



## Mark schemes

1

(a) any **two** from:

- nuclear
- oil
- (natural) gas

2

(b) 4 (hours)

1

(c) a system of cables and transformers

1

(d) The power output of wind turbines is unpredictable

1

(e) 1500 / 0.6

1

2500 (wind turbines)

1

*allow 2500 with no working shown for 2 marks*

(f) Most energy resources have negative environmental effects.

1

**[8]**

2

(a) power output increases (to meet demand) due to people returning home from work / school  
*accept many electrical appliances are switched on (which increases demand)*

1

*accept other sensible suggestions*

(b) 00.00

*accept midnight*

1

*allow answers between 00.00 and 04.00*

(c) any **two** from:

- conserves fuel reserves
- spare capacity to compensate for unreliable renewable resources
- provides spare capacity in case of power station emergency shut-down
- so as to not make unnecessary environmental impact

2

**[4]**

<b>3</b>	(a) geothermal	1
	nuclear	1
	biofuel	1
	(b) gravitational (potential)	1
	kinetic	1
	sound	1
	(c) (i) 90% or 0.9(0)	
	<i>an answer of 0.9(0) with a unit gains 1 mark</i>	2
	(ii) 60 (MW)	
	<i>allow 10%</i>	1
	(iii) increased	1

**[10]**

<b>4</b>	(a) any <b>one</b> from:	
	<ul style="list-style-type: none"> <li>• high cost of installing overhead power lines or underground cables or pylons</li> <li>• high cost as (very) long cables needed</li> <li>• amount of electricity required is too low</li> </ul>	
	<i>allow not enough (surplus) electricity would be generated</i>	1
	(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should apply a 'best-fit' approach to the marking.	
	<b>Level 3 (5 – 6 marks):</b> clear comparison of advantages <b>and</b> disadvantages of <b>each</b> method	
	<b>Level 2 (3 – 4 marks):</b> at least <b>one</b> advantage <b>and one</b> disadvantage is stated for <b>one</b> method <b>and</b> a different advantage <b>or</b> disadvantage is stated for the other method	
	<b>Level 1 (1 – 2 marks):</b> at least <b>one</b> advantage <b>or one</b> disadvantage of either method	
	<b>Level 0 (0 marks):</b> No relevant information	

## examples of physics points made in the response

### Advantages of both methods:

- both renewable sources of energy
- both have no fuel (cost)
- both have very small (allow 'no') running costs
- no carbon dioxide produced

*accept carbon neutral*

*accept no greenhouse gases*

*accept doesn't contribute to global warming*

### Advantages of wind:

- higher average power output

*produces more energy is insufficient*

### Advantages of hydroelectric:

- constant / reliable power (output)
- lower (installation) cost

### Disadvantages of wind:

- higher (installation) cost
- variable / unreliable power output
- (may) kill birds / bats

### Disadvantages of hydroelectric:

- lower power output
- (may) kill fish or (may) damage habitats
- more difficult to set up (within river)

### Disadvantages of both methods:

- (may be) noisy
- visual pollution

*ignore payback time unless no other relevant points made*

*ignore time to build for both*

5

(a) any **two** from:

- cost per kWh is lower (than all other energy resources)  
*allow it is cheaper*  
*ignore fuel cost*  
*ignore energy released per kg of nuclear fuel*
- infrastructure for nuclear power already exists  
*accept cost of setting up renewable energy resources is high*  
*accept many renewable power stations would be needed to replace one nuclear power station*  
*accept (France in 2011 already had a) surplus of nuclear energy, so less need to develop more renewable capacity for increased demand in the future*  
*accept France benefits economically from selling electricity*
- more reliable (than renewable energy resources)  
*accept (nuclear) fuel is readily available*  
*ignore destruction of habitats for renewables*

2

(b) any **two** from:

- non-renewable  
*allow nuclear fuel is running out*
- high decommissioning costs  
*accept high commissioning costs*
- produces radioactive / nuclear waste  
*allow waste has a long half-life*
- long start-up time
- nuclear accidents have widespread implications  
*allow for nuclear accident a named nuclear accident*  
*eg Fukushima, Chernobyl*  
*ignore visual pollution*

2

(c) 0.48 (kW)

*allow 1 mark for correct substitution*  
*ie  $0.15 = P / 3.2$*   
*an answer of 480 W gains 2 marks*  
*an answer of 48 or 480 scores 1 mark*

2

- (d) the higher the efficiency, the higher the cost (per m<sup>2</sup> to manufacture)  
*accept a specific numerical example*

1

more electricity could be generated for the same (manufacturing) cost using lower efficiency solar panels

**or**

(reducing the cost) allows more solar panels to be bought

*accept a specific numerical example*

1

[8]

6

- (a) (i) high levels of infrared radiation (from the Sun)

*allow lots of (solar) energy (available)*

*do **not** accept 'heat' for infrared*

*'it is hot' is insufficient*

*'lots of sunlight' is insufficient*

1

- (ii) reflected

1

- (iii) boiler

*correct order only*

1

turbine

1

transformer

1

- (b) 2 100 000 (kWh)

*allow 1 mark for correct substitution i.e. 140 000 × 15 provided no subsequent step*

2

(c) (i) only 1 wind turbine was considered  
*accept only one location is considered*

1

**or**

other wind turbines may have generated more electricity  
*accept insufficient sample size*

only 1 week's weather was reported on

**or**

wind speed varies from one week to another  
*'wind speed varies' is insufficient*

1

(ii) any **one** from:

- wind speed is too high / low

*allow no wind*

*allow too windy*

- wind is unreliable.

*allow wind is variable*

1

(iii) any **one** from:

- wind is a renewable energy source
- do not use fuel
- energy source is free
- do not release carbon dioxide
- do not release greenhouse gases
- do not release sulfur dioxide
- do not cause acid rain
- do not cause climate change
- do not cause global warming
- do not cause global dimming.

*answer must be an advantage of wind, converse answers in terms of fossil fuels are insufficient*

*accept do not release pollutant gases*

*'no pollution' is insufficient*

1

[11]

7

- (a) (i) infrared (radiation)  
*accept IR (radiation)* 1
- (ii) (heated) water turns to steam  
*ignore reference to fossil fuels*  
*do **not** accept water evaporates to steam* 1
- steam turns a turbine 1
- turbine turns a generator  
*accept turbine connected to a generator* 1
- (b) (i) (so the molten salts) can store large amounts of energy  
*accept there is a small temperature change for a large energy transfer*  
*accept heat for energy* 1
- (ii) 16 (hours)  
*an answer that rounds to 16 gains 2 marks eg 15.71*  
*allow 1 mark for a correct substitution ie  $2\,200\,000 = 140\,000 \times t$*  3
- (iii) the number of daylight hours varies  
*less sunlight is insufficient* 1
- the (mean) power (received from the Sun per square metre) varies  
*accept an answer in terms of maximum possible electrical output only possible during Summer for 1 mark* 1

(c) (i) non-renewable power stations have higher Capacity Factors than renewable power stations

1

fuel (for non-renewable power stations) is always available

*reference to non-renewable power stations operating all the time is insufficient*

*non-renewable energy sources are reliable is insufficient*

1

(most) renewable energy sources are unpredictable / unreliable

*accept (most) renewable energy sources depend on the weather*

1

(ii) the (proportion of) time that solar storage power stations can generate electricity is greater (than for other renewable energy sources)

1

[14]

8

(a) (i) water

1

heated

*accept boiled or turned to steam*

*do **not** accept evaporated*

1

generator

1

(ii) geothermal power stations provide a reliable source of electricity

1

(b) falling water

1

[5]

9

(a) advantage

any **one** from:

- produce no / little greenhouse gases / carbon dioxide  
*allow produces no / little polluting gases*  
*allow doesn't contribute to global warming / climate change*  
*allow produce no acid rain / sulphur dioxide*  
*reference to atmospheric pollution is insufficient*  
*produce no harmful gases is insufficient*
- high(er) energy density in fuel  
*accept one nuclear power station produces as much power as several gas power stations*  
*nuclear power stations can supply a lot of or more energy is insufficient*
- long(er) operating life  
*allow saves using reserves of fossil fuels or gas*

1

disadvantage

any **one** from:

- produce (long term) radioactive waste  
*accept waste is toxic*  
*accept nuclear for radioactive*
- accidents at nuclear power stations may have far reaching or long term consequences
- high(er) decommissioning costs  
*accept high(er) building costs*
- long(er) start up time

1

(b) (i) 12 000 (kWh)

*allow 1 mark for correct substitution eg*

$$2000 \times 6$$

**or**

$$2\,000\,000 \times 6$$

**or**

$$\frac{12\,000\,000}{1000}$$

*an answer of 12 000 000 scores 1 mark*

2

- (ii) any idea of unreliability, eg
  - wind is unreliable  
*reference to weather alone is insufficient*
  - shut down if wind too strong / weak
  - wind is variable

1

(c) any **one** from:

- cannot be seen
- no hazard to (low flying) aircraft / helicopters
- unlikely to be or not damaged / affected by (severe) weather  
*unlikely to be damaged is insufficient*
- (normally) no / reduced shock hazard  
*safer is insufficient*  
*less maintenance is insufficient*  
*installed in urban areas is insufficient*

1

[6]

10

(a) water moves (from a higher level to a lower level)

1

transferring GPE to KE

1

rotating a turbine to turn a generator

*accept driving or turning or spinning for rotating*  
*moving is insufficient*

1

transferring KE to electrical energy

*transferring GPE to electrical energy gains 1 mark of the 2 marks*  
*available for energy transfers*

1

(b) (TVs in stand-by) use electricity

*accept power / energy*

1

generating electricity (from fossil fuels) produces CO<sub>2</sub>

*accept greenhouse gas*  
*accept sulfur dioxide*

1

(CO<sub>2</sub>) contributes to global warming

*accept climate change for global warming*  
*accept greenhouse effect if CO<sub>2</sub> given*  
*accept acid rain if linked to sulfur dioxide*

1

- (c) a factor other than scientific is given, eg economic, political or legal  
*personal choice is insufficient*

1

[8]

11

- (a) water heated by radiation (from the Sun)  
*accept IR / energy for radiation*

1

water used to heat buildings / provide hot water

*allow for 1 mark heat from the Sun heats water if no other marks given*

*references to photovoltaic cells / electricity scores 0 marks*

1

- (b) 2 (minutes)

$$1.4 \times 10^3 = \frac{168 \times 10^3}{t}$$

*gains 1 mark*

*calculation of time of 120 (seconds) scores 2 marks*

3

- (c) (i) 150 (kWh)

1

- (ii) £60(.00) or 6000 (p)

*an answer of £6000 gains 1 mark*

*allow 1 mark for  $150 \times 0.4(0)$   $150 \times 40$*

*allow ecf from (c)(i)*

2

- (iii) 25 (years)

*an answer of  $6000 / 240$*

**or**

*$6000 / \text{their (c)(ii)} \times 4$*

*gains 2 marks*

*an answer of  $6000 / 60$*

**or**

*$6000 / \text{their (c)(ii)}$  gains 1 mark, ignore any other multiplier of (c)(ii)*

3

- (iv) any **one** from:

- will get £240 per year  
*accept value consistent with calculated value in (c)(iii)*
- amount of light is constant throughout the year
- price per unit stays the same
- condition of cells does not deteriorate

1

(d) any **one** from:

- angle of tilt of cells
- cloud cover
- season / shade by trees
- amount of dirt

1  
[13]

12

(a) (i) 77

1

(ii) Oil

1

(b) water

*accept H<sub>2</sub>O*

1

(c) Carbon dioxide causes global warming

1

[4]

13

(a) (i) changing the distance may / will affect / change the voltmeter reading

*accept so only one independent variable*

*accept distance affects speed of wind (turbine)*

*accept it is a control variable*

*accept to give valid results*

*fair test is insufficient*

*to make the results accurate is insufficient*

1

(ii) any sensible practical suggestions, eg

- so fan reaches a steady / full speed

*accept power for speed*

- so wind (turbine) reaches a steady / full speed

- so voltmeter reaches / gives a steady reading

*accept accurate or valid reading a correct reading is insufficient*

*do **not** accept precise reading*

1

(iii) as the number of blades increases so does the (voltmeter) reading / output / voltage

*number of blades affects the reading / output is insufficient*

1

further relevant detail, eg

- voltmeter increase is greatest up to 3 blades
- voltmeter reading hardly changes with 4, 5 or 6 blades  
*accept does not change between 4 and 6 blades*
- increase is directly proportional up to 3 blades
- it reaches a limit  
*accept does not change after 4 / 5 blades*
- a numerical example giving two pairs of numbers, eg 2 blades = 0.6V, 4 blades = 1V

1

(b) C

*reason scores only if C is chosen*

1

wind speed / strength varies

*accept wind is **not** constant / reliable*

1

[6]

14

(a) (i) produces carbon dioxide / nitrogen oxides

*accept greenhouse gases*

*ignore pollutant gases*

1

that (may) contribute to global warming

*accept causes global warming*

*damages ozone layer negates this mark*

*accept alternative answers in terms of: sulfur dioxide / nitrogen oxides causing acid rain*

1

(ii) carbon capture / storage

*answer must relate to part (a)(i)*

*collecting carbon dioxide is insufficient*

**or**

plant more trees

**or**

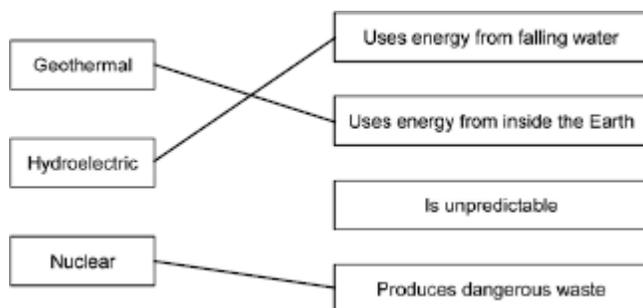
remove sulfur (before burning fuel)

1

- (b) (i) (power station can be used) to meet surges in demand  
*accept starts generating in a short time*  
*can be switched on quickly is insufficient* 1
- (ii) can store energy for later use  
*accept renewable (energy resource)*  
*accept does not produce CO<sub>2</sub> / SO<sub>2</sub> / pollutant gases* 1
- (c) (i) turbines do not generate at a constant rate  
*accept wind (speed) fluctuates*  
*accept wind is (an) unreliable (energy source)* 1
- (ii) any **one** from:
- energy efficient lighting (developed / used)  
*use less lighting is insufficient*
  - increased energy cost (so people more likely to turn off)  
*accept electricity for energy*
  - more people becoming environmentally aware 1

[7]

15



*allow 1 mark for each correct line*  
*if more than one line goes from an energy source then all lines from that energy source are wrong*

[3]

16

- (a) electrical 1
- chemical 1
- light 1

(b) 25% **or** 0.25

*allow 1 mark for correct substitution, ie  $50 \div 200$  provided no subsequent step shown*

**or**

*answers of 25 with a unit **or** 0.25 with a unit gain 1 mark*

*answers of 25 without a unit **or** 0.25% gain 1 mark*

2

(c) the information board can be used anywhere it is needed

1

[6]

17

(a) any **three** from:

- gas can be switched on (and off) quickly but nuclear cannot  
*gas has a short start-up time alone is insufficient*
- gas can be used to meet surges in demand  
*accept specific times from graph, anything from 1700 to 2200*
- gas can contribute to / meet the base load
- nuclear provides base load  
**or**  
nuclear is used to generate all of the time

3

- (b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the [Marking guidance](#), and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content.

**Level 1 (1-2 marks)**

There is a brief description of one advantage **or** disadvantage of using either biogas or wind

**or**

makes a conclusion with a reason.

**Level 2 (3-4 marks)**

There is a description of some advantages **and / or** disadvantages for biogas **and / or** wind

**or**

there is a direct comparison between the two systems **and** at least one advantage / disadvantage

**or**

a detailed evaluation of one system only with a conclusion.

**Level 3 (5-6 marks)**

There is a clear and detailed comparison of the two systems.

There must be a clear conclusion of which system would be best with at least one comparative reason given for the choice made.

## Examples of the points made in the response *extra information*

### Biogas

- renewable
- energy resource is free
- reliable energy source  
*accept works all of the time*
- does not depend on the weather
- uses up (animal) waste products
- concentrated energy source
- cheaper (to buy and install)  
*accept once only*
- shorter payback-time (than wind)
- adds carbon dioxide to the atmosphere  
*when waste burns it produces carbon dioxide is insufficient*
- contributes to the greenhouse effect  
**or**  
contributes to global warming
- no transport cost for fuels

### Wind turbine

- renewable
- energy resource is free
- not reliable
- depends on the weather / wind
- will be times when not enough electricity generated for the farm's needs
- dilute energy source
- longer payback-time (than biogas)
- more expensive (to buy and install)  
*accept once only*
- does not produce any carbon dioxide  
*accept does not pollute air*

*accept pollutant gases for carbon dioxide  
produces visual or noise pollution is insufficient  
harmful gases is insufficient*

6

[9]

18

(a) any **one** from:

- energy / source is constant
- energy / source does not rely on uncontrollable factors  
*accept a specific example, eg the weather*
- can generate all of the time  
*will not run out is insufficient*

1

(b) (dismantle and) remove radioactive waste / materials / fuel

*accept nuclear for radioactive  
knock down / shut down is insufficient*

1

(c) any **two** from:

- reduce use of fossil fuelled power stations  
*accept specific fossil fuel  
accept use less fossil fuel*
- use more nuclear power  
*accept build new nuclear power stations*
- use (more) renewable energy sources  
*accept a named renewable energy source  
do **not** accept natural for renewable*
- make power stations more efficient
- (use) carbon capture (technology)  
*do **not** accept use less non-renewable (energy) sources*

2

(d) (by increasing the voltage) the current is reduced

1

this reduces the energy / power loss (from the cable)

*accept reduces amount of waste energy  
accept heat for energy  
do **not** accept stops energy loss*

1

and this increases the efficiency (of transmission)

1

[7]

- 19** (a) (i) an unreliable energy source 1
- (ii) a renewable energy source 1
- (b) plant / grow (at least) one new tree 1
- (c) greater than 4% 1
- [4]**

- 20** (a) light 1
- correct order only*
- electrical 1
- (b) 0.2 or 1/5 2
- accept 20% for both marks*
- allow 1 mark for correct substitution ie  $\frac{35\,000}{175\,000}$*
- answers of 0.2% **or** 20 gain 1 mark only*
- (c) any **one** from: 1
- produces no (pollutant) gases
  - or**
  - no greenhouse gases
  - accept named gas*
  - accept no air pollution*
  - do **not** accept no pollution*
  - accept less global warming*
  - accept harmful for pollutant*
  - accept produces no carbon*
  - do **not** accept environmentally friendly*
  - produces no / less noise
  - less demand for fuels
  - accept any other sensible environmental advantage*
- [5]**

- 21** (a) (i) replaced faster than it is used 1
- accept replaced as quick as it is used*
- accept it will never run out*
- do **not** accept can be used again*

(ii) any **two** from:  
*two sources required for the mark*

- wind
- waves
- tides
- fall of water  
*do not accept water / oceans  
accept hydroelectric*
- biofuel  
*accept a named biofuel eg wood*
- geothermal

1

(b) (i) any **two** from:

- increases from 20° to 30°
- reaches maximum value at 30°
- then decreases from 30°
- same pattern for each month  
*accept peaks at 30° for both marks  
accept goes up then down for 1 mark  
ignore it's always the lowest at 50°*

2

(ii) 648

*an answer of 129.6 gains 2 marks  
allow 1 mark for using 720 value only from table  
allow 2 marks for answers 639, 612, 576, 618(.75)  
allow 1 mark for answers 127.8, 122.4, 115.2, 123.75*

3

(c) (i) (sometimes) electricity demand may be greater than supply (of electricity from the system)

*accept cloudy weather, night time affects supply*

**or**

can sell (excess) electricity (to the National Grid)

1

(ii) decreases the current

*accept increases the voltage*

1

reducing energy loss (along cables)  
*accept less heat / thermal energy lost / produced*

1  
[10]

22

(a) grid  
*accept any unambiguous indication*

1

(b) (i) A (only)

1

(ii) D (only)

1

(c) less than

1

[4]

23

(a) (i) correct data point identified (4, 0.96)

1

(ii) a decrease in

1

(b) (i) no / less atmospheric pollution

*accept specific examples eg no CO<sub>2</sub> / greenhouse gases produced*

*accept no harmful gases / fumes*

*accept reduced pollution from transportation (of coal)*

*accept does not contribute to global warming*

*it / they refers to solar cells*

*do **not** accept no / less pollution*

*does not harm the environment is insufficient*

*it is a renewable energy source is insufficient*

1

(ii) 8

*allow 1 mark for showing correct method ie  $\frac{7600}{950}$  provided that no subsequent step is shown*

2

(iii) increase

1

(iv) **these marks can score even if (b)(iii) is wrong**

*less / no electricity generated*

*accept energy for electricity*

*accept reduced power / voltage output*

1

(because) lower light intensity (hitting solar panel / cell)  
**or**  
so decreases money paid / gained (from selling electricity)  
*allow less light / sun (hitting solar panel / cell)*

1

[8]

24

(a) increases the voltage (across the cables)  
**or**  
decreases the current (through the cables)

1

reducing energy losses (in cables)  
*accept heat for energy*  
*do **not** accept electricity for energy*  
*do **not** accept no energy loss*  
*accept wires do not get as hot*

**or**  
increases efficiency of (electricity / energy) transmission  
*ignore reference to travel faster*

1

- (b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response.  
Examiners should also refer to the Marking Guidance, and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content

**Level 1 (1-2 marks)**

There is a brief description of one advantage or disadvantage of using either overhead or underground cables.

**Level 2 (3-4 marks)**

There is a description of some of the advantages **and / or** disadvantages for both overhead and underground cables, with a minimum of three points made. There must be at least **one** point for each type of cable.

**Level 3 (5-6 marks)**

There is a clear and detailed description of the advantages and disadvantages of overhead **and** underground cables, with a minimum of five points made. At least one advantage and one disadvantage for each type of cable.

**examples of the points made in the response**

*marks may be gained by linking an advantage for one type of cable with a disadvantage for the other type of cable*

*eg*

*overhead cables are easy to repair = 1 mark*

*overhead cables are easier to repair = 1 mark*

*overhead cables are easier to repair than underground cables = 2 marks*

Overhead  
Advantages

- (relatively) quick / easy to repair / maintain / access  
*easy to install is insufficient*  
*do **not** accept easy to spot / see a fault*
- less expensive to install / repair / maintain  
*less expensive is insufficient*
- cables cooled by the air  
*accept thermal energy / heat removed by the air*
- air acts as electrical insulator  
*accept there is no need for electrical insulation (around the cables)*
- can use thinner cables  
*difficult to reach is insufficient*  
*land beneath cables can still be used is insufficient*

## Disadvantages

- spoil the landscape
- greater risk of (fatal) electric shock
- damaged / affected by (severe) weather  
*accept specific examples eg high winds, ice  
more maintenance is insufficient*
- hazard to low flying aircraft / helicopters  
*kites / fishing lines can touch them is insufficient  
hazard to aircraft is insufficient*

## Underground

### Advantages

- cannot be seen
- no hazard to aircraft / helicopters
- unlikely to be / not damaged / affected by (severe) weather  
*less maintenance is insufficient*

(normally) no / reduced shock hazard

*installed in urban areas is insufficient*

### Disadvantages

- repairs take longer / are more expensive  
*accept harder to repair / maintain  
have to dig up for repairs is insufficient*
- (more) difficult to access (cables)  
*hard to locate (cables) is insufficient  
faults hard to find is insufficient*
- (very) expensive to install
- thicker cables required
- need cooling systems
- need layers of electrical insulation
- land disruption (to lay cables)  
*accept damage to environment / habitat(s)*  
**or**  
cannot use land either side of cable path  
*accept restricted land use*

(c) examples of acceptable responses:

*allow 1 mark for each correct point*

- closest to cables field from underground is stronger
- field from overhead cables stronger after 5 metres
- field from underground cables drops rapidly
- field from overhead cables does not drop much until after 20 metres  
*accept values between 20 and 30 inclusive*
- overhead field drops to zero at / after 50 metres
- underground field drops to zero at / after 30 metres
- (strength of) field decreases with distance for both types of cable  
*if suitably amplified this may score both marks*

2

(d) ethical

1

[11]

25

(a) *answers must be in terms of nuclear fuels*

concentrated source of energy

*idea of a small mass of fuel able to generate a lot of electricity*

1

that is able to generate continuously

*accept it is reliable*

**or** *can control / increase / decrease electricity generation*

*idea of available all of the time / not dependent on the weather*

*ignore reference to pollutant gases*

1

the energy from (nuclear) fission

1

is used to heat water to steam to turn turbine linked to a generator

1

(b) carbon dioxide is not released (into the atmosphere)

1

but is (caught and) stored (in huge natural containers)

1

[6]

26

(a) (i) any **one** from:

- produces no (air / atmospheric) pollution  
*accept named pollutant eg CO<sub>2</sub>*  
*accept no harmful gases*  
*accept produces no emissions*  
*accept does not add to global warming*  
*environmentally friendly is insufficient*
- energy (source) is free  
*accept no fuel costs*  
*accept the wind / it is free*

1

(ii) any **one** from:

- waves
- tides
- falling water  
*accept hydroelectric*  
*do **not** accept water (flow)*
- solar  
*accept Sun / sunlight*  
*accept solar panels / cells*
- geothermal
- biofuel / biomass  
*accept a named biofuel*

1

(b) (i) 3000 (kilowatts)

*accept 3 megawatts / MW*  
*accept 3 000 000 watts / W*

1

- (ii) (average) wind speed below 6 m/s  
*answers giving a wind speed greater than 3 but less than 6 m/s  
 gain both marks  
 allow 1 mark for calculating the output as 500 kW (maximum)  
 and  
 allow 1 mark for wind speed too low or wind not strong enough  
 do **not** accept wind above 25 m/s  
 do **not** accept the turbines are frozen*
- 2

- (iii) A small amount of nuclear fuel generates a large amount of electricity.  
*both required*
- Nuclear power stations do not depend on the weather to generate electricity.
- 1

**[6]**

**27**

- (a) 9
- allow 2 marks for power = 1400 (kW)  
 if a subsequent calculation is shown award 1 mark only  
**or**  
 allow 1 mark for correct substitution and transformation*
- $$\text{power} = \frac{5600}{4}$$
- allow 1 mark for using a clearly incorrect value for power to read a  
 corresponding correct value from the graph*
- 3

- (b) (i) system of cables and transformers  
*both required for the mark  
 ignore reference to pylons  
 inclusion of power stations / consumers negates the mark  
 wire(s) is insufficient*
- 1

- (ii) (uses step-up transformer to) increase pd / voltage  
*accept (transfers energy / electricity at) high voltage*  
**or**  
 (uses step-up transformer to) reduce current  
*accept (transfers energy / electricity at) low current  
 ignore correct references to step-down transformers*
- 1

(c) build a power station that uses a non-renewable fuel or biofuel

*accept a named fuel*

*eg coal or wood*

**or**

buy (lots of) petrol / diesel generators

1

stockpile supplies of the fuel

*accept fuel does not rely on the weather*

**or**

fuel provides a reliable source of energy

*accept as an alternative answer idea of linking with the National Grid (1)*

*and taking power from that when demand exceeds supply (1)*

**or**

*when other methods fail*

**or**

*when it is needed*

*answers in terms of using other forms of renewables is insufficient*

1

[7]

28

(a) gas (burning)

1

(b) (i) (transmission) cables and (step-up and step-down) transformers

*if transformers are named ie step-up transformer then both step-up and step-down must be given*

*mention of power station or consumer negates mark*

1

(ii) voltage

1

more efficient

1

(c) increase

1

[5]

29

- (a) (i) energy from hot rocks in the Earth

*accept heat that occurs naturally in the Earth*

*accept steam / hot water rising to the Earth's surface*

*accept an answer in terms of the energy released by radioactive decay in the Earth*

*heat energy is insufficient*

1

- (ii) water is pumped / moved

1

up (to a higher reservoir)

*this mark point only scores if first mark point is awarded*

1

- (b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the Marking Guidance and apply a 'best-fit' approach to the marking.

**0 marks**

No relevant content

**Level 1 (1-2 marks)**

There is a brief description of at least one advantage or disadvantage for either the planned wind turbines or the suggested electricity power link.

**Level 2 (3-4 marks)**

There is a description of advantages and disadvantages for either the planned wind turbines or the suggested electricity power link.

**or**

A description of the advantages or disadvantages for both the planned wind turbines and the suggested electricity power link.

**Level 3 (5-6 marks)**

There is a clear and detailed description of at least one advantage and one disadvantage for both the planned wind turbines and suggested electricity power link.

**examples of the points made in the response**

## Offshore wind turbines

### advantages

- renewable (energy resource)
- low running costs
- energy is free
- no gas emissions (when in use)
  - accept a named gas eg CO<sub>2</sub>*
  - accept no fuel is burned*
  - accept less dependent on fossil fuels*
- land is not used (up)

### disadvantages

- unreliable – accept wind does not always blow
  - ignore references to destroying or harming habitats*
- hazard to birds / bats
- visual pollution – do not accept noise pollution
  - do **not** allow if clearly referring to onshore wind turbines*
  - do **not** accept spoils landscape*
- difficulty of linking turbines to the National Grid
- large initial cost
- difficult to erect / maintain
  - accept a lot of maintenance needed*
- CO<sub>2</sub> emissions in manufacture (of large number of turbines)

## Suggested Link

### advantages

- income for Iceland
- using Iceland's (available) energy (resources)  
*accept using (Iceland's) renewable energy (resources)*  
*do **not** accept reduce the amount of Iceland's wasted energy*
- provide electricity when wind does not blow / reliable
- provide electricity at times of peak demand
- even out fluctuations in supply
- excess electricity from Britain (windy days) to Iceland and used to pump water up to store energy
- Britain less dependent on fossil fuels  
*accept Britain needs fewer (new) power stations*  
*accept conserves fossil fuels*

### disadvantages

- large initial cost  
*accept expensive (to lay cables)*
- power loss along a long cable
- (engineering) difficulties in laying / maintaining the cable  
*accept difficult to repair (if damaged)*

6

[10]

30

- (a) can be replaced as fast / faster than it is used  
*accept will not run out*  
*can be used again negates this mark*

1

(b) any **one** from:

- reduce demand on power stations / National Grid (system)
- to increase the amount of electricity generated (from renewable energy)
- to conserve fossil fuels  
*accept use less fossil fuels*
- plenty of animal waste / fuel (available)  
*accept so animal waste can be used usefully*  
*accept to save money / sell the electricity*  
*produces less harmful gases / SO<sub>2</sub> is insufficient*  
*better for environment is insufficient*

1

(c) 60 (months) / 5 (years)

*ignore any unit given*

1

(d) *answers must be in terms of the biogas generator*

any **two** from:

- reliable energy source  
**or**  
does not depend on the weather  
*accept works all of the time*
- uses up waste products  
*accept animal waste readily available*
- not visually polluting
- concentrated energy source
- quieter  
*ignore it is renewable*  
*do **not** accept generates more electricity (than wind turbine)*

2

[5]

31

(a) (i) solar and wind

*both required for mark either order*

1

(ii) 37(%)

*accept their **two** sources in a(i)*  
*correctly added as an error carried forward (ecf)*

1

- (b) **A** 1
- (c) gas is non-renewable  
*do **not** accept they are not all renewable*  
*statements such as gas produces CO<sub>2</sub> is neutral* 1

[4]

32

- (a) kinetic 1
- (b) (i) generates a lot more energy / electricity / power  
*need fewer conventional large-scale hydroelectric power stations is neutral*  
**or**  
 can supply (energy / electricity / power) to more homes 1
- (ii) Large areas of land are flooded. 1
- (c) (i) National Grid  
*this answer only* 1
- (ii) less energy / heat loss (from the cables)  
*accept wasted for loss*  
*accept answers in terms of fewer transformers needed*  
*do **not** accept less electricity lost / wasted*  
*do **not** accept no energy lost* 1
- (d) any **one** from:  
 • fewer rivers (suitable for generators)  
 • less mountainous (so rivers fall smaller distances)  
*accept answers in terms of difficulty linking villages and towns to grid (in Nepal)*  
*accept answers in terms of more isolated communities*  
*accept answers in terms of UK having more resources for large-scale power stations* 1

[6]

33

(a) marks are awarded only for the reason but must match the ringed answer  
for both marks a **MAYBE** answer should include a **YES** and **NO** response answers in terms of the sources being renewable or non-renewable are insufficient

any **two** from:

**YES** answers may include:

- wind produces no pollutant gases  
accept wind burns no fuel  
accept CO<sub>2</sub> / SO<sub>2</sub> / oxides of nitrogen / greenhouse gas for pollutant gases
- nuclear produces no pollutant gases  
accept nuclear burns no fuel
- (burning) gas does not produce SO<sub>2</sub>  
accept gas does not cause acid rain  
do **not** accept they don't / none produce pollutant gases

**NO** answers may include:

- nuclear produces radioactive waste
- (burning) gas produces CO<sub>2</sub> / pollutant gases / air pollution  
accept contributes to global warming / greenhouse effect

2

(b) nuclear power stations use a non-renewable fuel  
accept uranium / plutonium is non-renewable  
do **not** accept some are unrenewable

1

[3]

34

(a) (i) kinetic  
accept KE  
do **not** accept movement

1

(ii) 0.75

allow 1 mark for correct substitution ie  $\frac{60\,000}{80\,000}$

**or**

75 %

an answer 0.75 % **or** 0.75 with a unit gains 1 mark only

an answer 75 with or without a unit gains 1 mark only

2

(b) any **one** from:

- large areas of land are flooded  
*uses large areas of land / takes up large areas of land is insufficient*
- people's homes may be destroyed
- habitat (of animals and plants) lost / damaged  
*construct is neutral*  
*very noisy is neutral*

1

(c) (i) system of cables and transformers

*both required for the mark*

*accept power lines / wires for cables*

*ignore reference to pylons*

*inclusions of power stations / consumers negates answer*

1

(ii) less energy loss / wasted (in the cables)

*accept heat for energy*

*do **not** accept no energy loss*

*do **not** accept electricity for energy*

1

as the cables are shorter

1

[7]

35

(a) (i) decommissioning

1

(ii) level of radiation **or** radiation dose (to workers) decreased

*accept the isotope / cobalt(-60) has decayed (a lot)*

*accept the isotope / cobalt(-60) has decayed in 2 half lives*

*accept exposed to less radiation*

*do **not** accept no radiation left*

1

less hazardous / dangerous (to workers' health)

*accept safer*

*do **not** accept there is no hazard*

*accept allows reactor to cool (down)*

*an answer of radiation levels decrease by 75 % or drops to 25 %*

*gains **2** marks*

1

(b) (i) more in favour

**or**

fewer against

*quoting figures alone is insufficient*

*do **not** accept it increases*

*ignore any reasons given*

1

(ii) any **one** from:

- sample too small
- do not know how many (people) were asked
- different people asked (in different years)
- sample not representative (of population)
- people did not understand the questions
- do not know who carried out the surveys  
*do **not** accept they are biased unless acceptable reason for bias given*
- do not know if surveys asked same questions

1

(iii) any **one** from:

- no / less pollutant gases produced  
*accept a named gas*  
*accept does not contribute to global warming*
- reliable source (of energy / electricity)
- running out of fossil fuels  
*accept a named fossil fuel*
- conserve fossil fuels  
*accept fossil fuels won't have to be used*
- meet increasing demand
- less reliance on imported fossil fuels / electricity  
*accept named fossil fuel*
- concentrated energy source(s)
- lower transportation costs for fuel
- to replace old nuclear power stations  
*ignore references to efficiency / job creation / local economy / selling electricity*

1

(c) economic issues

1

[7]

36

(a) (i) 4

*allow 1 mark for correct transformation and substitution*

*ie  $\frac{0.6}{0.15}$*

*substitution only scores if no subsequent steps are shown*

2

(ii) diagram showing two output arrows with one arrow wider than the other with the narrower arrow labelled electrical / electricity / useful

1

(b) any **one** from:

- to check reliability / validity / accuracy
- to avoid bias

1

(c) any **two** from:

- produce no / less (air) pollution  
*accept named pollutant*  
*accept produces no waste (gases)*
- energy is free  
*accept it is a free resource*  
*do **not** accept it is free*
- (energy) is renewable
- conserves fossil fuel stocks
- can be used in remote areas
- do not need to connect to the National Grid

2

[6]

37

(a) (i) gas

1

(ii) one variable is categoric, the other is continuous

1

(iii) fuel is **not** burned

*accept nothing is burned*

*do **not** accept they don't use fossil fuels*

1

(b) (i) boiler

1

steam

1

turbine

1

generator

1

(ii) any **one** from:

- wind  
*accept wind turbines*
- waves
- tidal  
*accept tide*
- geothermal
- solar  
*accept the Sun / sunlight*  
*accept solar panels / cells*  
*do **not** accept light*
- falling water  
*accept hydroelectric*  
*do **not** accept water*  
*do **not** accept any named biofuel*

1

(iii) 18 000

*allow 1 mark for showing a correct method*  
*ie  $36\,000\,000 \div 2\,000$*   
*an answer of 0.018 gains 1 mark*

2

[10]

38

(a) (i) (dismantle and) remove radioactive waste / materials / fuels

*accept nuclear for radioactive*  
*do **not** accept knock down / shut down*

1

(ii) increases it

*do **not** accept it has a negative effect*

1

(b) (i) *if efficiency is not mentioned it must be implied*

*answers in terms of energy*  
*generated only gains no credit*

**K** most efficient

**or**

**M** least efficient

*accept **K** and / or **L** are more efficient than **M***

1

(efficiency) of **K** and **L** increases, (efficiency) of **M** (almost) constant / slightly reduced

*all 3 power stations must be mentioned to get this mark*

1

(ii) any **two** from:

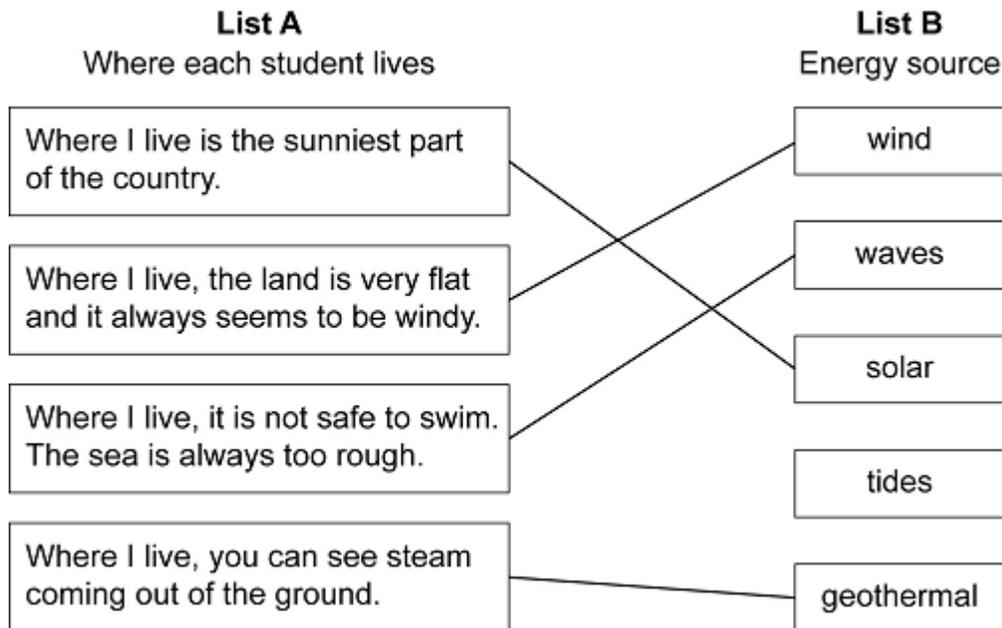
- do not know how many (nuclear) power stations there will be
- power stations may continue to increase in efficiency
- do not know what type of power station new ones will be  
*accept new methods may be found to generate electricity / energy*  
*accept other ways of generating energy may be expanded*
- do not know future energy / electricity demands  
*accept we may become more energy efficient*
- may be new uses for uranium

2

[6]

39

(a) all 4 lines correct



*allow 1 mark for each correct line*

*if more than 1 line goes from a box in **List A** then all those lines are incorrect*

4

(b) all renewable

*accept a correct description of renewable*  
*eg replaced faster than used **or** never run out*  
*do **not** accept can be used again*  
*accept any other common feature*  
*eg do not produce pollution /*  
*polluting (gases)*  
*no fuel is burnt*  
*(energy input) is free*  
*eco-friendly / environmentally friendly / natural resources /*  
*sustainable sources are insufficient*

1

(c) large areas of land are flooded

1

[6]

40

(a) (i) tidal / tides

*do **not** accept water / waves*

1

(ii) any **three** from:

- shorter journey time  
*accept easier to go from town to town*  
*accept less petrol / fuel used*
- less pollution from traffic  
*accept CO<sub>2</sub> / carbon emissions reduced*
- energy source is free
- energy source / tides are predictable
- produces less / no pollutant gases (than fuel burning power stations)  
*accept no CO<sub>2</sub> / greenhouse gases produced*  
*accept air pollution for pollutant gases*
- conserves supplies of fossil fuels
- uses renewable energy (to generate electricity)
- provides employment
- no visual / noise pollution  
*less harm to the environment is insufficient*  
*the electricity is cheaper is insufficient*  
*do **not** accept produces no radioactive waste*  
*the pollution mark scores twice only if it is clear one reference is to traffic and the other is to electricity generation*

3

(b) (i) (sometimes) electricity demand may be greater than supply (of electricity from the system)

*accept in case turbines / generators fail*

**or**

can sell (excess) electricity (to the National Grid)

1

(ii) decreases the current

*accept increases the voltage*

1

reducing energy loss (along cables)

*accept less heat / thermal energy lost / produced*

1

[7]

41

(a) (i) 0.2 **or** 1/5

*accept 20% for both marks*

*allow 1 mark for correct substitution answer of 0.2%*

**or** 20 gains 1 mark

*ignore units*

2

(ii) wasted

*accept transformed to heat / other forms*

*accept transferred to the air / surroundings sound = neutral*

1

(b) (i) any **one** from:

- can fly at night  
*accept can fly when it is cloudy*  
*accept as a back-up*
- can stay in the air for longer
- can fly in the winter
- can fly faster  
*increases power is neutral*

1

(ii) any **one** from:

- produces no (pollutant) gases
- or** no greenhouse gases
- accept named gas*
  - accept no air pollution*
  - do **not** accept no pollution*
  - accept less global warming*
  - accept harmful for pollutant*
  - accept produces no carbon*
  - do **not** accept environmentally friendly*
- produces no / less noise
  - less demand for fuels  
*accept any other sensible environmental advantage*

1

- (iii) accept any sensible suggestion eg, map the Earth's surface / weather forecasting / spying / monitoring changes to the Earth's atmosphere, etc  
*do not accept ideas in terms of transporting*  
*accept use as a satellite*

1

[6]

42

- (a) (i) any **one** from:

- waves  
*do not accept water*
- tides
- falling water  
*accept hydroelectric*
- biofuel / biomass
- solar  
*accept sun / sunlight*  
*do not accept light*  
*accept solar cells / panels*
- geothermal  
*do not accept heat*

1

- (ii) decrease

1

- (b) (i) increases from 4am (to 8am) remains constant from 8am (to 10am)  
*accept increases from 30 000*  
*accept stays constant from 40 000*  
*allow 1 mark for goes up then stays the same*  
*for full credit must be some indication of time or power*

2

- (ii) natural gas

1

[5]

43

(a) 1/25 or 1:25 or 0.04

accept 4 % or  $\frac{15}{375}$  or  $\frac{3}{75}$  or 1 in 25 for both marks

allow 1 mark for total of 375

allow 1 mark for a clearly correct method using a clearly incorrect total

do **not** accept 1:26

2

(b) (i) **B**

do **not** credit reason if **B** is not chosen

1

(only) burning fossil fuels produces carbon dioxide / carbon (emissions)

**or** nuclear fuels don't produce carbon dioxide

*insufficient – smallest amount of fossil fuels*

*accept less carbon dioxide*

1

(ii) accept anything reasonable eg

increased level of insulation

use energy efficient light bulbs

do not leave appliances on standby

switch thermostats down (1°C)

generate own electricity

install solar panels

*accept insulate*

*accept specific examples eg loft*

1

(c) (i) any **three** from:

- no power output until wind speed exceeds 4m/s
- output rises rapidly after 4m/s
- output begins to level out / rises less rapidly at / after 13m/s
- output peaks at 21 / 22m/s
- output constant between 21 / 22 and 25 / 26 m/s
- output falls (rapidly) after 25 / 26m/s  
*accept for 1 mark goes up then comes down*

3

(ii) any **one** from:

- unreliable energy source
- dilute energy source
- take up too much land  
*accept wind does not always blow*  
*accept need thousands / lots of turbines*  
*ignore reference to visual / noise pollution*  
*ignore reference to kill birds*

1

[9]