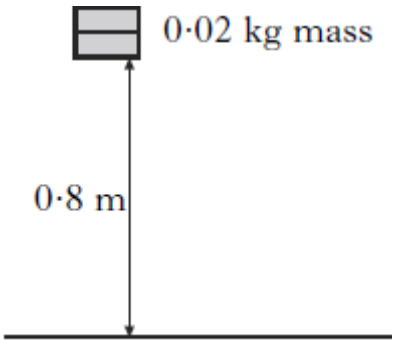
Energy Conversions Questions – NAT 5

1) A 0.02kg mass is held at a height of 0.8m above the ground.

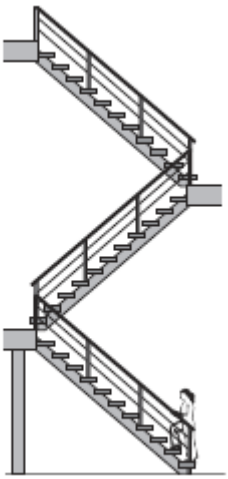


a) Calculate the gravitational potential energy stored in the mass before it is dropped.

b) i) State the kinetic energy of the mass just before it hits the ground?

ii) Calculate the speed of the mass just before it hits the ground.

2) A student records the time that it takes to run up a flight of stairs in school.



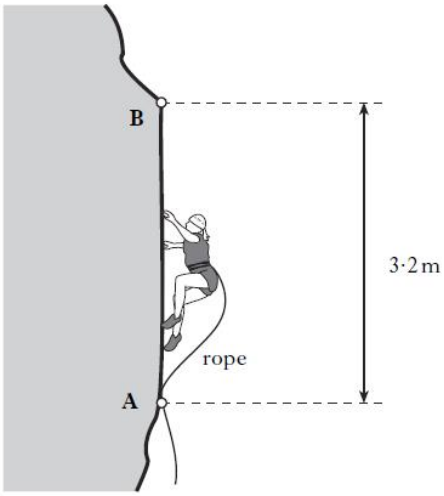
The following information was recorded during the run by a fellow student.

Mass of student (kg)	**60**
Height of stairs (m)	**15**
Time to climb stairs (s)	**12**

a) Calculate the gravitational potential energy gained by the student at the top of the stairs.

b) Calculate the power developed by the student.

3) A climber of mass 65kg is attached by a rope to point A on a rock face. She climbs up to point B in 20s, where B is 3.2m vertically above point A.



a) i) Calculate the average speed of the climber between A and B.

ii) Calculate the weight of the climber.

iii) Calculate the gain in gravitational potential energy of the climber.

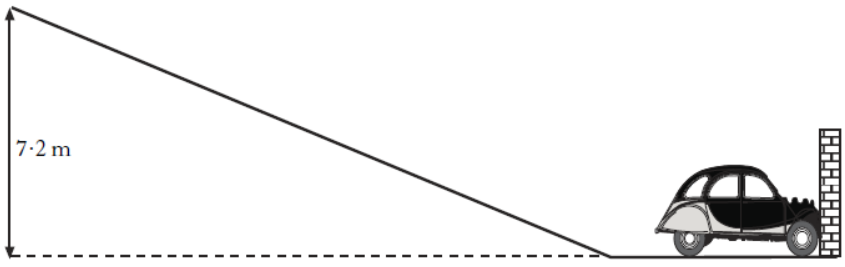
b) She then loses her footing and free falls from point B. After passing point A she is held safely by the rope.

i) Calculate her speed as she passes point A.

ii) How would her actual speed when passing point A compare with the speed Calculated in b) i)? **Explain your answer**.

4) The first car crash testing involved a car rolling down a slope with a wall at the bottom.

In one test a car of mass 779kg starts from rest at the top of a slope with a height of 7.2m.

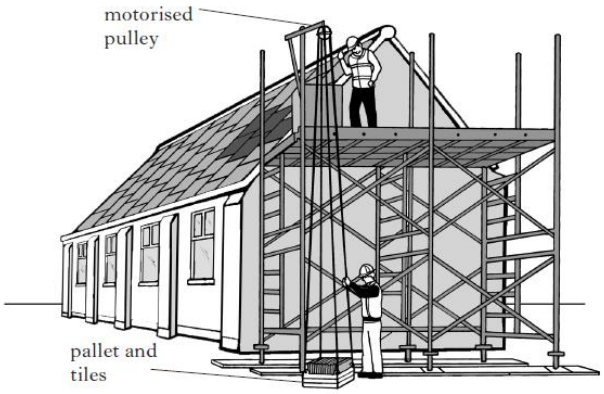


a) Calculate the gravitational potential energy of the car at the top of the slope.

b) i) State the kinetic energy of the car at the bottom of the slope.

ii) Calculate the speed of the car at the bottom of the slope just before hitting the wall, assuming there is no force of friction on the slope.

5) Builders repair the roof of a local community centre. They use scaffolding and a motorised pulley system to lift a pallet of tiles to roof level.



a) Calculate the weight of the pallet and tiles, which have a total mass of 230kg.

b) State the minimum force required to lift the tiles.

c) Calculate the gravitational potential energy gained by the tiles if they are lifted up to a height of 6m.

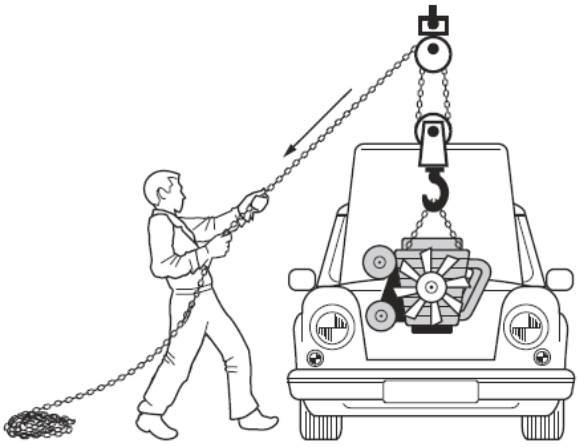
d) When they are unloaded on to the scaffolding at a height of 6m, **one tile** falls.

If a tile has a mass of 1.98kg and falls from rest:

i) Calculate the speed of the tile just before it hits the ground.

ii) **Explain** why the actual speed of the tile just before hitting the ground is less than that calculated in d) i).

6) In a garage, a mechanic lifts an engine from a car using a pulley system.



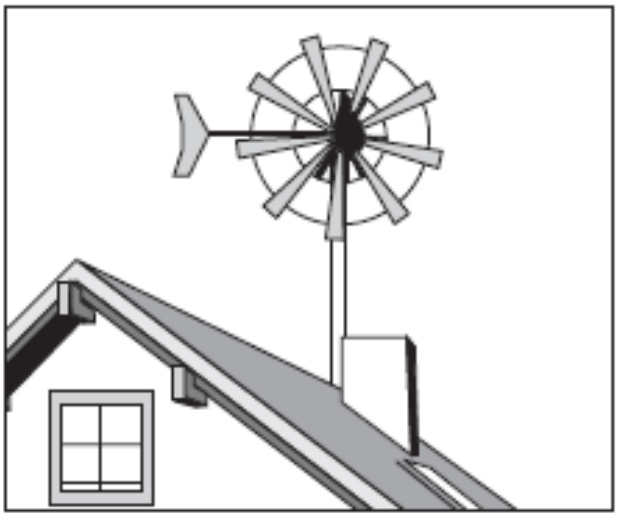
a) The mechanic pulls 4.5m of chain with a constant force of 300N.

Calculate the work done by the mechanic.

b) The engine has a mass of 146kg and is raised 0.80m.

Calculate the gravitational potential energy gained by the engine.

7) A family have a wind turbine electrical energy generator installed on their roof.



The table below gives information about the wind turbine.

Rated power output	1·5 kilowatts
Product life	20 years
Installation cost	£1600

a) In 2014 the wind turbine generated electrical energy for 2000 hours.

Calculate the electrical energy generated in kilowatt-hours during 2014.

b) An electricity supplier charges 15p per kilowatt-hour.

Calculate the cost of buying the same quantity of electrical energy as generated by the wind turbine in 2014.

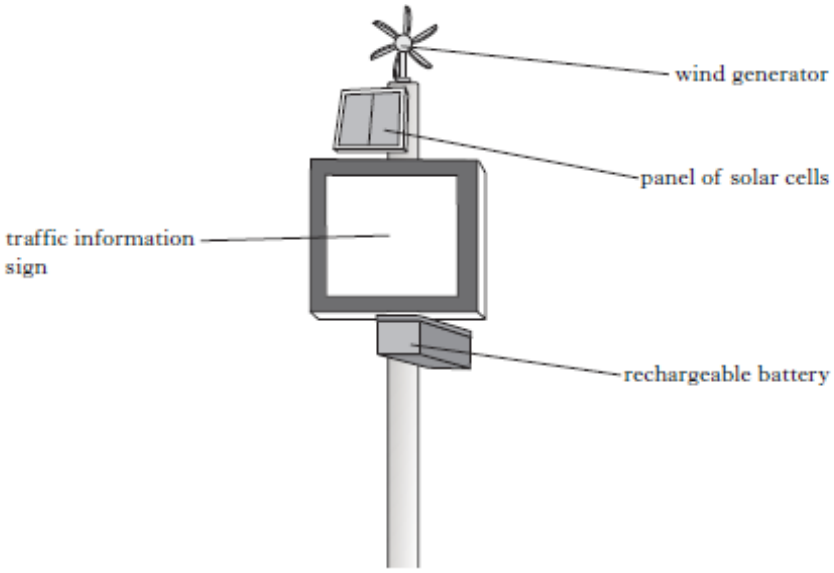
c) The wind turbine costs £2100 to install. It is used to generate electrical energy for 20years. Each year it generates the same amount of energy as it did in 2014.

Calculate how much money the householder will save if the turbine is used to generate electrical energy over this time.

8) A traffic information sign is located in a remote area.

The sign is supplied with energy by both a panel of a solar cells and a wind generator.

They are both connected to a rechargeable battery.



a) One square metre of solar cells can generate up to 80 watts.

The panel of solar cells has an area of $0.4m^2$.

i) State the energy change that takes place in the solar cells.

ii) Calculate the maximum power produced by the panel of solar cells.

b) The following table shows the power produced by the wind generator at different wind speeds.

wind speed (metres per second)	*power output of wind generator* (watts)
2	8
4	16
6	
8	32
10	40

i) Suggest the power produced when the wind speed is $6ms^{-1}$.

ii) At a wind speed of $10ms^{-1}$ the voltage produced by the wind generator is 16 volts.

Calculate the current produced by the wind generator.

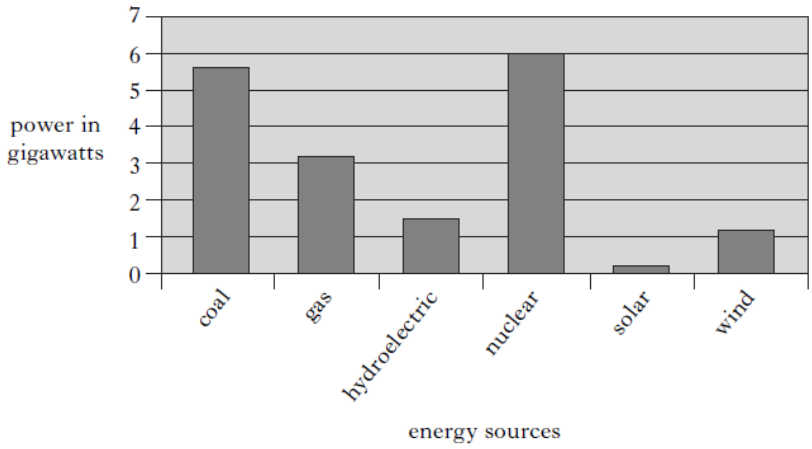
c) Explain why a rechargeable battery is also required to supply energy to the traffic information sign.

9) Increasing the electrical energy generated from renewable sources is important for the future of the country.

a) At present, fossil fuels are the main source of energy.

State **one** problem with this source of energy.

b) The bar chart shows the main energy sources used in Scotland.



Use the names of the energy sources in the bar chart to compete the table.

Renewable	*Non-renewable*

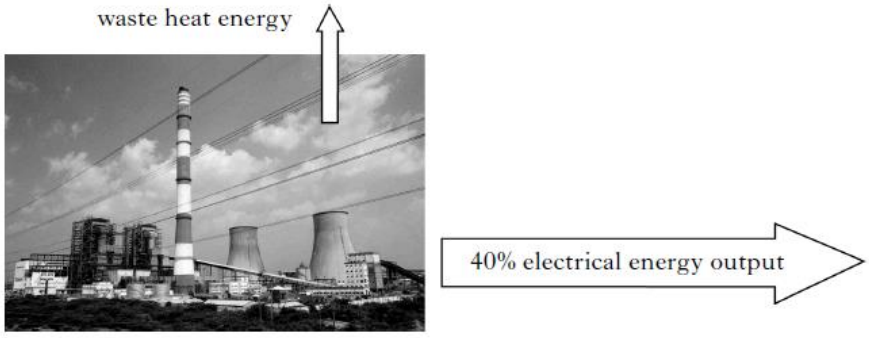
c) From the bar graph above, how many hydroelectric power stations would be required to produce the same power output as a nuclear power station? (approx.!!!)

d) If a bar graph of the same energy sources was drawn 10 years later, comment on what you think would happen to the power readings for:

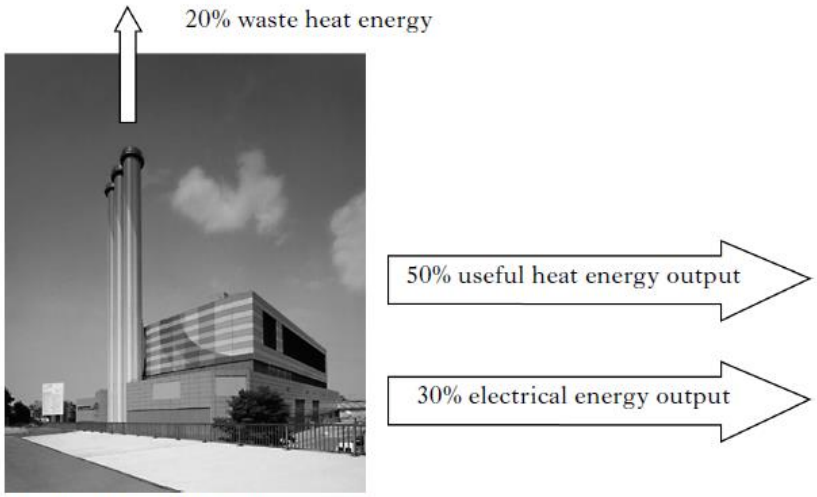
i) Coal

ii) Wind?

10) A thermal power station has an efficiency of **40%**. A combined heat and power station is more efficient; it uses heat to produce hot water for homes as well as generating electrical energy. The energy output for each power station is shown in the diagram below.



Thermal power station



Combined heat and power station

a) i) Calculate the **% of waste heat** for the **thermal power station**.

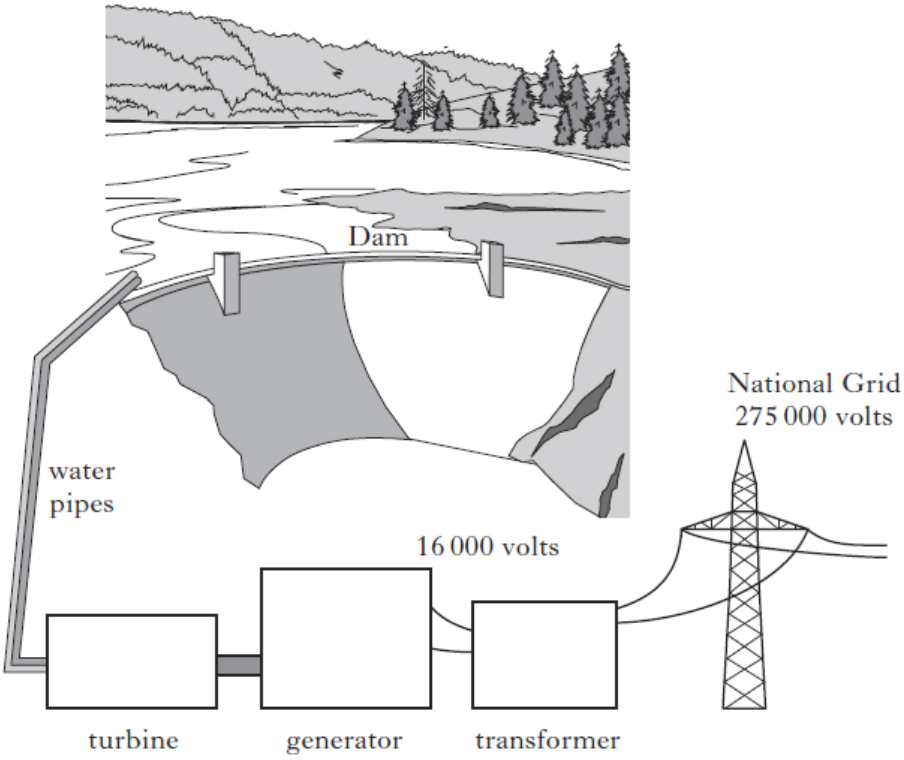
ii) Calculate the **total % useful energy output** of the **combined heat and power station**.

b) A combined heat and power station saves energy in the power industry.

i) Describe **one** method of saving energy in the home.

ii) Describe **one** method of saving energy in the transport.

11) A hydroelectric power station uses water stored in a dam to generate electrical energy. The power station generates electrical energy at 16kV. The electrical energy is then transmitted across the country at 275kV using the National Grid.



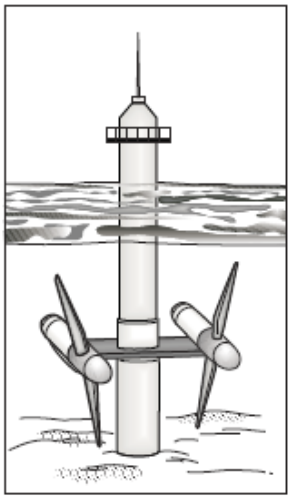
a) State the energy transformation:

i) in the water pipes;

ii) at the generator.

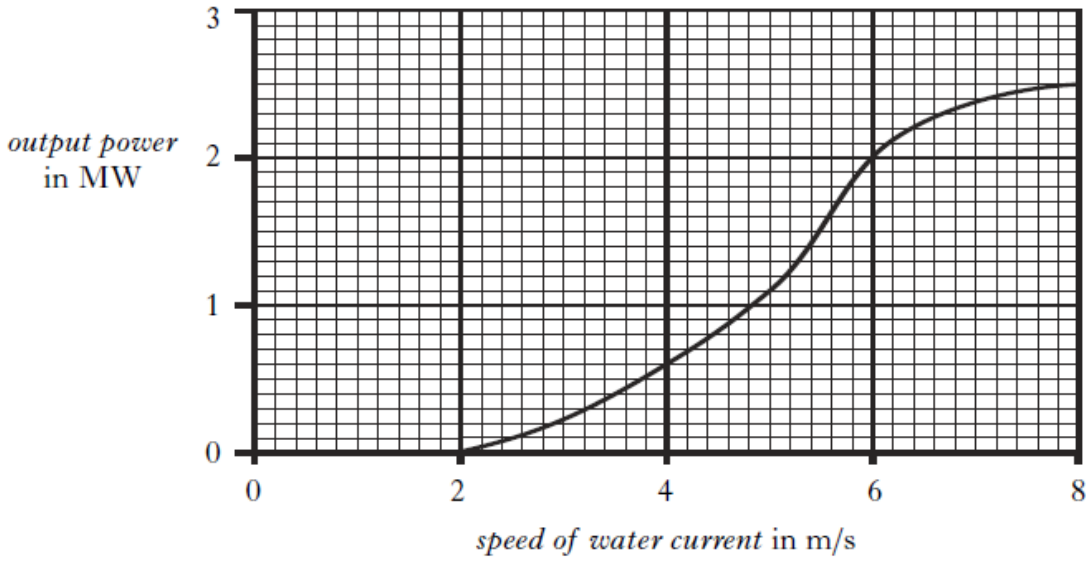
b) Why is the electrical energy transmitted at a very high voltage across the National Grid?

12) An underwater generator is designed to produce electrical energy from water currents in the sea.



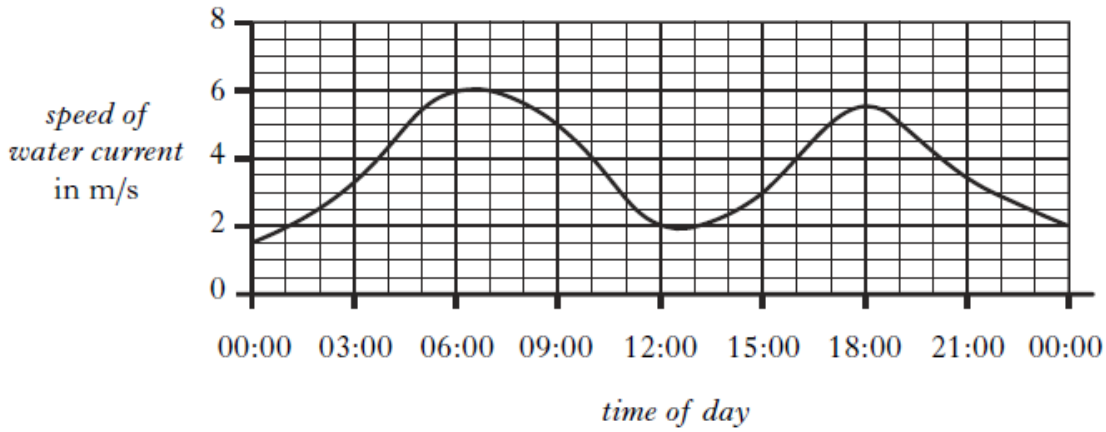
The output power of the generator depends on the speed of the water currents as shown in Graph 1.

Graph 1



The speed of the water current is recorded at different times of the day shown in Graph 2.

Graph 2



a) i) State the output power of the generator at 09:00.

ii) State **one** disadvantage of using this type of generator.

b) The voltage produced by the generator is stepped-up by a transformer.

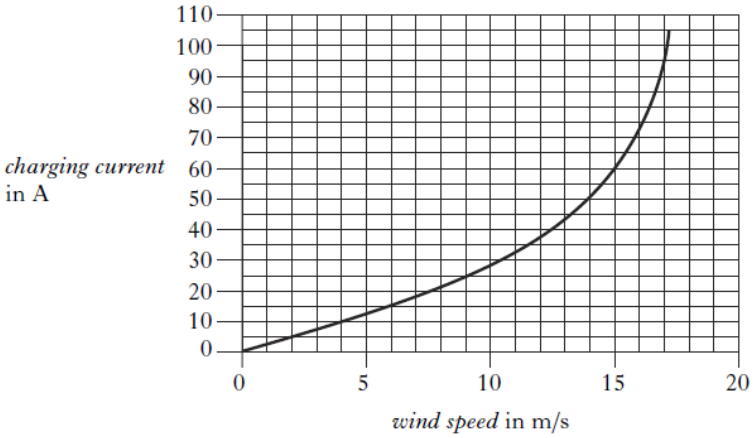
At one point in the day the electrical current at the input of the transformer is 900A and the voltage is 2kV.

i) Calculate the input power to the transformer at this time.

ii) Calculate the output power from the transformer at this time if it is 95% efficient.

13) A wind generator is used to charge a 12V battery. The charging current depends on the wind speed.

The graph shows the charging current at different wind speeds.



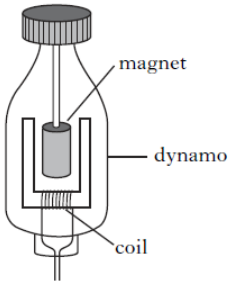
a) During one charge of the battery, the wind speed is constant at $15ms^{-1}$.

During this time of charge of 4500C is transferred to the battery.

Calculate the **time taken** to transfer this charge to the battery.

b) At another wind speed the generator has an output power of 120W and is 30% efficient. Calculate the **input power** to the generator.

c) A bicycle has a small generator called a dynamo. The dynamo contains a magnet that spins near a coil of wire.



When the magnet spins, a voltage is induced in the coil.

State **two** factors that affect the size of the induced voltage.

14) A farm in a remote location has a wind turbine to generate electrical energy.

a) In one year the wind turbine produces 18,250 kilowatt-hours of energy.

Calculate the number of kilowatt-hours produced per day.

b) On average the wind turbine operates for 8 hours per day.

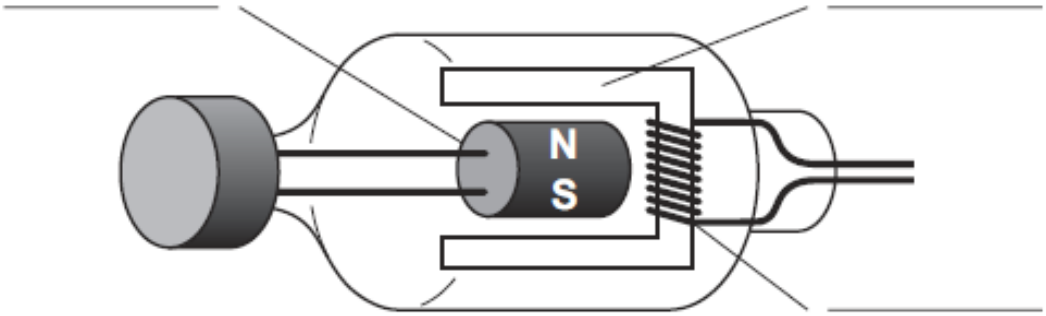
Calculate the average power of the wind turbine.

c) i) The wind turbine uses an ac generator.

A diagram of the ac generator is shown.

Label the diagram using the following words:

Rotor, **Stator Coil** and **Iron Core**.



ii) **Explain** how the ac generator works.

iii) State **two** changes that can be made to the generator to increase the power output.

15) Electrical energy can be generated from different energy sources.

a) Examples of energy sources are:

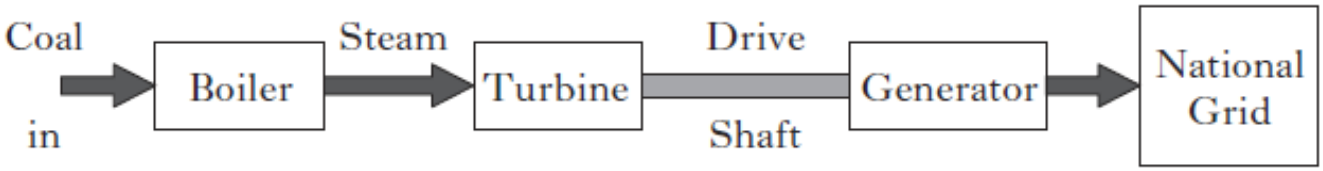
Gas, Wind, Oil, Solar, Wave, Hydro and Coal.

These energy sources can be classified as renewable or non-renewable.

Complete the table below to show which of these examples are renewable and which are non-renewable.

Renewable	*Non-renewable*

b) A coal-fired power station burns coal in order to generate electrical energy. A simplified diagram of a coal-fired power station is shown.



State the energy transformation that takes place in the:

i) Boiler

ii) Turbine

iii) Generator.