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 18pt

Candidate forename		Candidate surname	

Centre number						Candidate number				

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

DC (SJF/CGW) 1654723095 79999

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 4–5.**
- **The Periodic Table is printed on page 35.**
- **The total number of marks for this paper is 60.**
- **Any blank pages are indicated.**

BLANK PAGE

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

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

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

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

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

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

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

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

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

ELECTRIC CIRCUITS

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

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

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

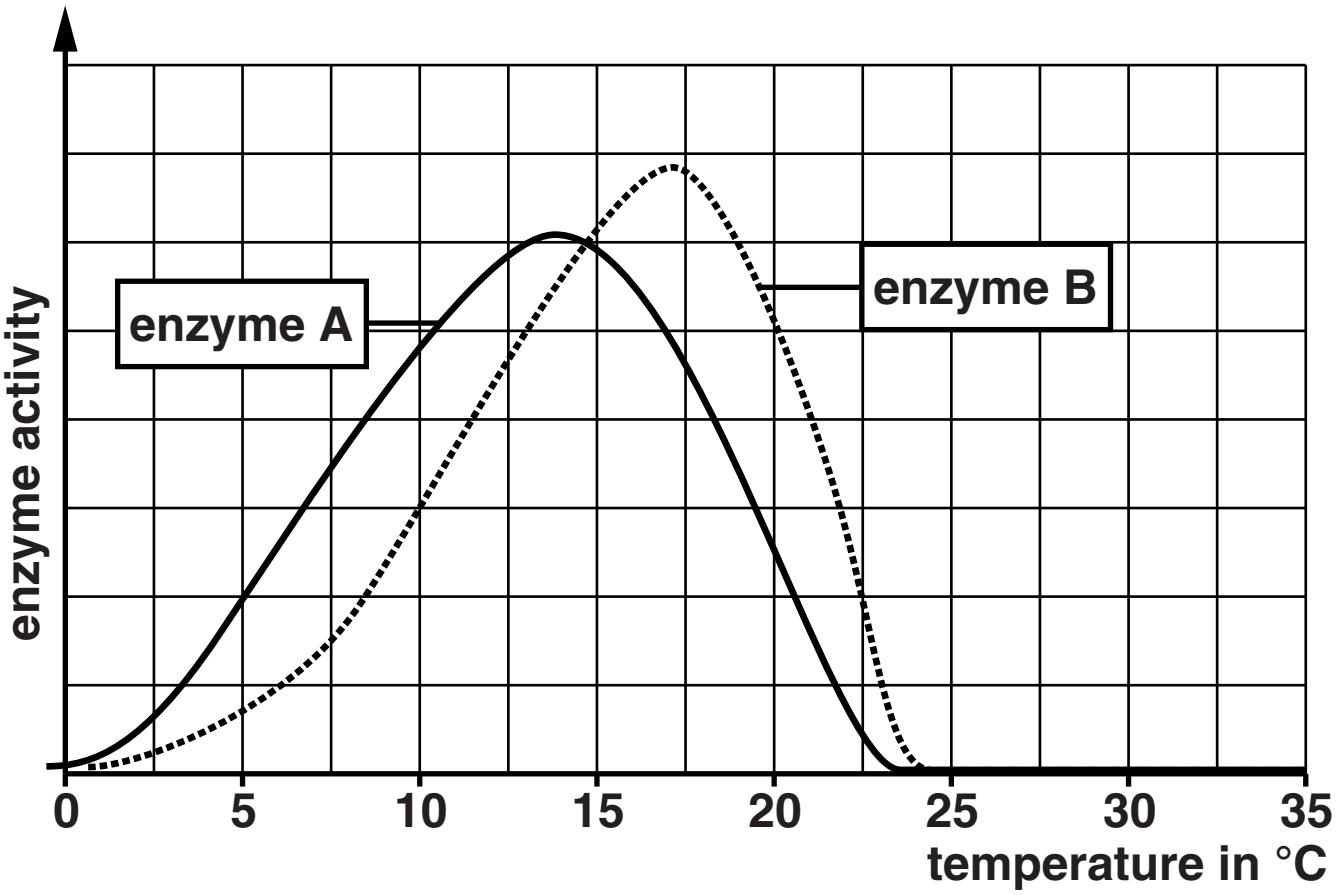
RADIOACTIVE MATERIALS

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

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.



Describe and explain the activity patterns of these two enzymes.

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

_____

_____

_____

_____

_____

_____

_____

_____

_____

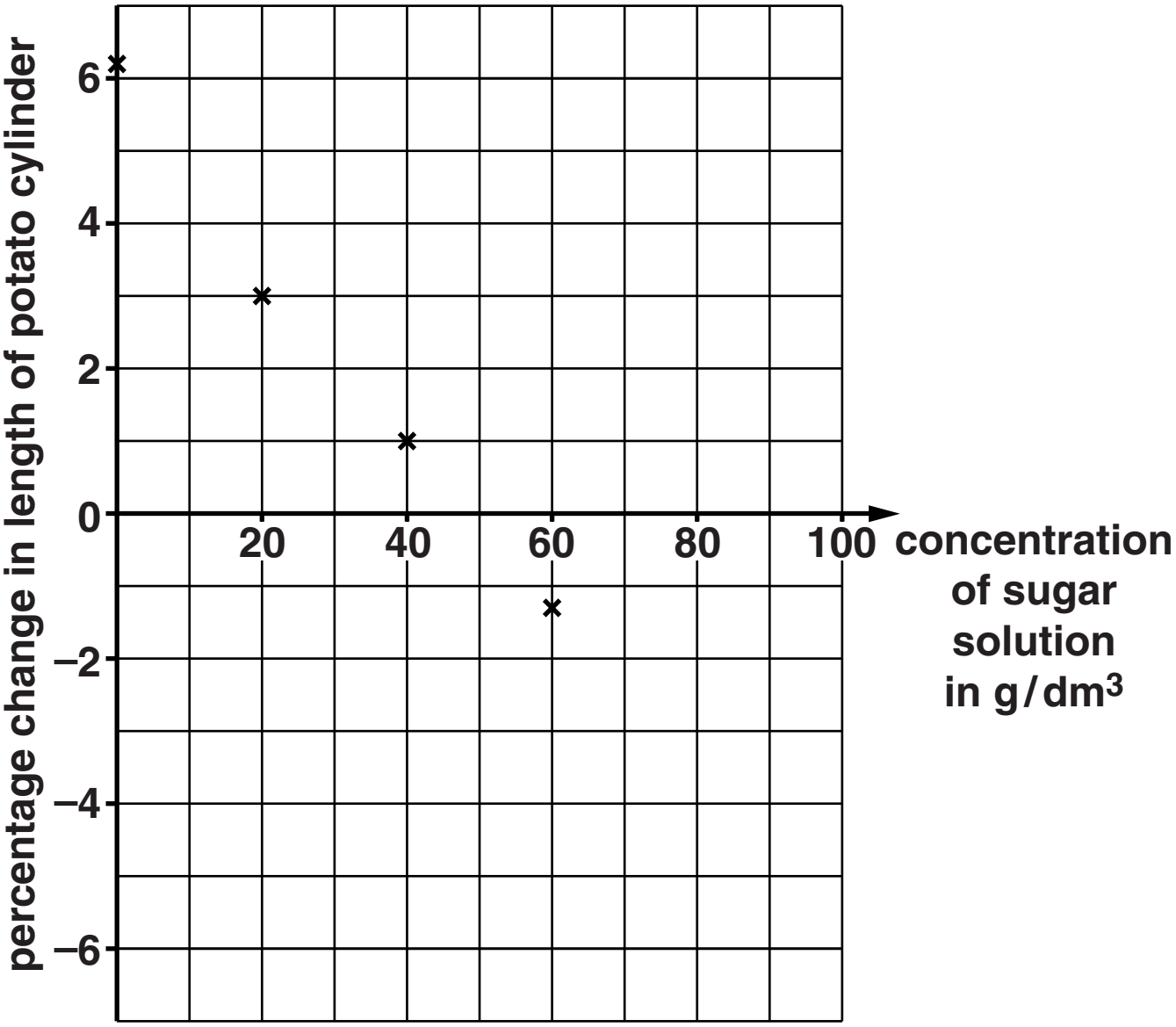
_____ **[6]**

[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/dm^3	% 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]

3 Paul studies how plants make glucose by photosynthesis.
The chemical formula for glucose is $C_6H_{12}O_6$.

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

_____ + _____

→ $C_6H_{12}O_6$ + _____

[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.

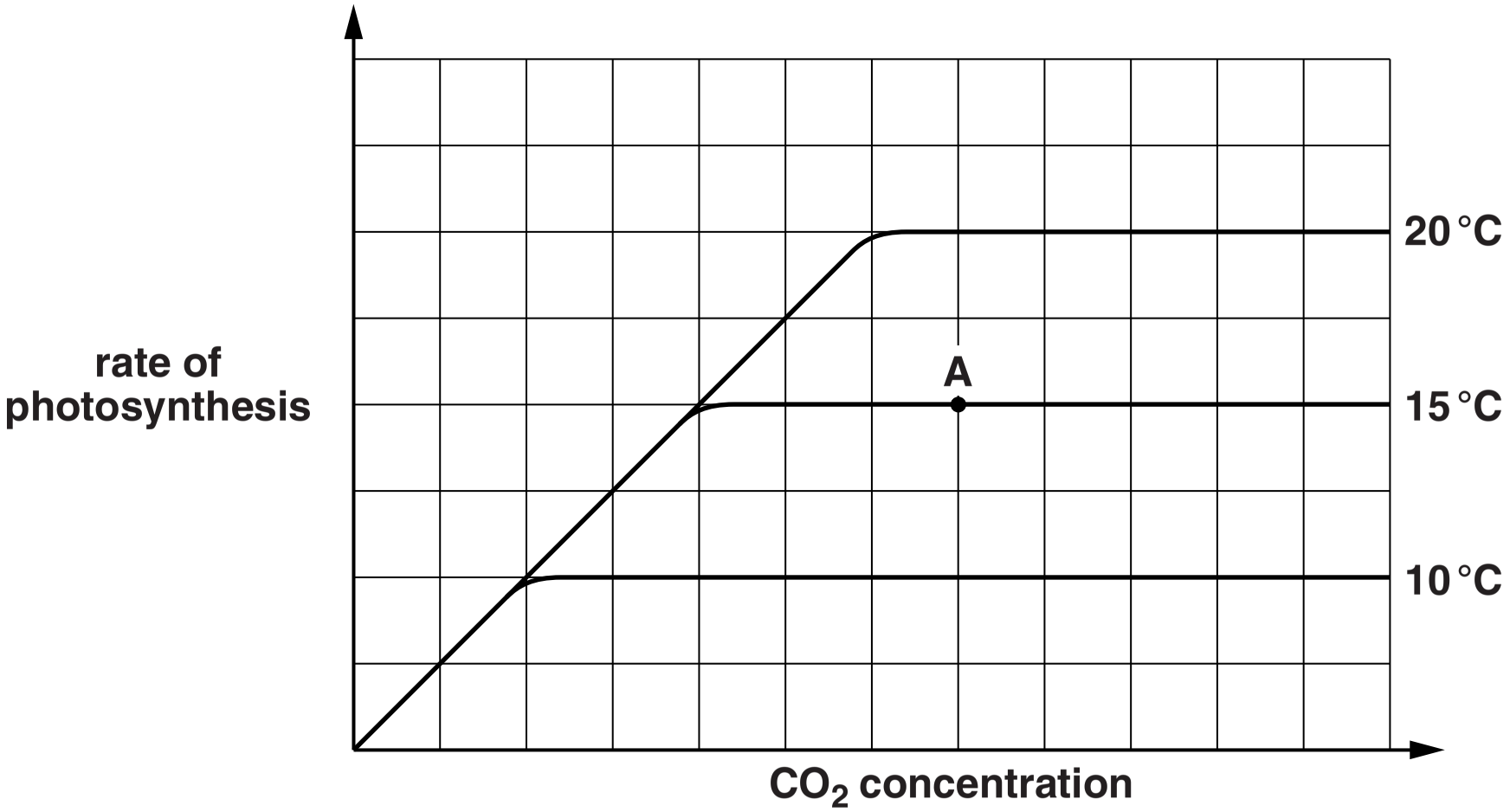
_____

_____

_____

_____ **[2]**

13



(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.

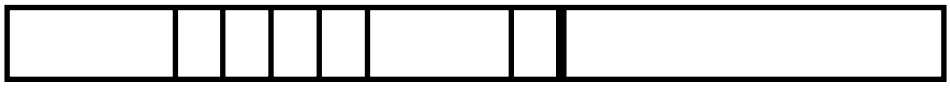
sample

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.

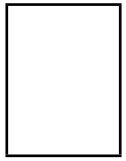
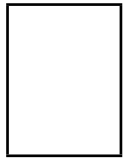
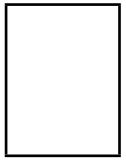
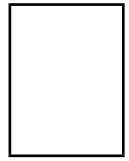
_____ **[2]**

(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]**

19 chlorine  + potassium iodide  → potassium chloride  + iodine 

(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]

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.

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

_____

_____

_____

_____

_____

_____

_____

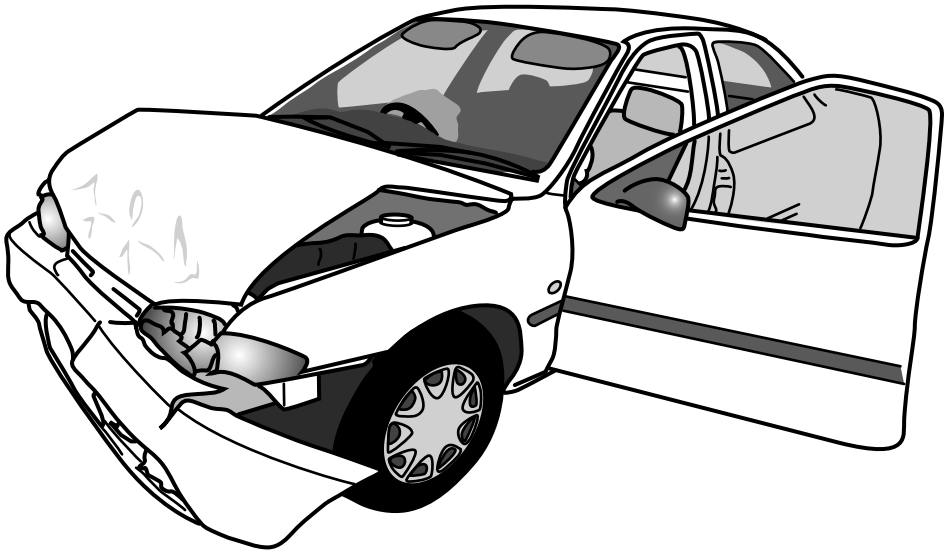
_____

_____

_____ **[6]**

[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.

_____

_____

_____

_____

_____

_____

_____

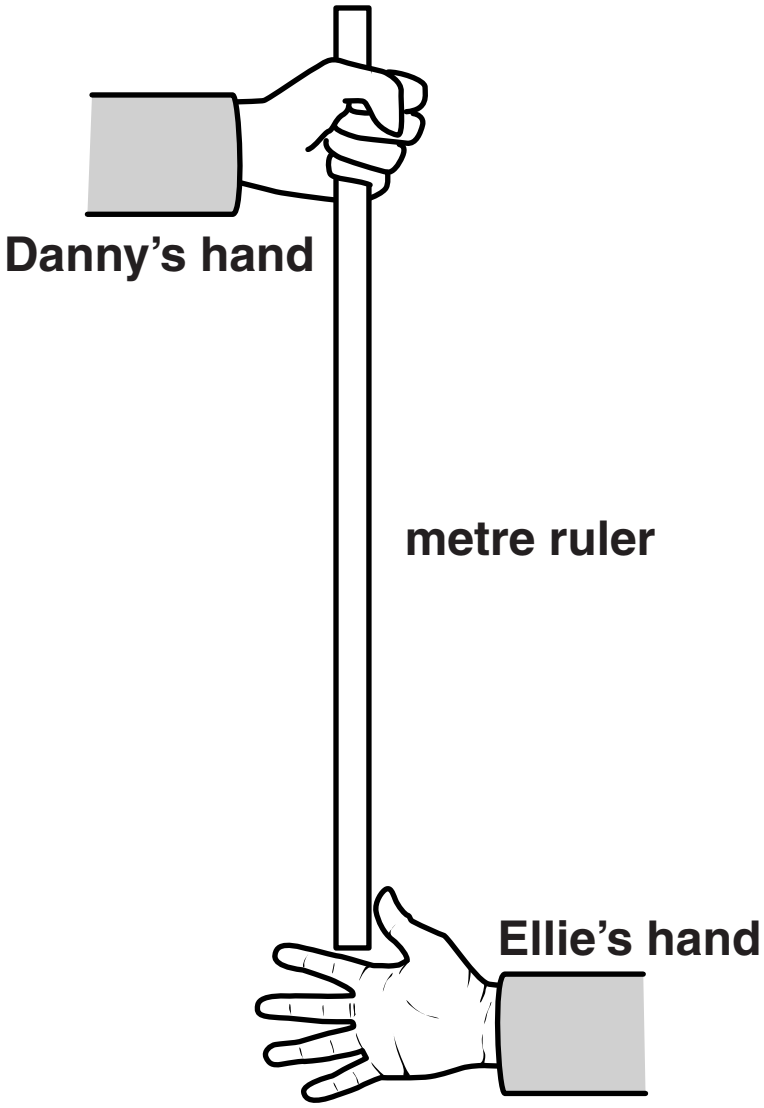
_____

_____

_____ **[6]**

[TOTAL: 6]

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 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.

_____

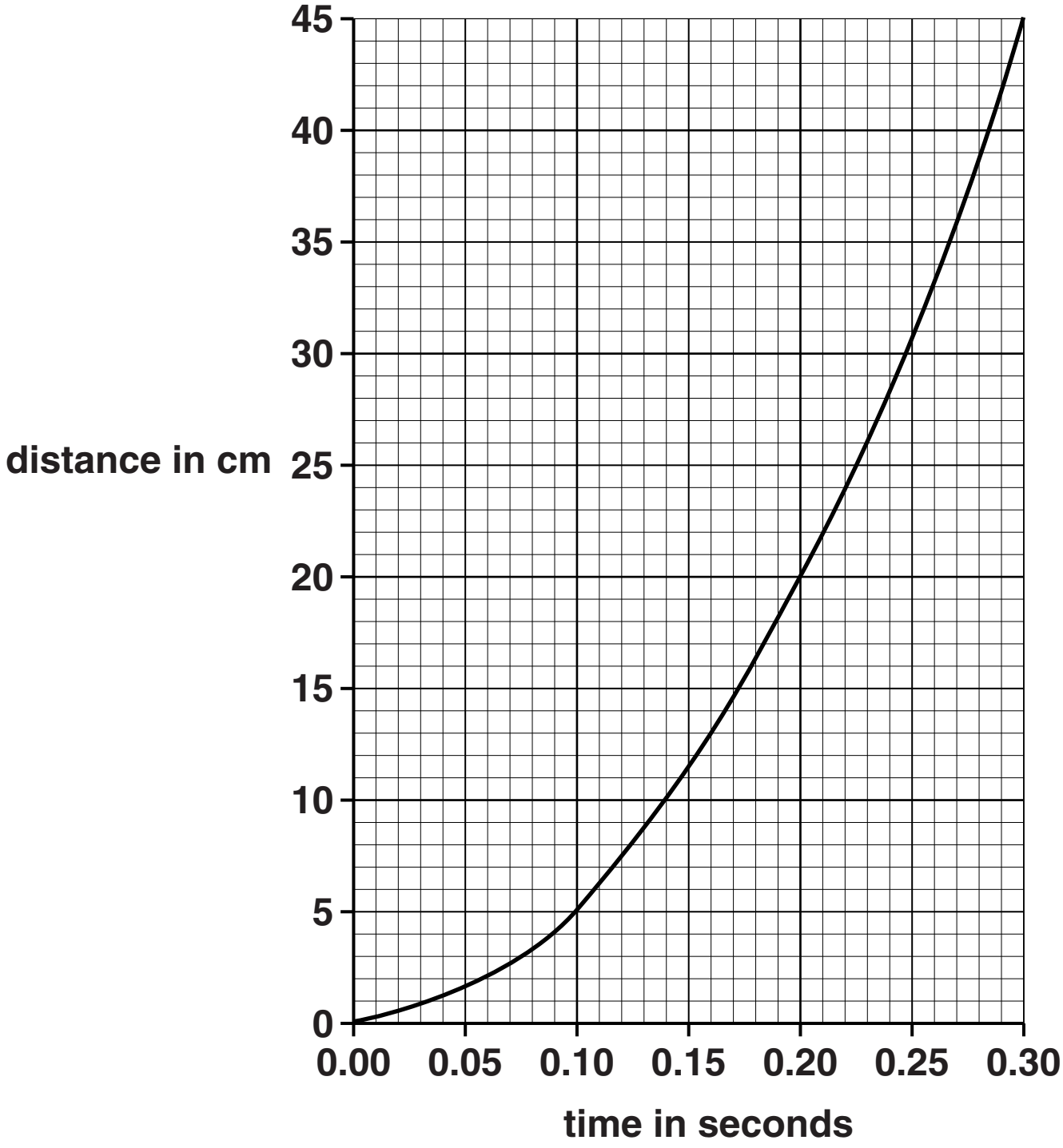
_____

_____

_____ **[3]**

BLANK PAGE

(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]

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

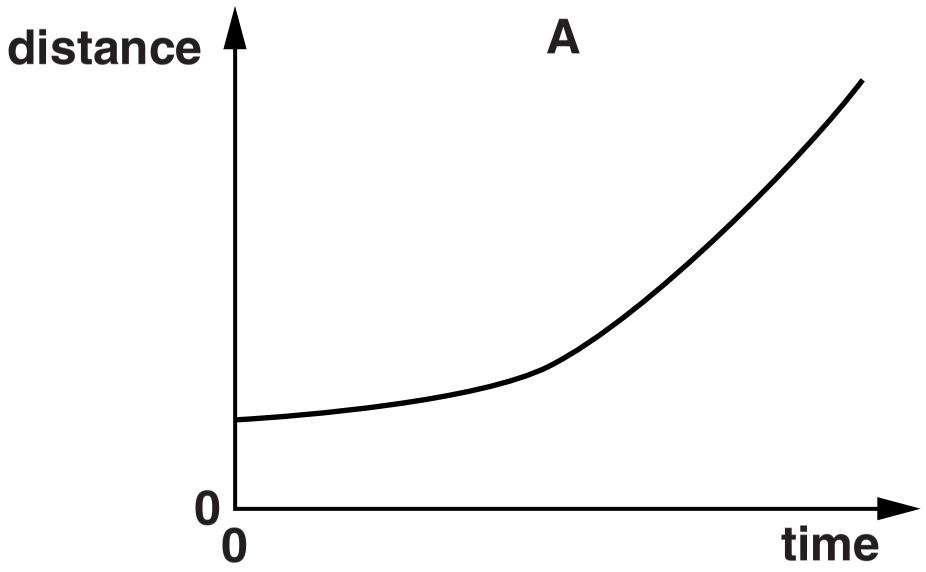
(a) He makes two speed measurements of the lorry. The first measurement gives a speed of 31 m/s. The second measurement gives a speed of 25 m/s. The measurements are separated by 1.5 s. Calculate the acceleration of the lorry.

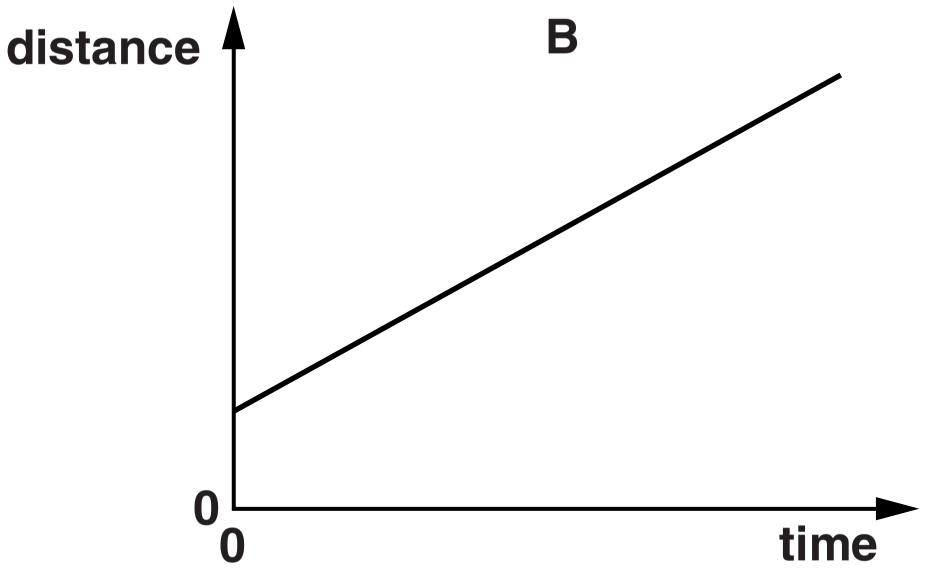
acceleration = _____ m/s^2 [2]

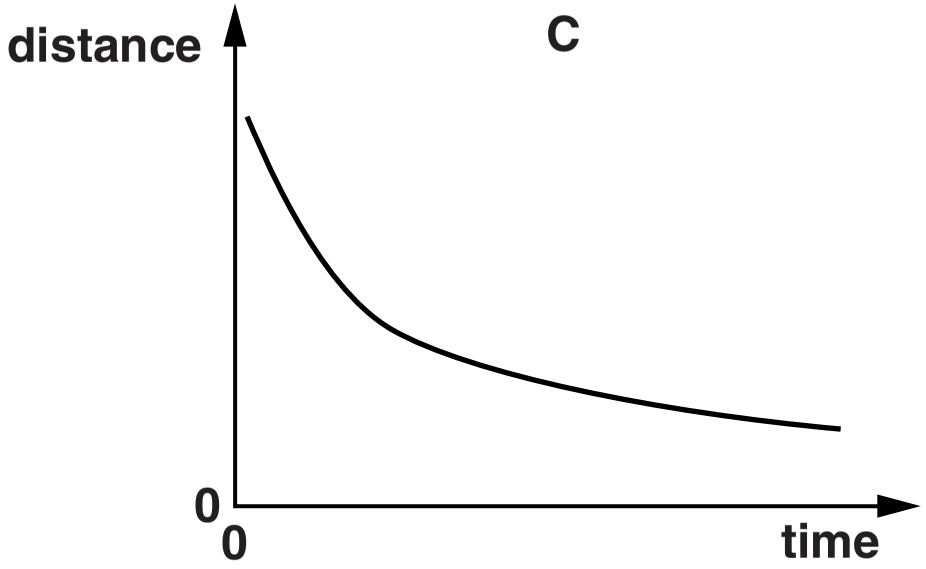
(b) Which of the distance-time graphs (opposite) shows the motion of the lorry? The distance is between the lorry and the policeman.

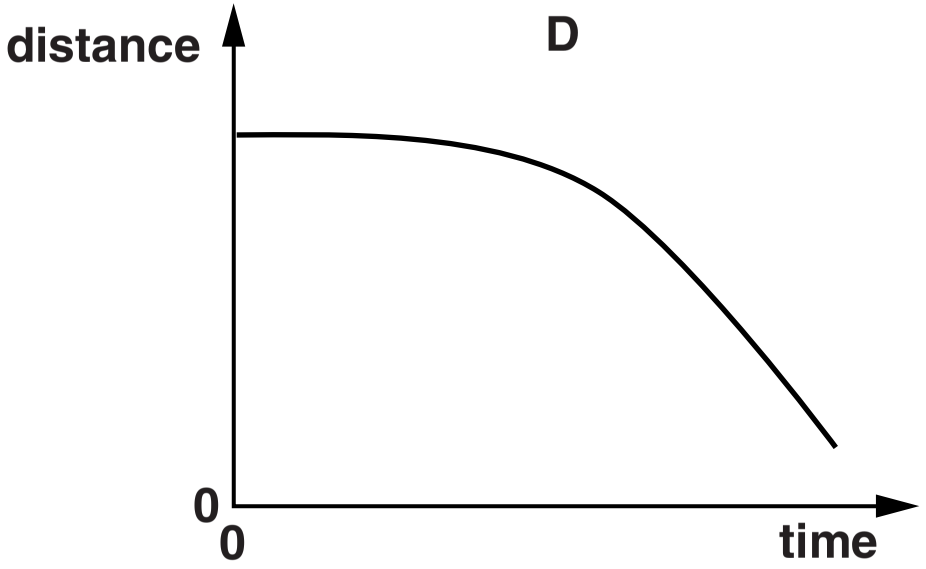
answer _____ [1]

[TOTAL: 3]

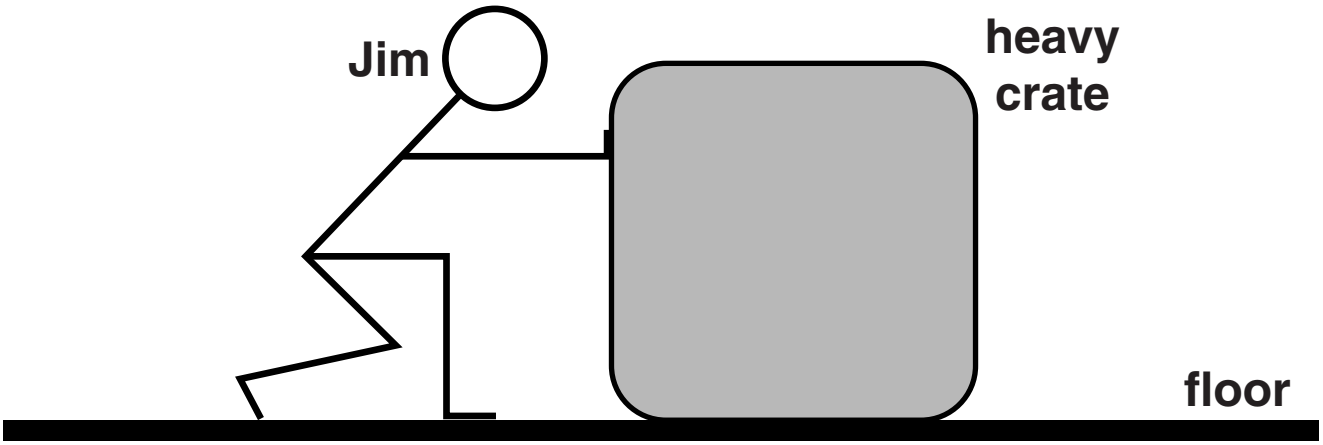

distance
A
0
0
time


distance
B
0
0
time

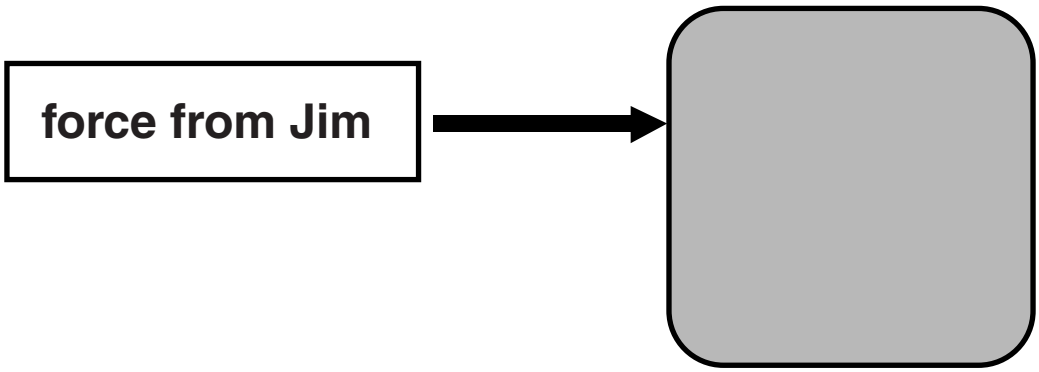

distance
C
0
0
time


distance
D
0
0
time

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.

DIRECTION	SIZE	EXPLANATION
up	100 N	Force is equal to weight times speed.
left	200 N	The force is half of an interaction pair.
right	400 N	Jim is not leaning his weight against the crate.
down	800 N	The friction equals the weight for steady speed.

[1]

[TOTAL: 4]

END OF QUESTION PAPER

BLANK PAGE

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.