Mark schemes

Q1.

(a) higher

1

(b) low(er)

1

hot(ter)

allow warm(er)

1

(c) advantage:

- water heated continuously (by the Sun)

1

one disadvantage from:

- temperature of water is lower (for most of the time than water heated by immersion heater)
- water may not be hot enough

allow less control over water temperature

- it takes longer to heat the water

1

(d) $\frac{4\,030\,000}{4\,070\,000}$

1

0.99

*an answer of 99% scores **2** marks*

*an answer of 99 or 0.99% scores **1** mark*

1

*an answer of 0.99 scores **2** marks*

*allow an answer that rounds to 0.99 for **2** marks*

(e) power = energy transferred / time

allow P = E / t

1

(f) $5000 = \frac{4\,070\,000}{t}$

1

$t = \frac{4\,070\,000}{5000}$

1

t = 814

1

seconds

other units of time must be consistent with numerical value

1

*an answer of 814 seconds scores **4** marks*

*an answer of 13.57 minutes scores **4** marks*

[12]

Q2.

(a) nucleus

1

neutron

1

gamma rays

1

in this order only

(b) $\frac{25\,000\,000}{2\,400\,000}$

1

11

*an answer of 10.4 with no working scores **1** mark*

1

*an answer of 11 scores **2** marks*

(c) any **two** from:

- waste is radioactive

  allow nuclear waste

- waste has a long half-life

  allow waste remains dangerous for a long time

- waste is toxic
- waste needs to be buried

  allow waste is difficult to dispose of

- risk of catastrophic accidents

  allow named accident e.g. Fukushima, Chernobyl, Three Mile Island

- fuel is non-renewable

2

(d) **similarity:**

(carbon dioxide concentration and global temperature have) both increased

allow they both show a positive correlation

1

difference:

the carbon dioxide (concentration) continues to increase whereas temperature (increase) levels off

allow carbon dioxide (concentration) increases more quickly than temperature (increase)

1

[9]

Q3.

(a) any **three** from:

- no <u>carbon dioxide</u> emitted (to produce electricity)
  no greenhouse gases is insufficient
- doesn't cause global warming
  allow climate change or greenhouse effect for global warming
- nuclear power doesn't cause earthquakes
- more energy released per kg of fuel (compared to shale gas)

3

(b) uranium
or
plutonium

ignore any numbers given

1

(c) a <u>neutron</u> is absorbed by a (large) nucleus

a description in terms of only atoms negates first two marking points

1

the nucleus splits into two (smaller) nuclei

1

releasing energy (and gamma rays)

1

and (two / three) neutrons

1

[8]

Q4.

(a) minimum distance between wind turbines is at least 500 m in all directions

turbines can rotate to face into wind and still maintain the minimum distance

1

(b) density = mass/volume

allow $\rho = m / V$

1

(c) $1.2 = \frac{51000}{V}$

1

$V = \frac{51000}{1.2}$

1

V = 42 500

1

V = 43 000

1

m^3

*an answer of 43 000 scores **4** marks*
*an answer of 42 500 scores **3** marks*

1

(d) $2.4 \times 10^9 / 1.6 \times 10^6$

1

1500

*an answer of 1500 scores **2** marks*

1

(e) wind power is unreliable

1

(very) large numbers of wind turbines would need to be constructed

allow calculation of this (15 625)

1

[11]

Q5.

(a)

Level 2: Relevant reasons are identified, given in detail and logically linked to form a clear account.	3-4
Level 1: Relevant reasons are identified, and there are attempts at logically linking. The resulting account is not fully clear.	1-2
No relevant content	0
Indicative content **nuclear** • no carbon dioxide released (when generating electricity) **or** doesn't release greenhouse gases • reliable • high energy density • power stations already built • other power stations being built **wind** • no carbon dioxide released (when generating electricity) **or**	

doesn't release greenhouse gases • renewable energy resource • no fuel cost	

4

(b) wind power is unreliable

1

(so) will be unable to meet demand when wind speed is low
or
when there is no wind
or
unable to maintain base load at all times

1

(c) electricity generation will need to increase (to meet higher demand)

1

(using)
nuclear power
or
wind power
or
other renewables

1

so that carbon dioxide emissions don't increase
or
reference to Paris Climate agreement

1

[9]

Q6.

(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]

Q7.

(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]

Q8.

(a) geothermal

1

nuclear

1

biofuel

1

(b) gravitational (potential)

1

kinetic

1

sound

1

(c) (i) 90% or 0.9(0)

*an answer of 0.9(0) with a unit gains **1** mark*

2

(ii) 60 (MW)

allow 10%

1

(iii) increased

1

[10]

Q9.

(a) any **one** from:

- high cost of installing overhead power lines or underground cables or pylons
- high cost as (very) long cables needed
- amount of electricity required is too low

allow not enough (surplus) electricity would be generated

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.

Level 3 (5 – 6 marks):
clear comparison of advantages **and** disadvantages of **each** method

Level 2 (3 – 4 marks):
at least **one** advantage **and one** disadvantage is stated for **one** method **and** a different advantage **or** disadvantage is stated for the other method

Level 1 (1 – 2 marks):
at least **one** advantage **or one** disadvantage of either method

Level 0 (0 marks):
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

6

[7]

Q10.

(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^2 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]

Q11.

(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]

Q12.

(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 × 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]

Q13.

(a) (i) <u>water</u>

1

heated

accept boiled or turned to steam
*do **not** accept evaporated*

1

<u>generator</u>

1

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

1

(b) falling water

1

[5]

Q14.

(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 × 6

or

2 000 000 × 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]

Q15.

(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_2

accept greenhouse gas
accept sulfur dioxide

1

(CO_2) contributes to global warming

accept climate change for global warming
accept greenhouse effect if CO_2 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]

Q16.

(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 × 0.4(0) 150 × 40*

*allow ecf from **(c)(i)***

2

(iii) 25 (years)

an answer of 6000 / 240

or

*6000 / their **(c)(ii)** × 4*

*gains **2** marks*

an answer of 6000 / 60

or

*6000 / 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]

Q17.

(a) (i) 77

1

(ii) Oil

1

(b) water

accept H_2O

1

(c) Carbon dioxide causes global warming

1

[4]

Q18.

(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

<u>wind</u> speed / strength varies

*accept <u>wind</u> is **not** constant / reliable*

1

[6]

Q19.

(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_2 / SO_2 / 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)

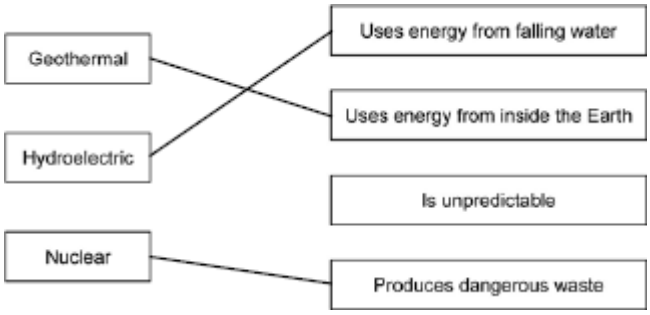
accept electricity for energy

- more people becoming environmentally aware

1

[7]

Q20.



*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]

Q21.

(a) electrical

1

chemical

1

light

1

(b) 25% **or** 0.25

*allow **1** mark for correct substitution, ie 50 ÷ 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]

Q22.

(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]

Q23.

(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]

Q24.

(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]

Q25.

(a) light

correct order only

1

electrical

1

(b) 0.2 or 1/5

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*

2

(c) any **one** from:

- produces no (pollutant) gases
  or
  no greenhouse gases

  accept named gas

  accept no <u>air</u> 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

[5]

Q26.

(a) (i) replaced faster than it is used

accept replaced as quick as it is used

accept it will never run out
*do **not** accept can be used again*

1

(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 <u>only</u> 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]

Q27.

(a) grid

accept any unambiguous indication

1

(b) (i) A (only)

1

(ii) D (only)

1

(c) less than

1

[4]

Q28.

(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_2 / 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]

Q29.

(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

6

(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 <u>both</u> types of cable
  if suitably amplified this may score both marks

2

(d) ethical

1

[11]

Q30.

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

- produces no (air / atmospheric) pollution
  accept named pollutant eg CO_2
  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
- <u>falling</u> 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 <u>megawatts / MW</u>
accept 3 000 000 <u>watts / W</u>

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]

Q31.

(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) <u>fission</u>

1

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

1

(b) <u>carbon dioxide</u> is not released (into the atmosphere)

1

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

1

[6]

Q32.

(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*

$power = \frac{5600}{4}$

*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]

Q33.

(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]

Q34.

(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_2
  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_2 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]

Q35.

(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 <u>increase</u> 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_2 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]