backup.

Problem 20 Forest and fossil fuel

1. $40\,000 \times 0.90 = \mathbf{36\,000\text{ kg.}}$
2. $\text{Area} = 36\,000 \div 1.0 = \mathbf{36\,000\text{ m}^2.}$
3. $36\,000 \div 10\,000 = \mathbf{3.6\text{ hectares.}}$