GCSE

4781/03

SCIENCE B

UNIT 1: Space, Energy and Life

PRE-RELEASE ARTICLE FOR USE IN THE FOLLOWING EXAMINATIONS ON 14 JANUARY 2016:

GCSE SCIENCE B FOUNDATION TIER (4781/01)
GCSE SCIENCE B HIGHER TIER (4781/02)

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INFORMATION FOR TEACHERS

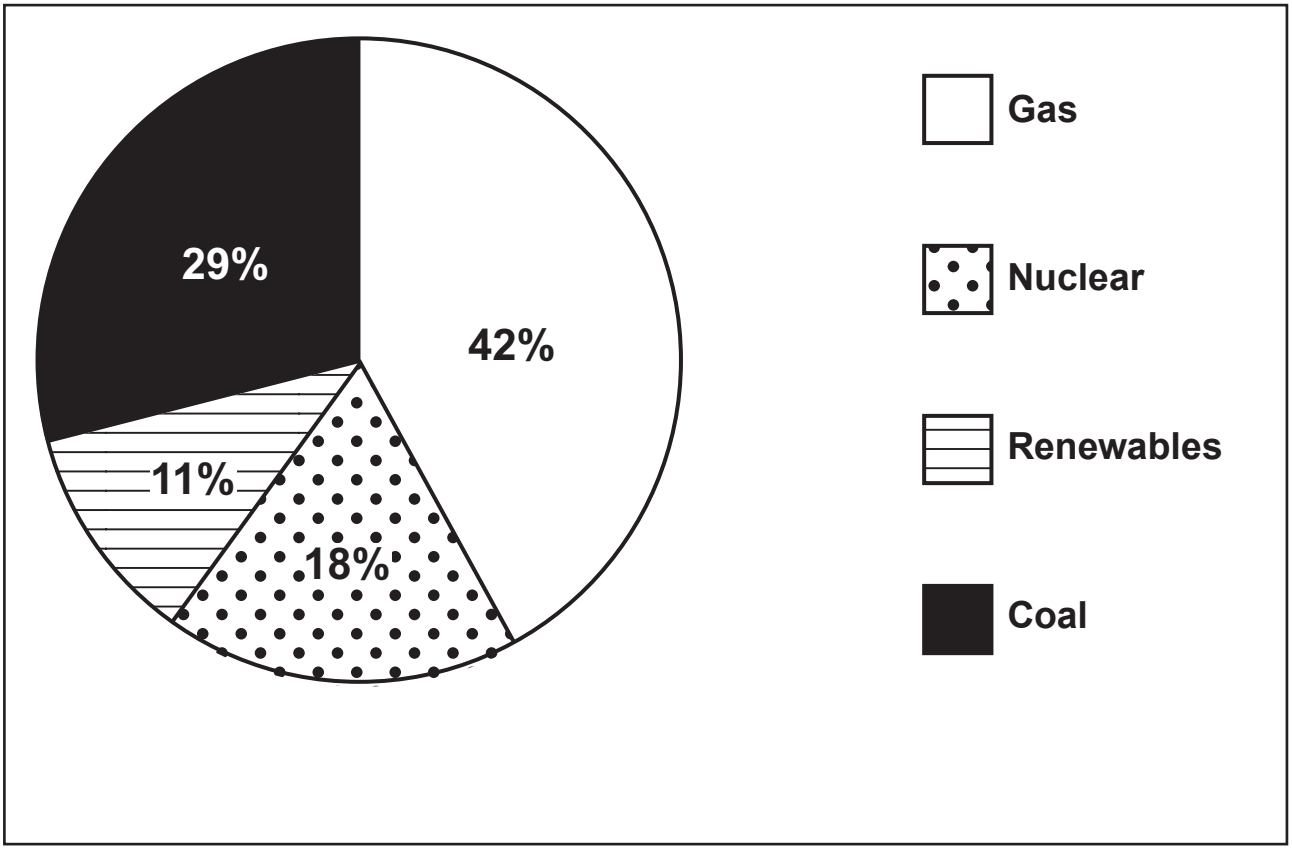
The pre-release sets the scene for the questions in SECTION B of the Foundation Tier and SECTION A of the Higher Tier. Questions will be based around pre-release and related specification content. There will be an emphasis on data handling/analysis in this section. The questions on the pre-release will be common between the two tiers. These questions will be worth 24 marks.

No recall or terminology is required over and above that in the specification.
Students will be expected to have discussed and studied the article together with relevant specification content prior to the examination. However, they will not be expected to memorise any part of it as a copy will be provided in the examination paper.

PRE-RELEASE ARTICLE – ELECTRICITY GENERATION

The energy sources used for electricity generation in 2010 are shown in DIAGRAM 1 below.

DIAGRAM 1



Since 2010, electricity has come increasingly from renewable sources. This will compensate for the phasing out of nuclear energy and help to reduce the number of fossil fuel-fired power plants.

For example, one study recommended that, by 2050, over 90% of the electricity produced in the UK should come from renewable energy sources.

BIOMASS

Sources of biomass are shown in DIAGRAM 2 below.

DIAGRAM 2

FORESTRY CROPS AND RESIDUES

AGRICULTURAL CROPS AND RESIDUES

SEWAGE

INDUSTRIAL RESIDUES

ANIMAL RESIDUES

MUNICIPAL SOLID WASTE

TABLE 1 shows how supply from different renewable technologies in the UK could change between 2010 and 2050.

TABLE 1

	2010	2020	2030	2040	2050
	Electricity generated (GW)				
Hydro	2	2	3	3	3
Biomass	0	1	1	2	2
Wind	2	5	8	12	18
Geothermal	0	1	1	1	1
PV	1	3	4	4	5
Ocean energy	0	1	1	2	2
TOTAL	5	13	18	24	31

1 GW = 1 000 MW
1 MW = 1 000 kW
1 kW = 1 000 W

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Table 2 shows information about some plants that could be used to make pellets. These pellets can be burned instead of fossil fuels to heat water in a biomass generator for the production of electricity.

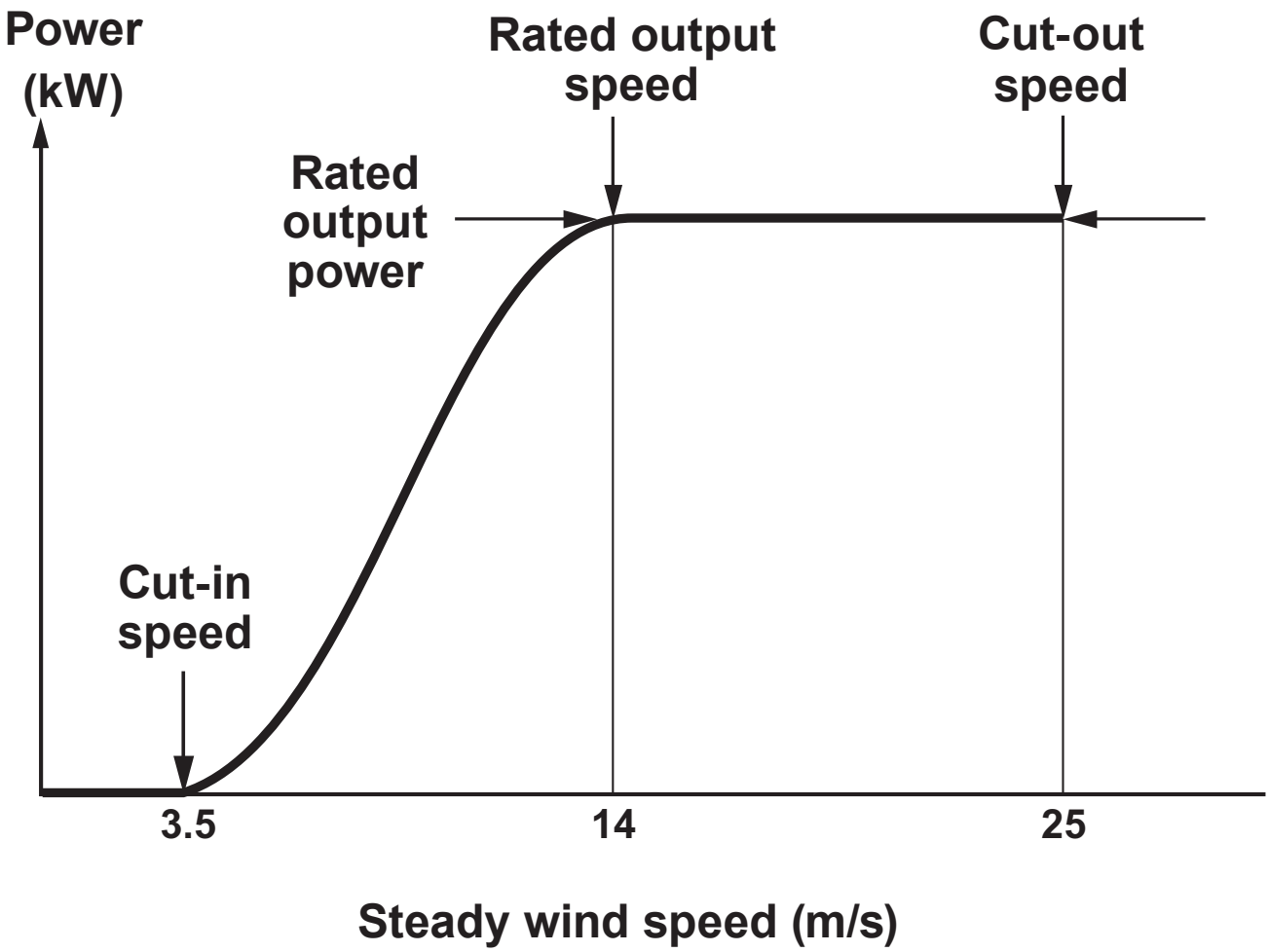
TABLE 2

Crop	Crop yield in a year from each km^2 of land (tonnes)	Energy content (units/tonne)
poplar	8	18
willow	15	20
grass	5	16

WIND

DIAGRAM 3 below illustrates how the power output from a wind turbine varies with steady wind speed.

DIAGRAM 3



CUT-IN SPEED

This is the speed at which the turbine first starts to rotate and generate power. It is typically between 3 and 4 m/s.

RATED OUTPUT POWER AND RATED OUTPUT SPEED

As the wind speed rises above the cut-in speed, the level of electrical output power rises rapidly. However somewhere between 12 and 17 m/s, the output power reaches the maximum limit. This limit is called the RATED OUTPUT POWER and the wind speed at which it is reached is called the RATED OUTPUT SPEED.

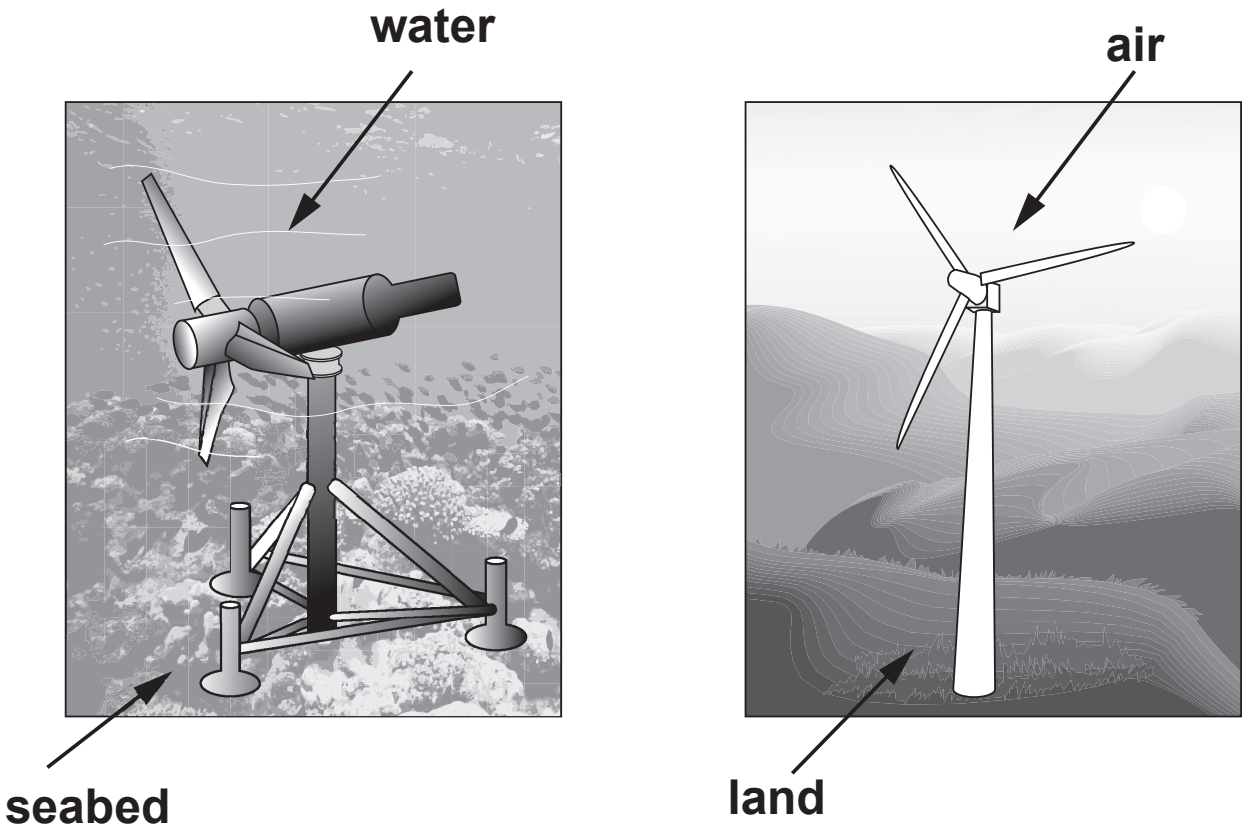
CUT-OUT SPEED

As the speed increases above the rated output wind speed, the forces on the turbine structure continue to rise and, at some point, there is a risk of damage to the rotor. As a result, a braking system is employed to bring the rotor to a standstill. This is called the CUT-OUT SPEED and is usually around 25 m/s.

TURBINES

Electricity can be generated using either tidal water turbines or wind turbines. DIAGRAM 4 shows the typical construction of these two types of turbine.

DIAGRAM 4



tidal water turbine **wind turbine**

Some differences between tidal water turbines on the seabed and wind turbines on land are shown in TABLE 3.

TABLE 3

	Tidal water turbine	Wind turbine
Speed of water or wind (m/s)	5	14
Density of water or air (kg/m^3)	1 000	1
Length of blade (m)	10	35
Area swept out by blade (m^2)	314	3 850
Power output at this speed (MW)	2.9	1.5

COMPARING WIND AND NUCLEAR POWER

TABLE 4 gives information about generating electricity from wind and nuclear power.

TABLE 4

	How they compare	
	A wind turbine	A nuclear power station
Overall cost of generating electricity (p/kWh)	5.6	2.8
Maximum power output (MW)	2	1 800
Lifetime (years)	15	45
Waste produced	None	Radioactive waste
Lifetime carbon footprint (g of CO_2/kWh)	4.64 / 5.25 (onshore/ offshore)	5
Commissioning cost (£ million)	3	4 000

HOW MUCH ELECTRICITY CAN I GENERATE WITH SOLAR PANELS?

The standard solar panel has an input rate of 1 000 watts per square metre. However, at present it only produces 200 W of electricity in good sunlight.

You may work out your expected output from the solar panels on your home as shown in the example below.

Take the number of square meters of solar panel on your property and multiply this by 200; then multiply the answer by the number of sun hours in your area in a day. This will give you your watt hours (Wh) per day.