Sustainable energy – 2021/20 GCSE 21st Physics B

1. Nov 2021/Paper_J259/01/No.9

The UK government plans to build more nuclear power stations in the future.

(a) Why is nuclear fuel a **non-renewable** energy source?

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..... **[1]**

(b) Nuclear power stations use uranium as a fuel. Energy is released from the uranium nuclei by nuclear fission.

Describe the process of nuclear fission.

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..... **[2]**

(c) A typical nuclear power station has a useful power output of 1600 MW.

The total power input is 4000 MW.

Calculate the efficiency of a typical nuclear power station.

Use the equation: $\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$

Give your answer as a **percentage**.

Efficiency = ... % **[3]**

2. Nov 2021/Paper_J259/02/No.1

(a) **Fig. 1.1** shows the wiring of four 3-pin plugs.

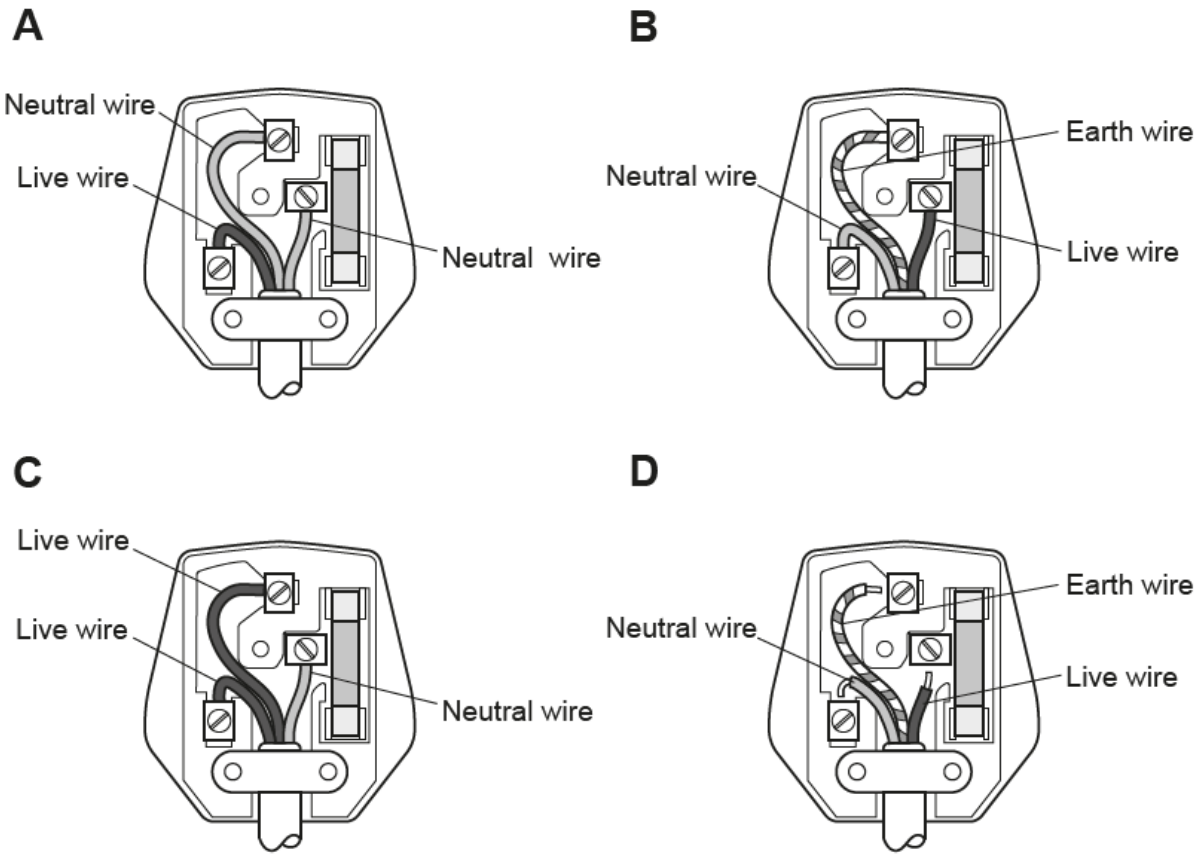


Fig. 1.1

Which diagram shows a correctly wired 3-pin plug?

Tick (✓) **one** box.

A ☐

B ☐

C ☐

D ☐

[1]

(b) **Fig. 1.2** shows part of the National Grid.

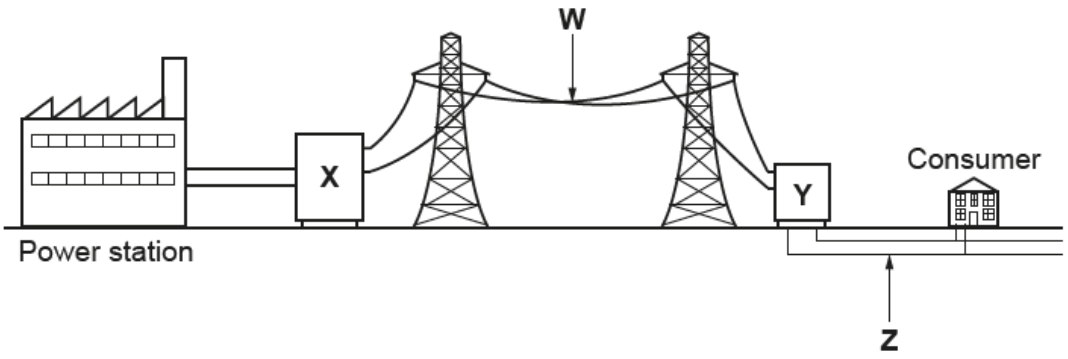


Fig. 1.2

(i) Which part of **Fig. 1.2** shows a step-up transformer?

Tick (✓) **one** box.

W ☐

X ☐

Y ☐

Z ☐

[1]

(ii) Which part of **Fig. 1.2** shows high voltage cables?

Tick (✓) **one** box.

W ☐

X ☐

Y ☐

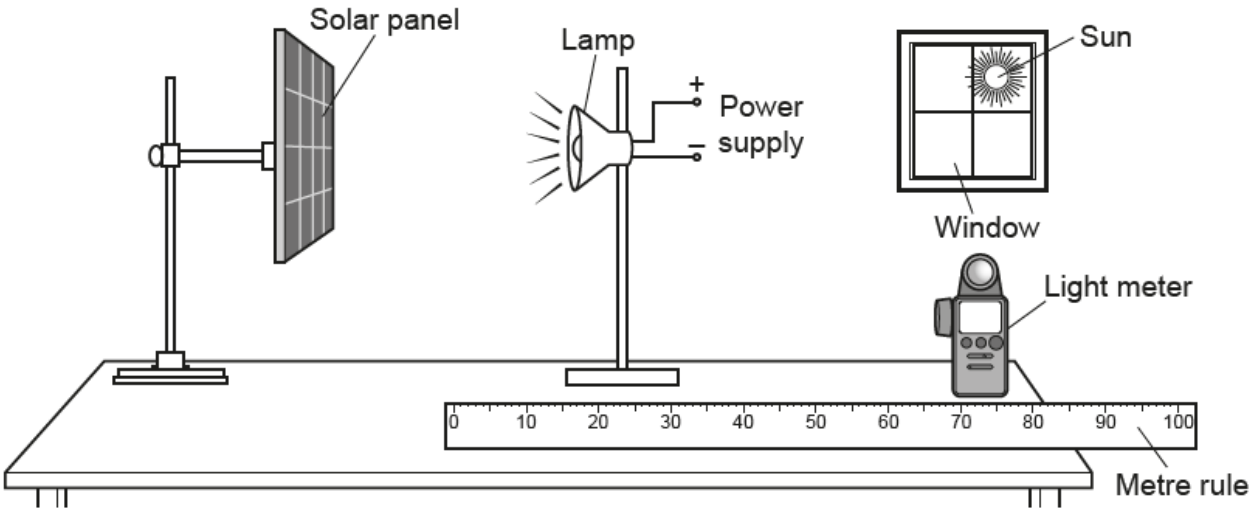
Z ☐

[1]

3. Nov 2021/Paper_J259/02/No.10

Solar panels generate electricity using energy from the Sun.

Kai investigates solar panels and sets up the equipment in the diagram.



Kai wants to use the light meter to record the total power input to the solar panel from the lamp.

Kai also wants to measure the distance between the lamp and the solar panel with the metre rule.

(a) Identify **two** sources of error in Kai's experiment, and describe how each error can be reduced.

Error 1 .....

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How to reduce **error 1** .....

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Error 2 .....

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How to reduce **error 2** .....

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[4]

(b) Kai corrects the errors in his experiment. He also records the useful power output of the solar panel, and the energy output of the solar panel in 30 seconds.

He records his results in the table.

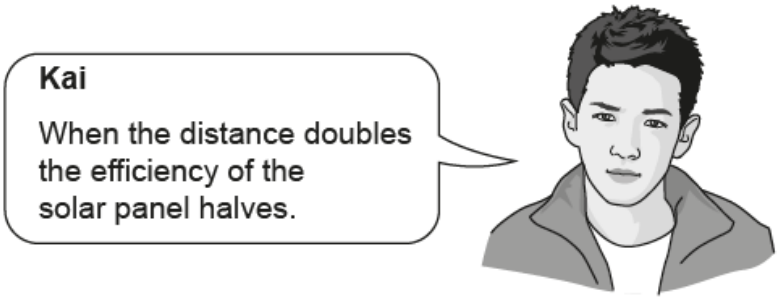
Distance between lamp and solar panel (cm)	Total power input to the solar panel (W)	Useful power output of the solar panel (W)	Energy output of the solar panel in 30 seconds (J)
10.0	4	2.85	85.5
20.0	1	0.63	18.9
30.0	0.44	0.28	8.40
40.0	0.25	0.14	4.20
50.0	0.16	0.06	.....
60.0	0.11	0.05	1.50

(i) Complete the table.

Use the equation: power = energy ÷ time

[2]

(ii) Kai makes a hypothesis.



Explain why Kai's hypothesis is incorrect.

Use calculations to support your answer.

Use the equation: efficiency = $\frac{\text{useful power output}}{\text{total power input}}$

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..... **[3]**

(iii) Space probes that travel to the outer planets of the solar system do **not** use solar panels to provide electricity.

Explain why solar panels are not used by these space probes.

Use data from the table to support your answer.

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..... **[2]**

4. Nov 2021/Paper_J259/02/No.11

Amir has bought an electric car.

(a) (i) The electric car has a power of 80 kW.

Define power, with reference to the energy store of the car's battery.

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.....

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..... **[2]**

(ii) Work is done when electric current passes from the battery to the motor, but some energy is wasted.

Describe how this energy is wasted and where this energy is transferred to.

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..... **[2]**

(b) 42 kWh of energy is stored in the fully charged battery.

(i) 1 kWh of electricity costs 16p.

Calculate the cost of fully charging the car, in £.

Cost = £ ..... **[2]**

(ii) Calculate the time taken, in hours, to fully charge the battery using a 7 kW charger.

Use the equation: power = energy ÷ time

Time = ... hours **[2]**

(iii) The manufacturer claims the car uses 1 kWh of energy to travel 6 km.

When the battery is fully charged Amir travels 220 km before the charge on the battery runs out.

Find out if the manufacturer's claim is correct.

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.....

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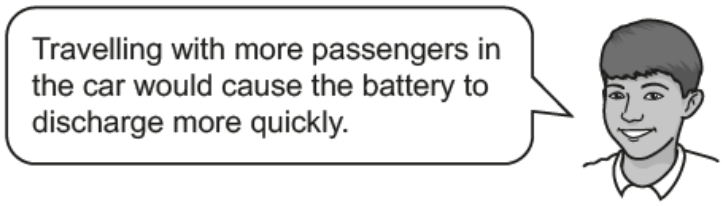
..... **[2]**

(c) Amir makes a hypothesis about the performance of the car's battery.



Amir has a small electrical motor and a trolley.

Outline an experiment that Amir could do in a school lab to investigate his hypothesis.

Include any additional equipment required in your answer.

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..... **[2]**

5. Nov 2020/Paper_J259/01/No.4

Eve needs to buy a vacuum cleaner. She compares two vacuum cleaners.

Vacuum cleaner **A** runs using mains electricity. It is connected to the mains using a cable.

Vacuum cleaner **B** does not have a cable. It runs from energy stored in a battery.

(a) Both vacuum cleaners transfer energy from an energy store.

(i) Name the form of stored energy that is used by wind turbines to generate mains electricity.

..... **[1]**

(ii) Name the form of stored energy in a battery.

..... **[1]**

(b) Vacuum cleaner **B** runs out of battery after two hours.

Describe what has happened to the energy which was stored in the battery.

.....

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..... **[2]**

(c) The table shows some information about the two vacuum cleaners.

Vacuum cleaner	**A**	**B**
Input power (W)	700	65
Potential difference (V)	230	11

Calculate the current in vacuum cleaner **B**.

Use the equation: current = power ÷ potential difference

Give your answer to **3** significant figures.

Current = ... A **[3]**

(d) **(i)** Calculate the energy transferred by vacuum cleaner **A** when it is operated for 600 seconds.

Energy transferred = ... J **[3]**

(ii) When both vacuum cleaners are operated for 600 seconds, vacuum cleaner **A** transfers more energy.

Explain why.

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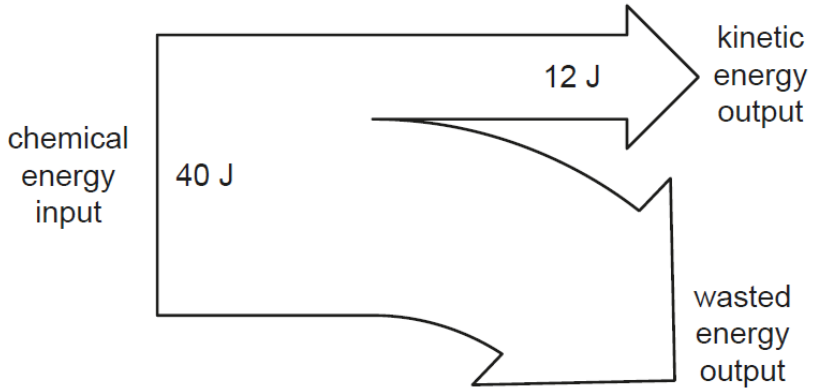
..... **[2]**

6. Nov 2020/Paper_J259/01/No.6

A Sankey diagram can be used to show how a device transfers energy.

The Sankey diagram below is for a car speeding up.



(a) Calculate the wasted energy output.

Wasted energy output = ... J **[1]**

(b) Calculate the efficiency of the car.

Use values from the Sankey diagram.

Use the equation: efficiency = useful energy transferred ÷ total energy transferred

Give your answer as a **percentage**.

Efficiency = ... % **[3]**

7. Nov 2020/Paper_J259/01/No.11

Amir investigates how insulation affects the rate of cooling.

He writes down his method.

1. Fill a metal tin with water at 80 °C.
2. Wait for 10 minutes.
3. Measure the new temperature and write it down.
4. Repeat the experiment for each of these types of insulation:

Experiment	Insulation
A	None
B	1 layer of aluminium foil
C	1 layer of bubble wrap
D	3 layers of bubble wrap
E	1 layer of bubble wrap **and** 1 layer of aluminium foil

(a) Predict which experiment will cool down the slowest. Explain your answer.

Experiment: .....

Explanation: .....

.....

.....

[2]

(b) Amir's teacher reads his method. The teacher says that the method is not detailed enough to make the experiment **reproducible**.

(i) Explain the meaning of the word **reproducible**.

.....

.....

..... **[2]**

(ii) Give **one** piece of additional information that you would need to **reproduce** Amir's experiment.

.....

..... **[1]**

8. Nov 2020/Paper_J259/01/No.12

A low-carbon source causes very little carbon dioxide to be given off into the atmosphere.

Some of the energy supplied to the UK comes from low carbon sources.

Fig. 12.1 shows how the percentage of UK energy supplied from low carbon sources has changed over time.

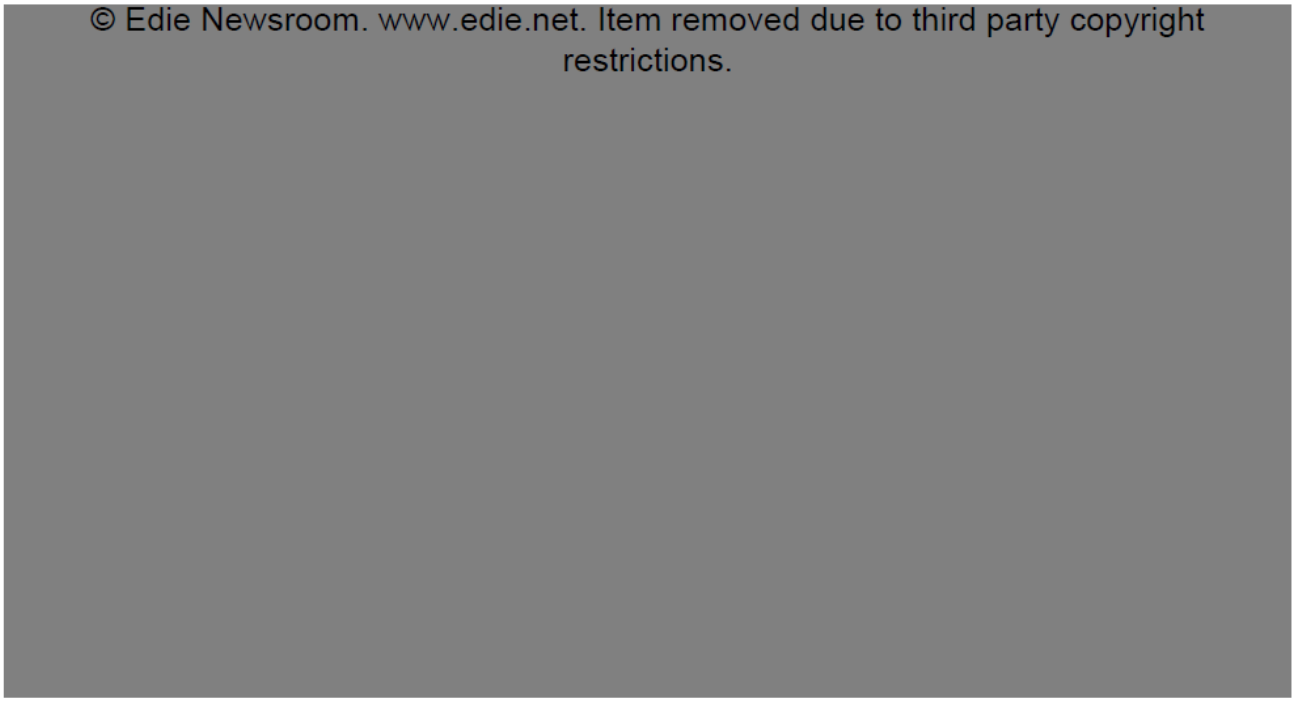


Fig. 12.1

(a) (i) Describe the trend in the percentage of UK energy supplied by **biofuels**.

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..... **[1]**

(ii) Suggest **one** reason for this trend.

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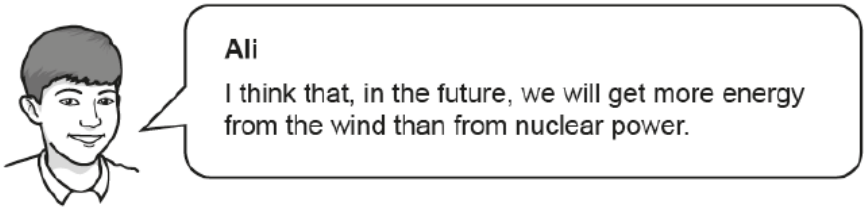
..... **[1]**

(b) Ali and Ling discuss the trends shown in the data.



(i) Evaluate whether the evidence shown in **Fig. 12.1** supports Ali's statement.

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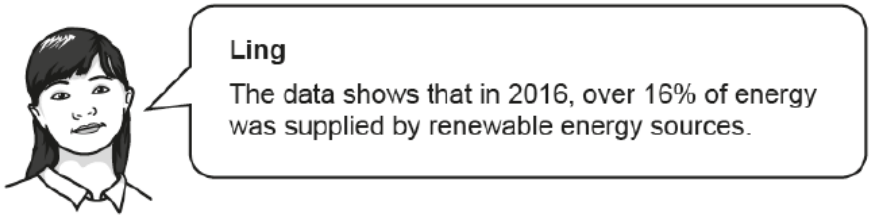
..... **[2]**



(ii) State why Ling is **incorrect**.

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..... **[1]**

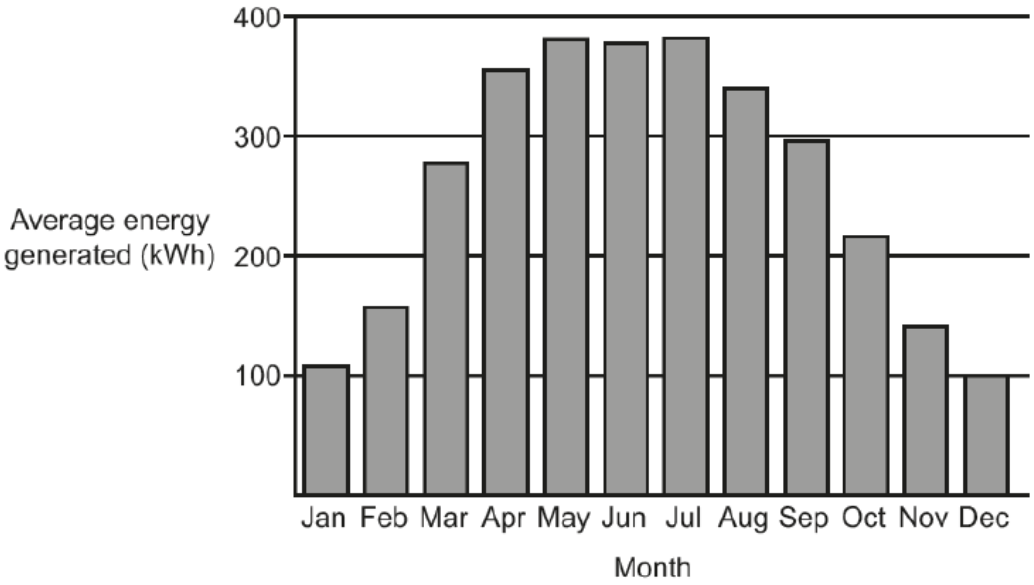
(iii) Using **Fig. 12.1**, estimate the correct percentage of energy that was supplied by renewable energy sources in 2016.

Percentage = ... % **[1]**

9. Nov 2020/Paper_J259/02/No.10

Kai wants to buy solar panels for his house.

A local solar panel company has provided him with **data** on the amount of energy he can **expect** to generate per month from a 4 kW solar panel system, based on average sunshine over the last 30 years.



Kai's friend Amir has owned solar panels for a year, and has recorded the energy his 4 kW solar panel system has generated over twelve months, as shown in the table.

Month	Energy generated (kWh)
January	150
February	160
March	170
April	210
May	350
June	400
July	300
August	380
September	360
October	180
November	160
December	40

(a) **(i)** Give **one** similarity and **one** difference between the data from the local solar panel company, and Amir's data.

Similarity

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Difference

..... **[2]**

(ii) Give **two** reasons why there is greater uncertainty in Amir's data than the local solar panel company's data.

1. .....

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2. .....

.....

[2]

(b) Kai requires a system that will deliver a minimum power of 3800 W to his house.

He must also buy storage batteries to provide electricity when solar or wind power is not available. These cost £250.

	One wind turbine	**One solar panel**
Maximum power output (W)	1250	350
Voltage (V)	12	12
Cost (£) per item	1500	415

(i) Calculate the total cost to deliver a minimum power of **3800 W** to his house, using **solar panels**.

Total cost = £ ..... **[3]**

(ii) Kai has £5000 to spend.

Which system should Kai use to deliver a minimum power of 3800 W to his house?

Wind turbines ☐

Solar panels ☐

Explain your answer.

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..... **[2]**

10. Nov 2020/Paper_J259/02/No.13

Electricity is transferred from power stations to consumers by the National Grid, as shown in **Fig. 13.1**.

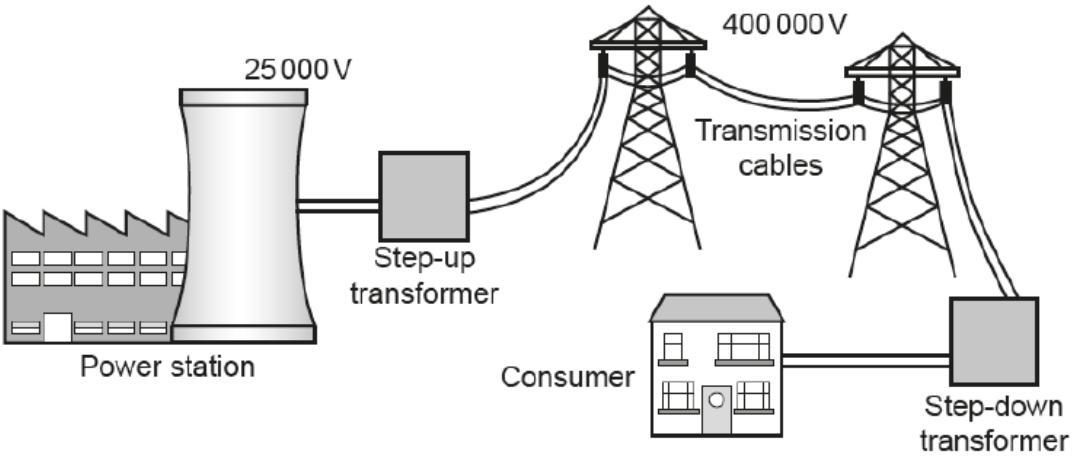

Fig. 13.1

(a) The National Grid uses a step-up transformer to increase the potential difference from 25 000 V to 400 000 V before the current is sent along the transmission cables.

The current in the primary coil of the step-up transformer is 2000 A.

Calculate the current flowing in the secondary coil of the step-up transformer.

Use the Data Sheet.

Current = ... A **[3]**

(b) **Fig. 13.2** shows the UK's demand for electricity during a 24 hour period, and the base load.

The base load is the amount of electricity which is constantly generated.

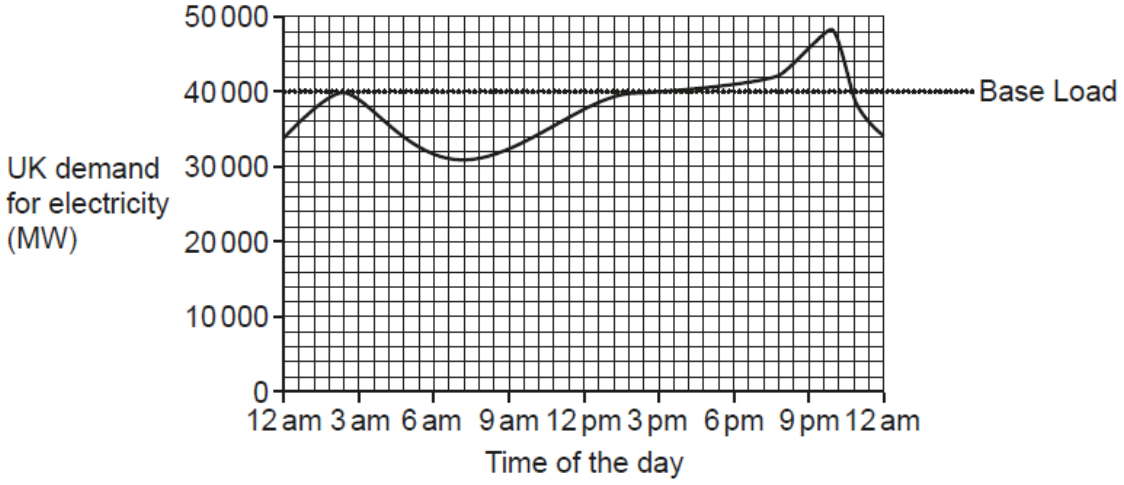

Fig. 13.2

(i) What is the value of the base load?

..... MW **[1]**

(ii) At which approximate time of the day is the demand for electricity the greatest?

..... **[1]**

(iii) At which approximate time of the day does the demand for electricity become greater than the base load?

Put a (ring) around the correct answer.

2.30am **7am** **4pm** **10.30pm**

[1]

(c)* The UK uses many types of power stations to meet electrical demand.

The table shows information about four types of power station.

Type of power station	Start-up time	Maximum power generated (MW)
Wind	10 minutes	14 000
Fossil fuel	1 to 2 days	38 000
Solar	Instant	5 000
Hydroelectric	1 minute	5 000

Describe the **advantages** and **disadvantages** of these four types of power station and **conclude** how these four types of power station could be used to meet electrical demand during the 24-hour period shown in **Fig. 13.2**.

Use your own knowledge of these four types of power station in your answer.

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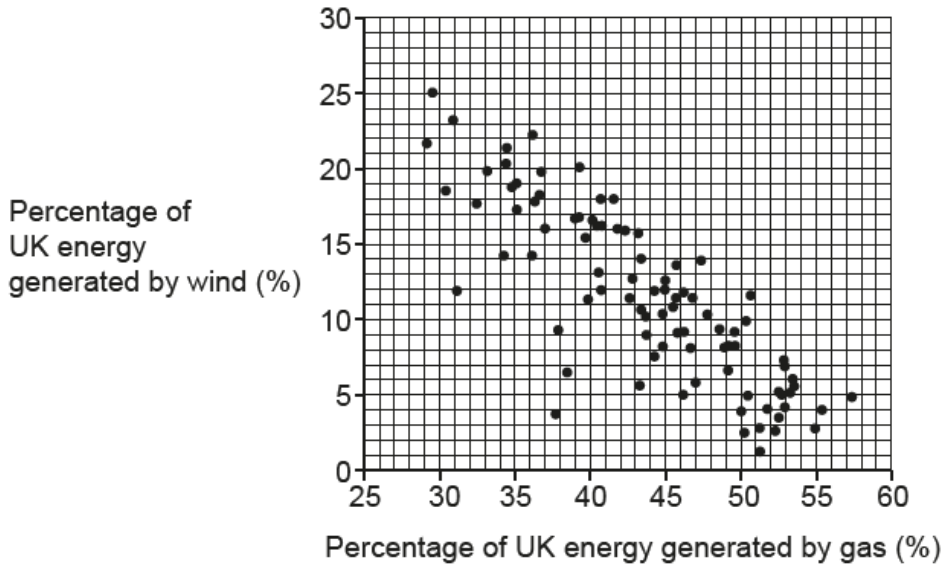
..... **[6]**

11. Nov 2021/Paper_J259/03/No.2

A large percentage of electricity in the UK is generated using wind turbines and gas-fired power stations.

The graph compares the percentage of UK energy generated by wind and gas from January to March 2017.

Each plot point shows the energy generated in one day.



(a) Describe and explain the relationship shown in the graph.

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..... **[3]**

(b) Mia and James discuss the data.

Mia

Gas power stations are bad for the environment.

(i) Give **one** reason why Mia is correct.

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..... **[1]**

James

In the future there will be more wind turbines, so we won't need gas power stations anymore.

(ii) Discuss James' comment.

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..... **[2]**

12. Nov 2021/Paper_J259/03/No.5

Hydroelectric power is a renewable source of energy. Hydroelectric power stations work by storing water in a reservoir behind a dam.

Fig. 5.1 shows an example of a hydroelectric power station.

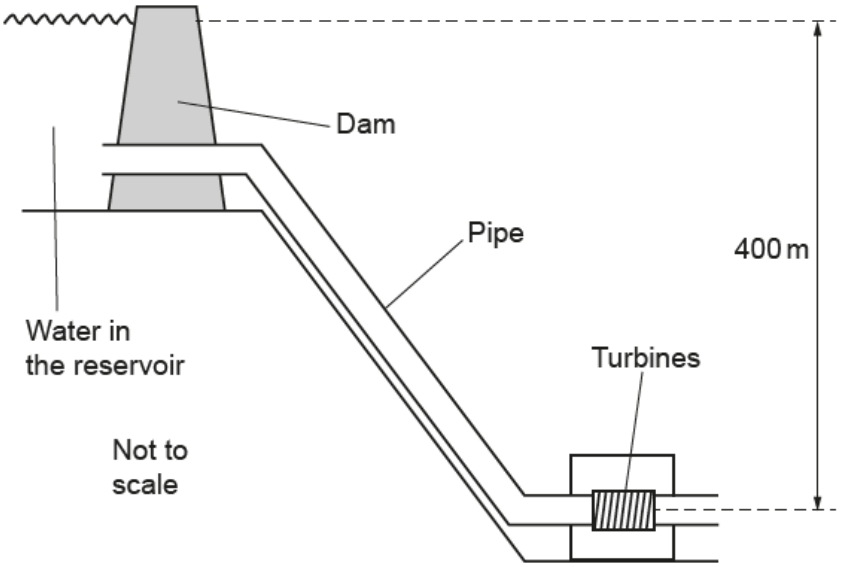

Fig. 5.1

(a) **Fig. 5.2** shows a representation of the reservoir in the hydroelectric power station.

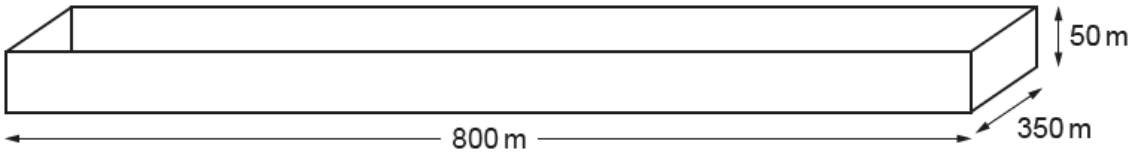

Fig. 5.2

Calculate the total mass of water that can be held in the reservoir.

Density of water = 1000 kg / m^3.

Mass = ... kg **[3]**

(b) The water in the reservoir is a store of gravitational energy. The water falls a vertical distance of 400 m from the reservoir to the turbines, as shown in **Fig. 5.1**.

Calculate the total available gravitational energy when the reservoir is holding 8.0×10^9 kg of water.

Gravitational field strength = 10 N / kg

Gravitational energy = ... J **[3]**

(c) The efficiency of the hydroelectric power station is 75%.

On one occasion, the hydroelectric power station has an output power of 140 MW for a time of 1 hour.

Calculate the total **energy input** required for this output power.

Use the equation: energy transferred = power × time

Give your answer in **joules**.

Total energy input = ... J **[4]**

13. Nov 2021/Paper_J259/03/No.9

Jamal and Beth want to install a boiler to heat their house.

They consider using wood pellets or heating oil as an energy source for their new boiler.

(a) Wood pellets are a type of biofuel. Heating oil is a fossil fuel.

Give the similarities and differences between biofuels and fossil fuels as energy sources.

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..... **[3]**

(b) They find the information shown in the table.

	Wood pellets	**Heating oil**
Energy density (MJ/kg)	20	40
Density (kg/m^3)	760	950
Cost (p/kg)	25	55

Which energy source should they use for their new boiler?

Wood pellets ☐

Heating oil ☐

Use calculations in your answer.

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..... **[3]**

14. Nov 2021/Paper_J259/04/No.1

Amir has bought an electric car.

(a) (i) The electric car has a power of 80 kW.

Define power, with reference to the energy store of the car's battery.

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.....

.....

..... **[2]**

(ii) Work is done when electric current passes from the battery to the motor, but some energy is wasted.

Describe how this energy is wasted and where this energy is transferred to.

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..... **[2]**

(b) 42 kWh of energy is stored in the fully charged battery.

(i) 1 kWh of electricity costs 16p.

Calculate the cost of fully charging the car, in £.

Cost = £ ..... **[2]**

(ii) Calculate the time taken, in hours, to fully charge the battery using a 7 kW charger.

Use the equation: power = energy ÷ time

Time = ... hours **[2]**

(iii) The manufacturer claims the car uses 1 kWh of energy to travel 6 km.

When the battery is fully charged Amir travels 220 km before the charge on the battery runs out.

Find out if the manufacturer's claim is correct.

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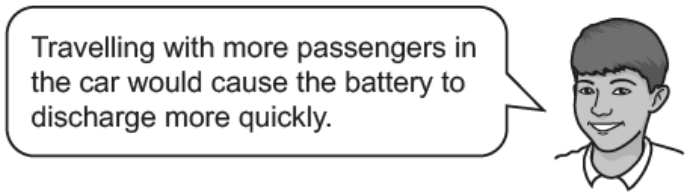
..... **[2]**

(c) Amir makes a hypothesis about the performance of the car's battery.



Amir has a small electrical motor and a trolley.

Outline an experiment that Amir could do in a school lab to investigate his hypothesis.

Include any additional equipment required in your answer.

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..... **[2]**

15. Nov 2020/Paper_J259/03/No.1

Amir investigates how insulation affects the rate of cooling.

He writes down his method.

1. Fill a metal tin with water at 80 °C.
2. Wait for 10 minutes.
3. Measure the new temperature and write it down.
4. Repeat the experiment for each of these types of insulation:

Experiment	Insulation
A	None
B	1 layer of aluminium foil
C	1 layer of bubble wrap
D	3 layers of bubble wrap
E	1 layer of bubble wrap **and** 1 layer of aluminium foil

(a) Predict which experiment will cool down the slowest. Explain your answer.

Experiment: .....

Explanation: .....

.....

.....

[2]

(b) Amir's teacher reads his method. The teacher says that the method is not detailed enough to make the experiment **reproducible**.

(i) Explain the meaning of the word **reproducible**.

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..... **[2]**

(ii) Give **one** piece of additional information that you would need to **reproduce** Amir's experiment.

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..... **[1]**

16. Nov 2020/Paper_J259/03/No.2

A low-carbon source causes very little carbon dioxide to be given off into the atmosphere.

Some of the energy supplied to the UK comes from low carbon sources.

Fig. 2.1 shows how the percentage of UK energy supplied from low carbon sources has changed over time.

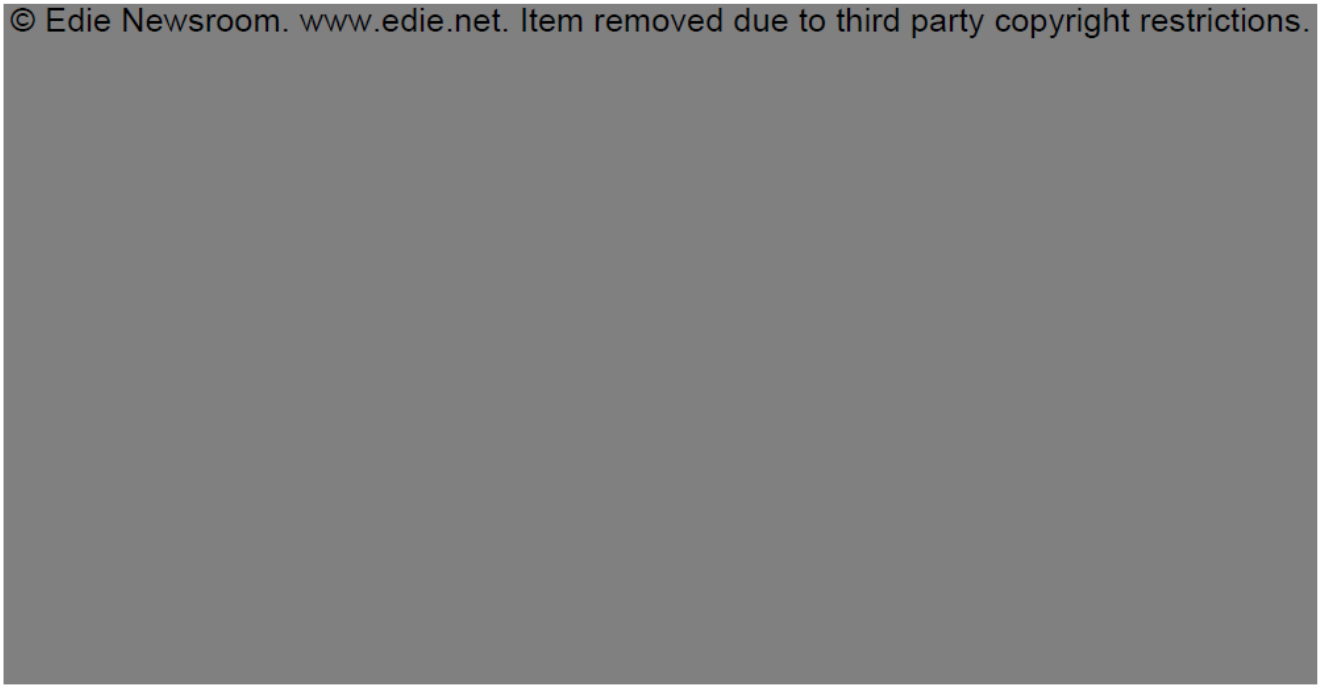

Fig. 2.1

(a) (i) Describe the trend in the percentage of UK energy supplied by **biofuels**.

.....

..... **[1]**

(ii) Suggest **one** reason for this trend.

.....

..... **[1]**

(b) Ali and Ling discuss the trends shown in the data.

Ali

I think that, in the future, we will get more energy from the wind than from nuclear power.

(i) Evaluate whether the evidence shown in **Fig. 2.1** supports Ali's statement.

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..... **[2]**

Ling

The data shows that in 2016, over 16% of energy was supplied by renewable energy sources.

(ii) State why Ling is **incorrect**.

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..... **[1]**

(iii) Using **Fig. 2.1**, estimate the correct percentage of energy that was supplied by renewable energy sources in 2016.

Percentage = ... % **[1]**

17. Nov 2020/Paper_J259/04/No.2

Electricity is transferred from power stations to consumers by the National Grid, as shown in **Fig. 2.1**.

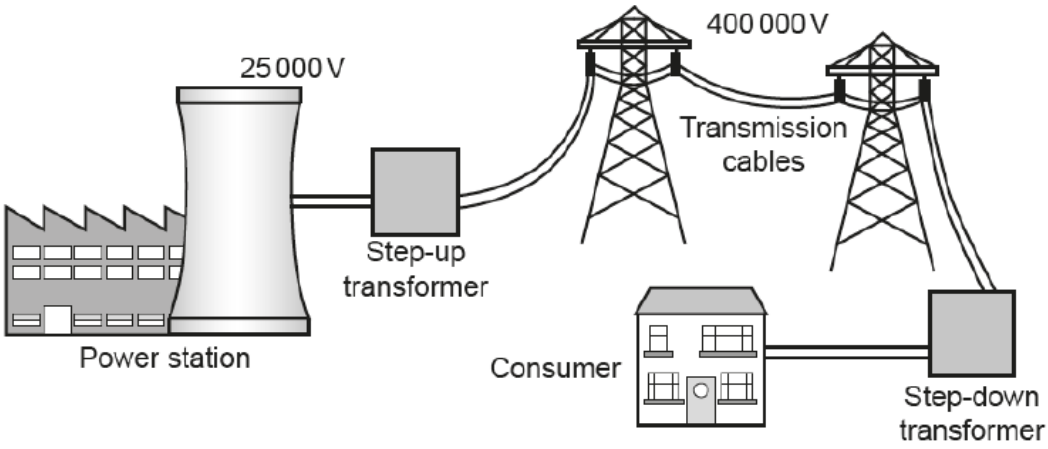

Fig. 2.1

(a) The National Grid uses a step-up transformer to increase the potential difference from 25 000 V to 400 000 V before the current is sent along the transmission cables.

The current in the primary coil of the step-up transformer is 2000A.

Calculate the current flowing in the secondary coil of the step-up transformer.

Use the Data Sheet.

Current = ... A **[3]**

(b) **Fig. 2.2** shows the UK's demand for electricity during a 24 hour period, and the base load.

The base load is the amount of electricity which is constantly generated.

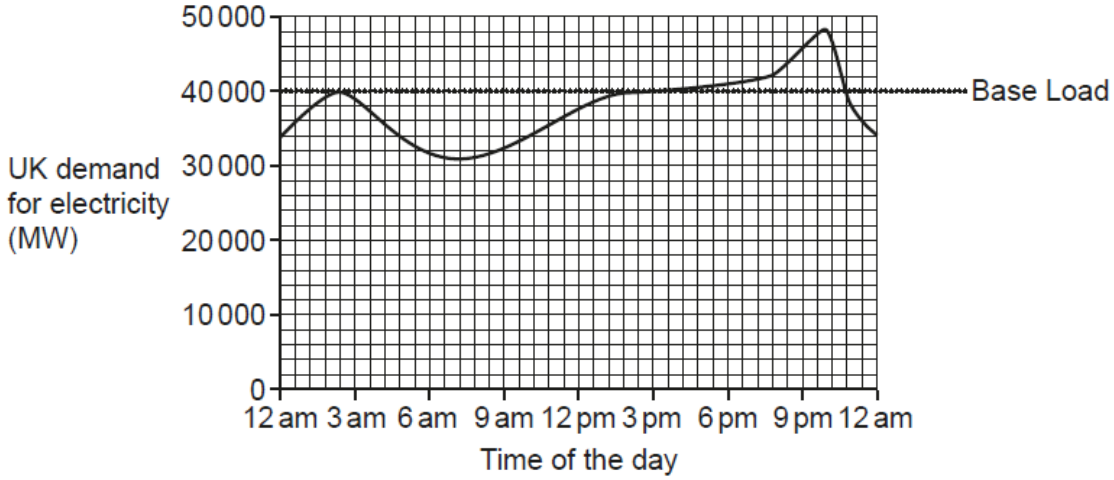

Fig. 2.2

(i) What is the value of the base load?

..... MW **[1]**

(ii) At which approximate time of the day is the demand for electricity the greatest?

..... **[1]**

(iii) At which approximate time of the day does the demand for electricity become greater than the base load?

Put a (ring) around the correct answer.

2.30am **7am** **4pm** **10.30pm**

[1]

(c)* The UK uses many types of power stations to meet electrical demand.

The table shows information about four types of power station.

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Describe the **advantages** and **disadvantages** of these four types of power station and **conclude** how these four types of power station could be used to meet electrical demand during the 24-hour period **shown** in **Fig. 2.2**.

Use your own knowledge of these four types of power station in your answer.

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..... **[6]**

18. Nov 2020/Paper_J259/04/No.9

Kai and Amir live near a wind farm.

They both believe that there is a relationship between average monthly temperature and the power generated by the wind farm.

Kai
I think there is a **strong** correlation between the power generated and average monthly temperature.

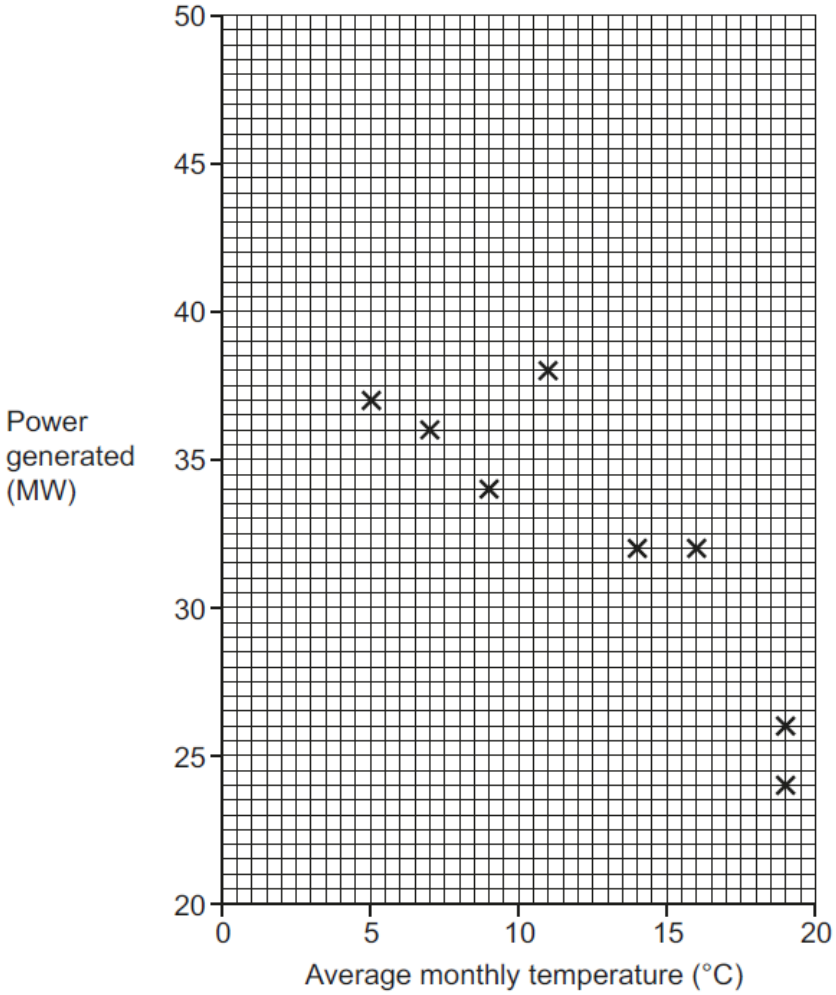
Amir
I think there is a **weak** correlation between the power generated and average monthly temperature.

The table shows data for the wind farm over twelve months.

Month	Average monthly temperature (°C)	Power generated (MW)
January	5	37
February	7	36
March	9	34
April	11	38
May	14	32
June	16	32
July	19	24
August	19	26
September	17	32
October	13	40
November	10	35
December	7	41

(a) (i) Complete the scatter graph by plotting the last four points from the table. **[1]**

(ii) Draw a line of best fit. **[1]**



(b) Discuss Kai and Amir's comments.

Use the graph to support your answer.

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