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1

Answer **all** the questions.

1 Use the article on '**Should We Build New Nuclear Reactors?**' to help you answer this question.

(a) Write down **two** uses of radioactive materials.

1 .....

2 .....[2]

(b) Write down the **two** most common sources of exposure to radiation.

1 .....

2 .....[2]

(c) Describe what is meant by 'background radiation'.
Give one example of a source of background radiation.

meaning .....

.....

example .....[2]

(d) Write a short letter to the government giving your views on building new nuclear power stations.
Your answer should include

- your view
- **two** reasons for your view, other than cost.

One mark will be for a clear and ordered answer.

Dear Sir,

.....

.....

.....

.....

.....

.....

.....

.....

[3+1]

(e) (i) The article says 'ionising radiation produced is harmful to living cells'.
Explain how ionising radiation harms living cells.

.....

.....

.....[2]

(ii) Cancer cells can be killed using ionising radiation from radioactive materials.
Suggest some benefits and risks a patient suffering from cancer should consider when deciding whether to have radiation treatment or not.

.....

.....

.....

.....[3]

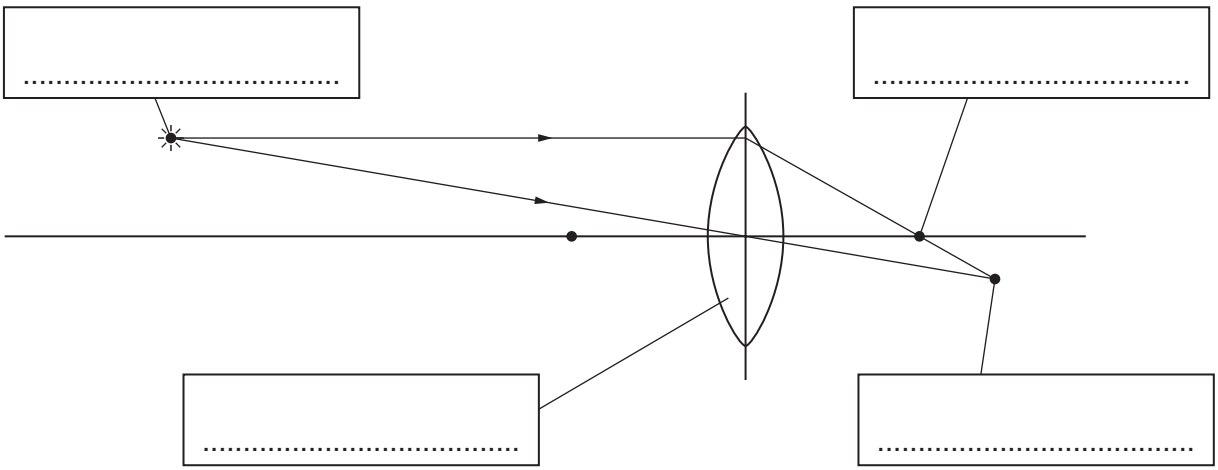
[Total: 15]

2 Billy is planning to make a telescope to look at distant stars.

He has some lenses made of glass.

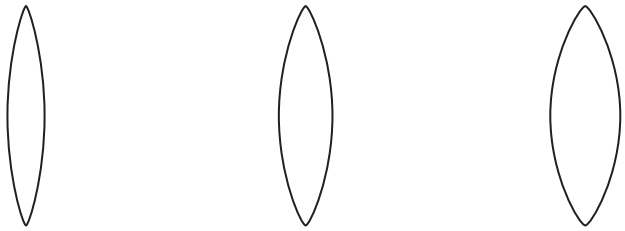
(a) He draws a diagram to show how a lens can produce an image from an object.

He forgets to label the diagram with the **lens**, **object**, **image** and **focus**.
Complete the diagram by adding the missing labels.



[3]

(b) Three of Billy's lenses are made from the same glass.



A **B** **C**

(i) Which lens **A**, **B** or **C** is the most powerful?
Explain your answer.

most powerful lens .....

reason .....

.....[2]

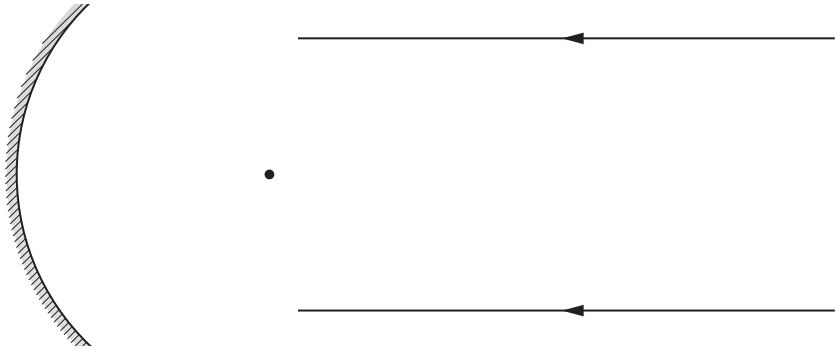
(ii) He decides to use lenses **A** and **C** for his telescope.
Which lens should he use for the eyepiece?
Explain why.

lens .....

reason .....[1]

(c) Sally says that most astronomical telescopes use concave mirrors.

(i) A concave mirror brings parallel light rays to a focus.
Complete the light rays on the diagram to show this.



[2]

(ii) Mirrors are used because it is easier to make very large mirrors than very large lenses.
Why is it important to have **large** lenses or mirrors in a telescope?

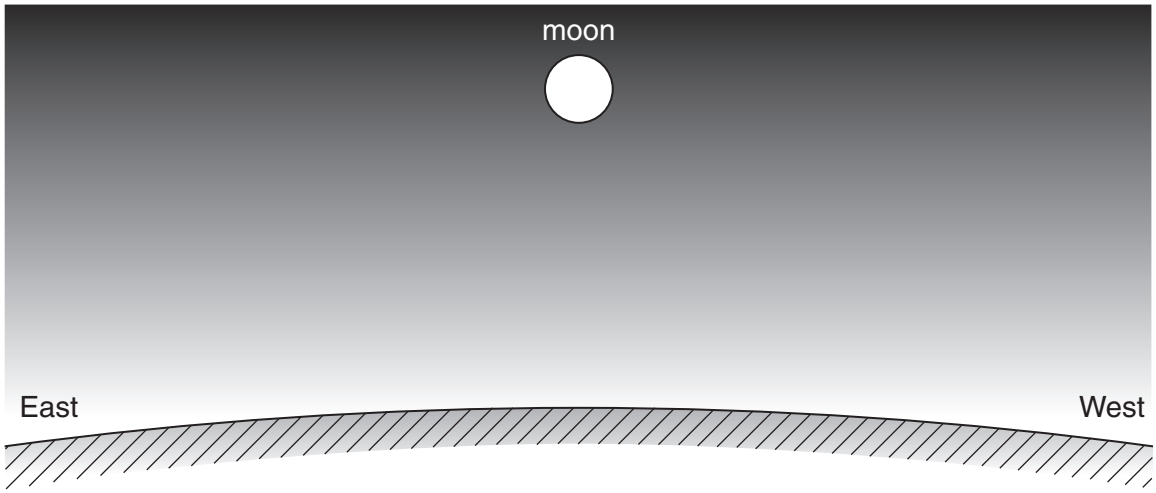
.....

.....[2]

[Total: 10]

3 **(a)** Sarah is making observations of the Moon.

(i) She records her observations during one night as the Moon moves across the sky.
The diagram shows the Moon in the middle of the night.



Draw a line to show the path of the Moon across the sky.
Include an arrow to show the direction it is moving along your line. [2]

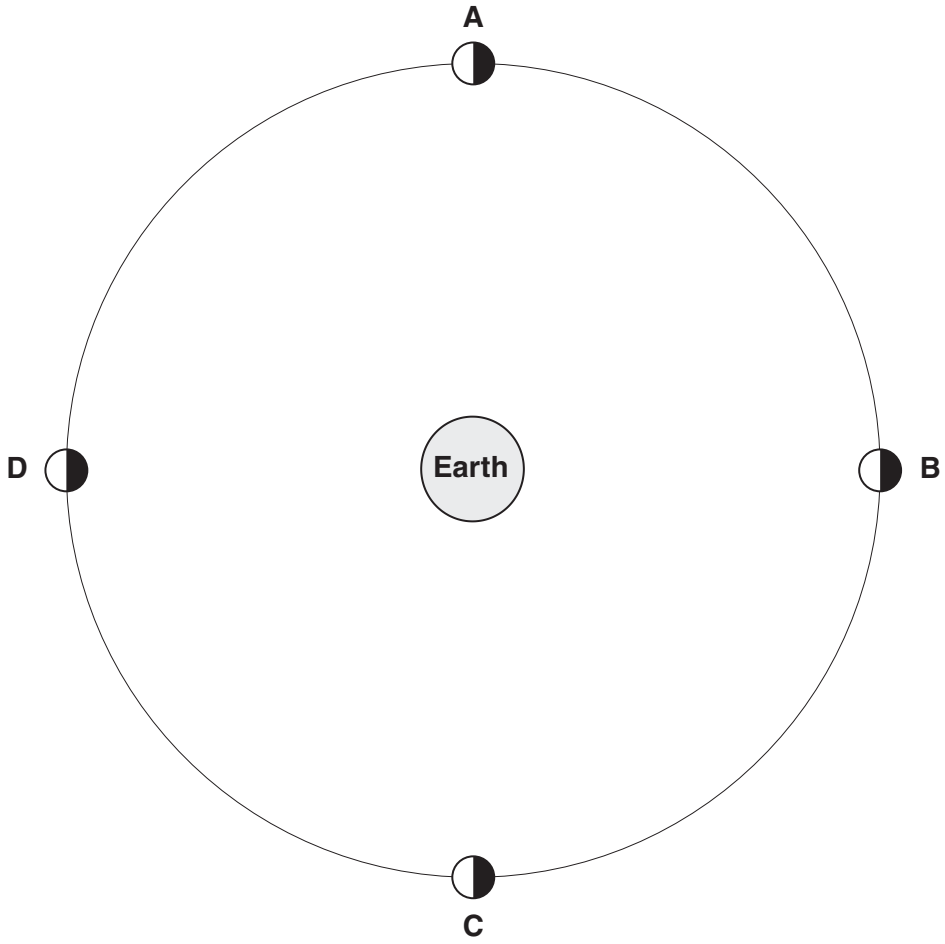
(ii) Explain why the Moon appears to move like this.

.....[1]

(iii) The Sun takes 24 hours to move once around the sky.
How long does it take for the Moon to go once around the sky?
Put a (ring) around the correct answer.

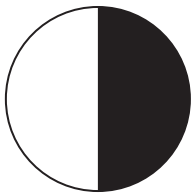
less than 24hrs **24hrs** **more than 24hrs** [1]

(b) Sarah has a diagram that shows the light and dark sides of the Moon as it orbits the Earth.



(i) Draw an arrow on Sarah's diagram to show a ray of light coming from the Sun. [1]

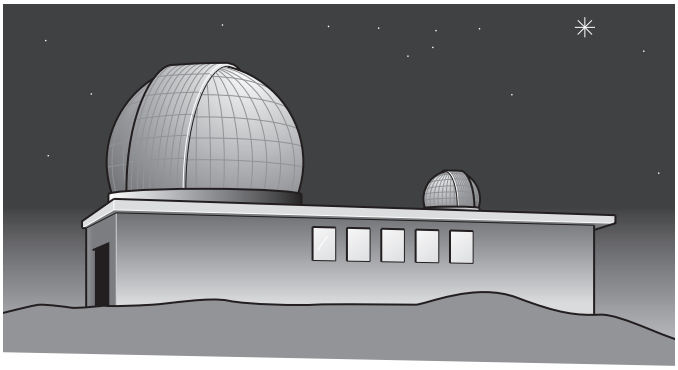
(ii) During a month Sarah sees the different phases of the Moon.
She draws these phases at each position **A**, **B**, **C**, and **D**.
Complete Sarah's table of observations.
One has been done for you.

position	phase of Moon
A	
B	
C	
D	

[4]

[Total: 9]

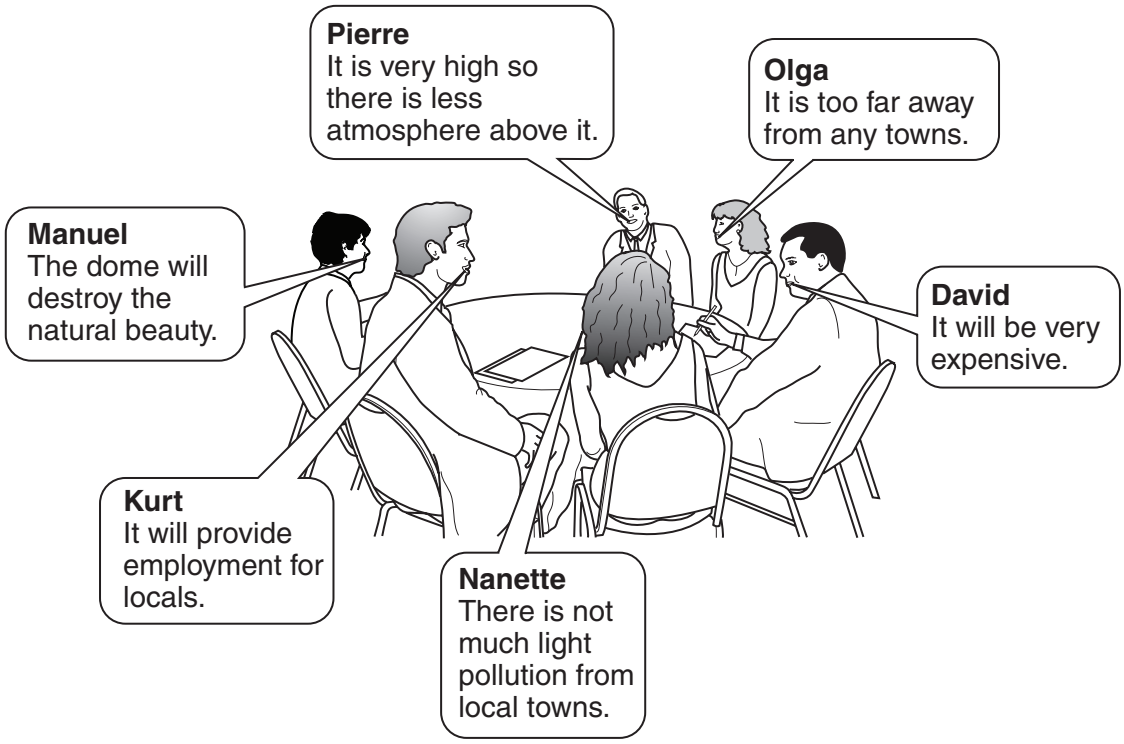
4 A group of countries are planning to build a new astronomical observatory.



(a) Write down the geographical location of a major astronomical observatory on Earth.

.....[1]

(b) At a meeting to decide where to build the new observatory several factors were discussed.



(i) Write down the names of **two** people who are talking about astronomical factors.

..... and .....[2]

(ii) Who is giving an economic argument **in favour** of building the observatory?

.....[1]

(c) One group of astronomers want the new telescope to be in space.

Give **one** advantage and **one** disadvantage of using a telescope in space.

advantage .....

.....

disadvantage .....

.....[2]

(d) Write down **one** advantage of a group of countries working together for a 'big science' project like this.

.....

.....[1]

[Total: 7]

5 The photograph shows stars forming in a gas cloud.

When a cloud of gas is compressed a protostar forms.

(a) What causes the gas cloud to compress?

.....[1]

(b) As the gas cloud compresses the temperature of the gas increases.

(i) As the temperature increases, the pressure in the gas cloud changes.
Explain how the pressure changes.
Your answer should include
- what happens to the pressure
- how the behaviour of the particles of the gas changes.

.....

.....

.....[2]

(ii) Initially the temperature of the cloud is about 3 K.
What temperature is 3 K in °C?

..... °C [1]

(c) As the temperature inside the protostar increases all the electrons are removed from the atoms. This leaves positively charged nuclei.

(i) The nucleus of an atom can contain two types of particle.
Complete the table to show the names of the particles.

name of particle	charge on particle
	positive
	none

[1]

(ii) There is a strong attractive force which holds the particles together.
Another force pushes some of the particles in the nucleus apart.
What is this force?

.....[1]

(d) When the temperature is high enough, nuclei can fuse together to form new elements. This releases energy.

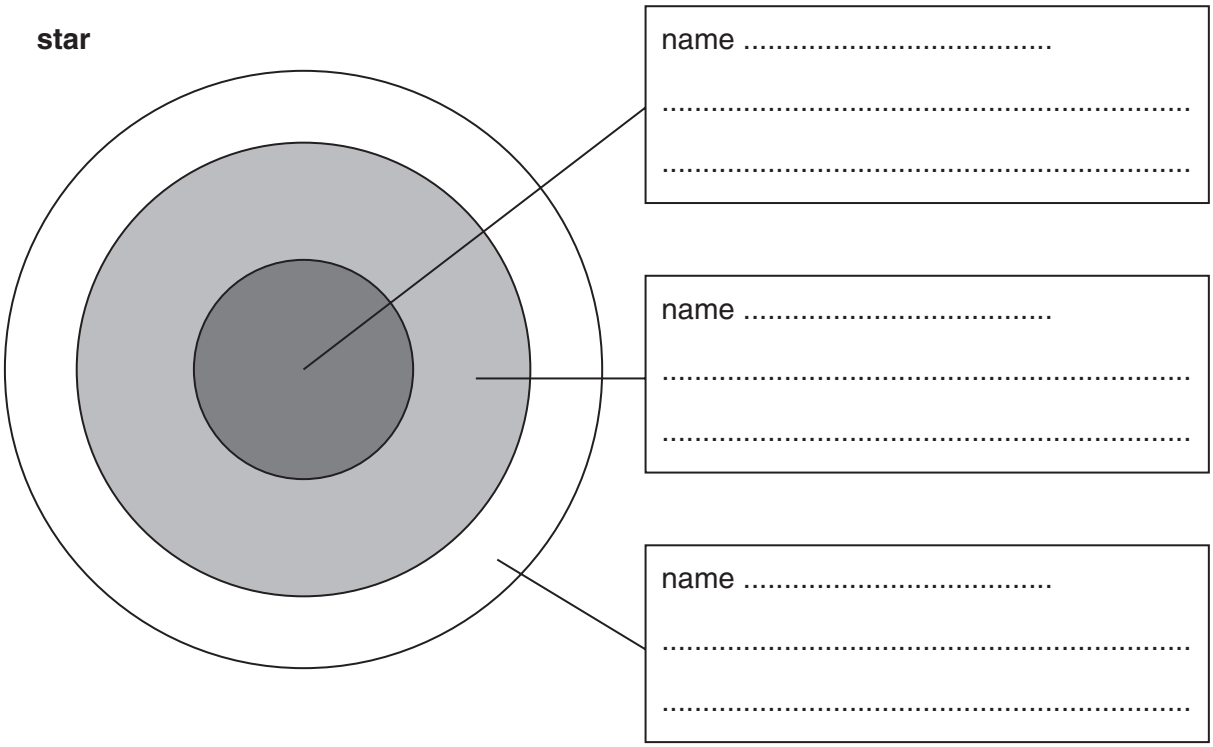
(i) Complete the equation for this fusion reaction with the names of the elements.

4 ..... → ..... + energy

[2]

(ii) The energy produced by the nuclear fusion is radiated into space.

The diagram shows the different regions inside a **star**.
Label each region with its name and say what is happening to the energy in that region.



[6]

[Total: 14]

END OF QUESTION PAPER

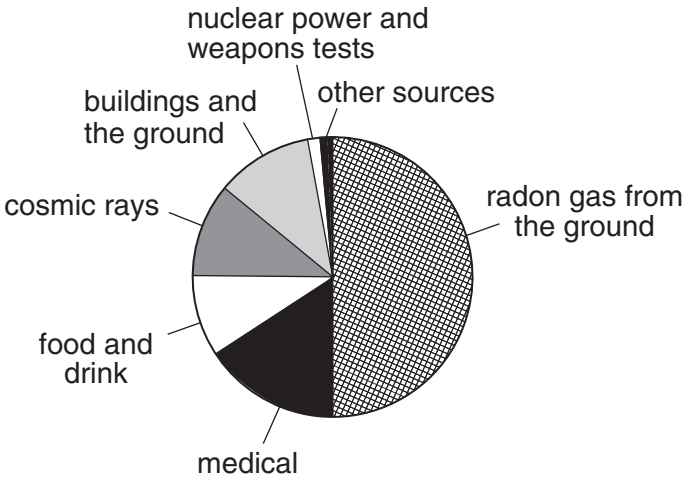
Should We Build New Nuclear Reactors?

The government is considering the future of nuclear power in the UK.
The UK relies on nuclear power for 20% of its electricity, but by 2023 only one of the existing power stations will still be working and will only supply about 7%.
No new reactors have been built since the 1980s because there have been problems with accidents, high decommissioning costs and the problem of nuclear waste. These problems have reduced political and public enthusiasm. But, with soaring oil and gas prices, dwindling domestic fossil fuel reserves and pressure to tackle climate change, many argue that a new generation of reactors has to be considered.

As well as producing electricity, nuclear reactors also produce radioactive materials. These are used in medicine to treat cancer, track chemicals in the body and sterilise surgical instruments. Radioactive materials are also used to sterilise food and are used in smoke detectors.

The main risk from nuclear power is exposure to radioactivity. The ionising radiation produced is harmful to living cells. This can be a hazard to health, and exposure to too much radiation is very dangerous. However, we are all exposed to 'background radiation' all the time.

Sources of exposure to radiation



Answer **all** the questions.

1 Use the article on '**Should We Build New Nuclear Reactors?**' to help you answer this question.

(a) (i) The article says 'ionising radiation produced is harmful to living cells'.
Explain how ionising radiation harms living cells.

.....

.....

.....[2]

(ii) Cancer cells can be killed using ionising radiation from radioactive materials.
Suggest some benefits and risks a patient suffering from cancer should consider when deciding whether to have radiation treatment or not.

.....

.....

.....

.....[3]

(b) In a nuclear reactor the fission of a uranium nucleus can give rise to a chain reaction.
Explain what is meant by a chain reaction.
You may use diagrams to help.

.....

.....

.....[3]

(c) The article mentions some new safety features of modern reactor designs.
Explain how **one** of these features reduces the risk associated with a nuclear reactor.

.....

.....

.....[1]

(d) The two types of uranium isotopes U-235 and U-238 have similarities and differences in the particles that make up their nuclei.
Describe a similarity and a difference between the two nuclei.

.....

.....

.....

.....[2]

(e) Uranium 238 has a half life of 4.5 billion years.
How long would it take for a sample of U-238 to lose 7/8 of its radioactivity?
Show your working.

answer ..... years [2]

[Total: 13]

2 The photograph shows stars forming in a gas cloud.

When a cloud of gas is compressed a protostar forms.

(a) What causes the gas cloud to compress?

.....[1]

(b) As the gas cloud compresses the temperature of the gas increases.

(i) As the temperature increases, the pressure in the gas cloud changes.
Explain how the pressure changes.
Your answer should include
- what happens to the pressure
- how the behaviour of the particles of the gas changes.

.....

.....

.....[2]

(ii) Initially the temperature of the cloud is about 3 K.
What temperature is 3 K in °C?

..... °C [1]

[Turn over

(c) As the temperature inside the protostar increases all the electrons are removed from the atoms. This leaves positively charged nuclei.

(i) The nucleus of an atom can contain two types of particle.
Complete the table to show the names of the particles.

name of particle	charge on particle
	positive
	none

[1]

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Another force pushes some of the particles in the nucleus apart.
What is this force?

.....[1]

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[2]

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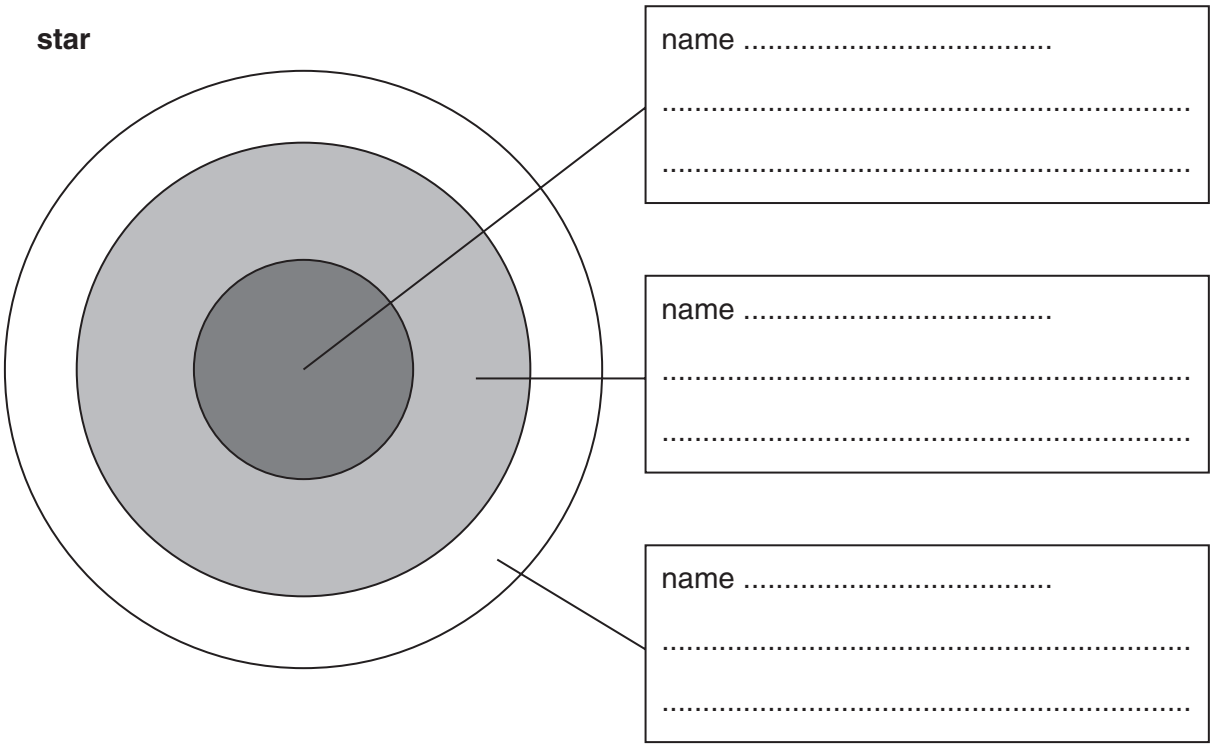
The diagram shows the different regions inside a **star**.
Label each region with its name and say what is happening to the energy in that region.



[6]

[Total: 14]

[Turn over

3 **(a)** Sarah measures how long it takes the Sun and Moon to move across the sky.
The Sun takes 24 hours to move once around the sky.
The Moon takes **longer** than 24 hours.

(i) How much **longer** does the Moon take to move once around the sky?

.....[1]

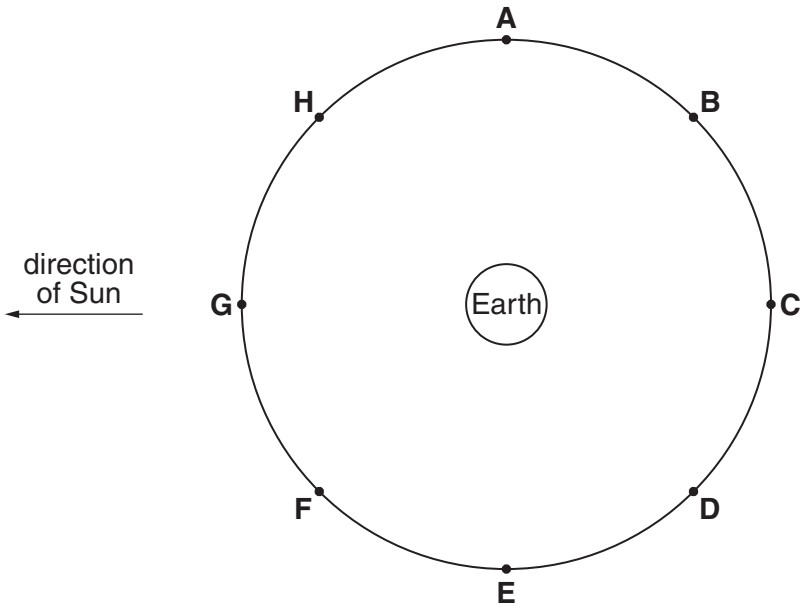
(ii) Explain why the Moon takes longer to move across the sky.

.....

.....

.....[2]

(b) The Moon orbits the Earth.
During an orbit it shows different phases.



Sarah sketches the phase of the Moon at different positions in its orbit.
Complete the table to show the position of the Moon in its orbit, for each phase.
One has been done for you.

phase of Moon	letter of position in orbit
	**A**
	
	
	

[3]

(c) The Moon orbits the Earth approximately once a month.
Solar eclipses occur much less often.
Explain what causes a solar eclipse and why they are so rare.
You may use a diagram to help you answer.

.....

.....

.....

.....

[3]

[Total: 9]

[Turn over

4 Many astronomical projects now involve international cooperation.
Describe one example of this.
Use your example to explain why international co-operation is important for big astronomical projects.

One mark will be for a clear and ordered answer.

.....

.....

.....

.....

.....

.....

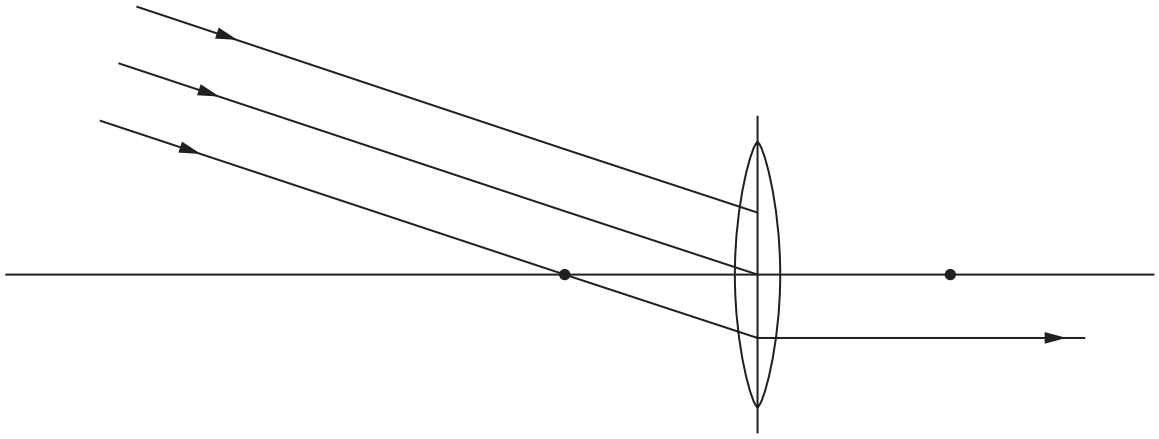
.....

.....[4+1]

[Total: 5]

5 Billy is making a simple telescope.

(a) He draws a diagram to show how a lens can produce an image of a distant object.
The focal points of the lens are shown by dots.
He draws three rays coming from the distant object.
Complete the diagram to show how the image is formed.
Label the position of the image on the diagram.



[3]

(b) Billy does some calculations to decide which lenses to use for his telescope.

(i) What is the focal length of a lens with power 20 dioptres?
You must show your calculation.

focal length = ... m [2]

(ii) The lenses he chooses have focal lengths of 0.5 m and 0.01 m.
What will be the magnification of the telescope?
You must show your calculation.

magnification = ... [2]

(iii) Explain why he should **not** choose two lenses with the same focal length.

.....

.....[1]

[Turn over

(c) Most astronomical telescopes do not use an objective lens.

(i) What do they use instead of an objective lens?

.....[1]

(ii) Draw a diagram to show how parallel rays of light are brought to a focus by your answer to part **(i)**.

[2]

(d) Radio waves and visible light waves have different wavelengths.
Radio telescopes must have much larger apertures than visible light telescopes to produce equally sharp images.
Explain why the radio telescopes need to be so much larger than optical telescopes.

.....

.....

.....

.....[3]

[Total: 14]

END OF QUESTION PAPER

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As well as producing electricity, nuclear reactors also produce radioactive materials. These are used in medicine to treat cancer, track chemicals in the body and sterilise surgical instruments. Radioactive materials are also used to sterilise food and are used in smoke detectors.

The main risk from nuclear power is exposure to radioactivity. The ionising radiation produced is harmful to living cells. This can be a hazard to health, and exposure to too much radiation is very dangerous.

The naturally occurring metal uranium (a heavy, unstable element) is most commonly used in power stations. There are several different types – called isotopes – of uranium, which produce different kinds of ionising radiation.

isotope	half life	type of radiation produced
U-235	700 million years	alpha
U-238	4.5 billion years	alpha
U-239	24 minutes	beta

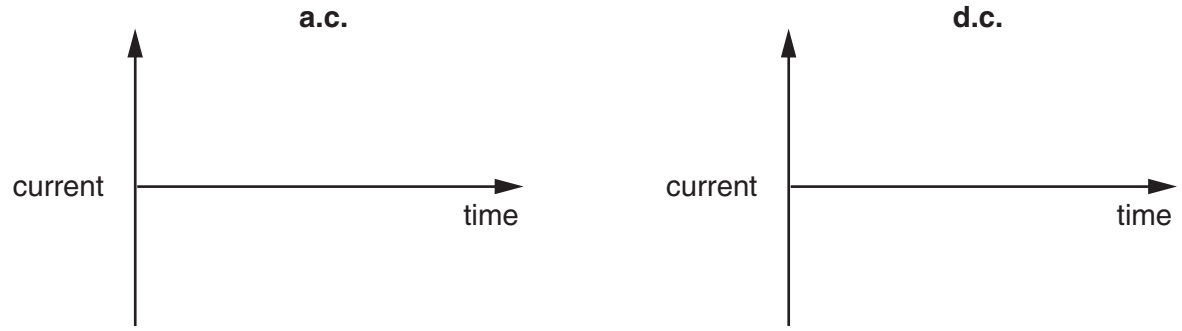
The worst type of accident in a nuclear power station is a melt-down, when the nuclear chain reaction gets out of control and generates enough heat to melt down the reactor. Modern reactors are designed in such a way that they shut themselves down if left alone. Constant intervention is needed to keep them operating – in contrast to the older reactor designs, which required constant intervention to keep the reaction under control. One recent design also has water stored above the reactor, which can be readily released onto the reactor.

Answer **all** the questions.

1 This question is based on the article, '**Sheffield Supertram System**'.

(a) The tram uses both alternating current and direct current.

(i) Complete the two graphs, one to show an alternating current (a.c.) and the other to show a direct current (d.c.)



[2]

(ii) On the tram, a device is used to store electrical energy and then produce a direct current.

What is the name of this device?

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

(b) The electrical power for the tram is supplied by the overhead power cables.

(i) What is the voltage used by the tram?

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

(ii) One of the motors on the tram uses a current of 30 amps.
Calculate the power produced by the motor.
Show your working.

power = ...watts **[3]**

(c) The motors provide the driving force on the tram.

(i) Write down two counter forces to the driving force on the tram.

1 .....

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

(ii) What can you say about the driving force and the counter force when the train is speeding up?

.....

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

(d) Draw a circuit diagram to show the tram circuit.
Include two trams in the circuit.
Use a resistor symbol for each tram.
Label the parts of your circuit.
You should include labels for

- overhead cable
- rail
- trams
- power supply.

[3]

(e) Calculate the momentum of the tram with no passengers when travelling at its maximum speed of 80 km/h (22 m/s).

momentum = ... kg m/s **[1]**

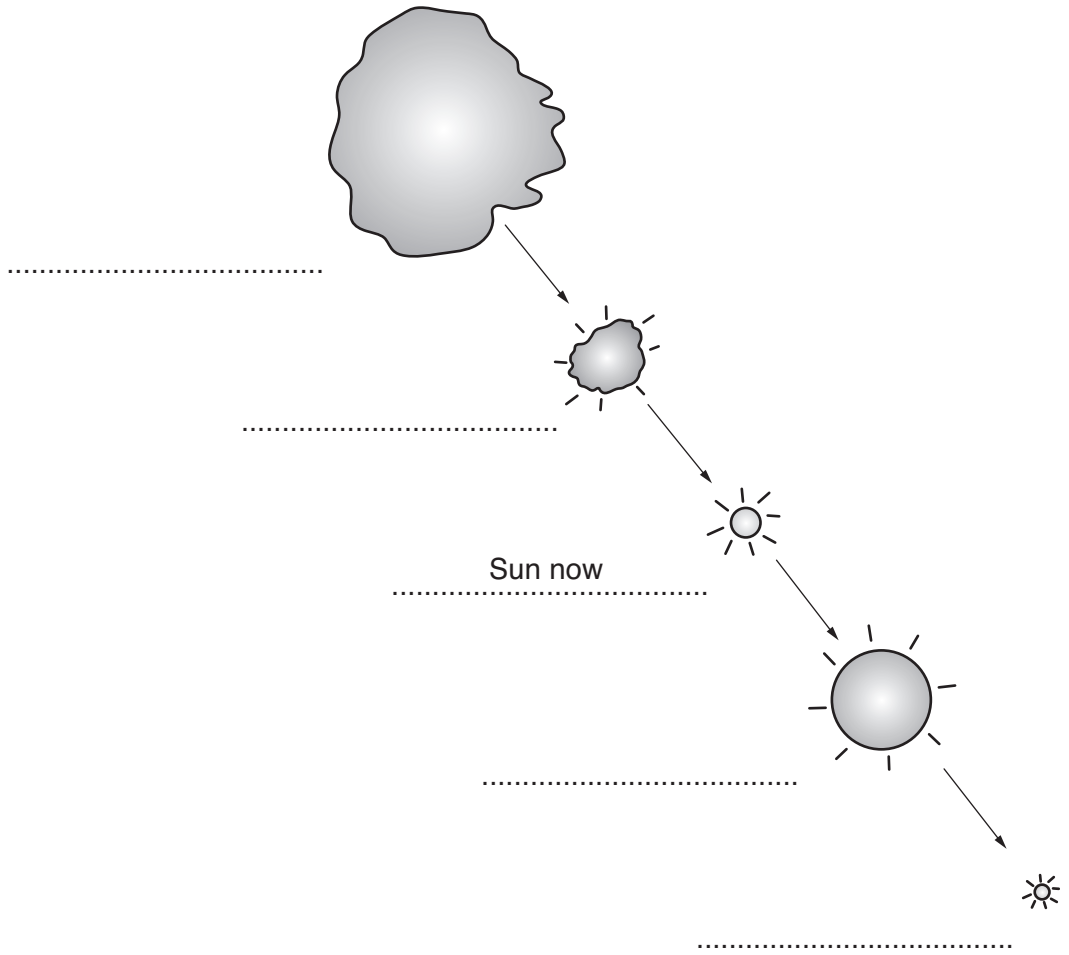
[Total: 14]

2 **(a)** The diagram shows the stages in the life of our Sun.

cloud of gas **neutron star** **protostar** **red giant**

Sun now **supernova** **white dwarf**

(i) Use some of the words from the list to label the different stages on the diagram.
The Sun as it appears now has been done for you.



[4]

(ii) A star that is much bigger than our Sun has different stages at the end of its life.
Which two stages in the list only happen in the life of a very large star?

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

(b) Heat produced in the core is transferred to the surface of the star.
What is the name of the part of a star that transfers the heat?

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

(c) Nuclear fusion takes place in the core of stars.

In nuclear fusion, elements with small nuclei fuse together to form elements with larger nuclei.
Use the table to help you answer the following questions.

element	size of nucleus (mass units)
hydrogen	1
helium	4
carbon	12
oxygen	16
iron	56
lead	207
uranium	238

(i) Which element in the table fuses to form helium when a young star forms?

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

(ii) Use one of the elements in the table to complete the sentence.

When stars run out of ..... in the core, they become red giants or red supergiants. **[1]**

(iii) Which **two** elements in the table, other than helium, might be produced in a red giant?

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

(iv) Iron is only likely to be produced in a red supergiant.
Put ticks (✔) in the boxes next to the **two** statements that best explain why.

Iron makes stars red.	☐
Very high pressures are needed.	☐
Iron has a large nucleus.	☐
There is no hydrogen to fuse.	☐

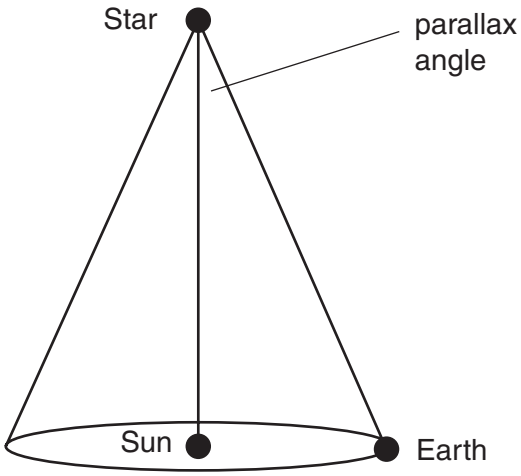
[2]

(v) Stars do not normally produce elements larger than iron.
Name an element from the table which could only be produced in a supernova.

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

[Total: 14]

3 **(a)** The diagram shows the parallax angle for a star.



(i) Sally is studying two stars, A and B.
Star A has a larger parallax angle than star B.
What can you say about the distances to star A and star B?

.....

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

(ii) The parallax angle measured for star A is 1/10 of a second of arc.
What is the distance to the star in parsecs?
Put a tick (✔) in the box next to the correct answer.

1 parsec	☐
10 parsecs	☐
100 parsecs	☐
1000 parsecs	☐

[1]

(b) The Hipparcos telescope was launched into space above the Earth's atmosphere.
It measured the parallax angle for many stars.
Give one advantage and one disadvantage of having a telescope in space.

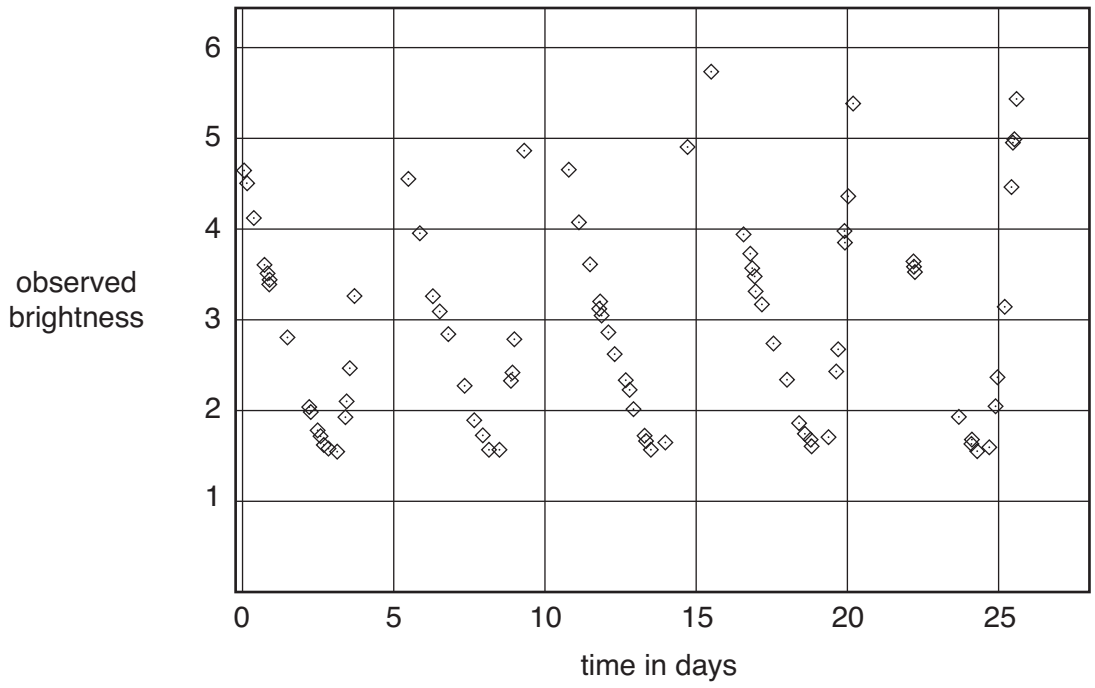
advantage .....

.....

disadvantage .....

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

(c) The graph shows how the observed brightness of the star, Delta Cephei, changes with time.



(i) What is the brightness of Delta Cephei at its dimmest?

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

(ii) The period is the time taken for one cycle of brightness.
What is the period of Delta Cephei?
Use the graph to find your answer.

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

(d) Astronomers use the luminosity (the intrinsic brightness) of stars to help work out the distance to a star.

(i) What **other** information about a star do astronomers need to work out the star's distance?

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

(ii) Which of the following factors affect the luminosity (intrinsic brightness) of a star?
Put ticks (✔) in the two boxes next to the correct factors.

size of star	☐
observed brightness	☐
temperature of star	☐
distance to star	☐

[2]

(e) **(i)** The following are units of distance.

metres **kilometres** **parsecs** **kiloparsecs** **megaparsecs**

Choose units from this list to complete the following sentences.

Distances between neighbouring stars in a galaxy are usually a few ..... .

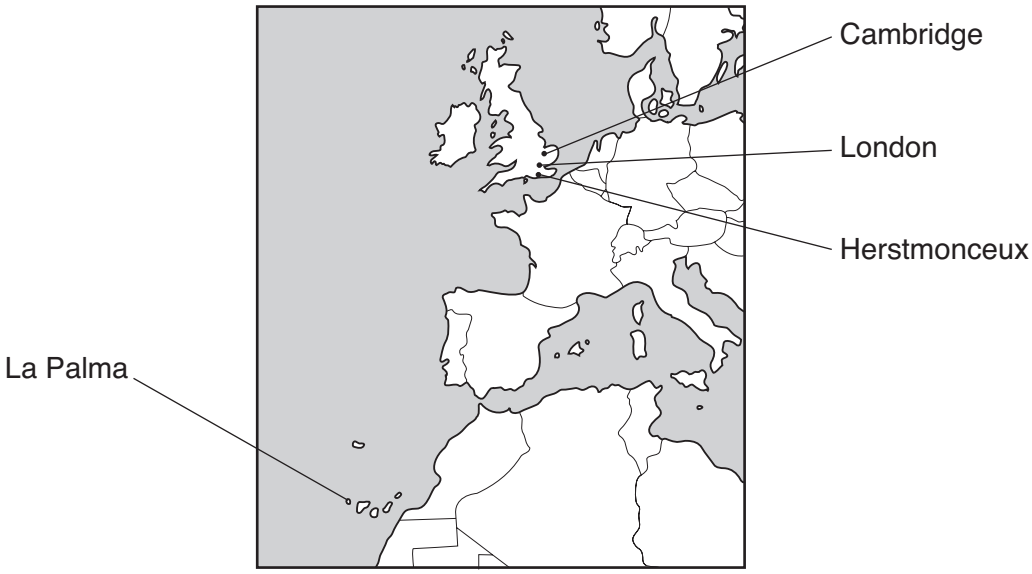
Distances between galaxies are usually measured in ..... . **[2]**

(ii) Write down the name of a distance unit, not in the list, that is similar in size to a parsec.

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

[Total: 13]

4 The Royal Greenwich Observatory was built in London near the river Thames in 1675. During the 1950s the observatory telescopes were moved to Herstmonceux in the countryside south of London. In 1979 a new telescope was opened at La Palma, in the Canary Islands. Since 1990 astronomers located in Cambridge have operated the La Palma telescope remotely.



(a) (i) Suggest an **astronomical** reason for moving the observatory from London to Herstmonceux, in the Sussex countryside.

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

(ii) One of the telescopes moved from London to Herstmonceux was the 26-inch Thompson telescope.
The 26-inch diameter lens has a focal length of 6.2 m.
Calculate the power of the lens.

power = ... dioptre **[1]**

(iii) How would the power of the eyepiece lens compare with the power of the 26-inch objective lens?

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

(b) When the main telescope was built on the top of a mountain on the island of La Palma many factors had to be taken into account.
Suggest two important **non-astronomical** factors to consider when choosing the site.

factor 1 .....

.....

factor 2 .....

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

(c) A new telescope, the Great Canary Telescope, at La Palma is a joint project involving several European countries. It has a mirror diameter of 10.4 metres.

(i) Very large telescopes use mirrors to collect the light.
Draw a diagram to show how a mirror can bring parallel rays of light to a focus.

[2]

(ii) The mirrors in modern astronomical telescopes are usually very large.
Explain why.

.....

.....

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

(d) Modern telescopes are controlled by computers.
Explain the advantages of computer control.

One mark is for a clear and well ordered answer.

.....

.....

.....

..... **[2+1]**

(e) Many astronomical projects now involve international co-operation.

Suggest two reasons for international co-operation.

reason 1 .....

.....

reason 2 .....

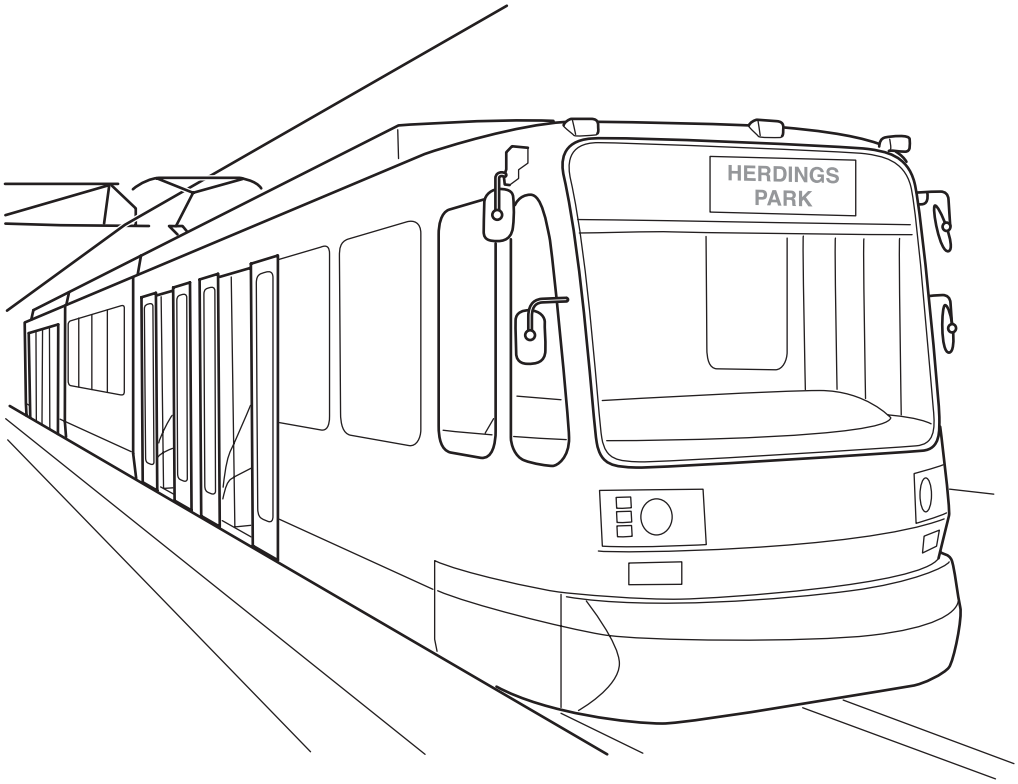
..... **[2]**

[Total: 14]

END OF QUESTION PAPER

1

Sheffield Supertram System



With a length of 34.8 m and a width of 2.65 m, the supertram is one of the largest articulated cars ever built for public transport. An empty supertram has a mass of about 50 000 kg. It can carry 88 people sitting down and an extra 162 passengers standing. The supertram has a top speed of 80 km/h. The momentum change when the supertram pulls away from a stop and reaches top speed is enormous.

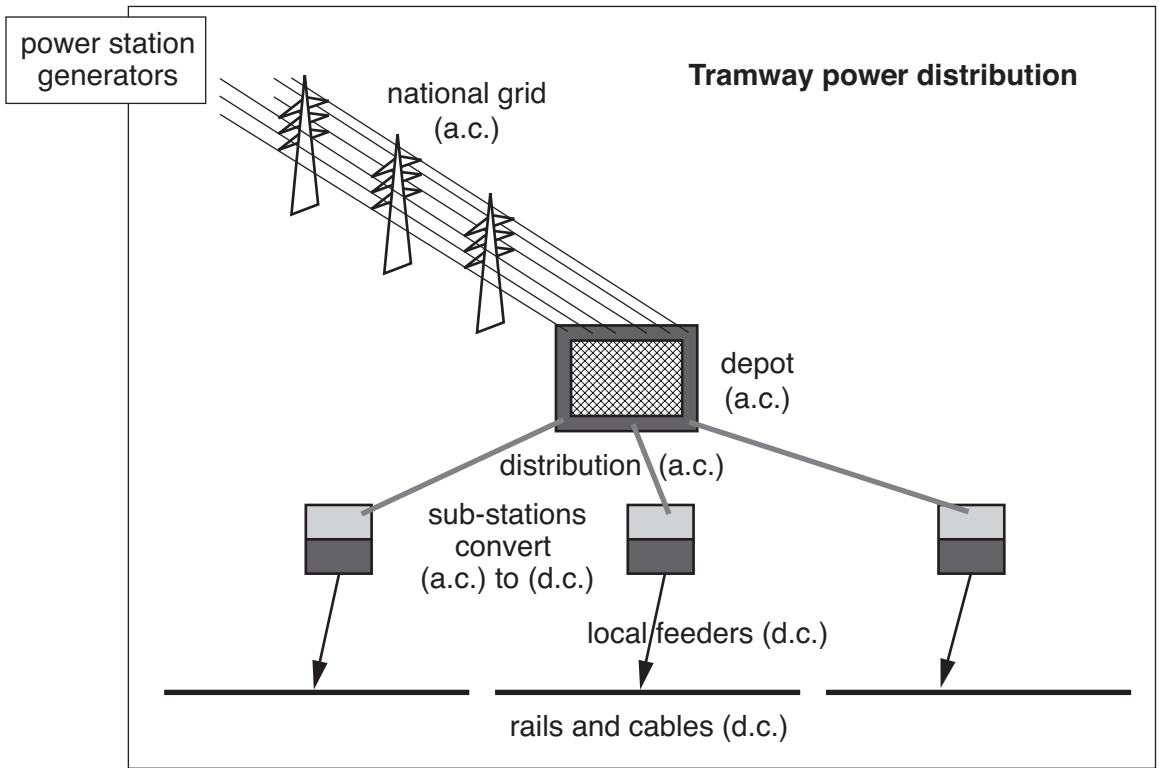
The steepest hill the supertram goes up and down has a slope of about 1 in 10. A lot of energy is needed for the tram to go up this hill in Sheffield. Going down the hill, the gravitational potential energy of the supertram is mostly converted to kinetic energy. When the regenerative brakes are used to slow down the tram, the kinetic energy is converted to electrical energy. The electrical energy can be stored in batteries or fed back into the tram circuit.

Electrical power

The tram uses electricity to work, usually from overhead cables. The electricity comes from the power supply, along the overhead cables and then flows down a pole. The pole sticks out of the top of the tram and touches the overhead cables.

The tram driver controls the flow of the electricity. The faster he wants to go, the more electricity he lets flow through.

The electricity flows through the motors, down to the wheels and into the rails. It flows back to the power supply along the rails. This means that if more than one supertram is on the tracks at the same time, they are in parallel in the electrical circuit.



The supertrams run on a 750 volt electrical supply. They use electricity from the national grid. This is transmitted as an alternating current (a.c.). The a.c. electricity is produced by generators in the power stations. The electricity is distributed across the tramway network as a.c. At local sub-stations near the rails it is transformed to the correct voltage for the overhead cable (750 volts) and converted to a direct current (d.c.).

Answer **all** the questions.

1 This question is based on the article, '**Sheffield Supertram System**'.

(a) Draw a circuit diagram to show the tram circuit.
Include two trams in the circuit.
Use a resistor symbol for each tram.
Label the parts of your circuit.
You should include labels for

- overhead cable
- rail
- trams
- power supply.

[3]

(b) Calculate the momentum of the tram with no passengers when travelling at its maximum speed of 80 km/h (22 m/s).

momentum = ... kg m/s **[1]**

(c) (i) The a.c. electricity of the national grid is produced by generators.
At its simplest, a generator is a coil of wire and a magnet.
Describe how an a.c. generator works and sketch a graph to show the voltage produced.

.....

.....

.....

.....

[3]

(ii) Explain why the electricity is transmitted as a.c. from the power station to the local sub-stations.

.....

.....

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

(d) During a safety test the fully loaded supertram is rolled down a slope without using its brakes, to see what its final speed will be.

The slope is 20 m high.
The mass of the fully loaded tram is 85 000 kg.
The weight of the fully loaded tram is 850 000 N.

(i) Calculate the final speed expected.
Use equations on page 2 to help you.

final speed = ...m/s **[4]**

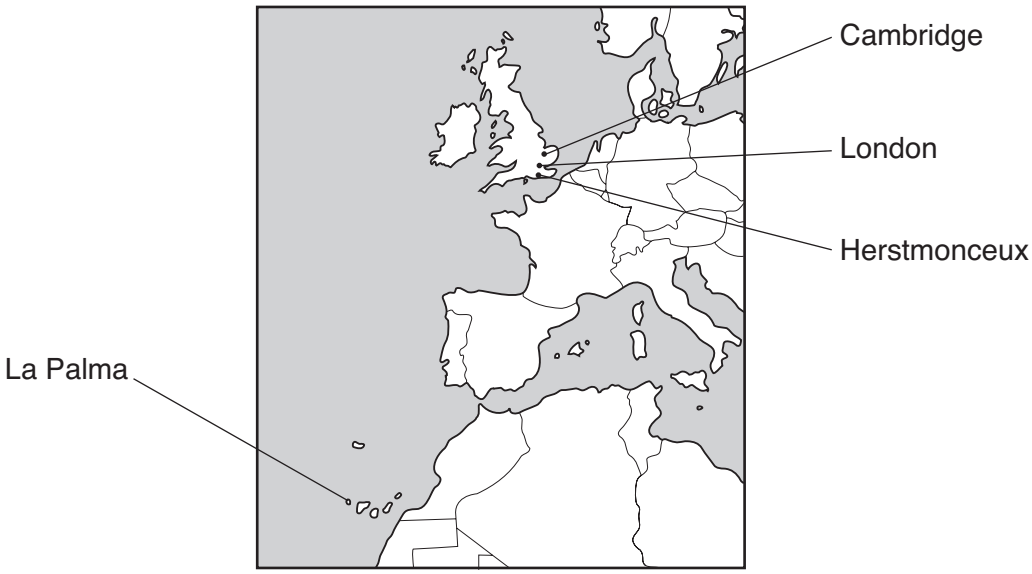
(ii) The speed measured was less than the speed you have calculated.
Explain why.

.....

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

[Total: 14]

2 The Royal Greenwich Observatory was built in London near the river Thames in 1675. During the 1950s the observatory telescopes were moved to Herstmonceux in the countryside south of London. In 1979 a new telescope was opened at La Palma, in the Canary Islands. Since 1990 astronomers located in Cambridge have operated the La Palma telescope remotely.



(a) (i) Suggest an **astronomical** reason for moving the observatory from London to Herstmonceux, in the Sussex countryside.

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

(ii) One of the telescopes moved from London to Herstmonceux was the 26-inch Thompson telescope.
The 26-inch diameter lens has a focal length of 6.2 m.
Calculate the power of the lens.

power = ... dioptre **[1]**

(iii) How would the power of the eyepiece lens compare with the power of the 26-inch objective lens?

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

(b) When the main telescope was built on the top of a mountain on the island of La Palma many factors had to be taken into account.
Suggest two important **non-astronomical** factors to consider when choosing the site.

factor 1 .....

.....

factor 2 .....

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

(c) A new telescope, the Great Canary Telescope, at La Palma is a joint project involving several European countries. It has a mirror diameter of 10.4 metres.

(i) Very large telescopes use mirrors to collect the light.
Draw a diagram to show how a mirror can bring parallel rays of light to a focus.

[2]

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Explain why.

.....

.....

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(d) Modern telescopes are controlled by computers.
Explain the advantages of computer control.

One mark is for a clear and well ordered answer.

.....

.....

.....

..... **[2+1]**

(e) Many astronomical projects now involve international co-operation.

Suggest two reasons for international co-operation.

reason 1 .....

.....

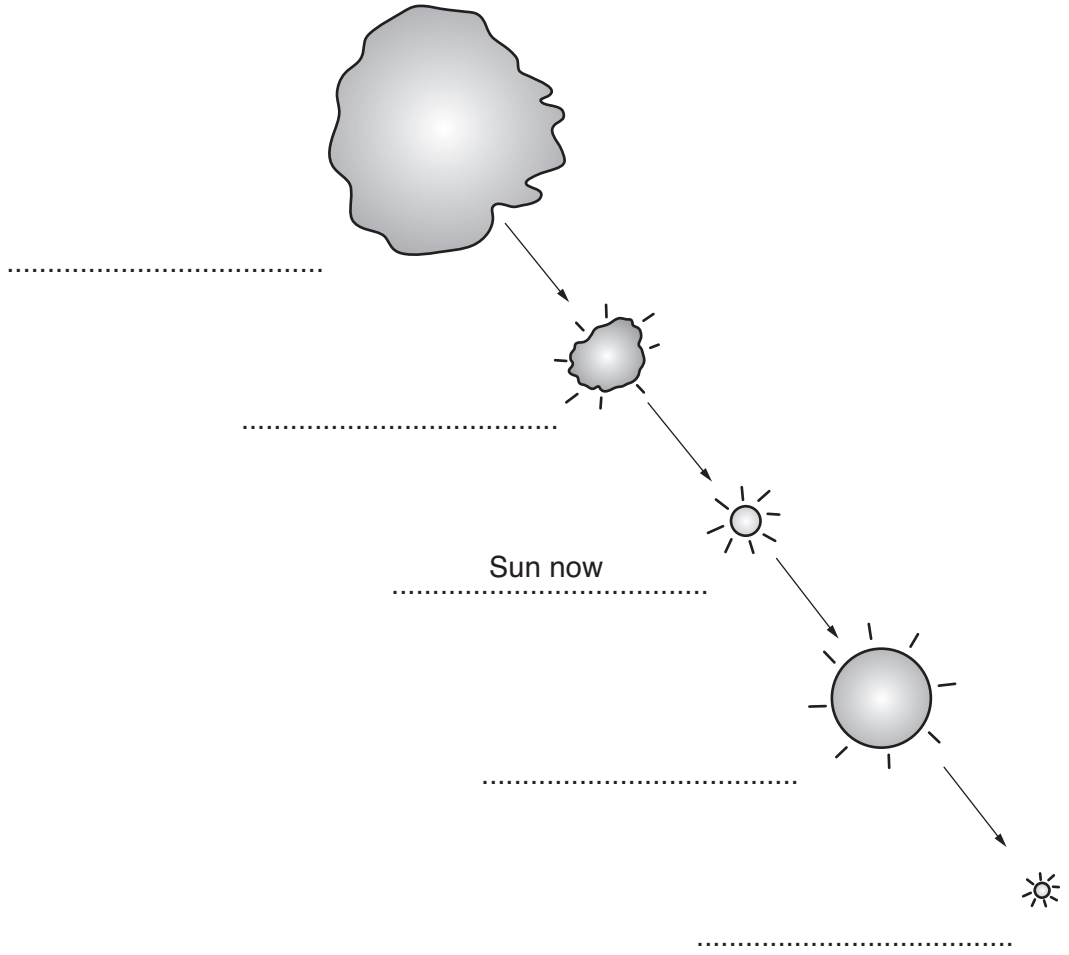
reason 2 .....

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

[Total: 14]

3 **(a)** The diagram shows the stages in the life of a low mass star such as the Sun.

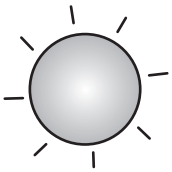
Complete labels for the different stages on the diagram.
The Sun as it appears now has been done for you.



[4]

(b) Complete and label a similar diagram for the later stages in the life of a star with very high mass.

giant star now
.....



.....

.....

.....

[3]

(c) Nearly all the elements are produced in stars by nuclear fusion.

When the hydrogen in the core is depleted, the processes taking place in a star change.

(i) What type of star is formed?

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

(ii) Write down two elements that are formed by fusion in this type of star

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

(iii) Which element fuses to form these elements? ..... **[1]**

(iv) Elements with large nuclei are produced in very massive stars.
The higher the mass of a star, the higher the core temperature will be.
Explain why elements with larger nuclei are produced in very massive stars.

Your answer should include ideas about:

- the structure of nuclei
- forces between charges
- nuclear fusion
- temperature and pressure in stars.

.....

.....

.....

.....

.....

.....

.....

..... **[4]**

[Total: 15]

4 **(a)** One way of measuring distances to stars is using parallax.

(i) Draw and label a diagram to show the parallax angle of a star.

You should include
- the parallax angle
- the star
- the Sun
- the Earth.

[3]

(ii) The parallax angle measured for a star is 0.2 seconds of arc.
What is the distance to the star in parsecs?
Show your working.

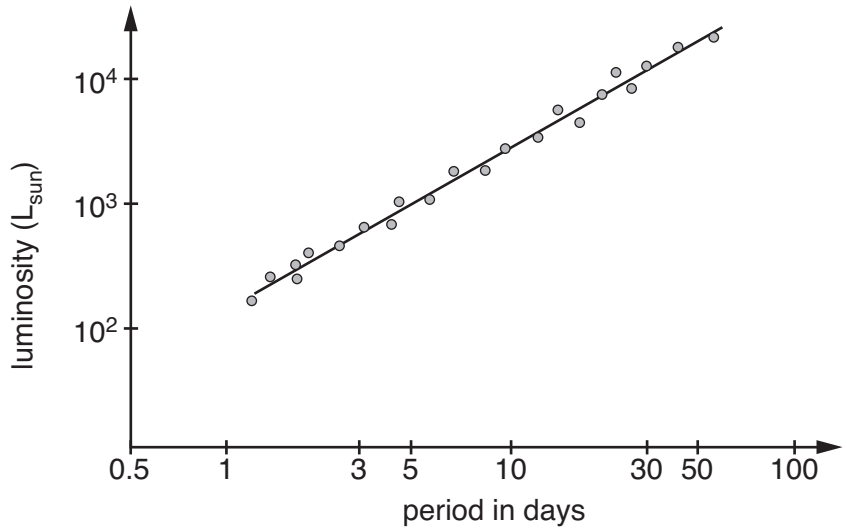
distance = ...parsecs **[1]**

(iii) In 1989 the Hipparcos satellite was launched to make parallax measurements.
The Hipparcos satellite was able to make more accurate measurements than Earth-based telescopes.
Give a reason why the Hipparcos satellite could make better measurements.

.....

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

(b) Another method of finding astronomical distance uses Cepheid variables.
The graph shows the luminosity (intrinsic brightness) of Cepheid variable stars plotted against the period.
The unit of luminosity (intrinsic brightness) is L_{sun}. This is the number of times the star is brighter than the Sun.



(i) What is the luminosity (intrinsic brightness) of a Cepheid variable with period 5 days?

.....L_{sun} **[1]**

(ii) Explain how the distance to a Cepheid variable star can be worked out.
Include in your answer

- how the graph helps
- what other information is needed
- how these are used to give the distance.

.....

.....

.....

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

(c) Explain how Edwin Hubble used observations of Cepheid variables to address the Curtis-Shapley debate.

.....

.....

.....

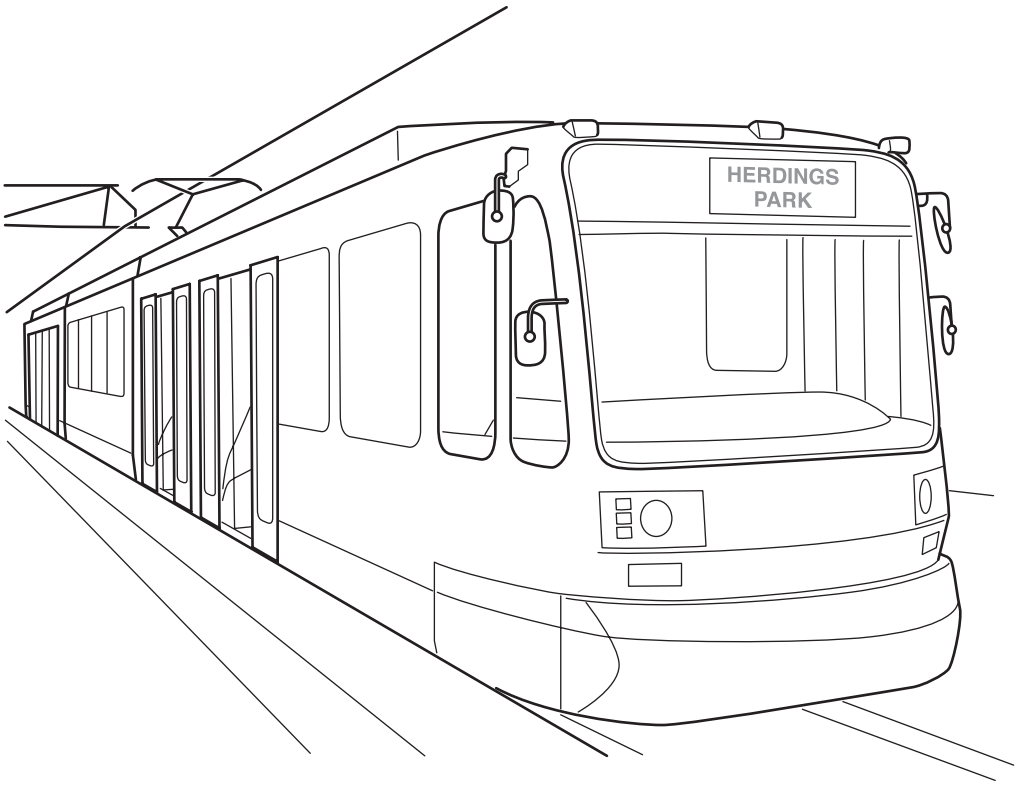
.....

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

[Total: 12]

END OF QUESTION PAPER

Sheffield Supertram System



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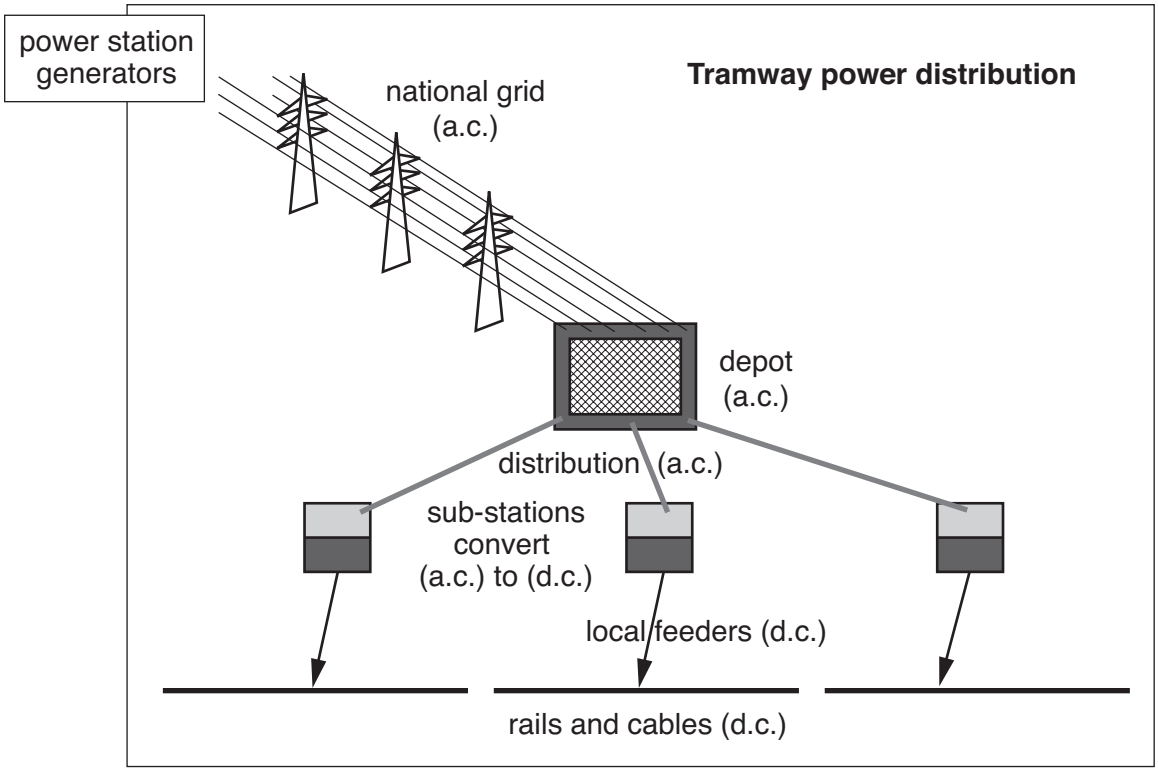

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Answer **all** the questions.

This question is based on the article 'Climate 'fix' could deplete ozone'.

1 (a) The article says that 'the bad side is definitely the ozone depletion'.

The sentences below explain why ozone depletion is 'bad'.

Use words from the list to complete the sentences.

absorbs **damages** **less** **lets through** **more** **only**

Ozone in the atmosphere …… ultraviolet radiation.

Less ozone means …… ultraviolet radiation reaches the surface of the Earth.

Ultraviolet radiation often …… living cells.

[3]

(b) Many people get confused between 'holes in the ozone layer' and 'the greenhouse effect'.

Complete the table to show the differences.

	main gas involved	**effect**
holes in the ozone layer	ozone	too much ultraviolet is a hazard to living organisms
the greenhouse effect		

[2]

(c) The article suggests that there is a correlation between an increase of sulfate particles in the upper atmosphere and a lowering of the Earth's temperature.

(i) What evidence is given in the article to support the idea that sulfate particles might cool the Earth?

.....

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

(ii) Give a different example of a correlation between two things, **taken from the article**.

.....

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

(d) Suggest two ways that climate change can cause problems.

1 .....

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

(e) In the article, Dr Tilmes says '… to make decisions you need to know what is good about it and what is bad about it.'

(i) In what situation might it be a good idea to use the sulfate particles to cool the planet?

Your answer should include

- a risk
- a benefit
- the situation when the benefit might outweigh the risk.

.....

.....

.....

.....

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

(ii) If the sulfate particles are used in the upper atmosphere, this can increase the risk to people.

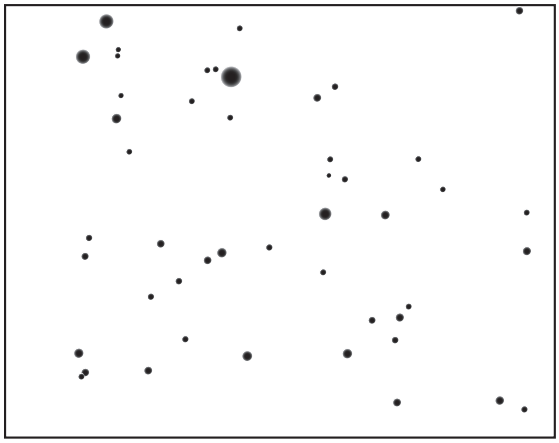
Suggest one thing that individuals could do to reduce the risk to themselves.

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

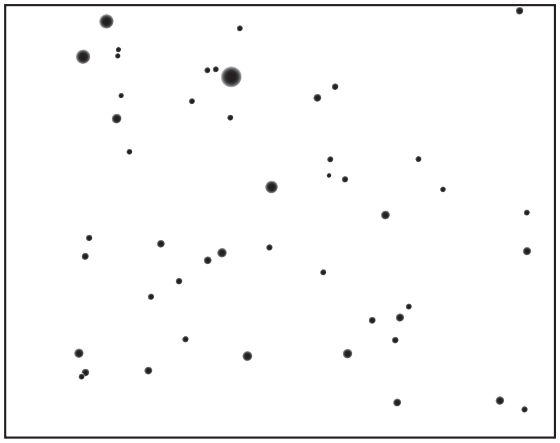
[Total: 14]

2 Angie is taking photos of the night sky.

Here are two of her pictures.



23rd July 2009



28th July 2009

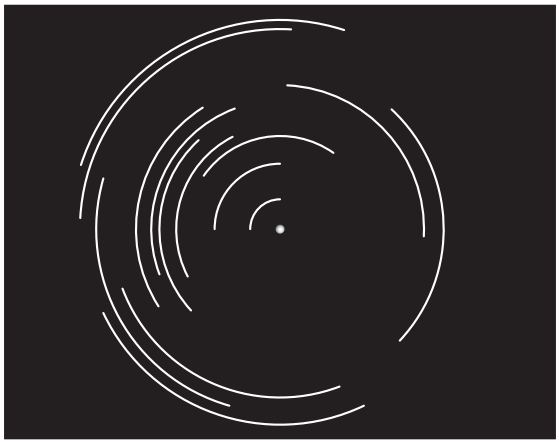
(a) (i) Clearly label the planet on one of the pictures. **[1]**

(ii) Suggest why the Ancient Greeks called the planets 'wandering stars'.

.....

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

(b) Angie points her telescope and camera at the pole star and takes a photograph over a few hours.



(i) Explain why most of the stars appear as lines in the photograph.

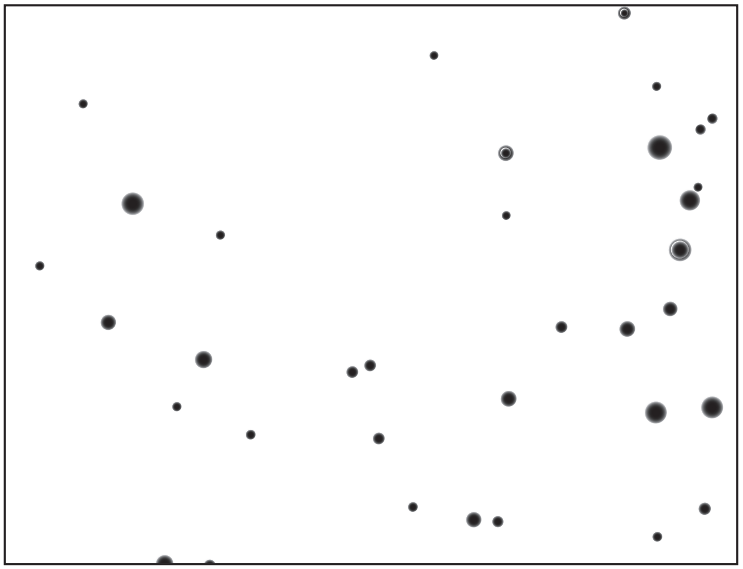
.....

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

(ii) For how long was the camera taking the photograph, to the nearest hour?

answer ..... hours **[1]**

(c) Angie takes a picture of the sky six months later at the same time of night.



23rd January 2010

Why are different stars seen in the picture?

You may use a diagram to help in your explanation.

.....

.....

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

(d) A solar day is the time it takes for the Sun to move once across the sky.

A sidereal day is the time it takes for the Earth to rotate once on its axis.

Explain why the solar day is longer than the sidereal day.

.....

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

(e) Angie wants to look at the Andromeda galaxy.

She looks up its position using the internet:

altitude: +32 deg 20 min
azimuth: +11 deg 12 min

Explain how these numbers help Angie find the Andromeda galaxy in the sky.

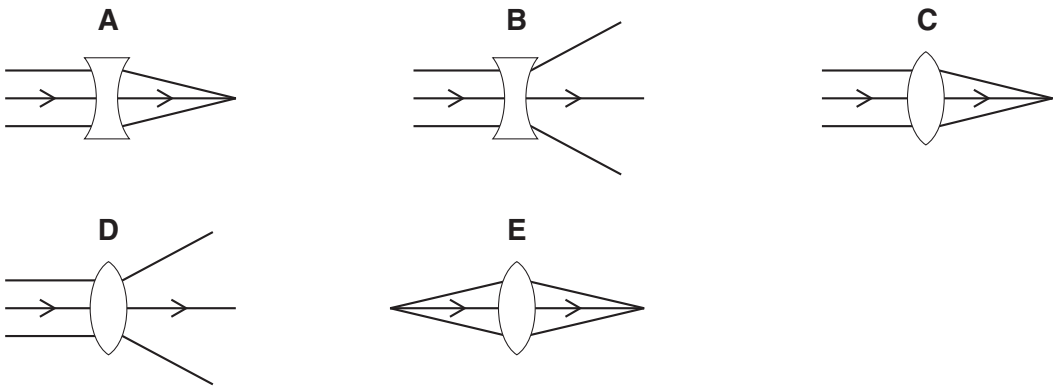
.....

.....

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

(f) **(i)** Angie focuses her telescope on a very distant star.

The light from the star passes through the objective lens of the telescope.



Which diagram, **A**, **B**, **C**, **D** or **E**, correctly shows the light passing through the lens?

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

(ii) Angie's telescope is at the bottom of her garden.

She wants to control it and view the images on her computer in her bedroom.

What advantages will Angie get from using a computer to remotely control her telescope?

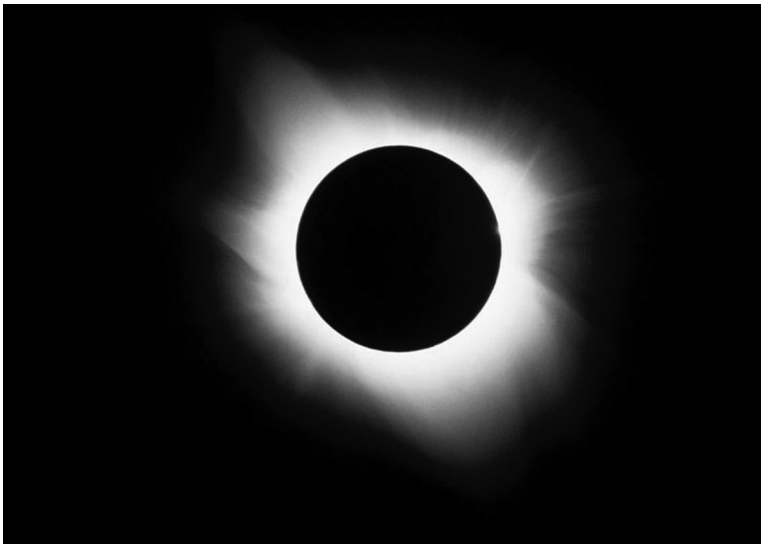
.....

.....

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

[Total: 13]

3 This is a picture of a solar eclipse.



Explain how a solar eclipse happens.

You should draw a diagram to help.

.....

.....

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

[Total: 3]

4 Fred is a lens maker.

Here are the properties of some lenses Fred made.

lens	diameter in cm	power in D	focal length in m
W	4	10	0.1
X	5	1	1
Y	10	0.67	1.5
Z	7		0.8

(a) (i) Lenses **W**, **X** and **Y** are made from the same type of glass.

Which lens has the most curved surface?

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

(ii) Calculate the power of lens **Z**.

power = ... unit ..... **[3]**

(iii) Fred is building a telescope to observe **very faint** stars.

He chooses lens **Y** as the objective lens that collects the light.

Put ticks (✓) in the boxes next to the **two** sentences that best explain why he chooses lens **Y**.

Lens **Y** has the largest diameter. ☐

Lens **Y** has the longest focal length. ☐

Lens **Y** is the most powerful. ☐

Lens **Y** will collect the most light. ☐

[2]

(b) Fred makes a telescope that only uses lenses.

What is the smallest number of lenses that he must use?

number of lenses = ... **[1]**

(c) Fred also makes telescopes that do not use a lens to collect the light.

These are called reflectors.

What is used to collect the light?

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

[Total: 8]

5 All the information we have about stars comes from the electromagnetic waves we receive from the stars.

(a) (i) Which of the following increase with the temperature of a star?

Put a (ring) around the **two** correct answers.

age **distance** **luminosity** **maximum wavelength** **peak frequency of light**

[2]

(ii) The surface temperature of a star is 6700 °C.

What is this temperature in kelvin?

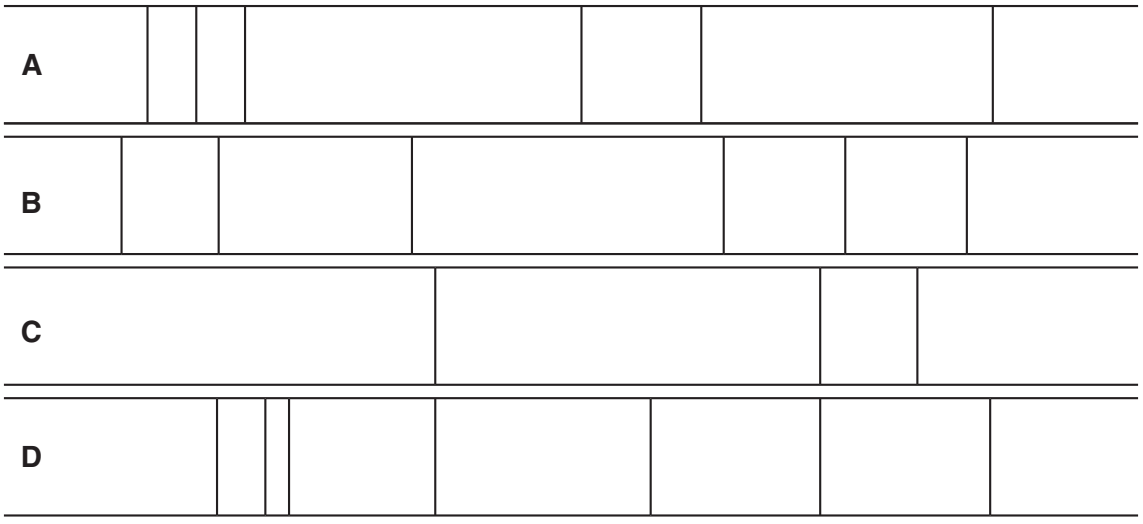
temperature = ... K **[1]**

(b) Astronomers often look at the spectrum of a star's light.

(i) The diagram shows the spectrum from a star.

The spectrum can be used to work out which chemical elements are in the star.

Use the line spectra for the elements shown below to work out which elements are in the star.



Which **two** elements, from **A**, **B**, **C** and **D**, are in the star?

answer ..... and ..... **[2]**

(ii) Complete the sentences about lines in a spectrum.

Choose words from the list.

electrons **light** **line** **neutrons** **parallax**

The lines in a spectrum from a star are caused by the movement of ……..…… in atoms.

This type of spectrum is called a ……..…… spectrum.

[2]

[Total: 7]

6 At the beginning of the 20th century scientists could not explain how stars produced so much energy.

(a) It was not until the structure of atoms was understood that an explanation for stars producing so much energy was found.

One of the key experiments was the Rutherford-Geiger-Marsden alpha particle scattering experiment.

What did the results of the Rutherford-Geiger-Marsden alpha particle scattering experiment tell us about atoms?

Put a tick (✓) in the box next to the correct answer.

Atoms have a small positive centre. ☐

Atoms are the smallest possible particles. ☐

Atoms are surrounded by large positive charges. ☐

Atoms only contain large negative charge. ☐

[1]

(b) (i) What is the process by which stars produce such large amounts of energy?

Put a tick (✓) in the box next to the correct answer.

reflection ☐

nuclear fusion ☐

combustion ☐

nuclear fission ☐

[1]

(ii) Describe briefly how the energy produced in the **centre** of the Sun is transferred to the Earth.

Your answer should include

- the two main methods of energy transfer inside the Sun
- the method of energy transfer to the Earth.

One mark is for a clear and well ordered answer.

.....

.....

.....

.....

..... **[3+1]**

[Total: 6]

Turn over for question 7

7 **(a)** The nearest star to the Earth, other than the Sun, is about 1 parsec (pc) away.

A galaxy is about 1 megaparsec (Mpc) away.

How many times further away is the galaxy than the star?

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

(b) Measuring the distance to stars and galaxies is difficult.

Many different methods are used.

Here are four methods.

A brightness and colour of stars
B Cepheid variable stars
C parallax
D speed of recession of galaxies

(i) Which method, **A**, **B**, **C** or **D**, showed that some nebulae were outside the Milky Way galaxy?

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

(ii) An astronomer used method **D** on a galaxy.

She found the galaxy is at a distance of 200 Mpc.

The Hubble constant is 70 km / s per Mpc.

Calculate the speed of recession of the galaxy.

Show your working.

speed = ... km / s **[2]**

[Total: 4]

END OF QUESTION PAPER

Climate 'fix' could deplete ozone

Research has cast new doubt on the wisdom of using sulfate particles to cool the planet.

Sulfate injection is an example of a geo-engineering solution to climate change being discussed by scientists.

But data published in the journal 'Science' suggests the strategy would lead to drastic thinning of the ozone layer.

This would delay the recovery of the Antarctic ozone hole by decades, and cause significant ozone loss over the Arctic, say US researchers.

The idea of pumping sulfate particles which reflect sunlight into the upper atmosphere to counteract global warming comes from nature.

Major volcanic eruptions emit vast quantities of sulfur-containing compounds that can cool the planet significantly. Evidence for this was observed following the 1991 volcanic eruption of Mount Pinatubo.

But one potential drawback is that sulfates provide a surface on which chlorine gases in polar clouds can become activated, causing chemical reactions that lead to the destruction of ozone molecules.

Polar stratospheric clouds provide a surface for ozone-destroying reactions.

"The bad side is definitely the ozone depletion"

Dr Simone Tilmes

Ozone loss

Dr Simone Tilmes of the National Center for Atmospheric Research in Boulder, Colorado, and colleagues used a combination of measurements and computer simulations to estimate future ozone loss if sulfate injections were carried out.

Quantities of sulfate capable of reducing climate change would destroy as much as three-quarters of the ozone layer over the Arctic, if carried out in the next few decades, they said.

This would also delay the expected recovery of the ozone layer over the Antarctic by about 30 to 70 years, they concluded.

Ozone depletion was increased in the Antarctic after the eruption of Mt Pinatubo.

Dr Tilmes said more research was needed before society attempted global geo-engineering solutions in the future.

However, she said the study should not rule out the approach altogether.

She told BBC News: "Politicians have to decide what is most important – if you have climate change you might have catastrophic conditions – they might decide to do this anyway.

"If you have to make decisions you need to know what is good about it and what is bad about it."