1(a). The national grid makes predictions about the electrical power it can supply and the electrical power customers demand for two different winters.

The national grid calculates the system margin using the equation:

system margin = electrical power supplied − electrical power demanded

The predictions for **winter 1** are:

Predicted supply = 64.2 GW
Predicted demand = 60.0 GW

Calculate the percentage system margin for **winter 1**.

Use the equation:

$$\text{percentage system margin} = \frac{(\text{predicted supply} - \text{predicted demand})}{\text{predicted demand}} \times 100\%$$

Percentage system margin = ... % **[2]**

(b). The predictions for **winter 2** are:

Lowest predicted system margin = 3.0 GW
Highest predicted system margin = 6.2 GW
Mean predicted system margin = 4.6 GW

i. Suggest **two** reasons why the national grid predicts a range of values for the system margin.

1 ____

____

2 ____

____ **[2]**

i. Calculate the percentage uncertainty in the predicted system margin for **winter 2.**

Use the equation: $\text{percentage uncertainty} = \frac{1}{2} \times \frac{\text{range of values}}{\text{mean value}} \times 100\%$

Percentage uncertainty = ... % **[2]**

(c).

i. Suggest why people working for the national grid may worry if the system margin is small.

____ **[1]**

ii. The electrical power that hydroelectric power stations are able to supply can be increased to help meet the customer demand.

On one winter's day:

- the electrical power demanded by customers = 1.0 GW
- the electrical power that can be supplied by a hydroelectric power station = 5.5 GW
- the system margin = 4.5 GW.

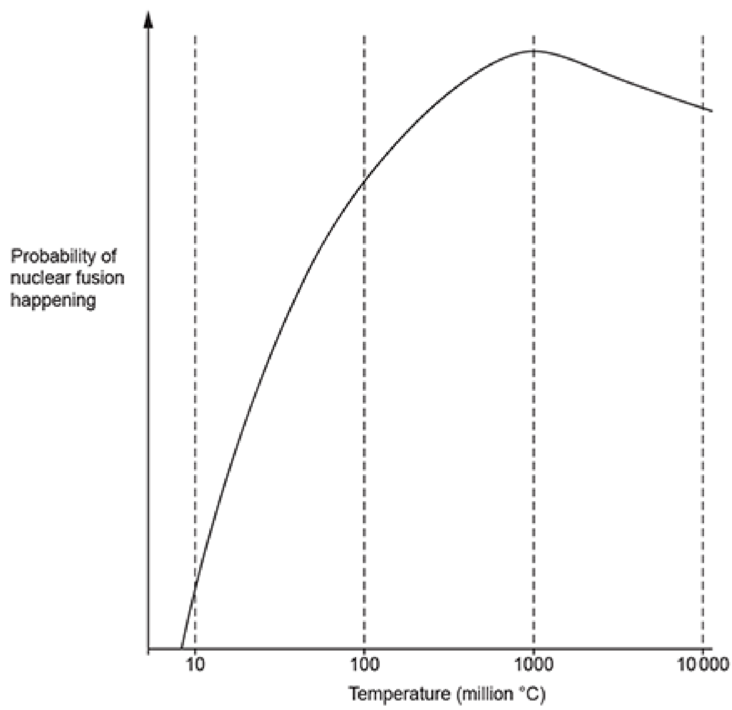
The electrical power that the hydroelectric power station is able to supply is then increased so that the system margin is increased by 4.0%.

Calculate the electrical power that the hydroelectric power station is able to supply after the system margin has been increased.

Electrical power supplied = ... GW **[2]**

2. Nuclear power stations use nuclear fission rather than nuclear fusion to generate energy.

This graph shows how the probability of a nuclear fusion reaction changes with temperature.



Compare the processes of fission and fusion.

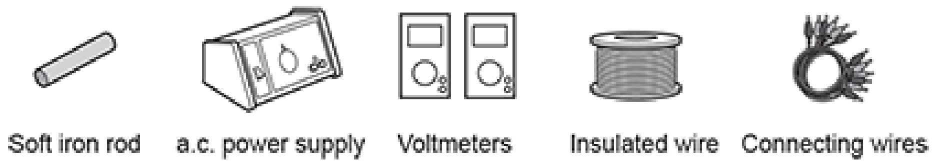
Explain why power stations only use nuclear fission at present.

Use the graph, and your scientific knowledge.

[6]

3(a). A student investigates how the potential difference across the secondary coil of a transformer changes with the number of turns on the secondary coil.

The diagram shows the student's equipment.



Describe a method that the student uses to obtain valid results.

You can include a labelled diagram to support your answer.

____

____

____ [4]

(b). A transformer is used to change the potential difference (p.d.) of a supply.

The table shows the data for this transformer.

Number of turns on the primary coil	3540
Number of turns on the secondary coil	300
p.d. across primary coil	230 V
Current in secondary coil	4.62 A

i. Calculate the p.d. across the secondary coil of the transformer.

Use the Equation Sheet June 23 J249-01-02-03-04.

p.d. across the secondary coil = ... V **[3]**

ii. Calculate the current in the primary coil of the transformer.

Use the Equation Sheet June 23 J249-01-02-03-04.

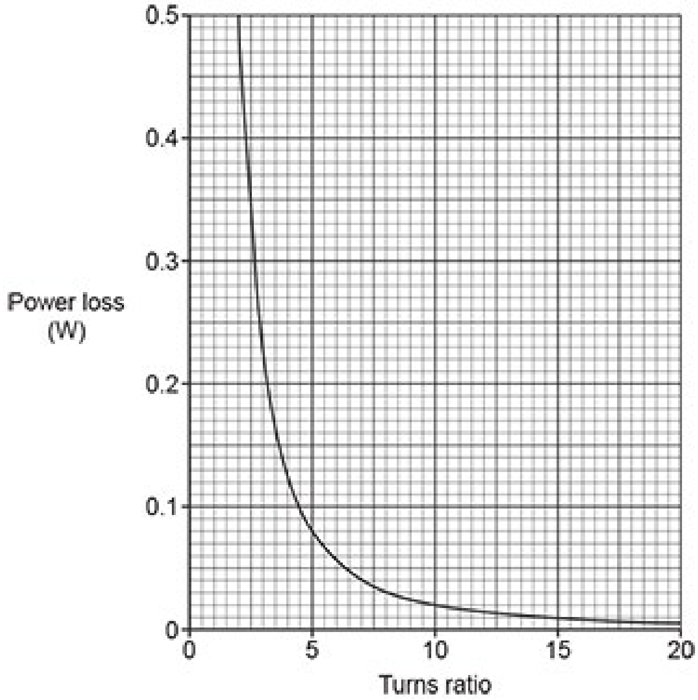
Current in primary coil = ... A **[3]**

(c). A teacher calculates power losses in a model power line.

The teacher changes the 'turns ratio' of a step-up transformer using the equation:

$$\text{turns ratio} = \frac{\text{number of turns in secondary coil}}{\text{number of turns in primary coil}}$$

The graph shows how power loss in the power line changes with the turns ratio.



i. A student says, 'As the turns ratio doubles, the power loss halves.'

Use data from the graph to explain why the student is **incorrect**.

[2]

ii. Explain why step-up transformers are used in the national grid.

[2]

4. A teacher plugs an electric kettle into the domestic electricity supply.

The kettle has a power rating of 2300 W.

What is the current in the kettle?

Use the Equation Sheet June 23 J249-01-02-03-04.

A 0.10 A
B 3 A
C 10 A
D 13 A

Your answer ☐ **[1]**

5(a).

Fig. 21.1 shows how the energy output per second of a wind turbine depends on the wind speed.

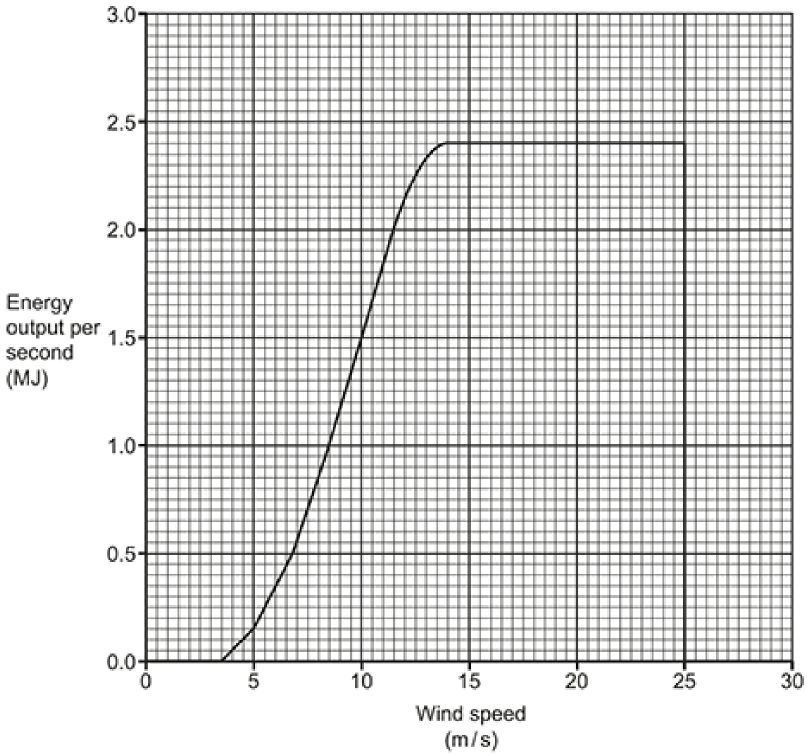


Fig. 21.1

i. Suggest a reason why energy output per second is zero when the wind speed is:

1 Less than 3.5 m / s.

2 Greater than 25 m / s.

____

____

[2]

ii. The wind turbine has an efficiency of 0.35.

Calculate the input energy per second when the wind speed is 10 m / s.

Use **Fig. 21.1** and the Data sheet_J249 01/02/03/04, June 2022.

Give your answer to **2** significant figures.

Input energy per second = ... MJ **[5]**

(b). Fig. 21.2 shows how the amount of electricity generated by wind in Europe has changed with time.

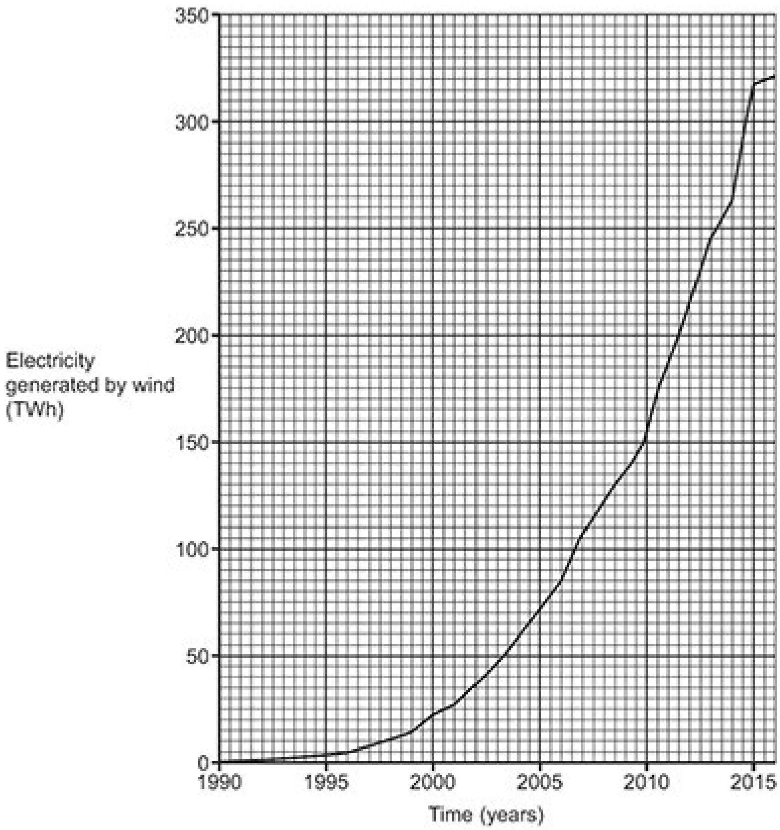


Fig. 21.2

i. State the amount of electricity generated by wind in 2012 in joules.

1TW h = 3.6×10^{15} J

Give your answer in standard form.

Electricity generated = ... J **[2]**

ii. Suggest **two** reasons for the change shown in **Fig. 21.2.**

1 ______________________________

____

2 ______________________________

____

[2]

(c). A wind turbine generates electricity at 900 V.

The wind turbine is connected to the national grid using a transformer.

i. The potential difference across the primary coil is 900 V.
The potential difference across the secondary coil is 36 000 V.
The current in the primary coil is 2800A.

Calculate the current in the **secondary** coil.

Use the Data sheet_J249 01/02/03/04, June 2022.

Current = ... A **[2]**

ii. Explain why the use of the transformer in **(i)** reduces power loss in the national grid.

____

____

____

____

____

[3]

iii. Another transformer has a power input of 864 900 W.

The current in the primary coil is 1860A.

Calculate the resistance of the primary coil.

Use the equation: power = $(\text{current})^2$ × resistance

Resistance = ... Ω **[3]**

END OF QUESTION PAPER