OCR
RECOGNISING ACHIEVEMENT

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Wednesday 9 January 2013 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE
SCIENCE A

A141/02   Modules B1 C1 P1 (Higher Tier)

Candidates answer on the Question Paper. A calculator may be used for this paper.	**Duration:** 1 hour
OCR supplied materials: None	
Other materials required: • Pencil • Ruler (cm/mm)	

Candidate forename		Candidate surname	

Centre number					Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- Your quality of written communication is assessed in questions marked with a pencil (✐).
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- A list of useful relationships is printed on page 2.
- The total number of marks for this paper is **60**.
- This document consists of **24** pages. Any blank pages are indicated.

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Turn over

TWENTY FIRST CENTURY SCIENCE EQUATIONS

Useful relationships

The Earth in the Universe

distance = wave speed × time

wave speed = frequency × wavelength

Sustainable energy

energy transferred = power × time

power = voltage × current

efficiency = $\dfrac{\text{energy usefully transferred}}{\text{total energy supplied}}$ × 100%

Explaining motion

speed = $\dfrac{\text{distance travelled}}{\text{time taken}}$

acceleration = $\dfrac{\text{change in velocity}}{\text{time taken}}$

momentum = mass × velocity

change of momentum = resultant force × time for which it acts

work done by a force = force × distance moved in the direction of the force

amount of energy transferred = work done

change in gravitational potential energy = weight × vertical height difference

kinetic energy = $\dfrac{1}{2}$ × mass × [velocity]^2

Electric circuits

power = voltage × current

resistance = $\dfrac{\text{voltage}}{\text{current}}$

$\dfrac{\text{voltage across primary coil}}{\text{voltage across secondary coil}} = \dfrac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$

Radioactive materials

energy = mass × [speed of light in a vacuum]^2

3

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Question 1 begins on page 4

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Answer **all** the questions.

1 This question is about inheritance.

(a) Complete the sentences by choosing the correct words from this list.

Each word may be used once, more than once or not at all.

alleles

chromosomes

dominant

heterozygous

homozygous

recessive

An individual may have two different versions of each gene.

Different versions of genes are called ....

If these versions are different, the person is said to be .... for that gene.

If only one of these versions is .... , it will not affect the characteristic of the person.

[2]

(b) The family tree shows the inheritance of a genetic condition called polydactyly.

People with polydactyly have extra fingers and toes.

Key

☐ unaffected male

■ affected male

◯ unaffected female

● affected female
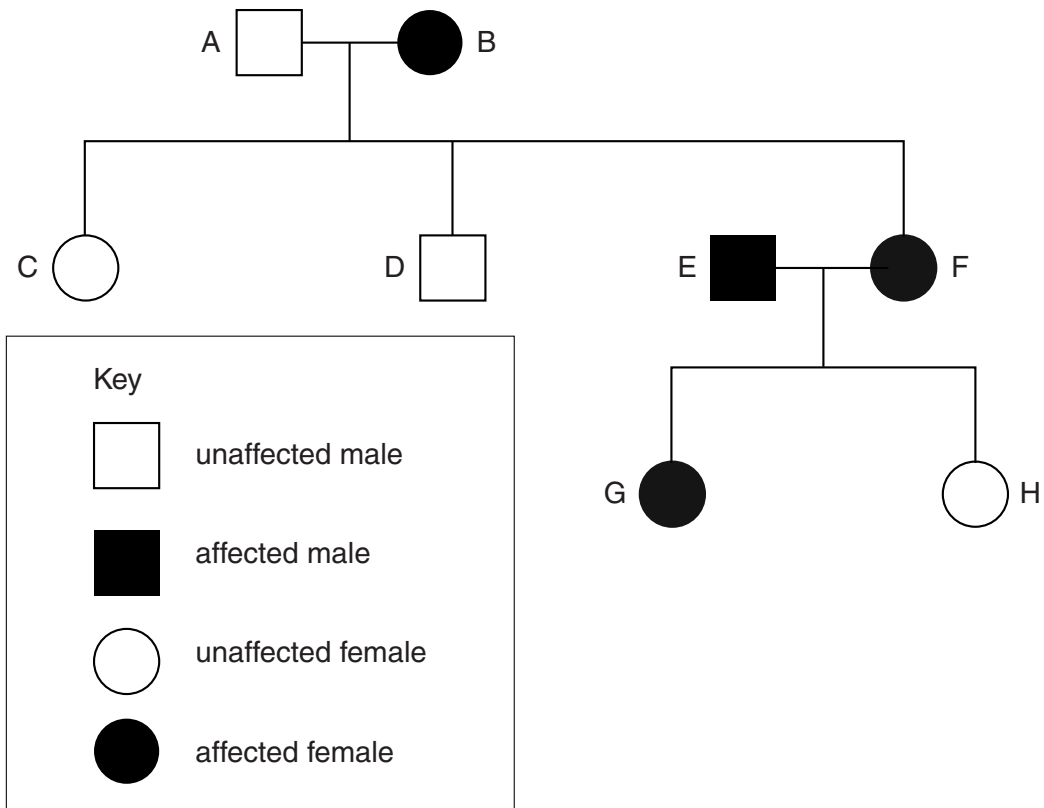
What does the pattern shown in the family tree tell you about how polydactyly is inherited?

Give evidence from the family tree to support your answer.

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.... **[3]**

[Total: 5]

2 This question is about embryo selection.

(a) In December 2010, a baby boy was born to help save the life of his older sister.

She has a rare blood disease.

She needs regular blood transfusions in hospital and can't fight infections.

An embryo was selected because it had an identical tissue match to the ill child.

Once the baby boy was born, some of his bone marrow was given to his sister.

This helped treat her illness.

The baby boy was the first successful 'saviour sibling' born in the UK.

Testing embryos for embryo selection is used to create 'saviour siblings'.

Here are some steps in this procedure.

A   The embryos are genetically tested.

B   A selected embryo develops into a baby.

C   Embryos with an identical tissue match to the ill child are selected.

D   Some of the mother's sex cells are removed from her body.

E   A number of embryos are produced.

F   The cells are fertilised by the father's sperm in a laboratory.

G   Some of these embryos are implanted into the mother.

Write the letters in the boxes to show the correct order.

One has been done for you.

			A			

[2]

(b) Discuss the possible implications of embryo selection, referring specifically to this example of saviour siblings.

The quality of written communication will be assessed in your answer.

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.... **[6]**

[Total: 8]

Turn over

3 William takes some cuttings from a geranium plant.

All the cuttings are clones.

(a) What is a clone?

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

individuals that have identical characteristics ☐

individuals that have identical genes ☐

individuals that have the same parents ☐

individuals that look the same ☐

individuals that show variation ☐

[1]

(b) Write down one way in which clones of plants can occur **naturally**.

.... **[1]**

(c) William puts his cuttings in the garden for four weeks.

He randomly selects 50 cuttings and measures their height.

Here are his results.

Height range in cm	Number of plants
< 16	0
16.0 – 17.9	5
18.0 – 19.9	12
20.0 – 21.9	19
22.0 – 23.9	10
24.0 – 25.9	3
> 25.9	1

(i) Describe the pattern shown by the data.

....

....

....

.... **[2]**

(ii) William's friend, Karen, looks at the data. She wants to calculate the mean height of the plants.

Karen is unable to accurately calculate the mean height of the 50 plants from this data.

Put a tick (✓) in the box next to the **correct** reason why.

There are too many different ranges. ☐

The height ranges do not all contain plants. ☐

Karen is likely to make a mistake in her calculations. ☐

There are different numbers of plants in each height range. ☐

Karen does not know the heights of individual plants within each range. ☐

[1]

(iii) Karen does not think all the plants can be clones because they are different heights.

William insists that clones can be different heights.

Use your knowledge and the data to explain who is correct.

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.... **[2]**

[Total: 7]

Turn over

4   Cars use petrol as a fuel.

When petrol burns **in a car engine** it makes air pollutants.

(a) The formulae of three pollutants are listed below.

Draw a straight line from each **formula** to **how it is made**.

Draw a straight line from each **formula** to **why it is harmful**.

how it is made	**formula**	**why it is harmful**
carbon atoms in the fuel burning in plenty of air		causes acid rain
	CO	
carbon atoms in the fuel burning in a limited supply of air		lowers the amount of oxygen blood can carry
	CO_2	
sulfur atoms in the fuel reacting with oxygen atoms in the fuel		major contributor to global warming
	SO_2	
sulfur atoms in the fuel reacting with oxygen atoms from the air		settles on surfaces making them dirty

[2]

(b) (i) Explain how nitrogen monoxide is made in a car engine.

....

....

....

.... **[2]**

(ii) Data show that air pollution by nitrogen oxides is now much less than in 1990.

Why is nitrogen oxide pollution lower now?

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

Fewer people are travelling by public transport.

The efficiency of vehicle engines is decreasing.

Fuels contain less sulfur now than in 1990.

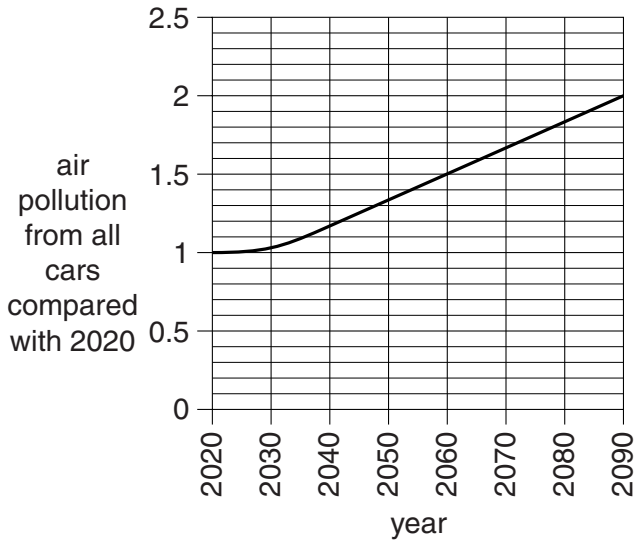Since 1993 all new cars have catalytic converters fitted.

[1]

[Total: 5]

Turn over

5 This is a question about future air pollution levels in the USA.

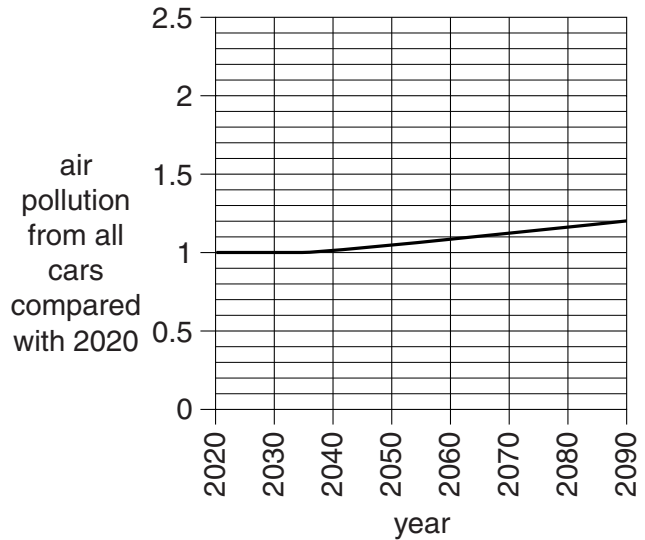**(a)** Look at the graphs about air pollution in the USA.

Graph 1 shows the predicted change in air pollution from 2020 to 2090 if all new cars run on petrol.

Graph 2 shows the predicted change in air pollution from 2020 to 2090 if all new cars are powered by biofuels.

graph 1 – new cars run on petrol   **graph 2 – new cars run on biofuels**

(i) Here are some statements about the **two** graphs.

Each statement is either **true** or **false**.

Put a tick (✓) in the correct box next to each statement to show whether it is true or false.

	true	false
Pollution doubles every 50 years if all new cars run on petrol.		
Pollution decreases between 2030 and 2080 if all new cars run on biofuels.		
There is no difference in pollution between the two fuels until 2040.		
If all new cars are run on biofuels, air pollution in 2090 will be 60% of what it would be if they were run on petrol.		

[2]

   (ii) The slope of graph 2 is less steep than the slope of graph 1.

   Explain why.

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   .... **[2]**

   (iii) Look at the graphs.

   Evaluate the effect of using biofuels for all new cars to provide a solution to problems of air pollution from cars.

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   .... **[2]**

 (b) At present, scientists believe it would be a mistake to replace all petrol with biofuels.

   Which two sentences, when put together explain this?

   Put ticks (✓) in the boxes next to the **two** correct answers.

   Many different crops are used to make biofuels.   ☐

   Very large areas of land will be needed to grow crops for biofuels.   ☐

   Fertilisers are not needed to grow crops for biofuels.   ☐

   Biofuels can only be made from fossil fuels.   ☐

   Less land will be available to grow food crops.   ☐

   Costs for transporting biofuels are higher than petrol.   ☐

   [1]

   [Total: 7]

6 The Earth's early atmosphere was formed **4000 million years ago**.

The composition of the Earth's atmosphere has changed over time.

Some scientists have estimated the composition of the Earth's atmosphere **1000 million years ago.**

Here are the scientists' data:

Composition of atmosphere 1000 million years ago	
Gas	**% by volume**
carbon dioxide	48.0
oxygen	
water vapour	2.0
nitrogen	47.5
total	100

(a) Calculate the percentage of oxygen in the atmosphere 1000 million years ago.

Show your working.

[2]

(b) 4000 million years ago the atmosphere was mainly carbon dioxide and water vapour. There was no oxygen present.

Describe and explain how the atmosphere changed between 4000 million years ago and 1000 million years ago.

🖉 *The quality of written communication will be assessed in your answer.*

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.... **[6]**

[Total: 8]

Turn over

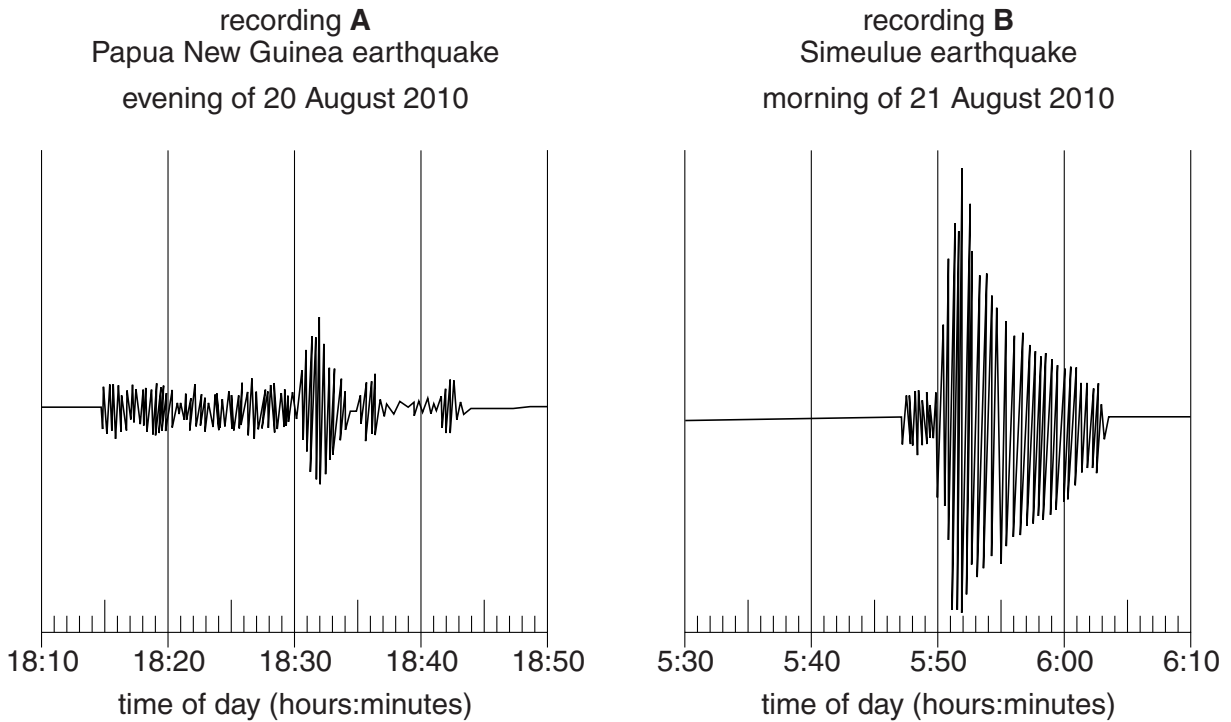**7** Read the article.

In August 2010 there were two earthquakes in the region between China and Australia. The first, at Papua New Guinea, was of magnitude 6.4. The primary (P) wave was followed a quarter of an hour later by the secondary (S) wave, which was followed immediately by two small 'aftershocks'. About 11½ hours later there was a slightly weaker earthquake 34 km below the sea floor at Simeulue.

earthquake detector
in Thailand

Simeulue

Papua New Guinea

The graphs show two recordings made by an earthquake detector in Thailand.

recording **A**
Papua New Guinea earthquake
evening of 20 August 2010

recording **B**
Simeulue earthquake
morning of 21 August 2010

18:10   18:20   18:30   18:40   18:50
time of day (hours:minutes)

5:30   5:40   5:50   6:00   6:10
time of day (hours:minutes)

(a) P-waves travel at 7 km/s, while S-waves travel at 3 km/s.

Papua New Guinea is 4750 km from the earthquake detector in Thailand.

Do a calculation to show that the S-wave from the Papua New Guinea earthquake arrived about a quarter of an hour after the P-wave.

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.... **[3]**

(b) The detector in Thailand was much closer to the weaker Simeulue earthquake than to the stronger Papua New Guinea earthquake.

Which **two** of the differences between the two earthquake recordings does this explain?

Put ticks (✓) in the boxes next to the **two** correct answers.

There are no aftershocks in recording **B**. ☐

The S-waves die away faster in recording **A**. ☐

The amplitude of S-waves is much greater in recording **B**. ☐

The duration of P-waves is much greater in recording **A**. ☐

The time between the arrival of the P-waves and the arrival of the S-waves is much greater in recording **A**. ☐

[2]

(c) Another earthquake detector in Senegal was on exactly the opposite side of the Earth to Papua New Guinea.

Earthquake detector in Senegal

Papua New Guinea
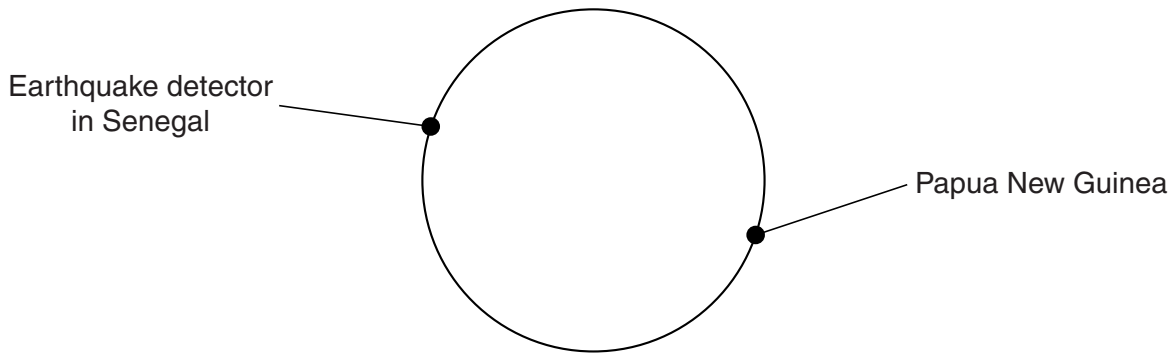
Section through the Earth

The earthquake recording made in Senegal, **C**, was different from recording **A**.

In which **two** ways would you expect recording **C** to be different?

Put ticks (✓) in the **two** correct boxes.

Recording **C** would not have P-waves. ☐

Recording **C** would not have S-waves. ☐

Recording **C** would have no aftershocks. ☐

The amplitude of the waves would be smaller in recording **C**. ☐

The lag time between P-waves and S-waves would be shorter in recording **C**. ☐

[2]

[Total: 7]

Turn over

8 The table shows the distances to four different galaxies, **A**, **B**, **C** and **D**, and the speed with which these galaxies are moving.

Galaxy	A	B	C	D
Distance (millions of light years)	300	800	1000	3000
Speed (km/s)	6500	18 000	21 000	67 000

(a) What do these data show about the evolution of the Universe?

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.... **[2]**

(b) Observations made on another galaxy, **E**, show that it is moving at a speed of 50 000 km/s.

Use data from the table to calculate the distance to galaxy **E**.

Write your answer to **two** significant figures.

Show your working.

distance = ... million light years **[3]**

(c) The ultimate fate of the Universe is hard to predict.

What are the reasons for this?

Put ticks (✓) in the boxes next to the **two** correct reasons.

Very distant galaxies do not show any redshift. ☐

The total mass of the Universe is hard to measure. ☐
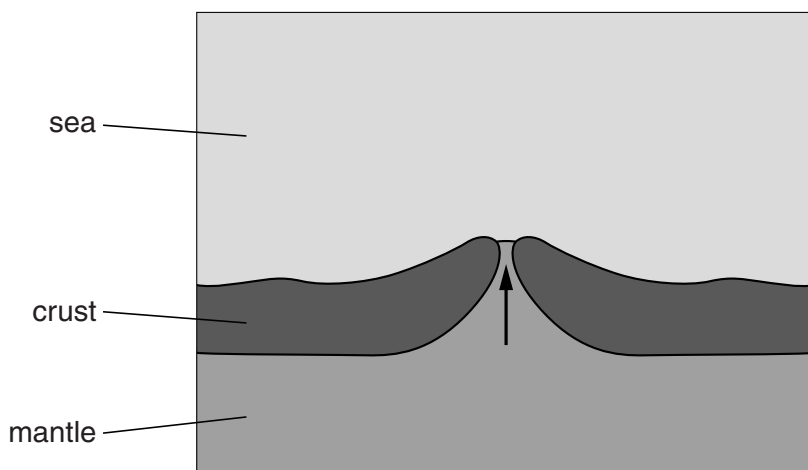
The distances to very distant galaxies are hard to measure. ☐

Very distant galaxies are observed as they existed far in the past. ☐

Light pollution makes observation of faint, distant galaxies impossibly difficult. ☐

[2]

[Total: 7]

Turn over

9 The diagram shows a section through the Earth's crust near the centre of the Atlantic Ocean.

In the 1950s, it was discovered that the Atlantic seafloor is spreading. This discovery made scientists develop new explanations for the behaviour of the Earth's crust and mantle.

Discuss this discovery and the new explanations that were developed for it.

The quality of written communication will be assessed in your answer.

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.... **[6]**

[Total: 6]

END OF QUESTION PAPER

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