

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GCSE**

A151/02

**TWENTY FIRST CENTURY SCIENCE
ADDITIONAL SCIENCE A**

Modules B4 C4 P4 (Higher Tier)

WEDNESDAY 5 JUNE 2013: Afternoon

DURATION: 1 hour

plus your additional time allowance

MODIFIED ENLARGED 24pt

Candidate forename		Candidate surname	
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Centre number						Candidate number				
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**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)

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 physics equations is printed on pages 4–6.**
- **The Periodic Table is printed on page 47.**
- **The total number of marks for this paper is 60.**
- **Any blank pages are indicated.**

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

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

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

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

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

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

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

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

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

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

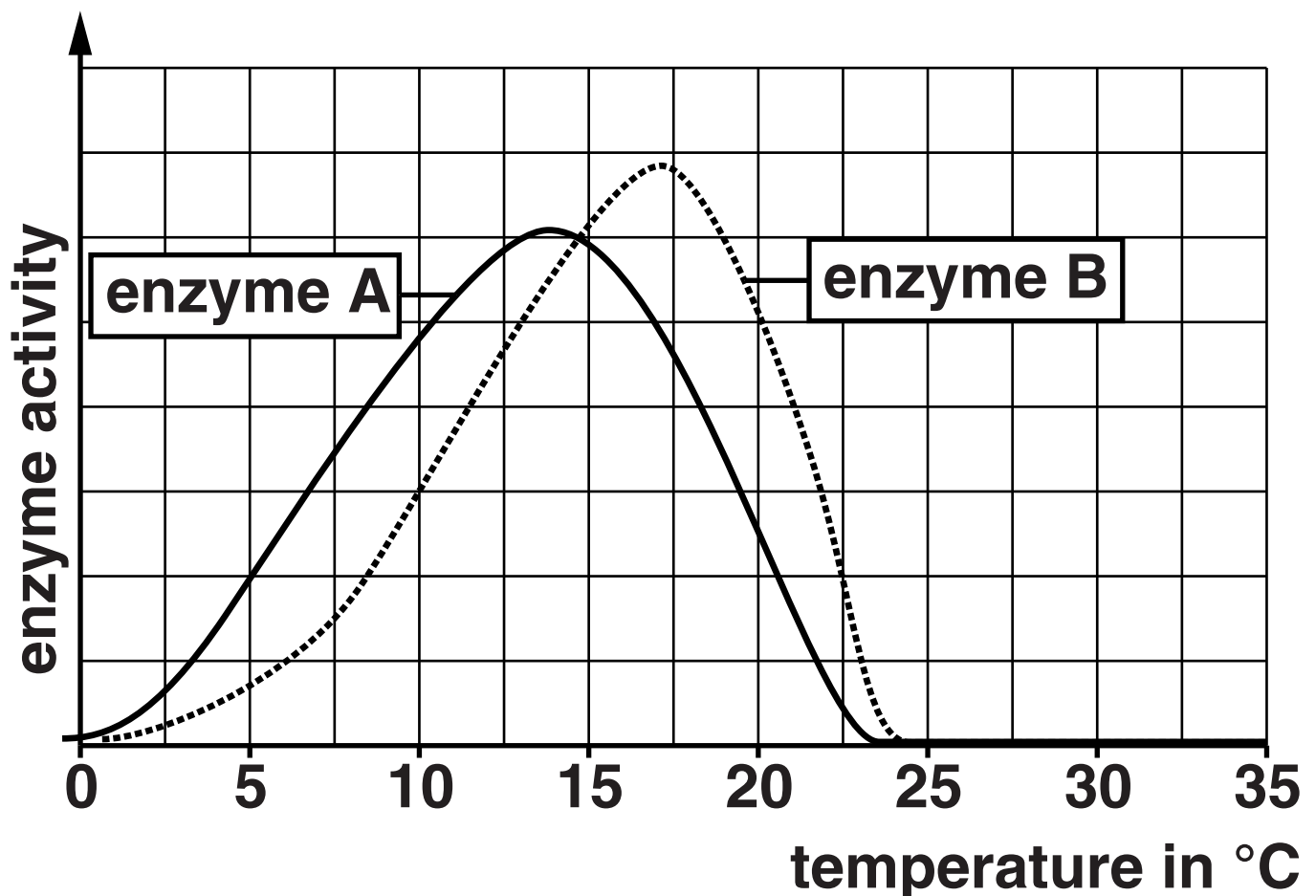
$$\text{energy} = \text{mass} \times [\text{speed of light in a vacuum}]^2$$

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Answer ALL the questions.

- 1 Scientists study two enzymes, A and B. Both enzymes have the same substrate.**

The graph shows the activity of each enzyme over a range of different temperatures.



[6]

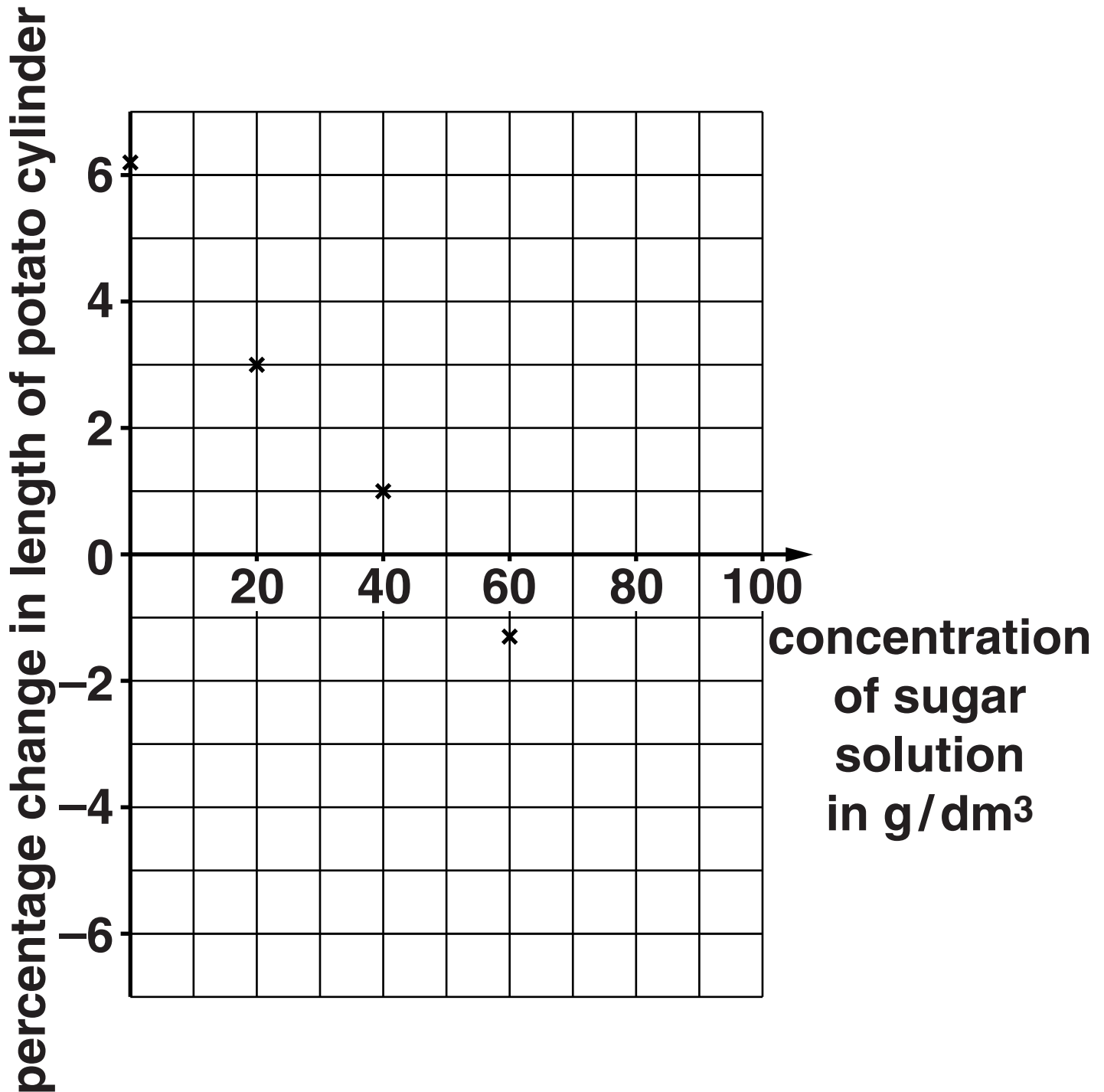
[6]

[TOTAL: 6]

- 2 Karen investigates osmosis using potato cylinders.**
She cuts six potato cylinders, each 50 mm long.
She places each potato cylinder in a different concentration of sugar solution.
After 60 minutes, she removes the potato cylinders and measures the length of each one.

Concentration of sugar solution in g/dm³	% change in length of potato cylinder
0	+6.2
20	+3.0
40	+1.0
60	-1.3
80	-4.4
100	-6.6

- (a) Plot a graph of these results on the axes and draw a straight line of best fit.
Four points have been done for you.



[1]

(b) What is the concentration inside the potato cells at the start of the experiment?

Justify your answer.

[2]

(c) Explain how Karen could improve her experiment to increase confidence in the conclusion.

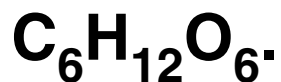
[2]

[TOTAL: 5]

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3 Paul studies how plants make glucose by photosynthesis.

The chemical formula for glucose is



(a) Write a balanced symbol equation for the process of photosynthesis.

+ _____

→ $\text{C}_6\text{H}_{12}\text{O}_6$ + _____

[2]

(b) Some of the glucose produced by photosynthesis is used to make other chemicals in plant cells.

One of these other chemicals is the amino acid proline, $C_5H_9NO_2$.

From this formula Paul concludes that one molecule of glucose is the only thing needed to make one molecule of proline.

Paul is wrong.

Explain TWO reasons why.

[3]

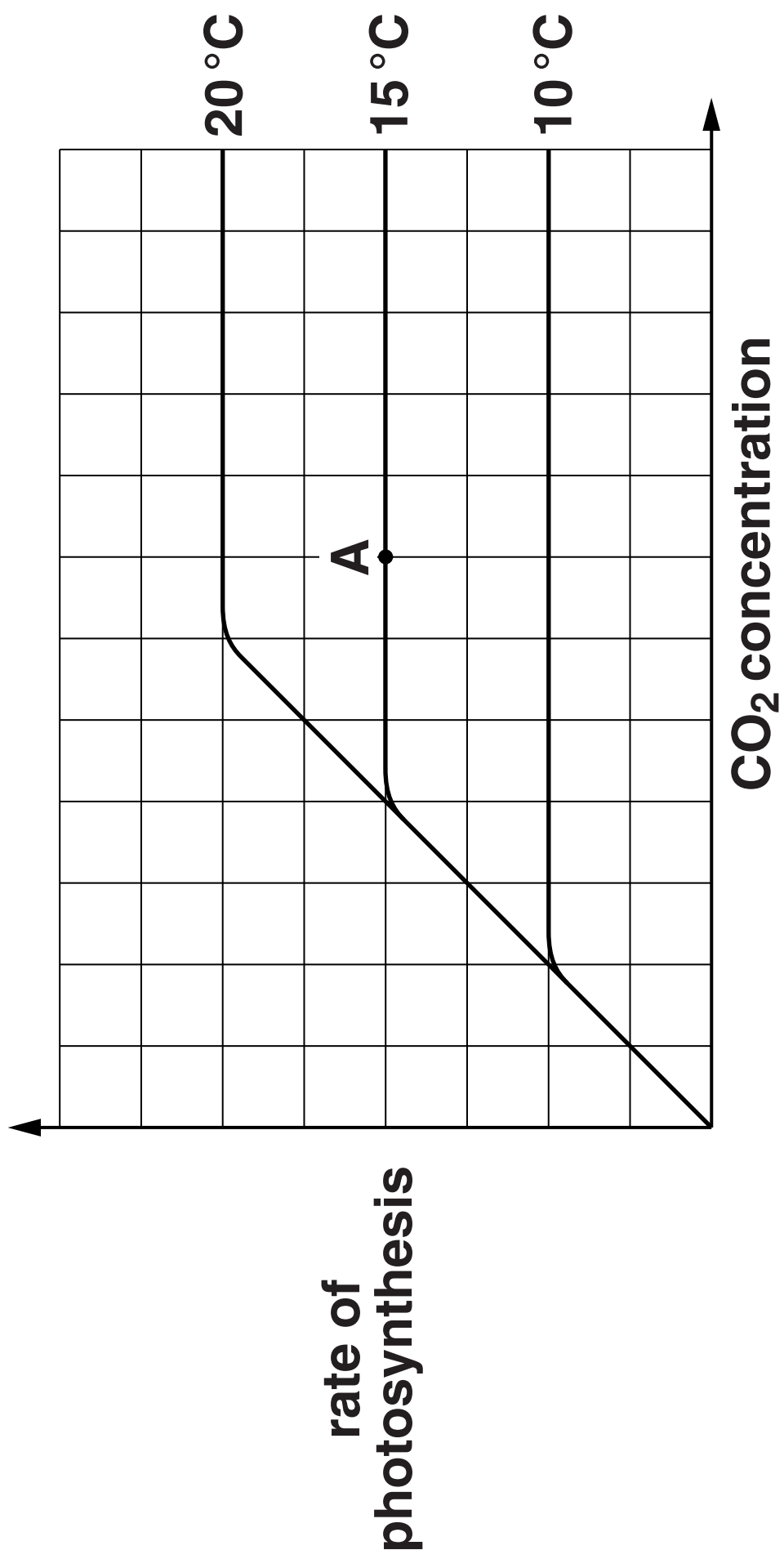
(c) Paul investigates the rate of photosynthesis at different concentrations of carbon dioxide at three different temperatures. The light intensity is kept constant. The results are plotted on the graph opposite.

The rate of photosynthesis can be affected by several limiting factors.

What is the limiting factor at point A?

Explain your answer.

[2]



(d) Paul makes these statements about his results.

Two of the statements can be concluded from Paul's results shown in the graph.

The other two statements require further research.

Put a tick (✓) in each row to complete the table.

	Can be concluded	Needs further research
Photosynthesis will slow down if there is not enough carbon dioxide.		
The overall rate of photosynthesis is due to a combination of three factors.		
Plants must take in carbon dioxide by diffusion.		
More than just the carbon dioxide concentration affects the rate of photosynthesis.		

[2]

[TOTAL: 9]

**4 Nigella puts a substance into a flame.
She photographs its spectrum.**

sample

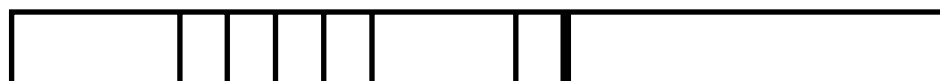


**Nigella thinks that the substance
contains sodium compounds and
potassium compounds.**

**Jo thinks it contains sodium
compounds, but no potassium
compounds.**

They look up some spectra in a book.

sodium



potassium



Who is correct? Explain your answer.

[3]

[TOTAL: 3]

5 The halogens are very reactive. This is because of the way that the nucleus holds the electrons around each atom.

(a) The relative atomic mass of one type of chlorine is 37.

This chlorine atom has 17 electrons around the nucleus.

Use this information to decide how many protons and neutrons are in the nucleus of each chlorine atom.

protons _____

neutrons _____ [1]

(b) The electron arrangement is 2.8.7 for a chlorine atom.

The element fluorine is also a halogen.

What is the electron arrangement for a fluorine atom?

_____ **[1]**

(c) When halogens react with metals, the halogen atoms become charged.

Describe how the halogen atoms turn into charged particles.

_____ **[3]**

(d) A solution of chlorine reacts with a solution of potassium iodide. A solid is made.

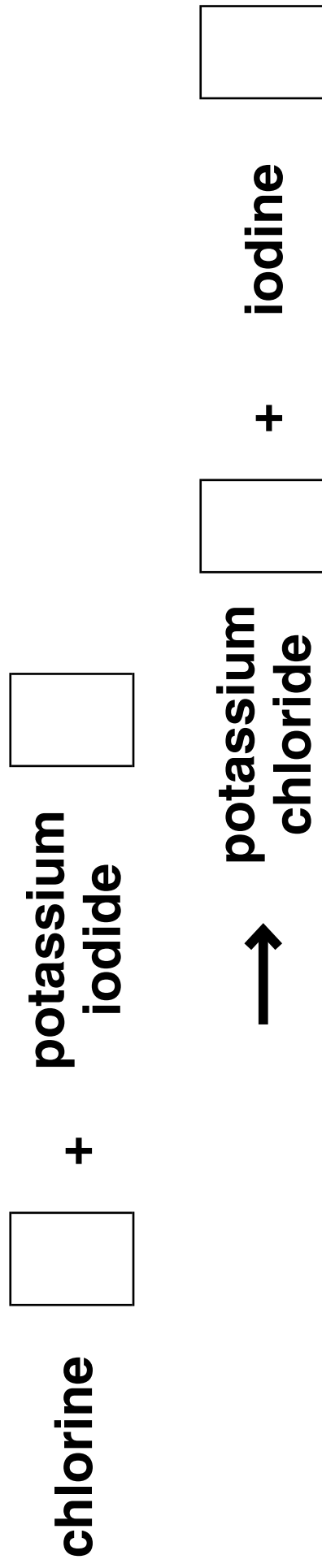
(i) Put state symbols in the boxes (opposite) for the word equation for this reaction. [1]

(ii) Write a balanced chemical equation for the reaction.

_____ **[2]**

(iii) Chlorine atoms are very reactive. The chloride ions in potassium chloride are not very reactive. Use your understanding of electrons to explain why chloride ions are much less reactive than chlorine atoms.

_____ **[2]**



(e) Potassium chloride solution conducts electricity.

Why is this?

Put a tick [✓] in the box next to the best reason.

Potassium is a metal and metals conduct.

☐

Potassium chloride is made of ions.

☐

The solution contains ions which can move.

☐

The water conducts the electricity.

☐

[1]

[TOTAL: 11]

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6 In 1869, Mendeleev arranged the known elements into his Periodic Table.

Two new elements were discovered a few years later.

After these discoveries scientists started to agree with Mendeleev's table.

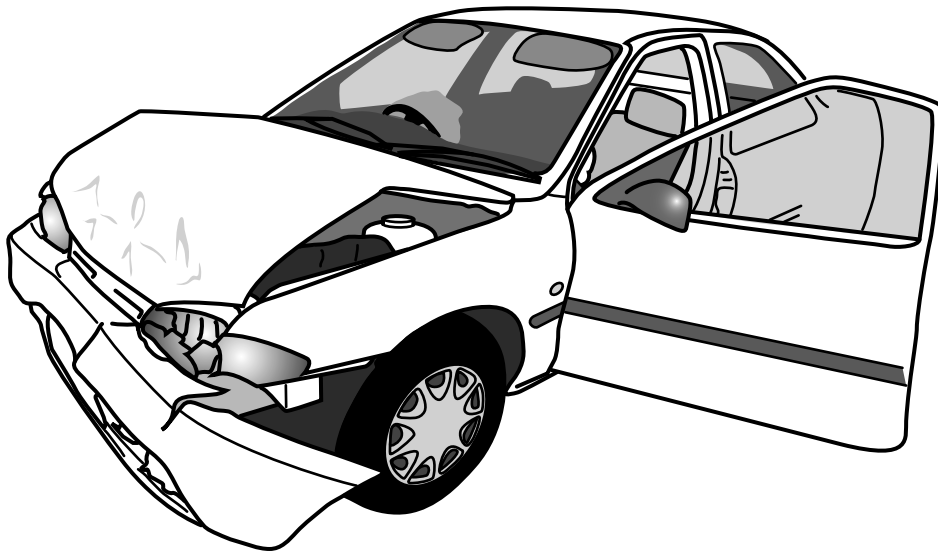
Suggest why the discovery of these two new elements helped his Periodic Table to become accepted. [6]



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

[TOTAL: 6]

7 Modern cars are built with larger crumple zones than older cars.



Explain why larger crumple zones are more effective than small ones.



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

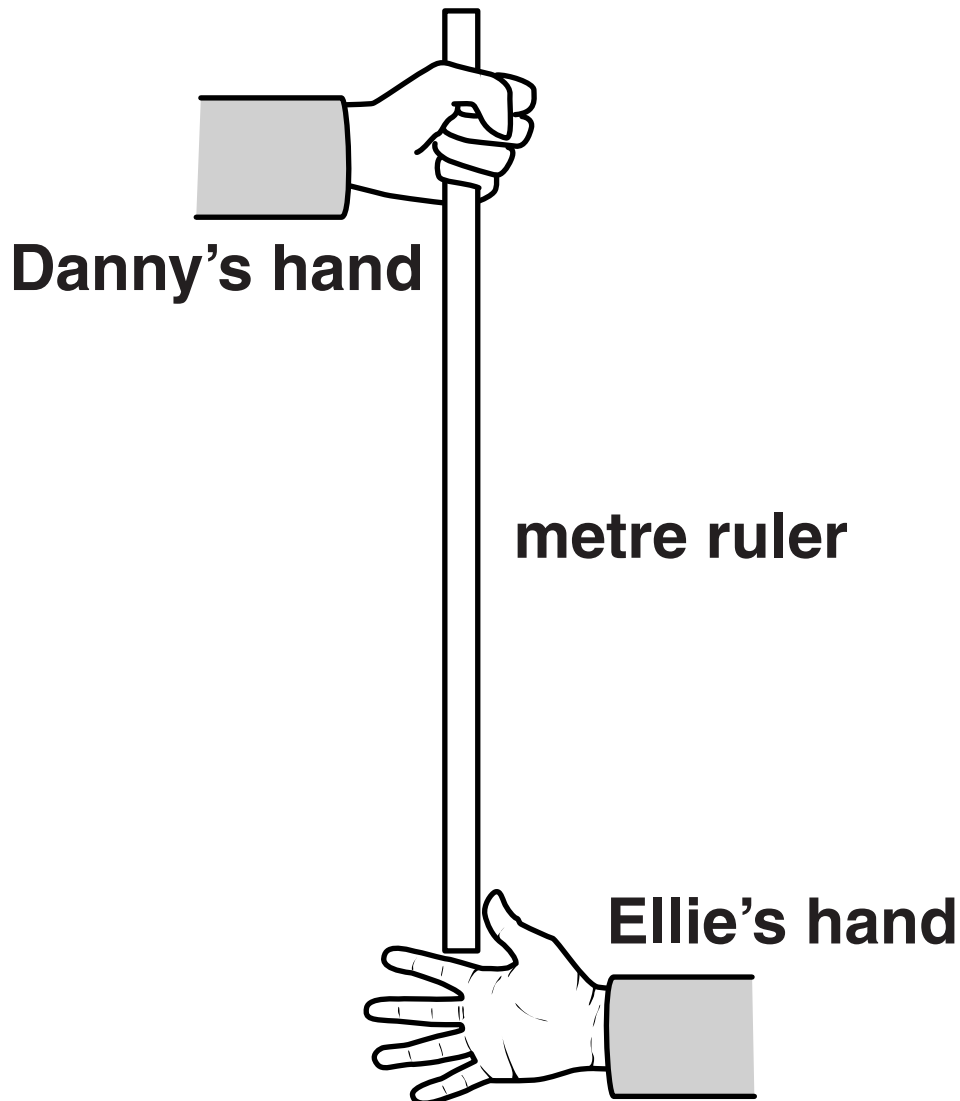
[6]

[6]

[TOTAL: 6]

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- 8 Danny holds a metre ruler above Ellie's open hand. She catches the ruler when he lets go of it without warning. They use the distance that the ruler falls to work out her reaction time.**



(a) Here are their results.

Test	Reaction time in seconds
one	0.29
two	0.18
three	0.22
four	0.19
five	0.21

Danny calculates the best estimate of the true value of her reaction time.

He uses

$$\frac{0.18 + 0.22 + 0.19 + 0.21}{4} = 0.20 \text{ s.}$$

Is he correct? Justify your answer.

[2]

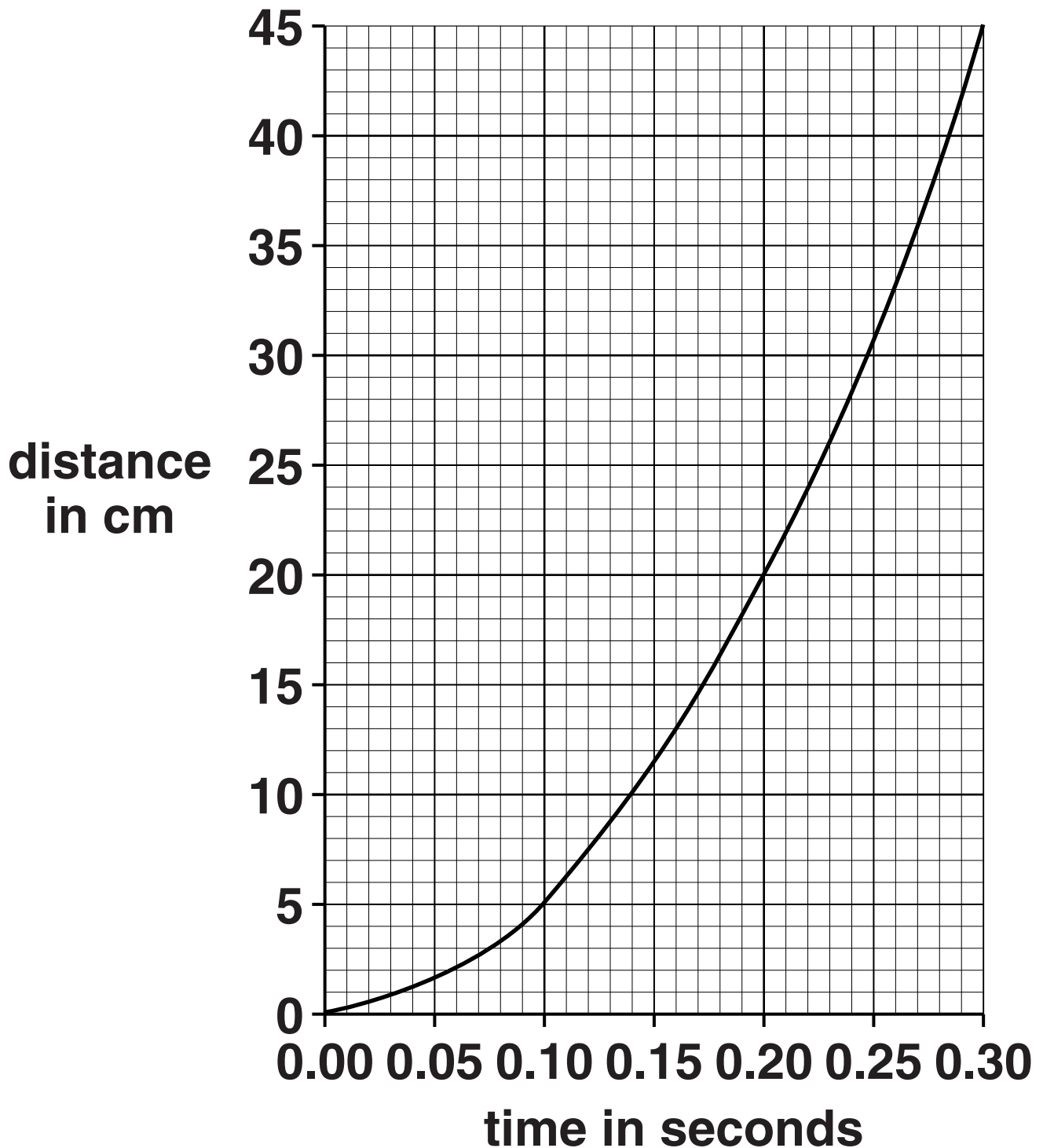
- (b) Ellie drinks an energy drink.
Half an hour later Danny measures
Ellie's reaction time again.
Here are their results.**

Test	Reaction time in seconds
six	0.18
seven	0.19
eight	0.16
nine	0.17
ten	0.20

**Does drinking the energy drink
affect Ellie's reaction time?
Justify your answer. Use data from
the tables.**

[3]

(c) Danny uses this graph to convert distance fallen by the ruler into a reaction time.



Explain how the graph shows that the ruler is speeding up as it falls.

[2]

[TOTAL: 7]

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9 A policeman uses a radar gun to measure the speed of a lorry moving towards him.

(a) He makes two speed measurements of the lorry.

The first measurement gives a speed of 31 m/s.

The second measurement gives a speed of 25 m/s.

The measurements are separated by 1.5 s.

Calculate the acceleration of the lorry.

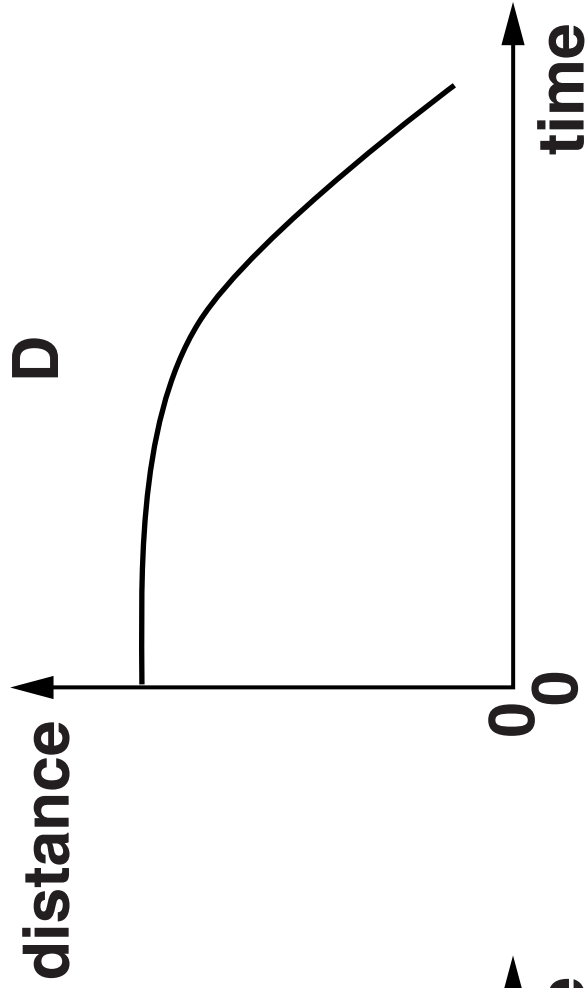
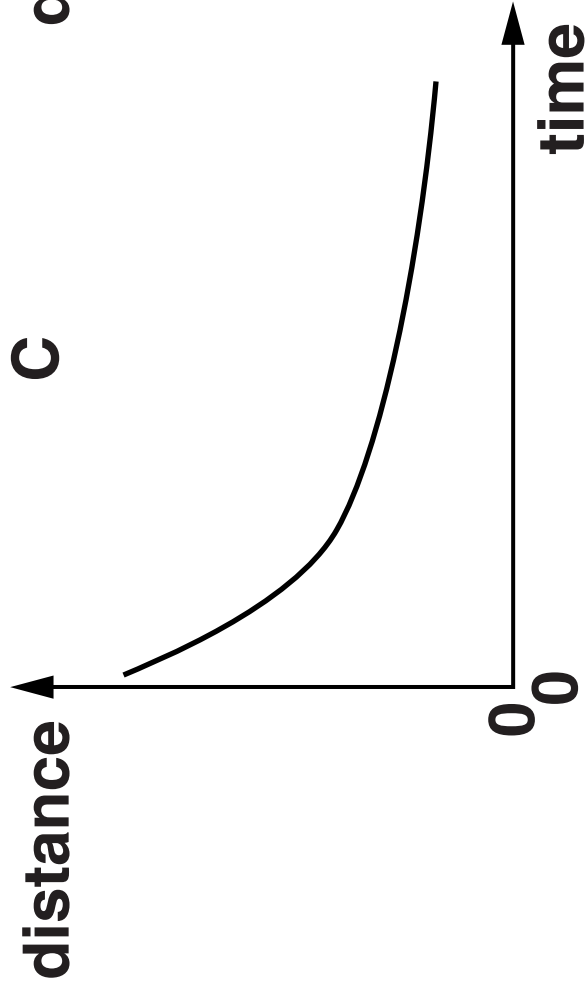
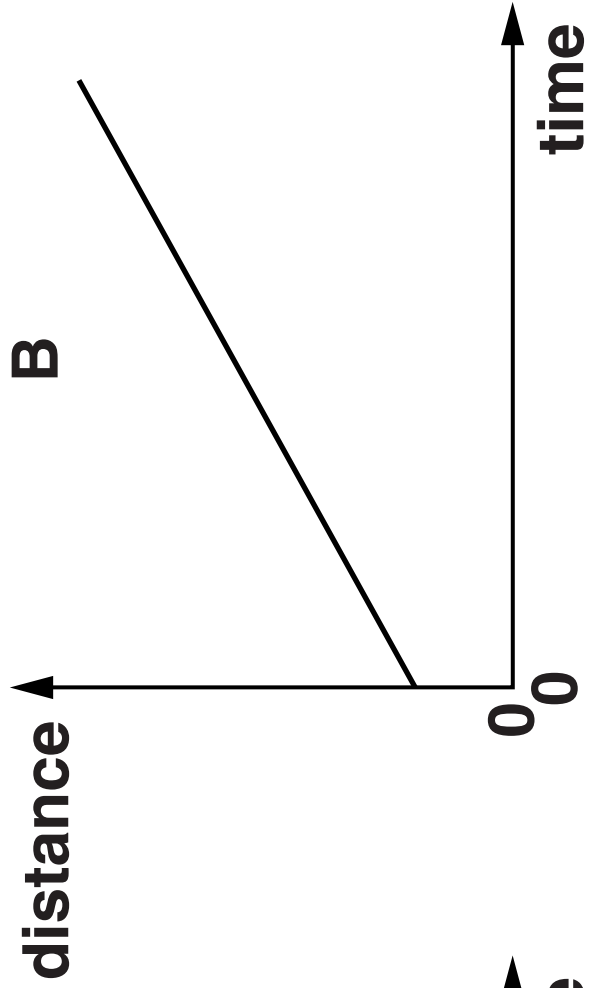
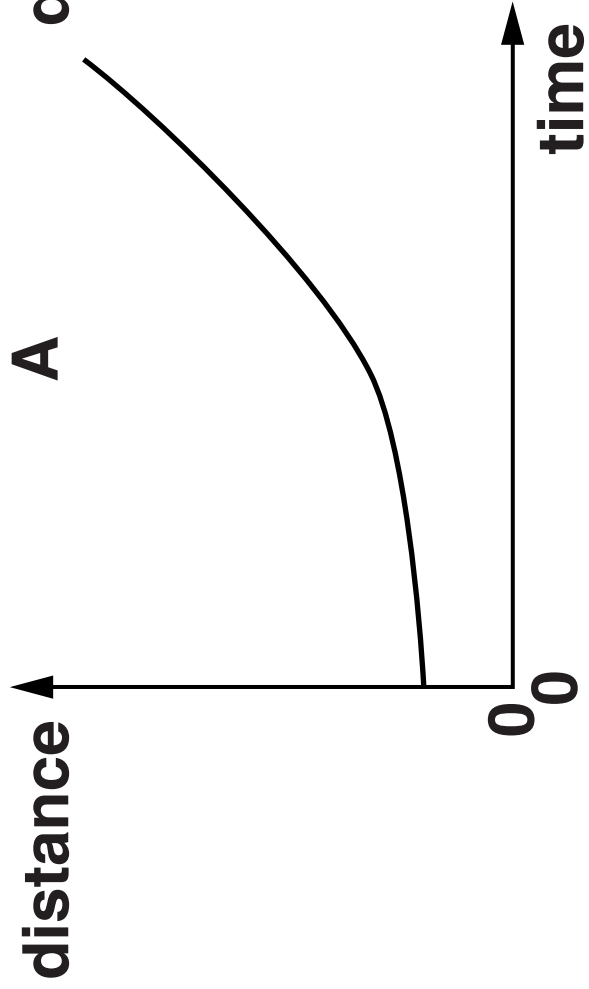
acceleration = _____ m/s² [2]

(b) Which of the distance-time graphs (opposite) shows the motion of the lorry?

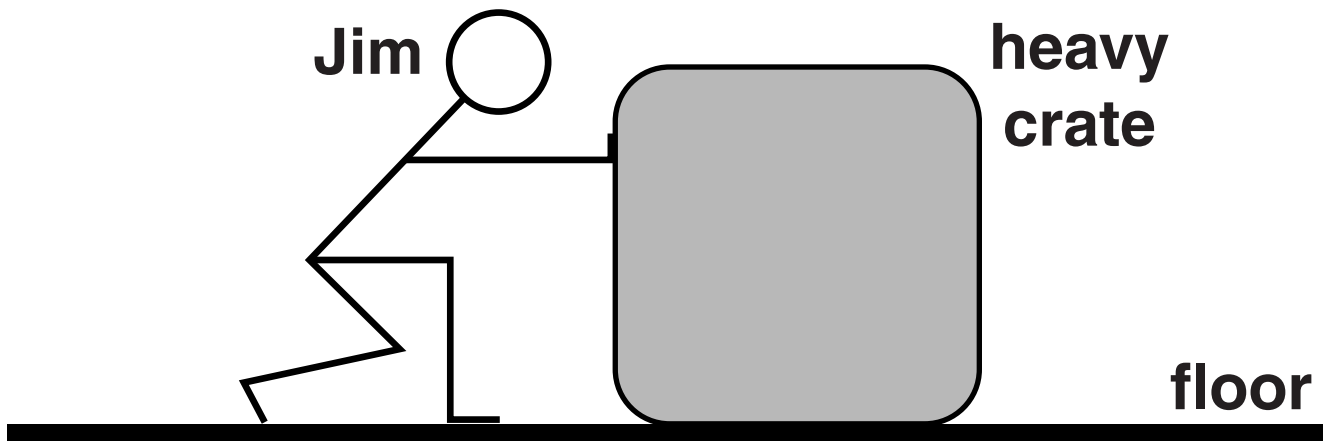
The distance is between the lorry and the policeman.

answer _____ [1]

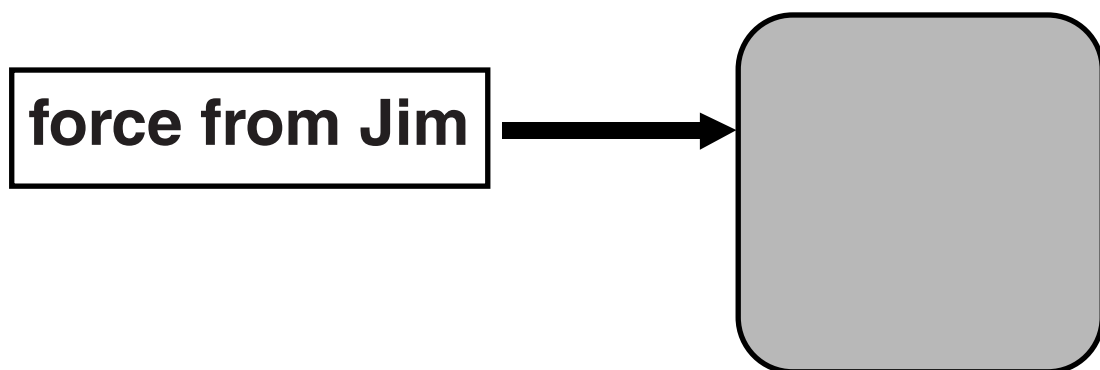
[TOTAL: 3]



10 Jim pushes a heavy crate across a level floor.



**(a) Four different forces act on the heavy crate.
One of them is shown below, acting to the right.**



**The force from Jim acts to the right.
Describe the other three forces
acting on the crate.**

[3]

**(b) Jim has a weight of 800 N.
He pushes ON the crate with a force
of 200 N, giving it a steady speed of
0.5 m/s.
The crate has a weight of 400 N and
a mass of 40 kg.
Draw ONE line to link the direction
of the force ON Jim from the crate to
its correct SIZE.
Draw another line to link the SIZE to
the correct EXPLANATION. [1]**

[TOTAL: 4]

END OF QUESTION PAPER

DIRECTION

up
left
right
down

SIZE

100 N
200 N
400 N
800 N

EXPLANATION

Force is equal to weight times speed.
The force is half of an interaction pair.
Jim is not leaning his weight against the crate.
The friction equals the weight for steady speed.

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The Periodic Table of the Elements

1	2	3										4	5	6	7	0		
		<div>1 H hydrogen 1</div>															<div>4 He helium 2</div>	
		Key																
		relative atomic mass atomic symbol name atomic (proton) number																
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							

* 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.

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