THIS IS A NEW SPECIFICATION

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RECOGNISING ACHIEVEMENT

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Monday 21 May 2012 – Morning

GCSE TWENTY FIRST CENTURY SCIENCE ADDITIONAL SCIENCE A

A151/02 Modules B4 C4 P4 (Higher Tier)

A135720612

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

A151102

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 physics equations is printed on page 2.
- The Periodic Table is printed on the back page.
- The total number of marks for this paper is **60**.
- This document consists of **24** pages. Any blank pages are indicated.

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

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

Explaining motion

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

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

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

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

Electric circuits

power = voltage × 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

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

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Question 1 begins on page 4

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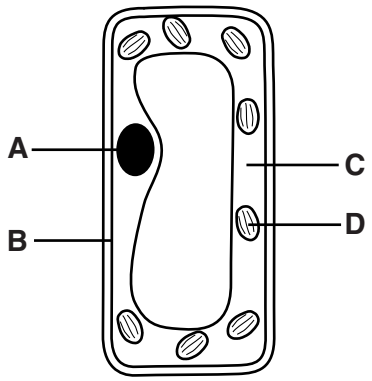
Answer **all** the questions.

1 **(a)** Here is a diagram of a cell from the leaf of a plant.



The structures shown in the diagram have different roles in photosynthesis.

Identify the structures and describe their roles in photosynthesis.

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

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..... **[6]**

(b) Paul is investigating photosynthesis.
He grows several samples of cress.

(i) Paul uses the mass of the cress as a measure of the rate of photosynthesis.

Why can the mass of cress be used as a measure of the rate of photosynthesis?

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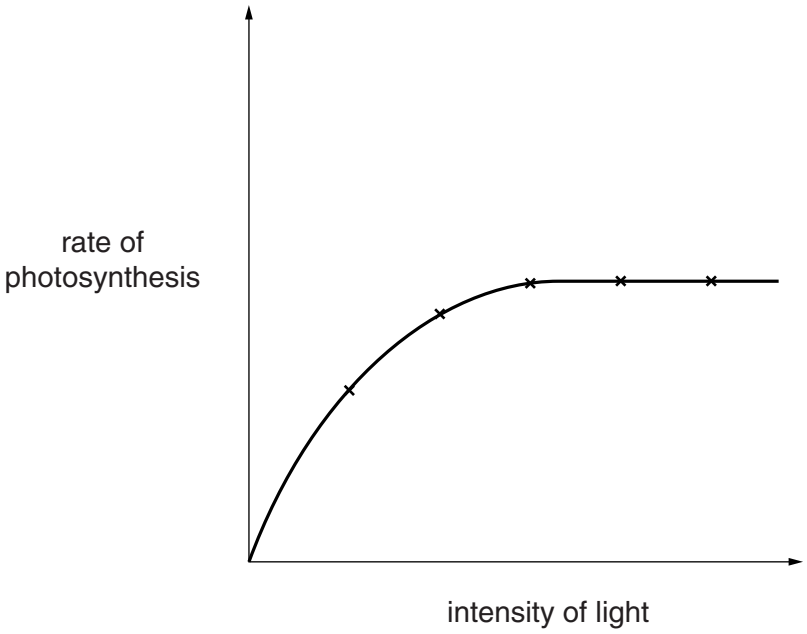
..... **[2]**

(ii) Each sample receives a different intensity of light.
Paul plots his results in a graph.



Paul repeats his experiment but this time gives all of the plants **more** carbon dioxide.
His results are different from the first experiment.

Draw a line on the graph to show how the results would be different. **[1]**

(iii) Paul has to control factors other than the amounts of light and carbon dioxide in this experiment.

Suggest one **other** factor and explain how failing to control it would affect his experiment.

factor .....

explanation .....

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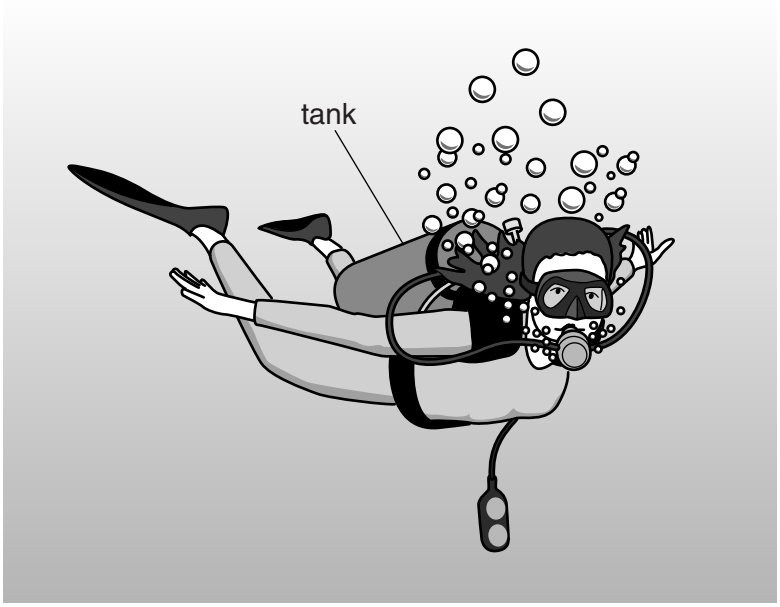
..... **[2]**

[Total: 11]

2 Caitlin goes scuba diving.



When she is at rest on the surface, Caitlin breathes in 4 litres of air every minute.

(a) (i) She takes 5% of this air into her blood as oxygen.

What volume of oxygen from the air enters Caitlin's blood in one minute?

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

(ii) Caitlin has a full tank of air, which gives her 30 litres of **oxygen**.

How long will she be able to stay under water if she uses oxygen at the same rate?

answer ..... minutes **[2]**

(b) While she is underwater, Caitlin swims against strong currents.

Use your knowledge of respiration to explain how this could affect how long she can now stay under water.

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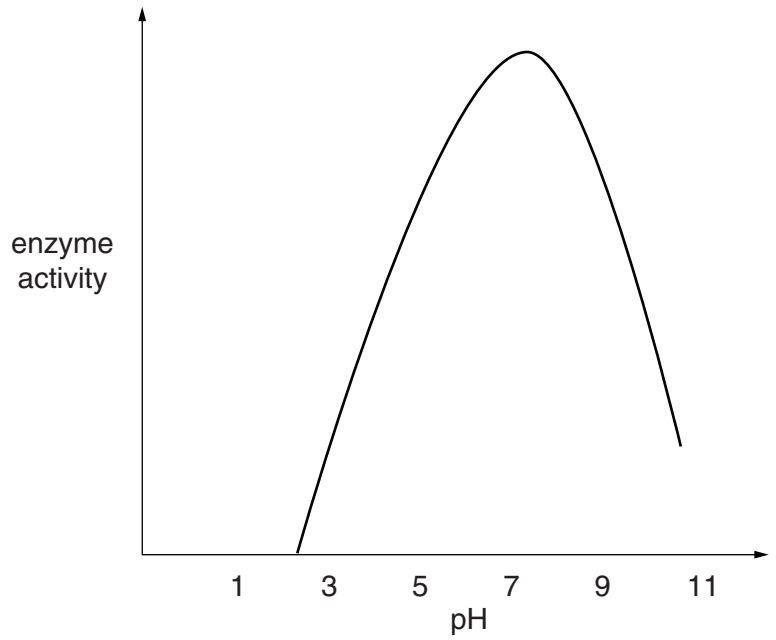
..... **[2]**

[Total: 5]

3 This question is about enzymes.
Enzyme **Y** helps to digest some foods in the small intestine.
Some people are unable to make enzyme **Y** in their small intestines.

(a) The activity of enzyme **Y** at different pH levels is measured.
The results are plotted on this graph.



Food goes through the stomach before it enters the small intestine.
The pH in the stomach is 2.

The pH in the small intestine is 7.5.

Use the graph to explain if scientists should develop a pill containing enzyme **Y** for people to swallow.

Use ideas about the active site in your answer.

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

(b) One group of scientists claim to be the first to repair cells that can not make enzyme **Y**. They make their claim in a newspaper.

Other scientists question this claim.

What are the reasons for this?

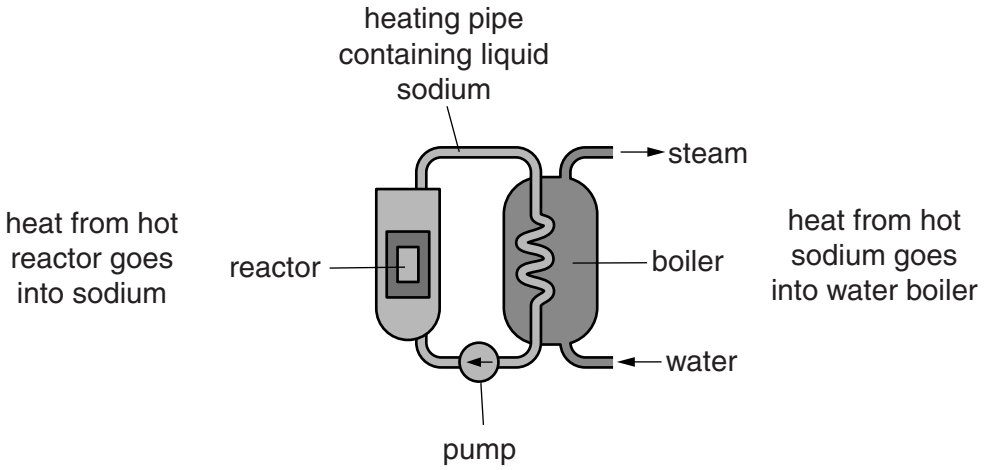
Put ticks (✓) in the boxes next to the **two** correct answers.

It costs a lot of money to make enzymes.	☐
The work has not been peer reviewed.	☐
The cells were taken from a rat.	☐
The process has only been done in single cells.	☐
The enzyme is only 95% effective.	☐
The test has not been repeated by other scientists.	☐

[1]

[Total: 4]

4 In some nuclear power stations sodium is used to carry the heat from the reactor to the boiler. Heat from the hot sodium turns the water in the boiler into steam.



The sodium must be melted so that it can flow through the pipes.

Sodium is a Group 1 metal.
Here is some information about Group 1 metals.

	Melting point	**Boiling point**
Lithium	180 °C	1342 °C
Sodium		883 °C
Potassium	63 °C	760 °C

(a) Estimate the melting point of sodium.

answer ..... °C **[1]**

(b) A student thinks that using sodium in a nuclear power station might cause problems.

He has two **reasons**

- the melting point makes it difficult to use sodium in pipes
- the sodium might be dangerous if the pipes leak inside the boiler.

Suggest and explain what these problems might be.

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

(c) When sodium reacts it makes a positive ion.

What happens when an atom changes into a **positive** ion?

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

[Total: 5]

5 Sodium reacts with chlorine to make sodium chloride.

(a) Complete the balanced symbol equation for this reaction.

..... + Cl_2 → ..... **[2]**

(b) A group of students describe what happens when sodium chloride crystals dissolve in water.

Some of these statements are true, and some are false.

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

When sodium chloride crystals dissolve in water …

	true	**false**
… the ions move freely.	☐	☐
… the ions turn into atoms.	☐	☐
… hydrogen gas is made.	☐	☐
… the solution conducts electricity.	☐	☐
… the ions separate from each other.	☐	☐
… the crystals float on the surface and react.	☐	☐

[2]

(c) Salt crystals from sea water are impure. They contain sodium chloride and also compounds of other elements.
We can find out what other elements are present by using a spectroscope.

Explain how the results of spectroscopy show that sodium and other elements are present.

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

(d) Complete the table about the particles in an atom of sodium.

Use the Periodic Table to help you.

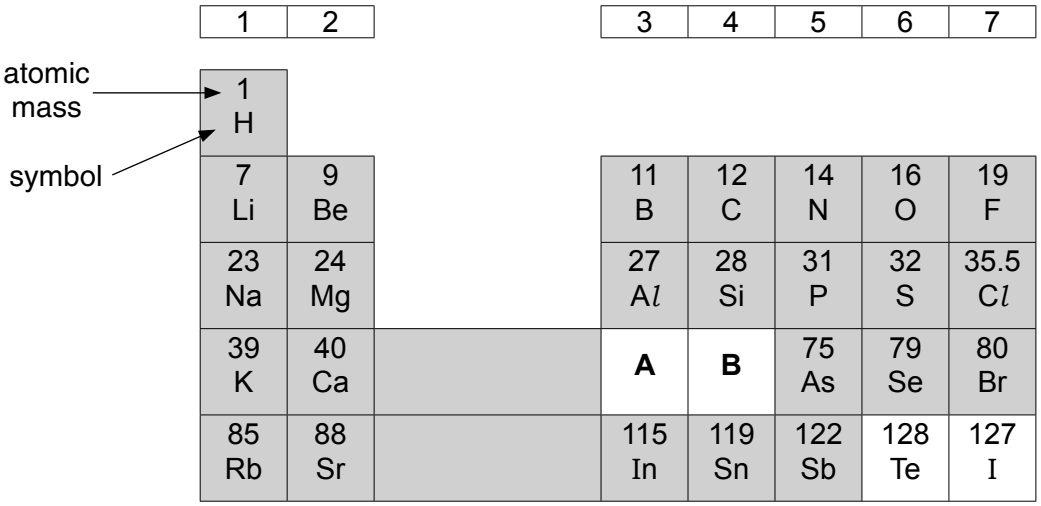
Particle	Number in an atom of sodium
electron	.....
proton	.....
.....	12

[2]

[Total: 9]

6 Mendeleev put all the elements that he knew about into a Periodic Table.
He used increasing atomic mass as the basis for his table.

Here is part of Mendeleev's table.



1	2				3	4	5	6	7
1 H									
7 Li	9 Be				11 B	12 C	14 N	16 O	19 F
23 Na	24 Mg				27 A*l*	28 Si	31 P	32 S	35.5 C*l*
39 K	40 Ca				**A**	**B**	75 As	79 Se	80 Br
85 Rb	88 Sr				115 In	119 Sn	122 Sb	128 Te	127 I

Mendeleev made important decisions about
- positions **A** and **B**
- elements Te and I.

Describe these decisions and explain why Mendeleev took them.

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

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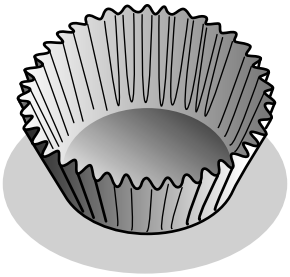
[Total: 6]

7 Jim investigates how paper cake cases fall through the air.
He thinks that they fall at a steady speed.



Jim releases the same cake case at different heights above the floor.
He times how long it takes for it to reach the floor.
Here are some of his results.

Height of drop in m	Time of fall in s	Speed in m/s	Average speed in m/s
1.00	2.00	0.500	.....
1.00	2.05	0.488	
1.00	1.90	0.526	
0.50	1.07	0.467	0.489
0.50	0.98	.....	
0.50	1.02	0.490	

(a) (i) Complete the **two** gaps in the table. **[2]**

(ii) Use the data in the table to comment on Jim's idea that the cake cases fall at a steady speed.

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

(b) For each height, Jim measures the time of fall more than once.
The measurements are not the same.

Suggest **two** reasons why.

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

[Total: 5]

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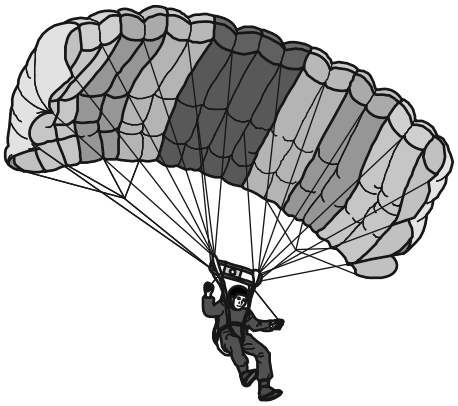
8 Ben uses a parachute to fall to the ground at a safe, steady speed.



Discuss the energy transfers which allow Ben and his parachute to drop at a steady speed.

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

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..... **[6]**

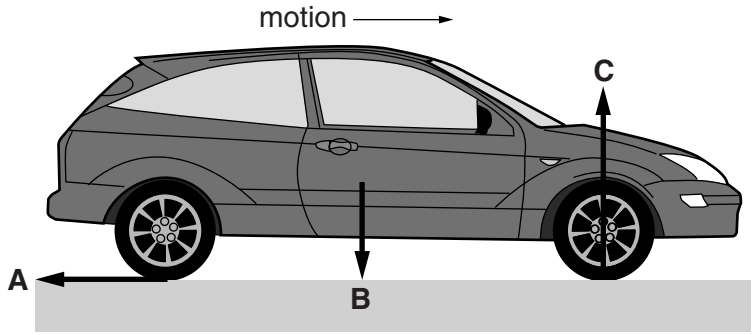
[Total: 6]

9 A car with a mass of 800 kg travels at a speed of 15 m/s on level ground.

(a) Calculate the braking force needed to stop the car in 2 s.

force = ... N **[2]**

(b) The brakes are applied so that all four wheels lock and the car skids to a halt.
The diagram shows three forces, **A**, **B** and **C**, acting on the car as it slows down.



(i) Draw lines to link each **force** with its **name**.

force	name
A	mass of entire car
	weight of entire car
B	friction on one wheel from the ground
	reaction on one wheel from the ground
C	force on one wheel from the engine

[2]

(ii) Here are some relationships between the forces while the car is skidding to a stop on level ground.

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

B – **C** = **A** ☐

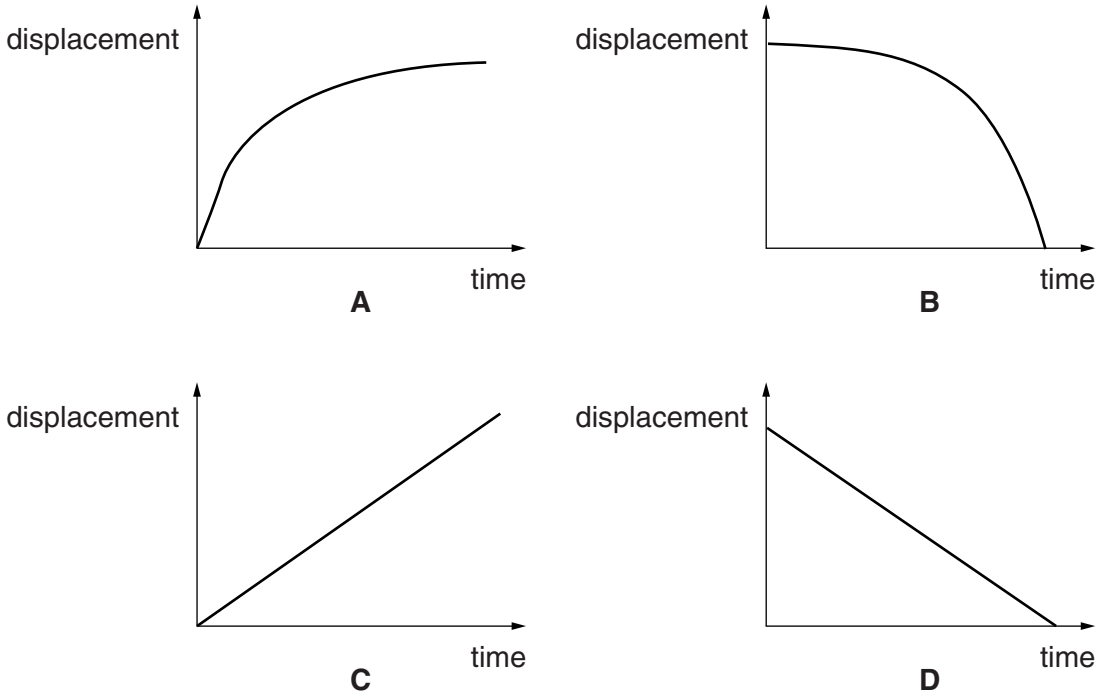
B – 4**C** = 0 ☐

B + **C** = **A** ☐

A + **B** + **C** = 0 ☐

[1]

(c) Here are four possible displacement-time graphs for the car as it slows down.

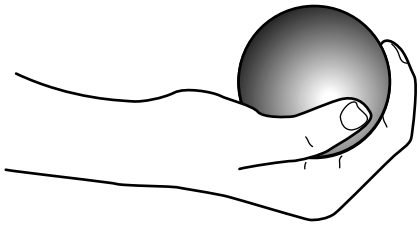


Which graph, **A**, **B**, **C** or **D**, is correct for a car which is slowing down?

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

[Total: 6]

10 Jill throws a ball into the air.
She catches it when it comes down again.



(a) Here are some statements about the ball in its flight.

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

The resultant force on the ball is downwards throughout the flight.	☐
The resultant force on the ball is zero at the highest point of the flight.	☐
Air resistance and gravity act in the same direction throughout the flight.	☐
The resultant force on the ball is upwards as it rises and downwards as it falls.	☐

[1]

(b) When Jill catches the ball, she allows her hand to move down with the ball.

Explain what effect this action has on the impact force of the ball on her hand.

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[Total: 3]

END OF QUESTION PAPER

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The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.