

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**  
**GCSE**

**A141/02**

**TWENTY FIRST CENTURY SCIENCE**  
**SCIENCE A**

**Modules B1 C1 P1 (Higher Tier)**

**WEDNESDAY 9 JANUARY 2013: Morning**

**DURATION: 1 hour**  
**plus your additional time allowance**

**MODIFIED ENLARGED 18pt**

<b>Candidate forename</b>		<b>Candidate surname</b>	
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<b>Centre number</b>						<b>Candidate number</b>				
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**Candidates answer on the Question Paper.**  
**A calculator may be used for this paper.**

**OCR SUPPLIED MATERIALS:**

**Insert A: Question 5**  
**Insert B: Question 7**

**OTHER MATERIALS REQUIRED:**


**Pencil**  
**Ruler (cm/mm)**

**READ INSTRUCTIONS OVERLEAF**

## **INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the boxes on the first page. 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).

## **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 pages 4–5.
- The total number of marks for this paper is 60.

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# **TWENTY FIRST CENTURY SCIENCE EQUATIONS**

## **USEFUL RELATIONSHIPS**

### **THE EARTH IN THE UNIVERSE**

$$\text{distance} = \text{wave speed} \times \text{time}$$

$$\text{wave speed} = \text{frequency} \times \text{wavelength}$$

### **SUSTAINABLE ENERGY**

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{power} = \text{voltage} \times \text{current}$$

$$\text{efficiency} = \frac{\text{energy usefully transferred}}{\text{total energy supplied}} \times 100\%$$

### **EXPLAINING MOTION**

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

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

$$\text{momentum} = \text{mass} \times \text{velocity}$$

$$\begin{array}{l} \text{change of} \\ \text{momentum} \end{array} = \text{resultant force} \times \text{time for which it acts}$$

$$\begin{array}{l} \text{work done} \\ \text{by a force} \end{array} = \text{force} \times \begin{array}{l} \text{distance moved in the} \\ \text{direction of the force} \end{array}$$

$$\text{amount of energy transferred} = \text{work done}$$

$$\text{change in gravitational potential energy} = \text{weight} \times \text{vertical height difference}$$

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times [\text{velocity}]^2$$

## **ELECTRIC CIRCUITS**

$$\text{power} = \text{voltage} \times \text{current}$$

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

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

## **RADIOACTIVE MATERIALS**

$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

**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.**

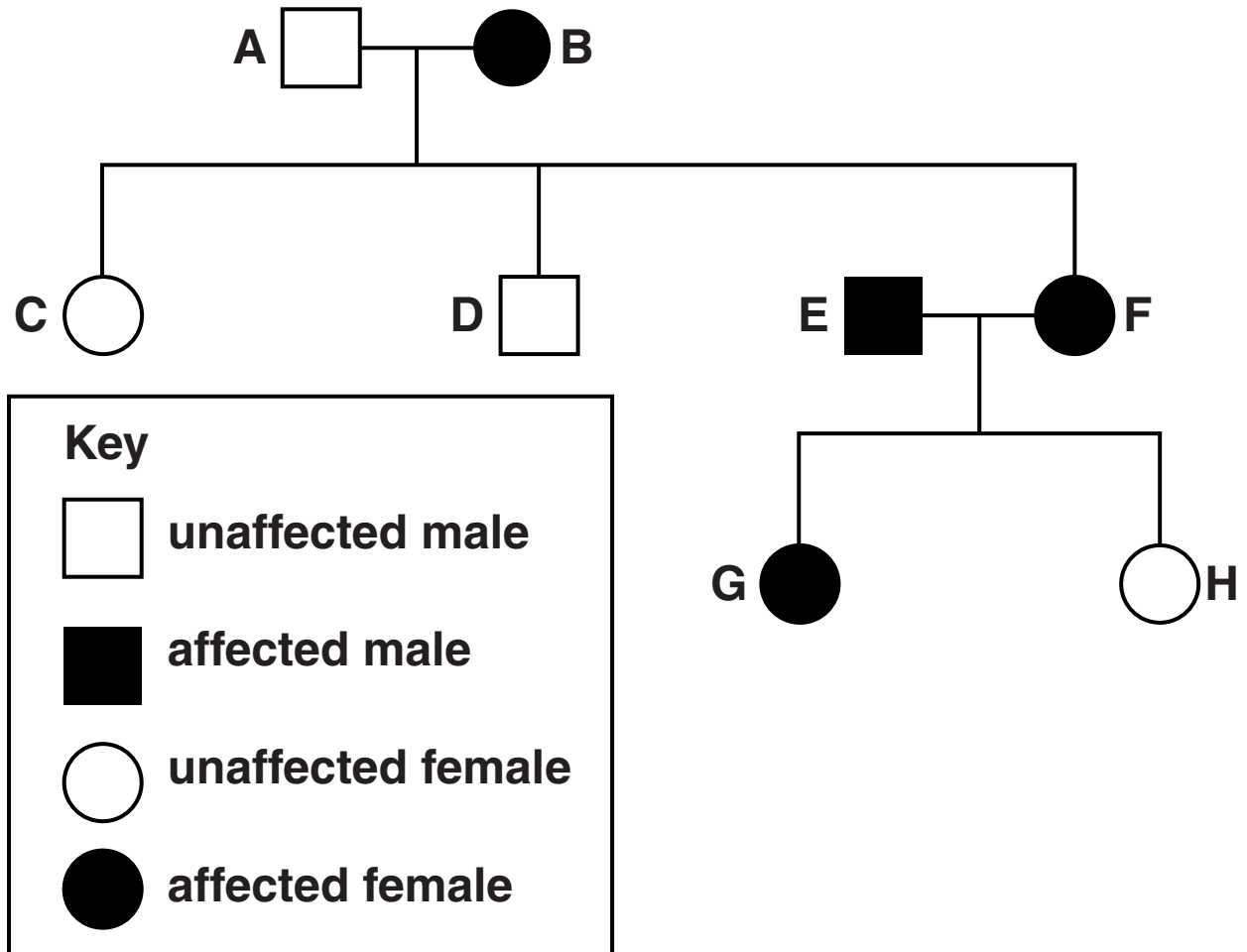
**If only one of these versions is**

**\_\_\_\_\_, 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.**





**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 the embryo selection process. The steps are not in the correct order.**

- 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. [2]**

**One has been done for you.**

			<b>A</b>			
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- (b) Discuss the possible implications of embryo selection, referring specifically to this example of saviour siblings.**



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[6]

**[TOTAL: 8]**

**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. [1]**

**individuals that have different characteristics**

☐

**individuals that have identical genes**

☐

**individuals that look the same**

☐

**individuals that show some variation**

☐

**(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.**

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

**(i) Describe the pattern shown by the data.**

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**[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. [1]

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.

☐

- (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]**



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#### **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 opposite.**

**Draw a straight line from each FORMULA to HOW IT IS MADE.**

**Draw a straight line from each FORMULA to WHY IT IS HARMFUL. [2]**

## how it is made

## formula

## why it is harmful

carbon  
atoms in the  
fuel burning  
in plenty of  
air

CO

causes  
acid rain

carbon  
atoms in the  
fuel burning  
in a limited  
supply of air

CO<sub>2</sub>

lowers the  
amount  
of oxygen  
blood can  
carry

sulfur atoms  
in the fuel  
reacting  
with oxygen  
atoms in the  
fuel

SO<sub>2</sub>

major  
contributor  
to global  
warming

sulfur atoms  
in the fuel  
reacting  
with oxygen  
atoms from  
the air

settles on  
surfaces  
making  
them dirty

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

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**[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. [1]**

**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.**

☐

**[TOTAL: 5]**

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

**(a) Look at the graphs on Insert A 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.**

**(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. [2]**

	true	false
<b>Pollution doubles every 50 years if all new cars run on petrol.</b>		
<b>Pollution decreases between 2030 and 2080 if all new cars run on biofuels.</b>		
<b>There is no difference in pollution between the two fuels until 2040.</b>		
<b>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.</b>		

- (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? [1]**

**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.**

☐

**[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:**

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

**(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]**

**7 Read the article on Insert B.**

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

**(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? [2]**

**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.**

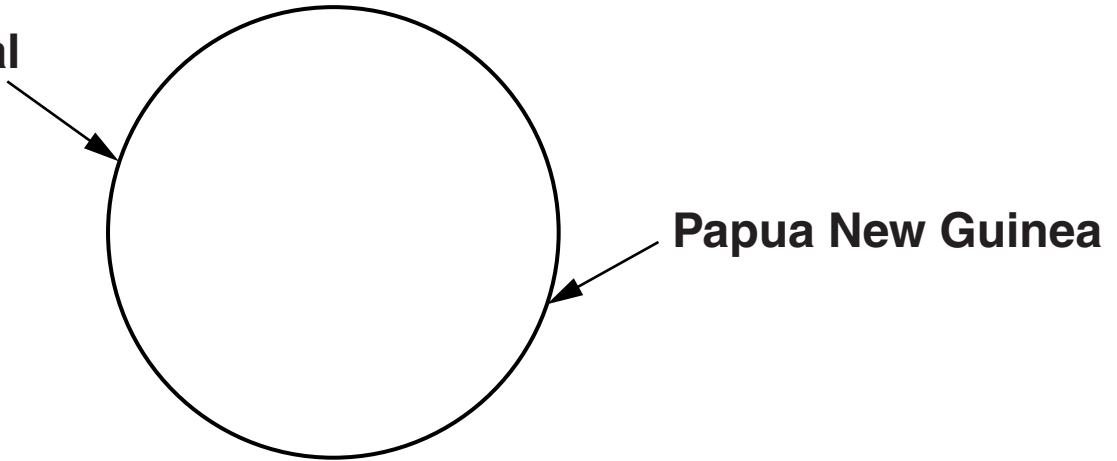
☐

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

☐

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

Earthquake  
detector  
in Senegal



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? [2]

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.

☐

[TOTAL: 7]

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

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

- (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. [2]**

**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.**

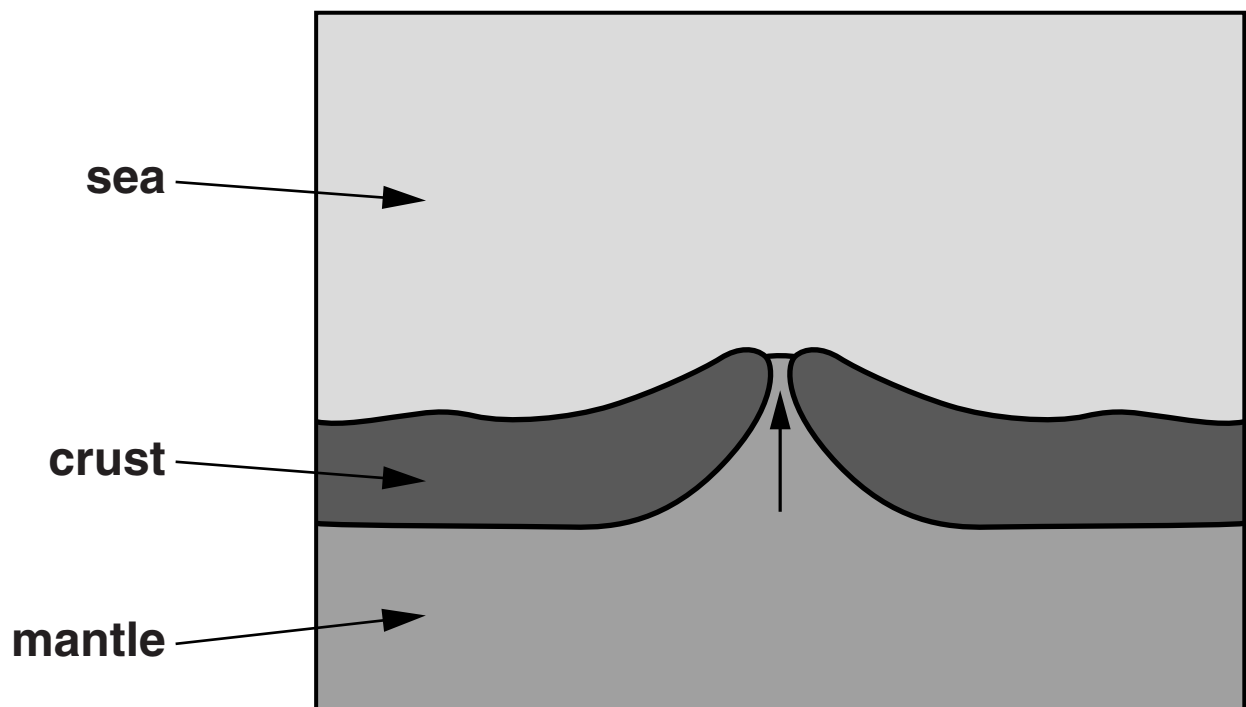
☐

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

☐

**[TOTAL: 7]**

- 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.**





**[Total: 6]**

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