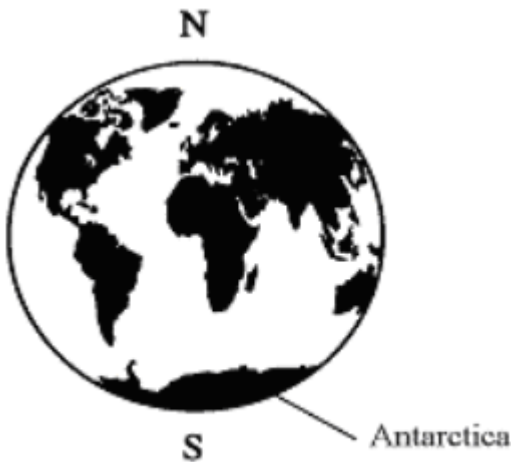
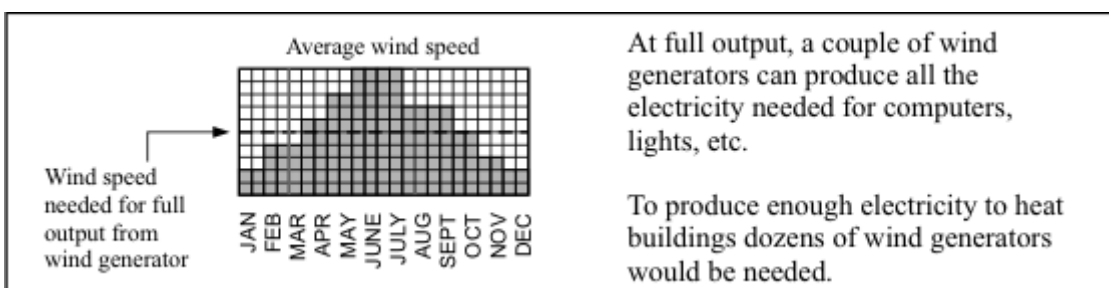
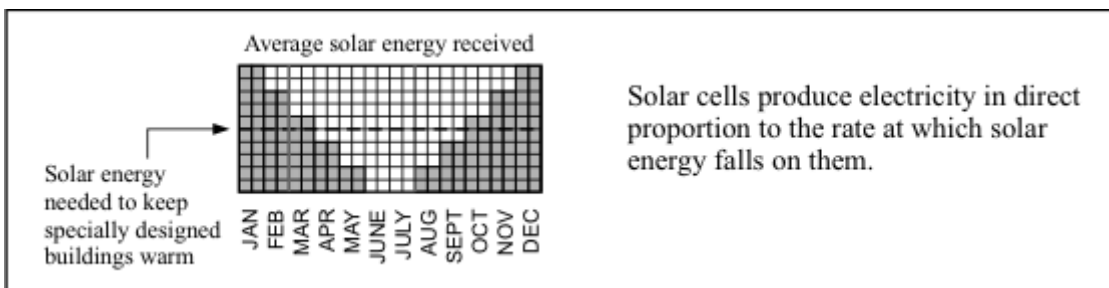


Q1. Antarctica is a huge land mass surrounding the Earth's south pole. It is covered in a very thick layer of ice and is the only remaining large area of the Earth's surface that has not been affected very much by humans.



There are, however, teams of scientists from various countries studying Antarctica. These scientists need electricity for lighting, for their computers and other scientific instruments and to communicate, via satellite, with the rest of the world. The temperature in Antarctica is always sub-zero, so the scientists need some way of keeping their buildings warm. They also need fuel to be able to get around on their snowmobiles.

Scientists cannot avoid affecting the environment. However, they want to affect it as little as possible.



Atmospheric pollution produced in one country eventually affects the whole of the Earth's atmosphere. The hole that appears each year in the ozone layer above Antarctica, for example, is mainly caused by pollutants such as CFCs from countries in the northern half

of the Earth.

Discuss the advantages and disadvantages of using the following energy sources to meet the scientists' needs:

- solar energy
- energy from the wind
- natural gas (present in large quantities deep down in the Antarctic land mass)
- diesel oil (which would have to be imported)

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(Total 10 marks)

Q2. Describe, in as much detail as you can:

- the evidence that the size of the observable Universe is changing;
- the evidence that, billions of years ago, all the matter in the Universe was tightly packed together in the same place.

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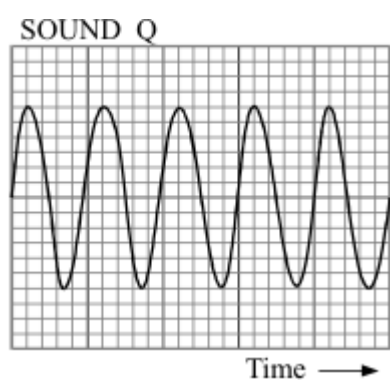
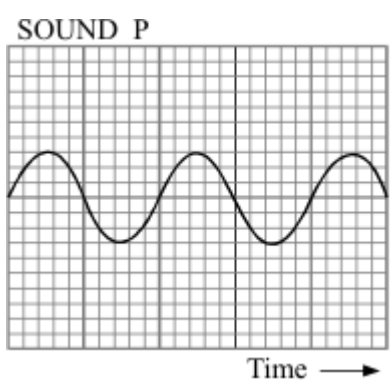
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(Total 5 marks)

Q3. The diagram shows the oscilloscope traces of two different sounds P and Q. The oscilloscope setting is exactly the same in both cases.



P and Q **sound** different.
 Write down **two** differences in the way they sound.
 Explain your answers as fully as you can.

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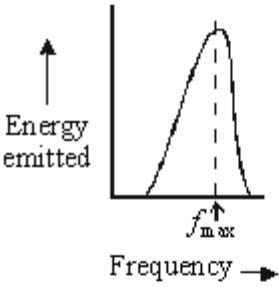
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Q4. Read the following information about cosmic microwave background radiation.

Then use it to answer the questions below.

<p>A Microwave “noise” reaches Earth with almost the same intensity from every direction. It is called cosmic microwave background radiation.</p>	<p>B All bodies with a temperature above zero kelvin (-273°C) emit electromagnetic radiation.</p>	<p>C Measurements made by the COBE satellite showed that there are very slight “ripples” in the cosmic microwave background radiation.</p>
<p>D Bodies which emit radiation do so across a range of frequencies, as shown on the graph.</p>  <p>Energy emitted ↑ Frequency → f_{max}</p>	<p>E Radiation in the microwave region of the electromagnetic spectrum reaches Earth from many stars and galaxies.</p>	<p>F In 1965, the astronomers Penzias and Wilson stopped trying to eliminate “noise” from their microwave detectors and studied it instead.</p>
<p>G The frequency at which a body radiates most energy (f_{max}) is directly proportional to the kelvin temperature.</p>	<p>H Cosmic microwave background radiation has an energy profile matching a temperature of 3 kelvin (-270°C).</p>	<p>I Because of the expansion of the Universe, the temperature of radiation from the time of the big bang will now be only a few kelvin.</p>
<p>J The early universe could not have been completely uniform otherwise galaxies would never have formed.</p>		

(You may find it helpful to begin by deciding which items of information belong to which question.)

- (a) Explain, as fully as you can, why the frequency profile of electromagnetic radiation is an indication of temperature.

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(3)

- (b) Describe, in as much detail as you can, what cosmic microwave background radiation is and how it was discovered.

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(3)

- (c) Explain, as fully as you can, how cosmic microwave background radiation fits in with the idea that the Universe, as it now is, began with a big bang.

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(4)

- (d) Some people think that Penzias and Wilson's discovery of cosmic microwave background radiation was just lucky. Others disagree.

What do you think? Give reasons for your answer.

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(2)
(Total 12 marks)

Q5. Explain, in as much detail as you can, the scientific evidence for the “big bang” theory of the origin of the Universe.

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(Total 5 marks)

Q6. (i) Use the words frequency, wavelength and wave speed to write an equation which shows the relationship between them.

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(1)

(ii) Calculate the speed of a sound wave with a frequency of 250 Hz and a wavelength

of 1.3 m.

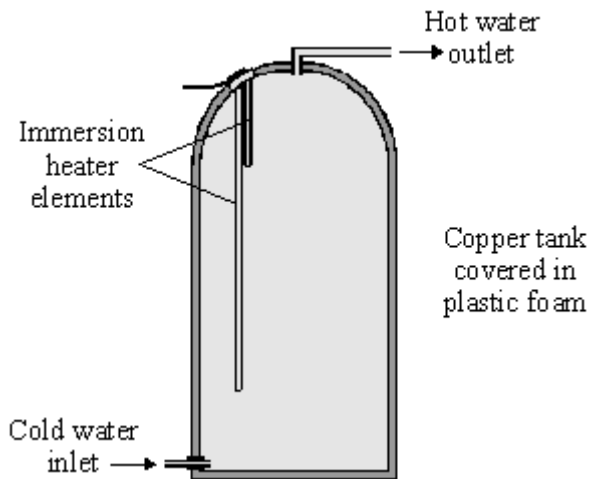
Show how you get to your answer and give the unit.

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.....

Speed =

(2)
(Total 3 marks)

Q7. The diagram shows a type of electric immersion heater in a hot water tank. These hot water tanks are normally found in airing cupboards.



Information on the immersion heater states:

230 V
10 A

- (a) Immersion heaters for hot water tanks often have a switch on them labelled *bath* or *sink*. The *bath* position of the switch has **both** parts of the immersion heater elements in the circuit. The *sink* position has only the short heater element in the circuit.
- (i) Explain why the hot water outlet is at the top of the tank, and the cold water inlet is at the bottom of the tank.

.....

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.....

(2)

(ii) Explain how the *sink* position for the immersion heater is able to save energy.

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.....
.....

(2)

(b) The copper tank is surrounded by plastic foam to minimise energy loss.

Explain why a pale, shiny surface to the foam also helps to minimise energy loss.

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(2)

(Total 6 marks)

Q8. Some students made a small hand-turned a.c. generator, similar to a bicycle dynamo. They connected it to the Y plates of a cathode ray oscilloscope, CRO, and turned the generator slowly. The trace on the CRO looked like this:



They then turned the generator faster and the trace looked like this:



(a) Why did the trace on the CRO show:

(i) an increase in frequency;

.....

(1)

(ii) a decrease in wavelength;

.....

(1)

(iii) an increase in amplitude?

.....

(1)

(b) One way to alter the output from the generator is to change the speed of turning. State **two** other ways to adapt parts of the generator to increase its output.

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(2)

(Total 5 marks)

Q9. What does the Big Bang theory state? In your answer you may include evidence for the theory.

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(Total 4 marks)

- Q10.** (a) The student is using a microphone connected to a cathode ray oscilloscope (CRO).



The CRO displays the sound waves as waves on its screen. What does the microphone do?

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.....

(2)

- (b) The amplitude, the frequency and the wavelength of a sound wave can each be either increased or decreased.

- (i) What change, or changes, would make the sound quieter?

.....

(1)

(ii) What change, or changes, would make the sound higher in pitch?

.....

(1)

(Total 4 marks)

Q11. Astronomers use red shift in two ways.
They calculate the distance to each galaxy from Earth.
They also calculate the speed at which galaxies are moving away from Earth.

The table shows some results. Distance is given in zettametres, Zm. One zettametre is 10^{21} metres.

Galaxy	Distance from Earth to galaxy in Zm	Speed at which galaxy is moving away from us in Zm per billion years	Time the galaxy has been moving away from us in billions of years (Calculated by distance \div speed)
Abell 963	25 000	1950	12.8
Abell 1302	14 000	1100	
Abell 1314	4 100	320	12.8
Abell 1978	18 000	1400	12.9
Abell 2255	10 000	770	13.0

(a) Complete the data for Abell 1302.

(1)

(b) Describe the relationship between the distance to a galaxy and the speed at which the galaxy is moving away from us.

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(1)

- (c) Explain how the data for time provides evidence for the theory that the origin of the Universe was a huge explosion ('big bang').

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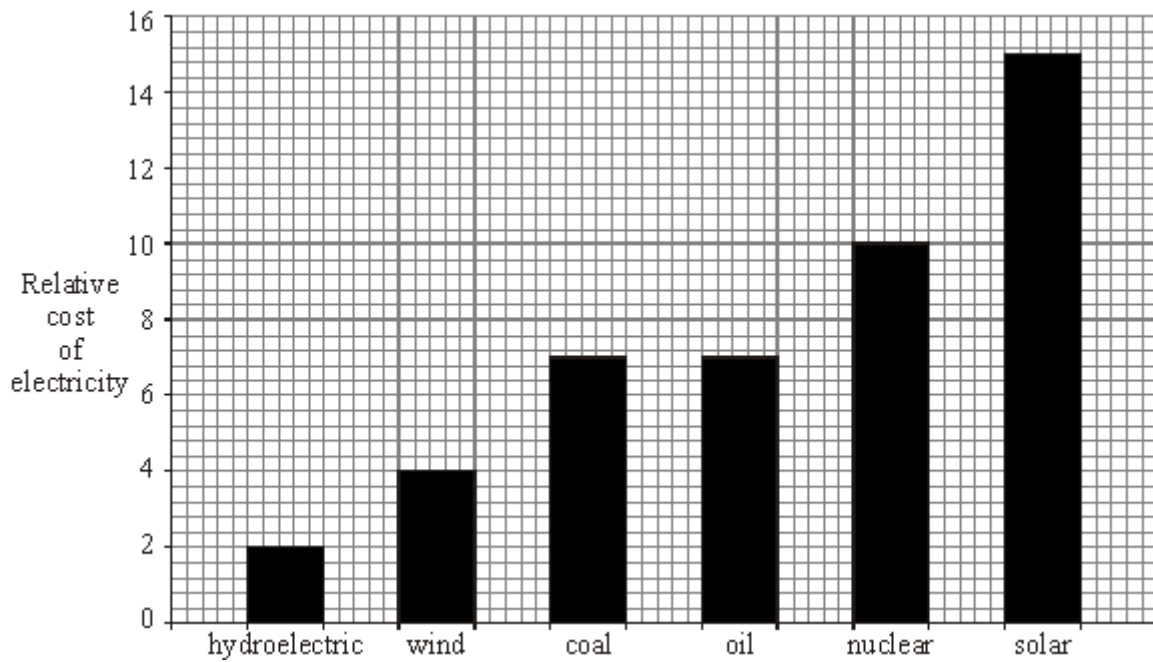
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(2)
(Total 4 marks)

- Q12.** The bar chart shows the relative costs of some different energy sources that are used to generate electricity.



- (a) Apart from cost, give **two** advantages that a hydroelectric power station has compared with a wind farm.

1

.....

2

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..... (2)

- (b) Apart from cost, give **one** advantage and **one** disadvantage that a nuclear power station has compared with a coal-fired power station.

Advantage

.....

.....

Disadvantage

.....

..... (2)

- (c) State and explain **one** situation where it is better to use solar energy, rather than any of the other energy sources, to generate electricity.

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(2)
(Total 6 marks)

Q13. 'Red shift' is one of the pieces of evidence which led scientists to propose the 'big bang' theory.

- (a) Describe the big bang theory.

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(2)

- (b) To gain full marks for this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

Explain how red shift provides evidence for the big bang theory.

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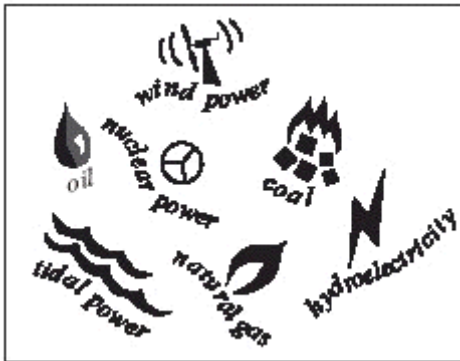
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(3)
(Total 5 marks)

Q14. Different energy sources are shown in the box.



An 'Eco-home' is one which is friendly to the environment. Imagine you are designing an 'Eco-home' which can use any of the energy sources above to generate electricity

- (a) Choose **one** non-renewable energy source from the box above that could provide the electricity supply to your 'Eco-home', but which would be **unsuitable**.

Write the energy source in the table and explain, as fully as you can, why it is **unsuitable** for an 'Eco-home'.

Non-renewable energy source	Unsuitable for an 'Eco-home' because
<p>.....</p> <p>.....</p>	<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>

(2)

- (b) Choose **two** suitable renewable energy sources from the box opposite that could provide an electricity supply to your 'Eco-home'.

Write the two energy sources in the table and describe, in as much detail as you can, the undesirable environmental effects of using these.

Renewable energy source	Undesirable environmental effects
<p>1</p> <p>.....</p> <p>.....</p>	<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>
<p>2</p>	<p>.....</p>

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(4)
(Total 6 marks)

Q15. The table gives information about some methods of conserving energy in a house.

Conservation method	Installation cost in £	Annual saving on energy bills in £
Cavity wall insulation	500	60
Hot water tank jacket	10	15
Loft insulation	110	60
Thermostatic radiator valves	75	20

- (a) Explain which of the methods in the table is the most cost effective way of saving energy over a 10 year period. To obtain full marks you must support your answer with calculations.

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(3)

(b) Describe what happens to the energy which is 'wasted' in a house.

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(2)
(Total 5 marks)

Q16. Use of renewable sources of energy is expected to increase. The table shows the comparative costs of producing 1 kWh of electricity from different energy sources.

Types of energy sources used in the UK	Cost of producing 1 kWh of electrical energy	
Fossil fuels (non-renewable)	Coal p	1.0
	Gas p	1.4
	Oil p	1.5
Nuclear fuels (non-renewable)	Nuclear p	0.9
Renewable	Hydroelectric	0.2 p
	Wind	0.9 p
Installation and decommissioning costs are not included		

At present about 2% of electricity generated in the UK uses renewable energy sources.

Consider the three types of energy sources in the table and give **one** advantage and **one** disadvantage for each (other than installation and decommissioning costs).

Advantage	Disadvantage
Using fossil fuels	Using fossil fuels
Using nuclear fuels	Using nuclear fuels
Using renewable sources	Using renewable sources

(Total 6 marks)

Q17. Studies of light from distant galaxies have provided evidence for the theory that the Universe started from one place and is expanding. Explain how.

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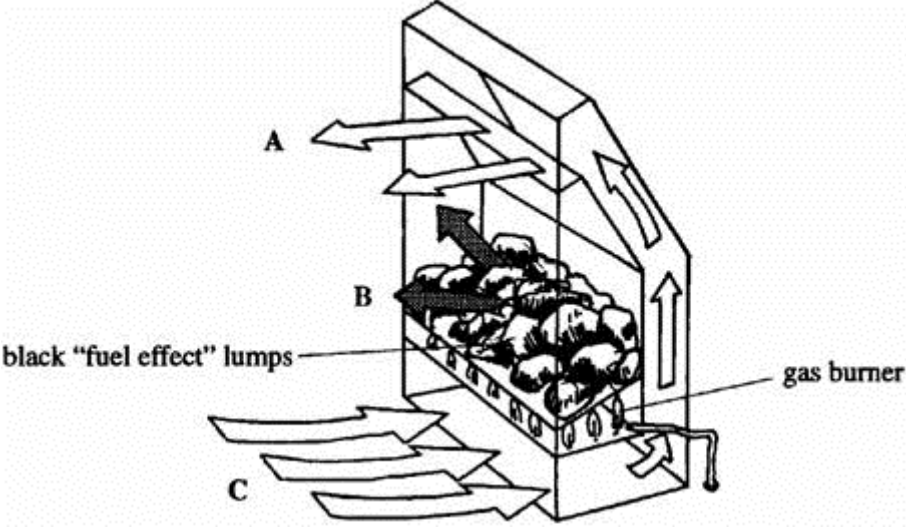
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(Total 3 marks)

Q18. The diagram comes from a leaflet about a “coal effect” gas fire. It shows how air circulates through the fire.



(a) Explain in detail why the air travels from **C** to **A**.

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(4)

(b) The black “fuel effect” lumps become very hot.

(i) Name the process by which the lumps transfer thermal energy to the room as shown at **B**.

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(1)

- (ii) Suggest **one** feature of the black “fuel effect” lumps which make them efficient at transferring energy.

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(1)
(Total 6 marks)

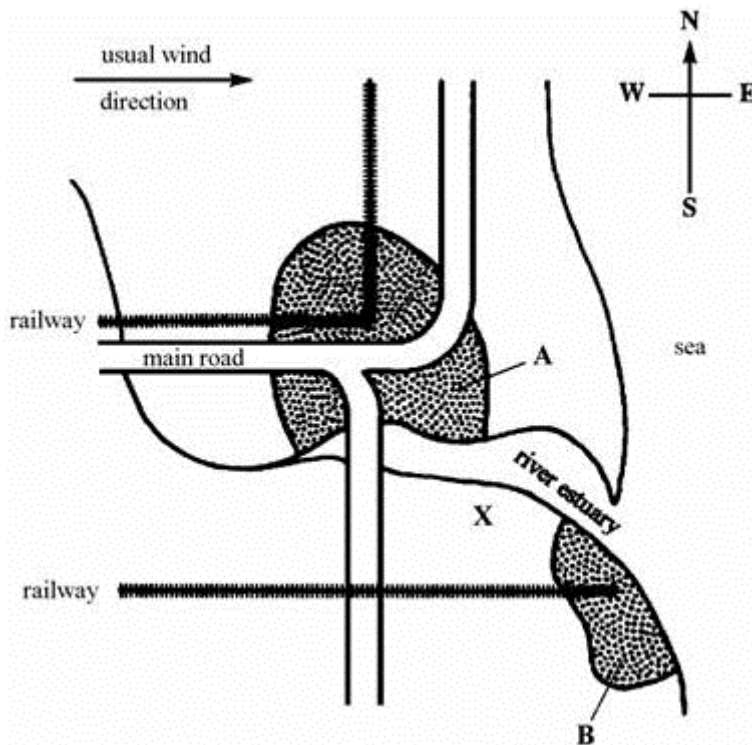
Q19. The map below shows the position of two towns, **A** and **B**, on the banks of a large river estuary.

A is an important fishing and ferry port.

The wind usually blows from the west. The major roads and railways are shown.

A power station is to be built in area X to generate electricity for the region.

The choice is between a nuclear power station and a coal fired power station.



- (a) State the advantages and disadvantages of the two methods of generating

electrical energy.

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(6)

(b) Which method would you choose for this site?

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Explain the reason for your choice.

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(3)

(Total 9 marks)

Q20. Astronomers believe that the Universe is expanding.

(i) How might the Universe have started?

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(1)

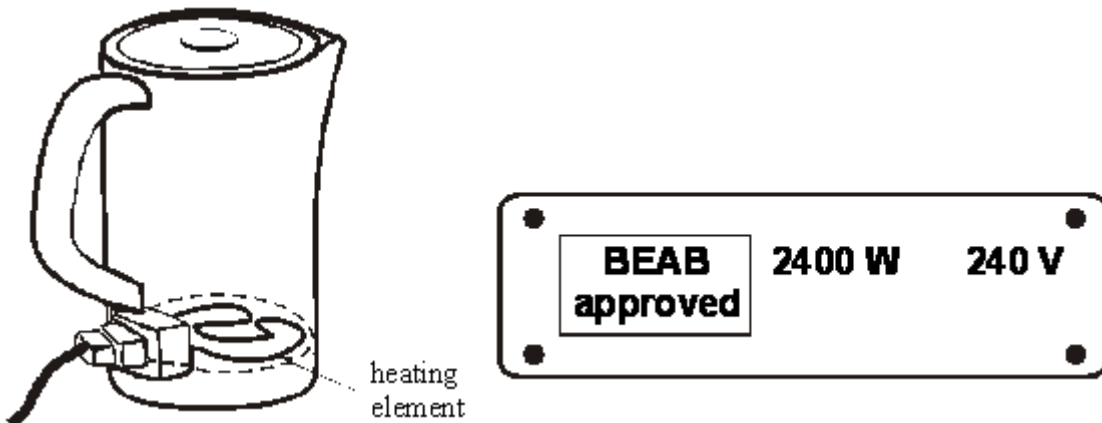
(ii) State and explain briefly, **one** piece of scientific evidence which may be used to support this belief.

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(2)

(Total 3 marks)

Q21. The diagram below shows an electric kettle and the label on the bottom of the kettle.



The water at the bottom of the kettle will heat up first.
This is because the heating element is near the bottom of the kettle.
Convection currents will then cause the rest of the water in the kettle to be heated.

(i) What are convection currents?

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(1)

(ii) Explain how convection currents are produced.
(Your answer should refer to **density** and **temperature**.)

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(4)

(Total 5 marks)

Q22. Radio waves, ultra-violet, visible light and X-rays are all types of electromagnetic radiation.

(a) Choose wavelengths from the list below to complete the table.

$3 \times 10^{-8} \text{ m}$ $1 \times 10^{-11} \text{ m}$ $5 \times 10^{-7} \text{ m}$ 1500 m

TYPE OF RADIATION	WAVELENGTH (m)
Radio waves	
Ultra-violet	
Visible light	
X-rays	

(4)

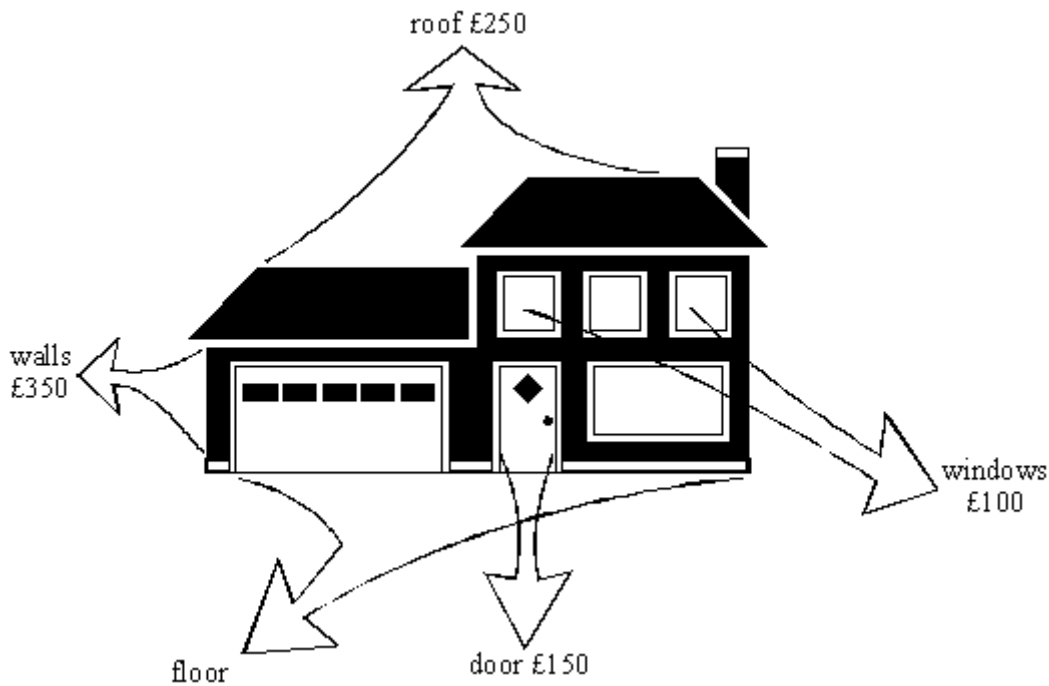
(b) Microwaves are another type of electromagnetic radiation.

Calculate the frequency of microwaves of wavelength 3 cm.
(The velocity of electromagnetic waves is 3×10^8 m/s.)

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(4)
(Total 8 marks)

Q23. The diagram below shows a house which has **not** been insulated. The cost of the energy lost from different parts of the house during one year is shown on the diagram.



- (a) The total cost of the energy lost during one year is £1000.
(i) What is the cost of the energy lost through the floor?

.....

(2)

(ii) Suggest one way of reducing this loss.

.....

(1)

(b) The table below shows how some parts of the house may be insulated to reduce energy losses. The cost of each method of insulation is also given.

WHERE LOST	COST OF ENERGY LOST PER YEAR (£)	METHOD OF INSULATION	COST OF INSULATION (£)
roof	250	fibre-glass in loft	300
walls	350	foam filled cavity	800
windows	100	double glazing	4500
doors	150	draught proofing	5

(i) Which method of insulation would you install first? Explain why.

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(3)

(ii) Which method of insulation would you install last? Explain why.

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(3)

(Total 9 marks)

Q24. Explain how observations at the red end of the spectrum of light from galaxies have led to one theory about the origin of the Universe.

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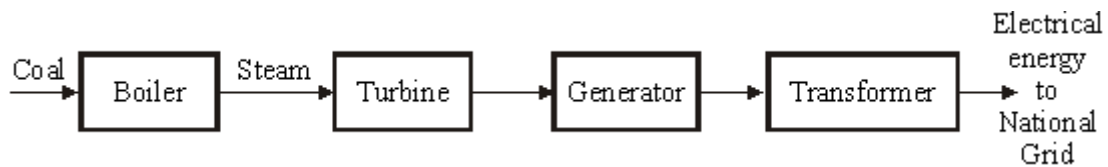
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(Total 6 marks)

Q25. The diagram below shows four stages in the production of electricity by a coal-fired power station.



(a) (i) Write down **two** environmental problems which are caused by burning coal to generate electricity.

1

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(ii) How may these environmental problems be reduced?

1

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(4)

(b) Some data for Didcot coal-fired power station is given below.

Number of generators	4
Maximum continuous power rating of a generator	500 MW at 23 500 V
Energy content of coal used	2.66×10^{10} J per tonne
Total quantity of coal used each day	18 289 tonnes

Use the given data to calculate:

(i) the total electrical energy output each day.

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AnswerJ/day

(ii) the total input of coal energy each day.

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.....
.....
AnswerJ/day

(iii) the efficiency of the power station.

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.....
Answer %

(8)

(c) Energy is conserved.

(i) Choose **one** of the stages in the diagram at the start of the question.
State what happens to the wasted energy during this stage.

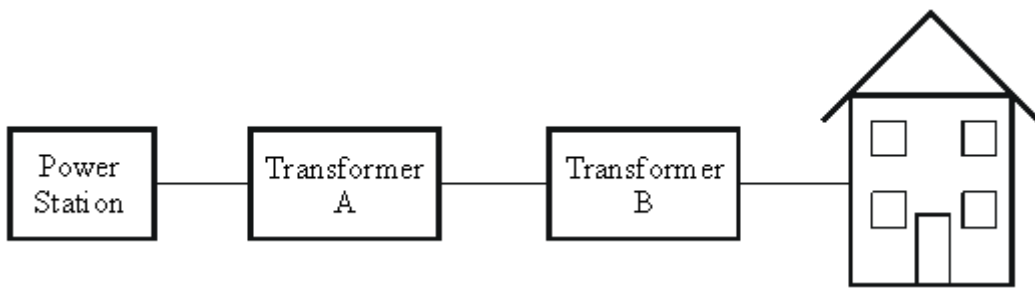
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(ii) Explain what happens to all wasted energy during energy transfers.

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(3)

(Total 15 marks)



Transformer A produces a very high voltage to transmit the electrical energy through the National Grid.

Explain why electrical energy is transmitted at a very high voltage.

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(Total 3 marks)

Q27. Describe, in as much detail as you can, how the energy stored in coal is transferred into electrical energy in a power station.

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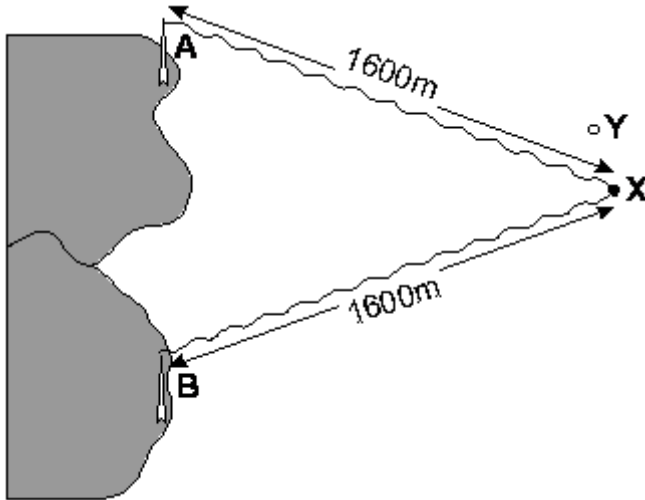
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(Total 5 marks)

Q28. In the diagram below A and B are two radio navigation beacons. They both transmit at 1.5 MHz. The waves from both A and B have the same amplitude and they are in phase with each other. A ship is at point X, 1600 m away from each beacon.



- (i) Calculate the wavelength of the radio waves.
(The speed of radio waves is 3×10^8 m/s.)

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(3)

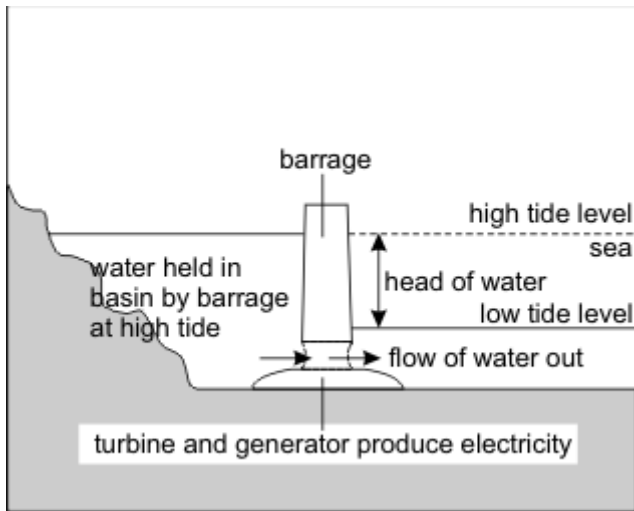
- (ii) Calculate the number of wavelengths which is equal to the distance between A and X.

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(1)

(Total 4 marks)

Q29. The outline diagram below shows a tidal power generating system.



Gates in the barrage are open when the tide is coming in and the basin is filling to the high tide level. The gates are then closed as the tide begins to fall.

Once the tide outside the barrage has dropped the water can flow through large turbines in the barrage which drive generators to produce electrical energy.

In one second 1.2×10^9 kg of water flows through the turbines at a speed of 20 m/s.

- (a) When used with a water speed of 20 m/s the system has an efficiency of 90% in converting the kinetic energy of the water into electrical energy. Calculate the power output of the generators.

.....

(2)

- (b) The power output of a coal fired power station is 1000 MW (1×10^9 W).

- (i) Suggest **two** advantages of coal fired power stations over tidal power generating systems.

1.

 2.

(ii) Suggest **two** advantages of tidal power generating systems over coal fired power stations.

1.

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2.

.....

(iii) Suggest and explain **one** disadvantage of a tidal power generating system.

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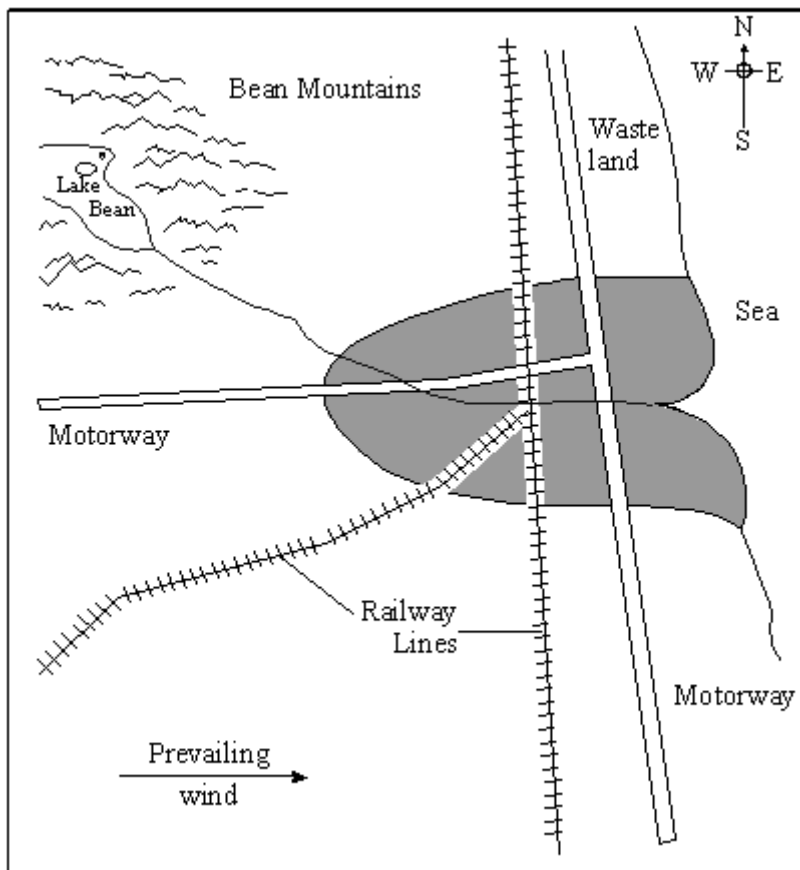
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(6)
(Total 8 marks)

Q30. The map below shows an industrial region (shaded).



The prevailing wind is from the west. There is a nearby mountainous area, from which a river flows through the region. The major road and rail links are shown.

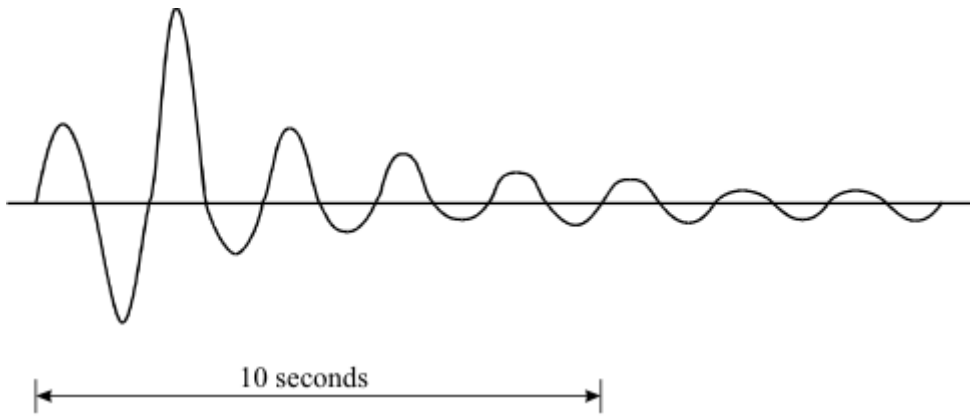
A power station is to be built to supply electrical energy to the region. The energy will be for a range of domestic and industrial uses.

The choice is between a coal fired power station, wind turbines and a hydroelectric scheme.

Three local groups each support a different option. Choose which option you would support and justify your choice by making reference to the financial, social and environmental implications of your choice compared with those of the alternative systems.

(Total 8 marks)

- Q31.** The vibration caused by a P wave travelling at 7.6 km/s has been recorded on a seismic chart.



(i) How many waves are produced in one second?

..... (1)

(ii) Write down the equation which links frequency, wavelength and wave speed.

..... (1)

(iii) Calculate the wavelength of the P wave. Show clearly how you work out your answer and give the unit.

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Wavelength =

(2)
 (Total 4 marks)

Q32. The Big Bang theory attempts to explain the origin of the Universe.

(i) What is the Universe?

.....
..... (1)

(i) What are the main ideas of the Big Bang theory?

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..... (2)

(iii) What is thought to be happening to the size of the Universe?

..... (1)
(Total 4 marks)

Q33. Microwaves are used to transmit signals to the satellite. The microwaves have a wavelength of 0.6 metres (m) and travel through space at a speed of 300 000 000 metres per second (m/s).

(i) Write down the equation which links frequency, wavelength and wave speed.

..... (1)

(ii) Calculate the frequency of the microwaves. Show clearly how you work out your answer and give the unit.

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.....

Frequency =

(3)
(Total 4 marks)

Q34. The Big Bang theory attempts to explain the origin of the Universe.

(i) What is the Big Bang theory?

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(1)

(ii) What can be predicted from the Big Bang theory about the size of the Universe?

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(1)

(Total 2 marks)

Q35. The Big Bang theory attempts to explain the origin of the Universe.

(i) What is the Big Bang theory?

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(1)

(ii) What can be predicted from the Big Bang theory about the size of the Universe?

.....

(1)

(Total 2 marks)

