

Energy Resources

Mark Scheme



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1. Energy resources are the different stores in nature that we harness to generate the electricity used to power our homes and industries.

- a) Which of the following creates the most accurate definition of a **renewable** energy resource?

B – is the only correct answer.	1 mark
	Total: 1 mark

- b) The flow chart below shows the stages of producing electricity in a fossil fuel power station.

In which specific box does energy shift from a kinetic store to an electrical store?

C – is the only correct answer.	1 mark
	Total: 1 mark

- c) Which gas is released by the burning of coal that is the main contributor to global warming?

B – is the only correct answer.	1 mark
	Total: 1 mark

- d) Which of the following is classified as a **non-renewable** energy resource?

A – is the only correct answer.	1 mark
	Total: 1 mark

- e) The figure below shows a section through a hydroelectric dam.

Which energy store is decreasing as the water flows from the top of the dam down toward the turbine?

C – is the only correct answer.	1 mark
	Total: 1 mark

- f) Which of the following is the original source of the energy harnessed by a geothermal power station?

D – is the only correct answer.	1 mark
	Total: 1 mark

(Total for Question 1 is 6 marks)

2. An energy company is proposing to build a new power station to supply electricity to a small town. They are deciding between a natural gas power station and a wind farm.

The table below shows the information about the two different methods.

Energy Resource	Startup time	CO ₂ released per kg of fuel	Relative Cost to Build
Natural Gas	Short	High	Medium
Wind Power	N/A	None	High

- a) Wind power is considered a **renewable** energy resource.

What is meant by a renewable energy resource.

Accept any answer that conveys the following:	
An energy resource that is replenished as it is used.	1 mark
Allow: it can be replaced at the same rate it is used or it will not run out.	
	Total: 1 mark

- b) The energy company decides to build the natural gas power station rather than the wind farm.

Using your own knowledge and the data in the table, suggest **two** reasons why the company chose natural gas, despite it releasing carbon dioxide.

Accept any two of the following:	
- Natural gas is cheaper to build / has a lower initial capital cost. - Natural gas has a short start-up time / can quickly respond to changes in demand. - Natural gas is a reliable/constant source of energy. - Wind power is unreliable / depends on the weather / only works when it is windy.	
	Total: 2 marks

- c) Natural gas is a fossil fuel. Name **one** other fossil fuel.

Accept any <u>two</u> of the following:	
Coal. Oil. Natural gas. Both correct are needed for the mark.	1 mark
	Total: 1 mark

- d) The engineer tests a sample of the natural gas. Burning the gas releases 800,000 J of thermal energy. The generator converts this into 280,000 J of useful electrical energy.

Calculate the efficiency of the natural gas power station. Give your answer as a percentage.

Show your working.

Efficiency = (useful energy ÷ total energy) × 100	1 mark
Efficiency = (280 000 ÷ 800 000) = 0.35	1 mark
Efficiency = 0.35 × 100 = 35 %	1 mark
	Total: 3 marks

(Total for Question 2 is 7 marks)

3. An offshore wind farm generates electricity which is transmitted to the mainland.



- a) Wind power is a renewable energy resource.

State **one** disadvantage of using wind turbines to generate electricity compared to a fossil fuel power station.

Accept any one of following:	
• Unreliable or dependent on the weather (wind speed). • Visual pollution or ruins the landscape. • Noise pollution. • Danger to birds or wildlife. • Large amounts of land or space can be required.	
	Total: 1 mark

- b) The wind farm generates 450 MW of electrical power.

The wind farm is connected to the national grid by a large cable at a potential difference of 150 kV.

- i. Calculate the current flowing through the transmission cable.

Use the equation: current = power ÷ potential difference

Power = 450 000 000 W or 450×10^6 W	1 mark
Current = $450\,000\,000\text{ W} \div 150\,000$	1 mark
Current = 3000 A	1 mark
	Total: 3 marks

- ii. The wind farm is upgraded. The total power output increases from 450 MW to 738 MW.

This increase is achieved by adding 80 new, high-efficiency turbines.

Calculate the power output of one single new turbine. Give your answer in MW.

Calculate total increase = $738 - 450 = 288$ MW	1 mark
Power = $288 \div 80$	
Power = 3.6 W	1 mark
	Total: 2 marks

- iii. The wind turbines are not 100% efficient. Friction occurs inside the turbine gearbox.

State what happens to the energy that is wasted due to friction.

Any one of the following:	
• It is dissipated (into the surroundings). • It is transferred to the thermal store of the surroundings. • Lost as heat.	
	Total: 1 mark

- c) A proposal is made to replace the existing transmission cables with new ones operating at a much higher potential difference of 400 kV.

The new cables will be suspended from fewer pylons, but the new pylons will be taller.
The route will cross a National Park.

Discuss the advantages and disadvantages of this proposal.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple, isolated statements are made. For example, it ruins the view or less energy is wasted. The physics principles are weakly applied or missing.
Level 2	3 - 4	A relevant discussion that attempts to address both advantages and disadvantages but may lack detailed physics reasoning (e.g., mentions it is "more efficient" but doesn't explain why regarding current), OR covers only advantages/disadvantages in excellent detail.
Level 3	5 - 6	A detailed, coherent, and logically structured discussion that includes both physics-based advantages (linking higher potential difference to lower current and increased efficiency) and context-based disadvantages (environmental/visual impact on the national park).

Indicative content:	
Advantages: - Increasing the potential difference (to 400 kV) decreases the current. - A lower current reduces the thermal energy transferred to the surroundings (reduces I^2R losses / heating of the cables). - This significantly increases the efficiency of transmitting the electricity to the mainland. - Having fewer pylons reduces the amount of land taken up at ground level in the national park. - Fewer pylons may mean less ongoing maintenance access is required on the ground. Disadvantages: - Taller pylons will create more visual pollution / be a bigger eyesore. - This is especially problematic in a national park which is meant to be a protected area of natural beauty / relies on tourism. - The construction process of the new, larger pylons will destroy habitats / disrupt local wildlife. - Taller pylons are more exposed to high winds / extreme weather, increasing the risk of damage. - Operating at a much higher potential difference increases the risk of sparking/arcing to the ground, which is why the pylons must be taller (safety hazard).	
	Total: 6 marks

(Total for Question 3 is 13 marks)

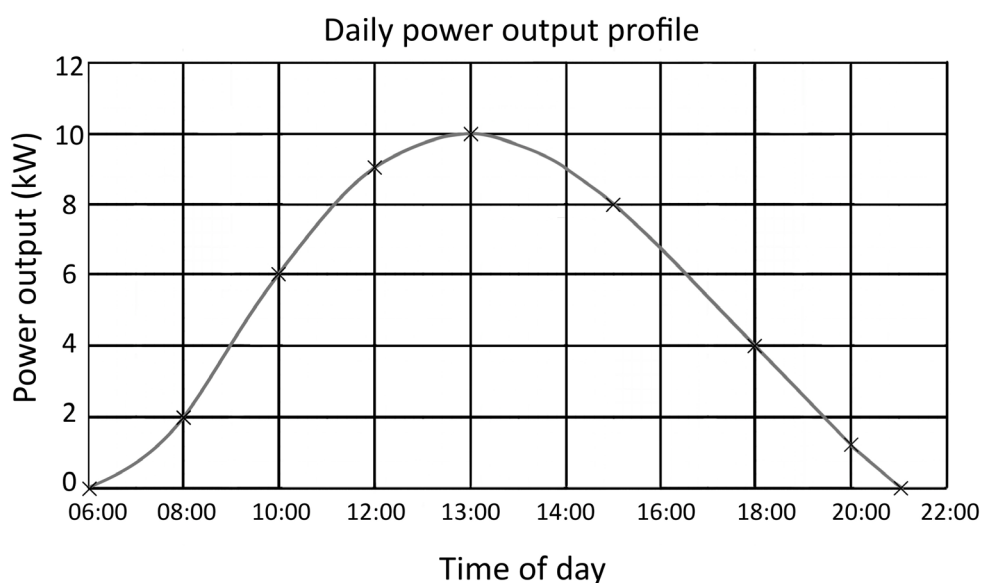
4. A homeowner installs a system of solar panels on the roof of their house to generate electricity.



- a) Solar power is a renewable energy resource.
Explain why solar power is **not** considered a reliable energy resource.

An explanation to include the following:	
The power output depends on the weather / sunlight.	1 mark
Allow: It only works when the sun is shining.	
So, it cannot generate electricity at night / in poor weather.	1 mark
	Total: 2 marks

- b) The graph below shows the power output of the solar panels on a typical summer day.



- i. At what time of day do the solar panels produce the maximum electrical power?

13:00	Allow: 1pm	1 mark
		Total: 1 mark

- ii. Suggest **one** reason why the power output is lower at 16:00 than it is at 13:00.

Accept any one of the following:	
- The sun is lower in the sky / less direct. - It is cloudier or weather conditions worsened. - Less sunlight or light intensity is hitting the panels.	
	Total: 1 mark

- c) At 12:00 pm, the solar panels are producing a constant power output of 3.2 kW.
Calculate the total energy transferred by the panels in 30 minutes. Give your answer in Joules.

Use the equation: energy transferred = power $\times$ time

Power = 3200 (W)	1 mark
time = 1800 (s)	1 mark
Substitution: Energy = 3200×1800	1 mark
Energy = 5 760 000 J	1 mark
	Total: 4 marks

- d) Even though solar panels do not release carbon dioxide while generating electricity, they are not completely **carbon neutral**. Explain why.

An explanation to include:	
Carbon dioxide / greenhouse gases are released during the manufacturing / transportation / installation of the solar panels.	1 mark
	Total: 1 mark

(Total for Question 4 is 9 marks)

5. The government is looking to reduce the country's dependence on fossil fuels.

Compare the advantages and disadvantages of using biofuels and nuclear power to generate electricity.

Marking guidance		
Level	Marks	Descriptor
Level 1	1 - 2	Simple, isolated statements are made about nuclear power or biofuels. For example, "nuclear makes radioactive waste" or "biofuels are renewable."
Level 2	3 - 4	A relevant comparison that addresses both energy sources but may lack detail. The student might only focus on advantages OR disadvantages, or they might completely miss one of the bullet points (e.g., discusses emissions in detail but fails to mention reliability).
Level 3	5 - 6	A detailed, coherent, and logically structured comparison. The student discusses both advantages and disadvantages for both nuclear power and biofuels. The answer explicitly addresses both bullet points in the prompt (environmental impact/waste AND reliability/availability).

Indicative content:	
Nuclear advantages: - Does not produce carbon dioxide / greenhouse gases during operation (does not contribute to global warming). - Does not produce sulfur dioxide (does not cause acid rain). Nuclear disadvantages: - Produces highly dangerous radioactive waste which is difficult/expensive to store safely for thousands of years. - Risk of nuclear accidents/meltdown which can catastrophically contaminate the environment. Nuclear reliability: Very reliable. Can run continuously day and night to provide a constant "base load" of electricity. Nuclear availability: High energy density (a very small amount of uranium provides a massive amount of energy), but it is ultimately non-renewable (uranium will eventually run out). Biofuels advantage: - Considered "carbon neutral" (the plants absorb CO₂ as they grow, which balances the CO₂ released when burned). Biofuels disadvantages: - Growing them requires large amounts of land, which can lead to deforestation or habitat destruction. - Releases CO₂ and other particulates at the point of burning. Biofuels reliability: Reliable. It is not dependent on the weather (like wind/solar) and can be burned on demand to meet spikes in energy needs. Biofuels availability: It is renewable (crops can be continuously replanted and replenished).	
	Total: 6 marks

(Total for Question 5 is 6 marks)

6. Iceland generates a significant amount of its electricity using geothermal power stations.

The figure below shows a geothermal power station.



a) Describe the source of the thermal energy used in geothermal power stations.

A description to include the following:	
Radioactive decay (of elements / isotopes).	1 mark
Allow: Specific elements like Uranium for the first mark.	
(Occurring in) rocks / the Earth's core / deep underground.	1 mark
	Total: 2 marks

b) Explain how this thermal energy is used to generate electricity in a geothermal power station.

An explanation to include any four of the following:	
• Cold water is pumped down to the hot rocks. • The water is heated and turns into steam. • The (high pressure) steam drives / turns a turbine. • The turbine drives / turns a generator. • The generator produces an alternating current / electricity.	
Allow: generator transfers kinetic energy into electrical energy" for the final marking point.	
	Total: 4 marks

c) Suggest **one** reason why geothermal power stations are not built in many parts of the UK.

Any one of the following:	
• There are very few suitable locations (in the UK). • The rocks close to the surface are not hot enough. • The UK is not volcanically active / is not on a tectonic plate boundary. • The Earth's crust is too thick (in the UK).	
	Total: 1 mark

(Total for Question 6 is 7 marks)

7. A company proposes building a tidal barrage across a river estuary to generate electricity for a coastal town. The figure below shows a tidal barge system.



- a) State the primary energy store involved in holding the water back behind the barrage when the tide is high.

Gravitational potential energy	1 mark
	Total: 1 mark

- b) Critics argue that tidal power is not a continuous energy source.

Explain why tidal power is predictable but not continuous.

An explanation to include the following:	
Predictable: Tides are caused by the moon / gravity so we know exactly when they will happen (times/heights are known in advance).	1 mark
Not continuous: water only flows in/out at certain times (there are periods where the water level isn't changing / turbines don't turn).	1 mark
	Total: 2 marks

- c) Compare tidal power to wind power in terms of reliability.

Tidal power is more reliable than wind power.	1 mark
Because tides happen at known times / twice a day, whereas wind speed fluctuates / is dependent on the weather.	1 mark
	Total: 2 marks

- d) As waves pass the device, the floating ball moves up and down.

Explain how this movement causes an alternating current to be generated in the coil of wire.

An explanation to include any four of the following:	
- The movement of the buoy causes the magnet to move (up and down inside the coil). - The magnetic field / field lines cut through the coil of wire. Allow: experiences a changing magnetic field instead of lines cut. - This induces a potential difference (voltage) across the ends of the coil. - The magnet changing direction (moving up then down) causes the induced potential difference or current to change direction.	
	Total: 4 marks

- e) The engineers want to modify the device so it generates a higher voltage for the same height of waves. Suggest **two** changes to the design of the device that would achieve this.

Any two of the following:	
• Use a stronger magnet. • Increase the number of turns / coils of wire. • Use a larger coil (greater cross-sectional area).	
	Total: 2 marks

- f) This device generates electricity using waves. Other marine systems generate electricity using tides. Explain why tidal power systems are considered more reliable than wave power systems.

An explanation to include:	
Tides are caused by the gravitational pull of the moon/sun (so they can be predicted accurately).	1 mark
Allow: waves can be very small on calm days, but tides always happen.	
Waves are created by the wind, which is unpredictable / weather-dependent.	1 mark
	Total: 2 marks

(Total for Question 7 is 13 marks)