OCR
RECOGNISING ACHIEVEMENT

SPECIMEN **H**

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE **A151/02**

ADDITIONAL SCIENCE A

Unit A151: Modules B4, C4, P4 (Higher Tier)

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

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

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

For Examiner's Use		
	Max	**Mark**
1	**4**	
2	**5**	
3	**11**	
4	**3**	
5	**2**	
6	**6**	
7	**2**	
8	**4**	
9	**3**	
10	**6**	
11	**6**	
12	**2**	
13	**4**	
14	**2**	
TOTAL	**60**	

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TWENTY FIRST CENTURY SCIENCE DATA SHEET

Useful Relationships

The Earth in the Universe

distance = wave speed x time

wave speed = frequency x wavelength

Sustainable Energy

energy transferred = power x time

power = voltage x 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 x velocity

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

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

amount of energy transferred = work done

change in gravitational potential energy = weight x vertical height difference

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

Electric Circuits

power = voltage x 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 Respiration is the process by which we release energy from our food.

(a) Anaerobic respiration is different from aerobic respiration.

Describe **two** ways in which it is different.

....

....

.... **[2]**

(b) Working muscle cells can carry out **anaerobic** respiration.

Complete the word equation for anaerobic respiration.

.... → .... (+ energy released) **[1]**

(c) Muscle cells contain different structures.

The structures have different roles in the process of respiration.

Draw a straight line between each **structure in the muscle cell** and its **role in respiration**.

structure in the muscle cell	**role in respiration**
mitochondrion	contains enzymes for anaerobic respiration
cell membrane	contains the genetic code for enzymes
DNA in nucleus	allows dissolved gases and water to pass freely in and out
cytoplasm	contains enzymes for aerobic respiration

[1]

[Total: 4]

2 Plants produce food by the process of photosynthesis.

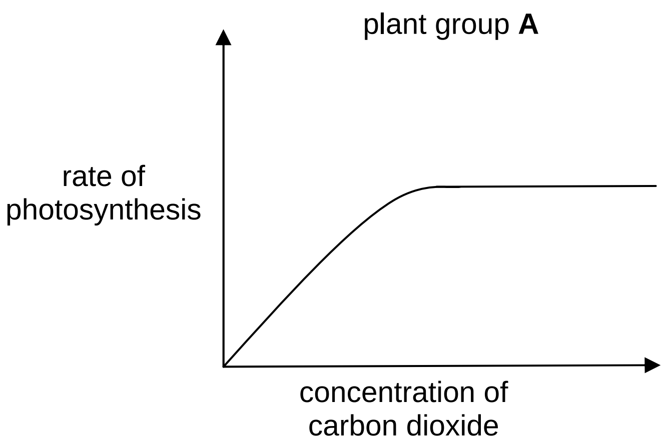
(a) Complete the balanced symbol equation to show this process.

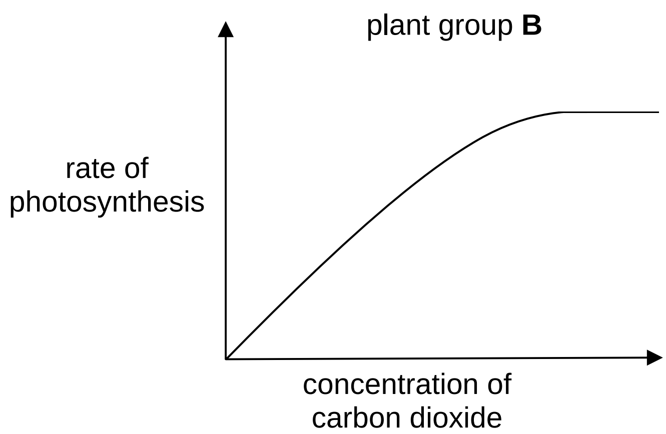
.... + $6H_2O \rightarrow C_6H_{12}O_6$ + ... **[1]**

(b) A student investigates the rate of photosynthesis in plants. She tests two groups of plants of the same species in different conditions.

For each group she measures the rate of photosynthesis at different concentrations of carbon dioxide.

The graphs show her results.





Suggest how the conditions for group **B** may have differed from group **A**, and explain why this has produced the results shown in the graphs.

....

....

....

....

....

.... **[4]**

[Total: 5]

3 Alex is investigating the activity of an enzyme called salivary amylase. The enzyme breaks down starch into glucose, and is present in saliva in the human mouth.

(a) Alex has read that the digestion of some foods begins in the mouth.

Alex has chicken and chips for lunch. She wonders which parts of her lunch will start to be digested by salivary amylase in her mouth. She knows that chicken meat is made of protein.

Explain why salivary amylase will start digesting the chips in her mouth but will not start digesting the chicken.

✎ *The quality of written communication will be assessed in your answer to this question.*

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.... **[6]**

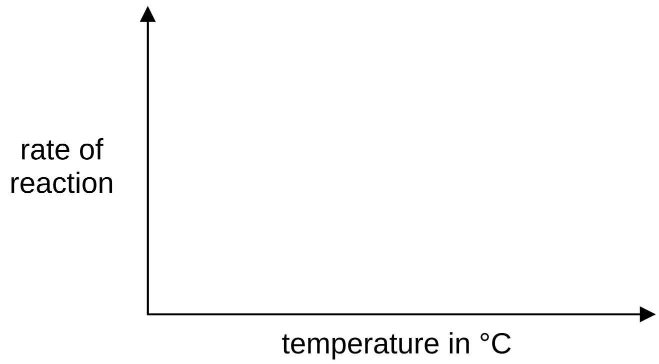
(b) Alex calculates the rate of reaction when salivary amylase breaks down starch.

She does this reaction four times at seven different temperatures.

Here are her results.

temperature in °C	**rate of reaction in arbitrary units**			
	experiment 1	**experiment 2**	**experiment 3**	**experiment 4**
20	5	8	5	4
30	9	11	6	10
40	14	17	19	16
50	9	4	3	5
60	2	3	1	2
70	1	0	0	1
80	0	0	0	0

(i) Sketch on the axes the **shape** of the graph that these data would give. Do not plot any data points.



[1]

(ii) Alex concludes that salivary amylase is well adapted to perform its role in the body.

Explain how the data and the graph you have drawn support this conclusion.

....

....

....

....

.... **[2]**

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(iii) Alex repeats the experiment at 40 °C but uses solutions of the substrate and enzyme in dilute acid instead of water.

Suggest what effects this could have on the rate of reaction, and explain why.

....

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....

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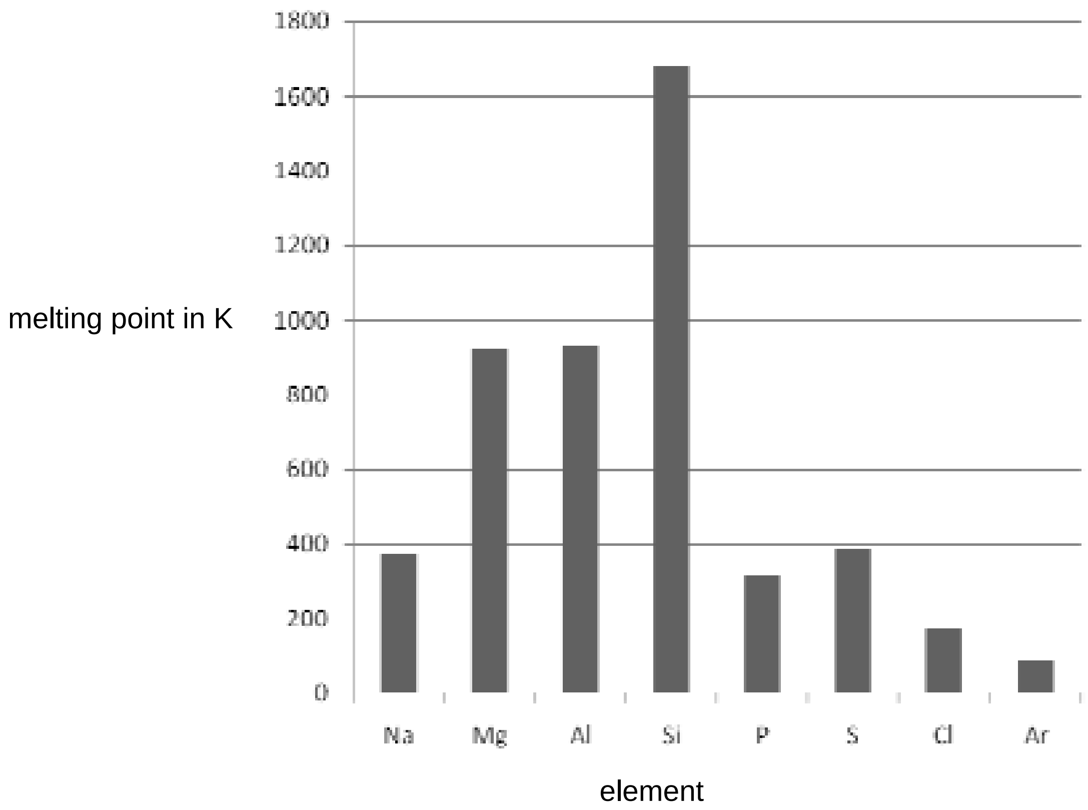
.... **[2]**

[Total: 11]

4 The bar chart shows melting points of elements across the third period of the Periodic Table.



Jack studies these data and makes two conclusions

- the melting points of metals increase from left to right across the Periodic Table
- the melting points of non-metals decrease from left to right across the Periodic Table.

Evaluate how well the data support this conclusion and suggest what further data you could obtain to support your evaluation.

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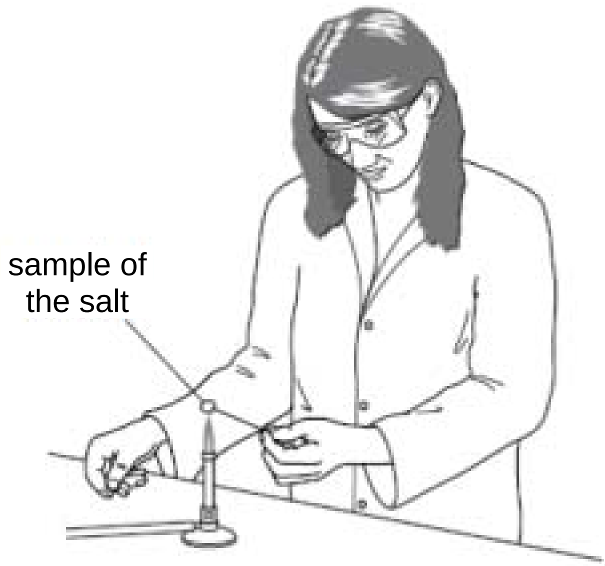
....

....

....**[3]**

[Total: 3]

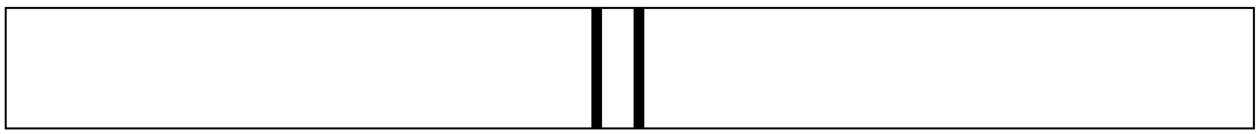
5 Eve tests some salts by doing a flame test.



Eve heats a sodium salt. She sees that it gives off a coloured light.

She looks at the spectrum of light through a spectroscope.

She sees some yellow lines.



Eve then heats a potassium salt and looks at the spectrum of light it gives off.

Write down one **similarity** and one **difference** between the two spectra that Eve sees.

....

....

....

.... **[2]**

[Total: 2]

6 The table shows some information about a sodium atom and a fluorine atom.

name of atom	**atomic (proton) number**	**relative mass**	**electronic configuration**	**ion formed by atom**
sodium	11	23	2.8.1	Na^+
fluorine	9	19	2.7	F^-

Use the data in the table to describe and explain the difference in structure of a sodium atom and a fluorine atom.

✎ *The quality of written communication will be assessed in your answer to this question.*

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.... **[6]**

[Total: 6]

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7 Sodium reacts with the halogens.

The reaction takes place between sodium metal and the halogen in the gas state.

The table shows what happens when hot sodium is put into jars containing different halogen gases.

halogen gas	**appearance of halogen gas at start**	**time for reaction to finish in seconds**	**appearance of product at end**
chlorine	pale green	5	white solid
bromine			
iodine	purple	15	white solid

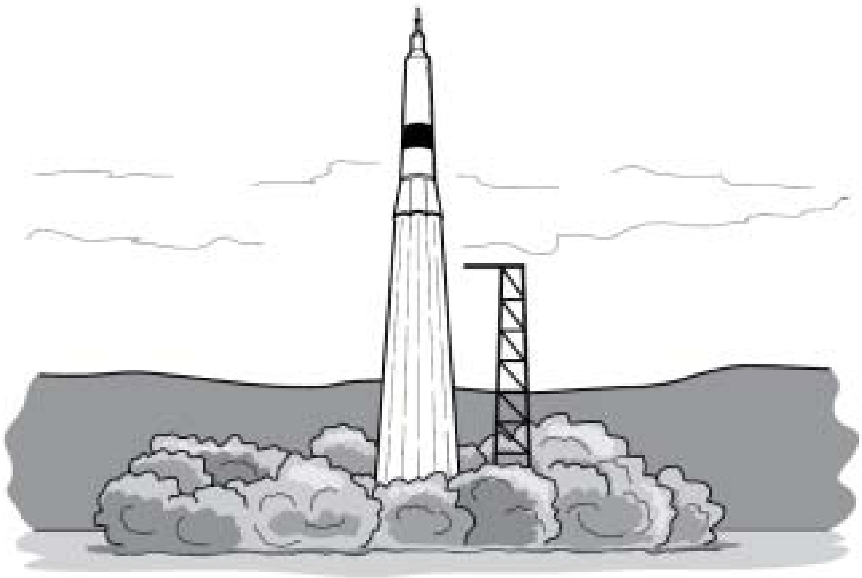
Complete the table to describe what you would see when sodium is put into a jar containing bromine gas.

[2]

[Total: 2]

8 Lithium is an element in Group 1 of the Periodic Table.

It can be added to rocket fuel to give an extra boost for take off.



(a) Lithium works well in rocket fuels because it is very reactive.

Which of the following statements about the reactivity of lithium are **true** and which are **false**?

Put ticks (✓) in the correct box in each row.

	true	false
Lithium reacts with cold water.		
Lithium reacts with other Group 1 elements to form compounds.		
Lithium tarnishes in moist air more quickly than potassium.		
Lithium chloride is very unstable		

[2]

(b) When the fuel burns, the lithium also burns.

Complete the balanced symbol equation to show what happens when lithium burns.

word equation lithium + oxygen → lithium oxide

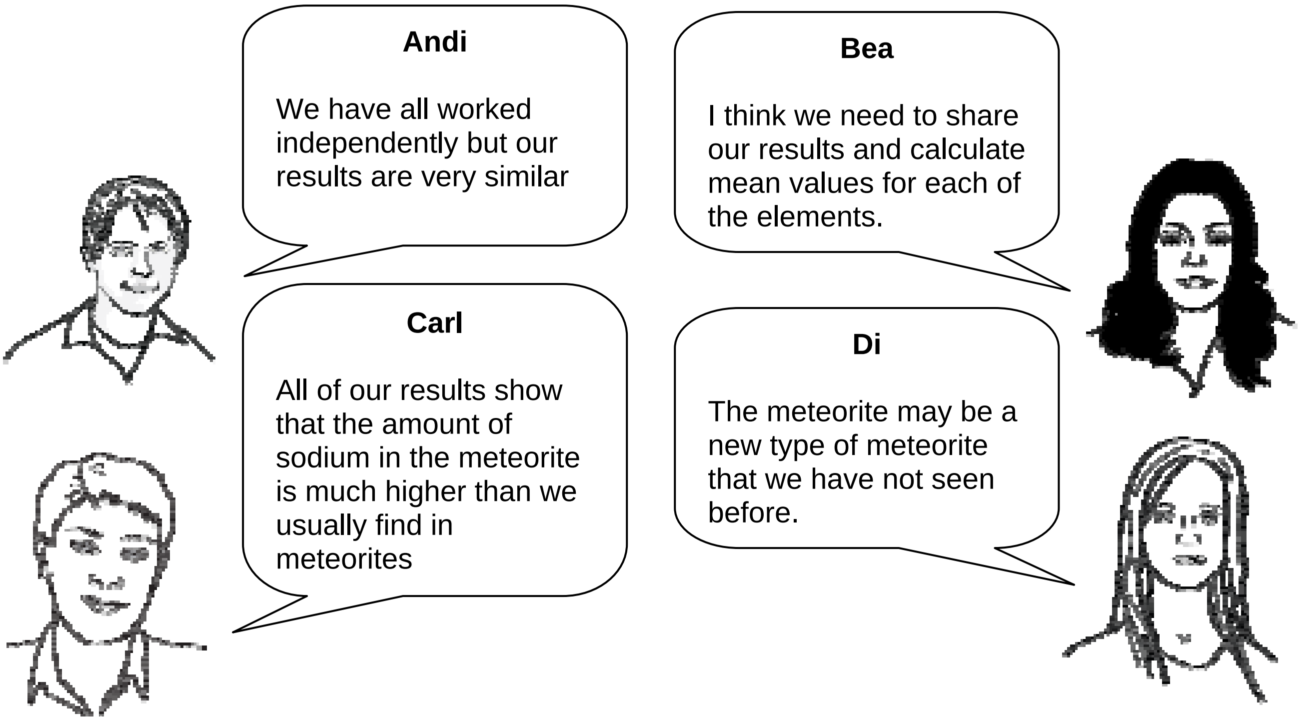
balanced symbol equation .... +.................... → …….Li_2O **[2]**

[Total: 4]

9 Meteorites are small pieces of rock that land on Earth from space.

Four scientists are investigating the amounts of different elements in a meteorite.

They talk about what they find.



(a) Put ticks (✓) in the table to identify who is making each type of statement.

	Andi	**Bea**	**Carl**	**Di**	**None of the scientists**
Who is talking about the reproducibility of data?					
Who is suggesting a hypothesis?					
Who is talking about an outlier?					
Who is making a suggestion that would help to work out a best estimate?					

[2]

(b) Di thinks that the meteorite is a new type of meteorite.

She wants to convince other scientists.

Here are some actions that she could take.

A publish a report in a newspaper so that everyone can see it

B publish a report in a scientific journal so that other scientists can see it

C repeat the experiment to confirm her results before she tells anyone else

D tell everyone immediately because it is important

E ask other scientists to repeat the experiment

F ask other scientists to identify outliers in her data

Choose one action from each pair then write the letters in the boxes to show the order in which she should do them.

start				**end**

[1]

[Total: 3]

10 This question is about different journeys made in a lorry.

(a) The lorry is passing through a built up area where the speed limit is 14 m/s.

In 20 seconds, the lorry travels 250 metres.

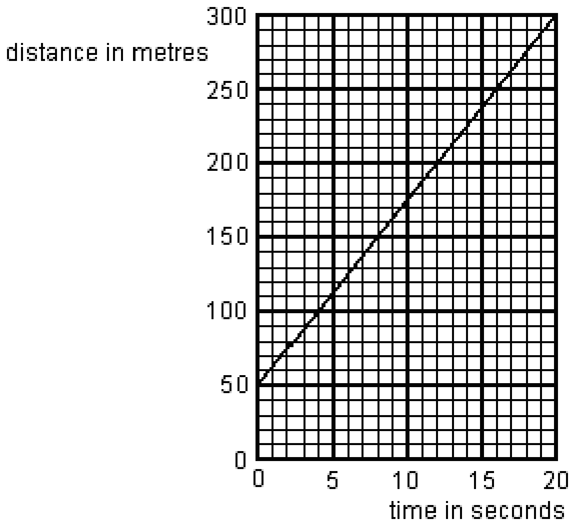
(i) Calculate the speed of the lorry, and decide whether the lorry is within the speed limit.

speed = ... m/s

....

.... **[1]**

(ii) Here is the distance-time graph for the 250 metre part of the journey.



Explain how the graph increases your confidence in your decision about whether the lorry is within the speed limit.

....

....

.... **[2]**

(b) The lorry is fitted with a speed limiter.

This sets its maximum speed to 25 m/s.

The lorry is driven down a test track to test the speed limiter.

Here are six measurements, taken on two successive days.

day	**trial number**	**measured speed**
one	1	24.7 m/s
	2	25.2 m/s
	3	24.9 m/s
two	4	24.8 m/s
	5	24.2 m/s
	6	24.5 m/s

Day two was much colder than day one.

Did this make any difference to the results?

Use calculations to justify your answer.

....

....

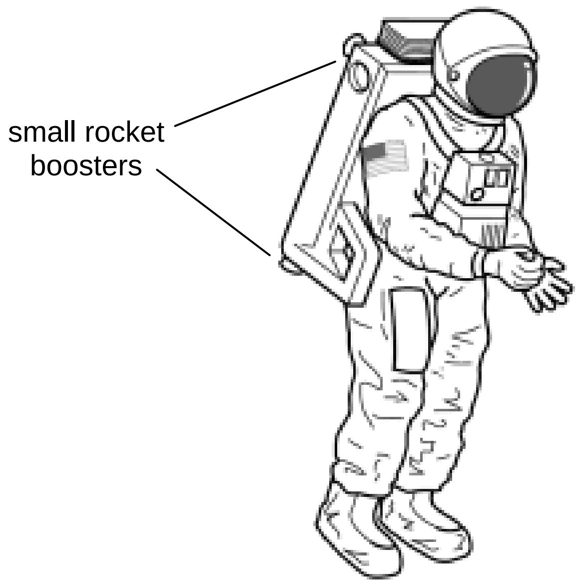
.... **[3]**

[Total: 6]

11 Buzz is an astronaut.

He is in space far away from the Sun or any planets, repairing the outside of his spacecraft.

He uses small rocket boosters on his space pack to move about.



Explain how the rockets move him from one end of the spacecraft to the other.

✎ The quality of written communication will be assessed in your answer to this question.

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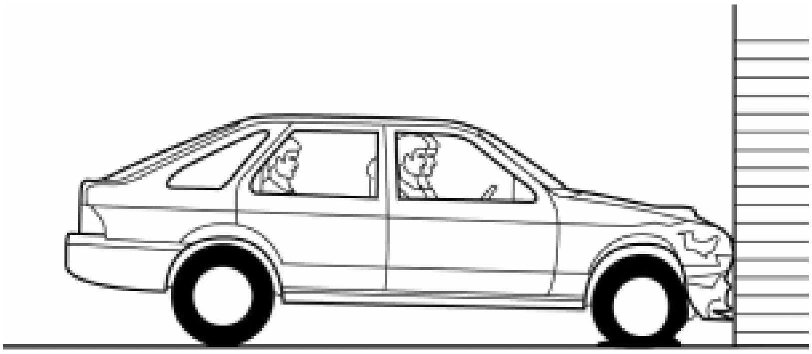
.... **[6]**

[Total: 6]

12 This question is about car safety features.



During safety tests a car of mass 1200 kg is crashed into a wall at a speed of 20 m/s.

The collision stops the car.

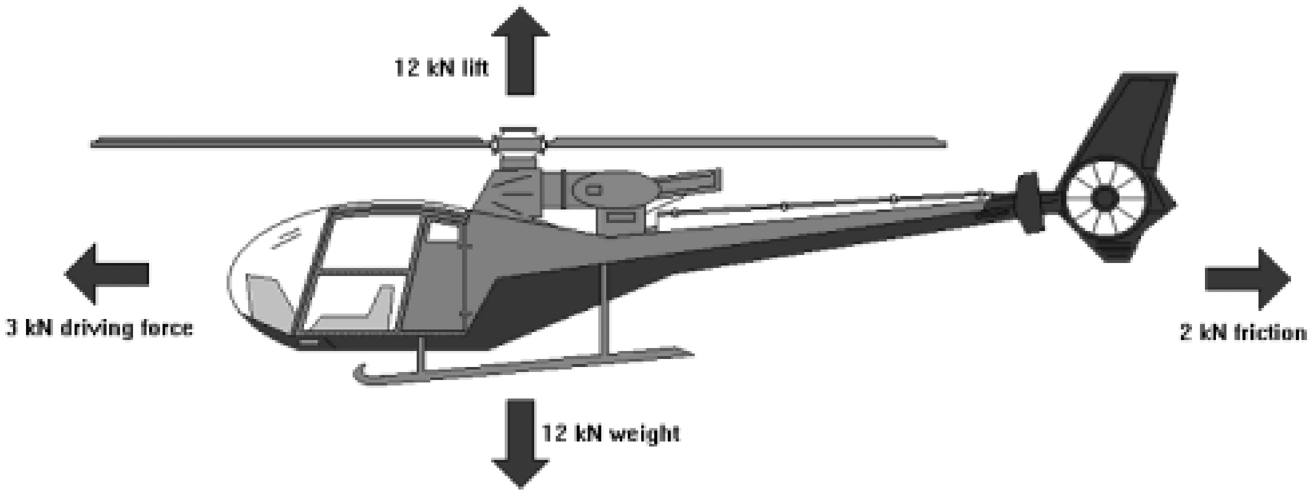
This takes a time of 1.2 seconds.

Calculate the force exerted by the wall to stop the car.

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

[Total: 2]

13 The diagram shows the forces acting on a helicopter in level flight.



(a) Describe the resultant force acting on the helicopter.

....

.... **[2]**

(b) Which of these quantities will be increasing for the helicopter?

Put rings around the **two** correct answers.

height

weight

momentum

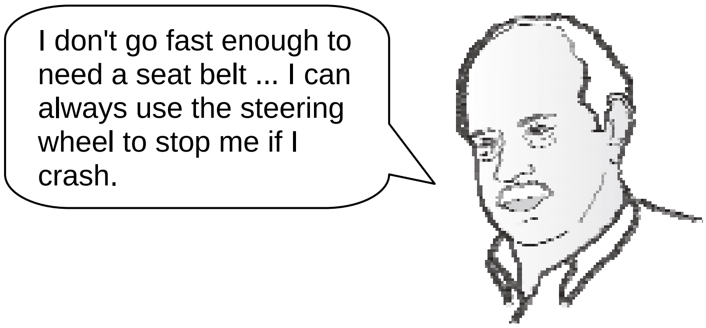
kinetic energy

gravitational potential energy

[2]

[Total: 4]

14 Paul is a taxi driver in town.



(a) How would a seatbelt help Paul if he had a crash?

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

A seatbelt increases the counterforce on him in a crash. ☐

A seatbelt transfers less energy to him as the car slows down. ☐

A seatbelt increases the time it takes for him to slow down in a crash. ☐

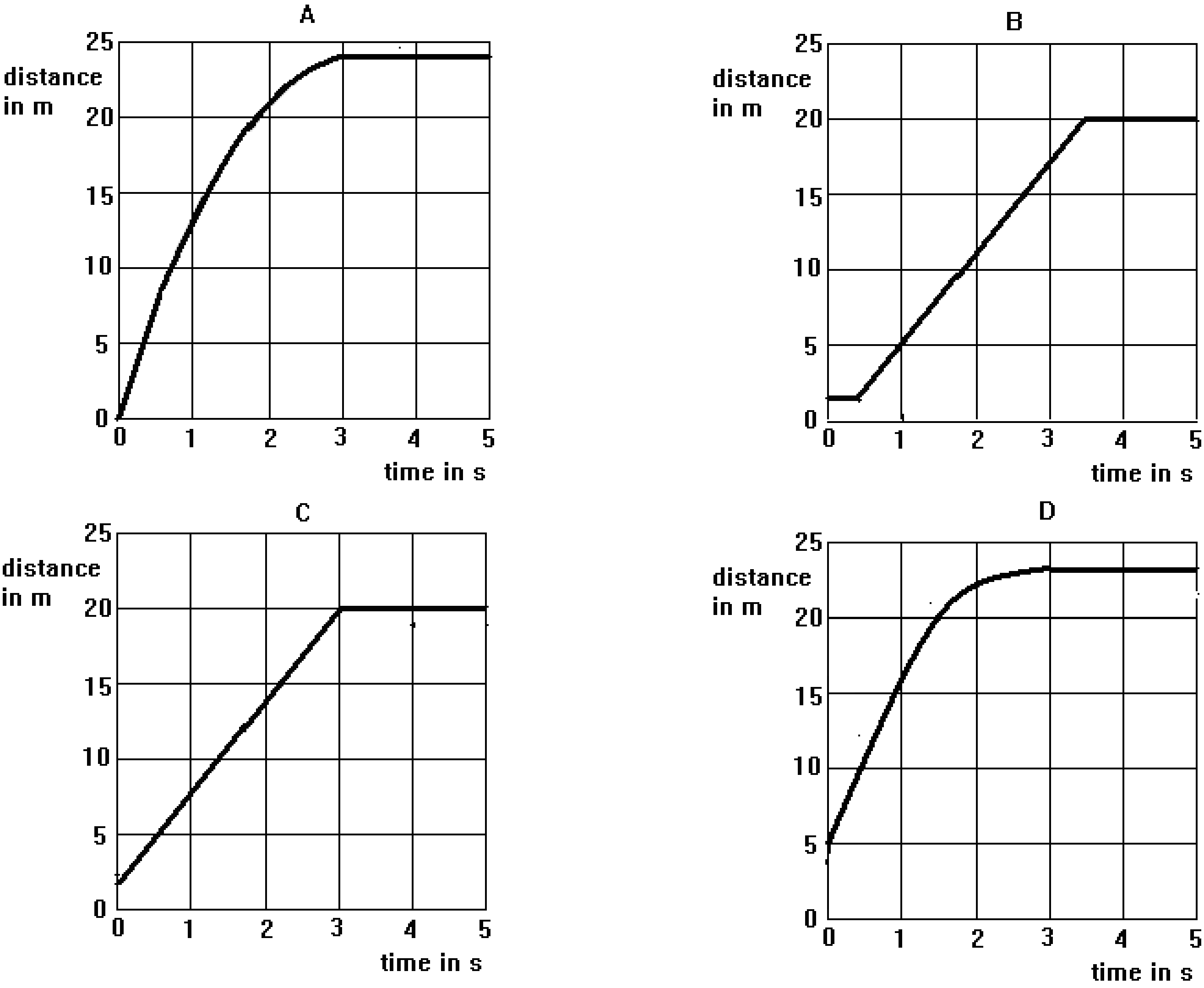
A seatbelt reduces the amount of momentum he needs to lose in a crash. ☐

[1]

(b) Paul's momentum is 900 kg m s^{-1} when he is travelling at 50 kph.

He slams on the brakes and stops the car in 3.0 s, moving a distance of 18 m.

Which is the correct distance-time graph for Paul as he stops?



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

[Total: 2]

[Paper Total: 60]

END OF QUESTION PAPER

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RECOGNISING ACHIEVEMENT

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Periodic Table

Key

relative atomic mass **atomic symbol** name atomic (proton) number

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						

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

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RECOGNISING ACHIEVEMENT

SPECIMEN **H**

GENERAL CERTIFICATE OF SECONDARY EDUCATION

TWENTY FIRST CENTURY SCIENCE **A151/02**

ADDITIONAL SCIENCE A

Unit A151: Modules B4, C4, P4 (Higher Tier)

MARK SCHEME

Duration: 1 hour

MAXIMUM MARK 60

This document consists of 16 pages

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Guidance for Examiners

Additional guidance within any mark scheme takes precedence over the following guidance.

1. Mark strictly to the mark scheme.

2. Make no deductions for wrong work after an acceptable answer unless the mark scheme says otherwise.

3. Accept any clear, unambiguous response which is correct, eg mis-spellings if phonetically correct (but check additional guidance).

4. Abbreviations, annotations and conventions used in the detailed mark scheme:

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
not/reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant – applies to neutral answers
allow/accept	=	answers that can be accepted
(words)	=	words which are not essential to gain credit
<u>words</u>	=	underlined words must be present in answer to score a mark
ecf	=	error carried forward
AW/owtte	=	alternative wording
ORA	=	or reverse argument

Eg mark scheme shows 'work done in lifting / (change in) gravitational potential energy' (1)
work done = 0 marks
work done lifting = 1 mark
change in potential energy = 0 marks
gravitational potential energy = 1 mark

5. Annotations:
The following annotations are available on SCORIS.

✓	=	correct response
✗	=	incorrect response
bod	=	benefit of the doubt
nbod	=	benefit of the doubt **<u>not</u>** given
ECF	=	error carried forward
^	=	information omitted
I	=	ignore
R	=	reject

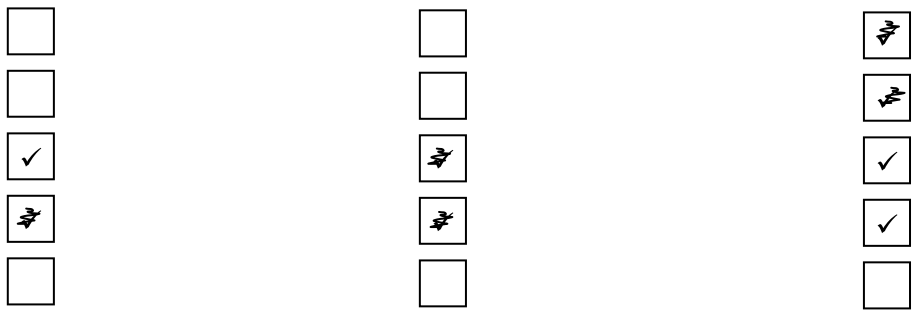
6. If a candidate alters his/her response, examiners should accept the alteration.

7. Crossed out answers should be considered only if no other response has been made. When marking crossed out responses, accept correct answers which are clear and unambiguous.
Eg
For a one mark question, where ticks in boxes 3 and 4 are required for the mark:

Put ticks (✓) in the two correct boxes.

Put ticks (✓) in the two correct boxes.

Put ticks (✓) in the two correct boxes.



This would be worth 0 marks.

This would be worth one mark.

This would be worth one mark.

8. The list principle:
If a list of responses greater than the number requested is given, work through the list from the beginning. Award one mark for each correct response, ignore any neutral response, and deduct one mark for any incorrect response, eg one which has an error of science. If the number of incorrect responses is equal to or greater than the number of correct responses, no marks are awarded. A neutral response is correct but irrelevant to the question.

9. Marking method for tick boxes:
Always check the additional guidance.
If there is a set of boxes, some of which should be ticked and others left empty, then judge the entire set of boxes.
If there is at least one tick, ignore crosses. If there are no ticks, accept clear, unambiguous indications, eg shading or crosses.
Credit should be given for each box correctly ticked. If more boxes are ticked than there are correct answers, then deduct one mark for each additional tick. Candidates cannot score less than zero marks.
Eg If a question requires candidates to identify a city in England, then in the boxes

Edinburgh	
Manchester	
Paris	
Southampton	

the second and fourth boxes should have ticks (or other clear indication of choice) and the first and third should be blank (or have indication of choice crossed out).

Edinburgh			✓			✓	✓	✓	✓	
Manchester	✓	×	✓	✓	✓				✓	
Paris				✓	✓		✓	✓	✓	
Southampton	✓	×		✓		✓	✓		✓	
Score:	2	2	1	1	1	1	0	0	0	NR

10. Three questions in this paper are marked using a Level of Response (LoR) mark scheme with embedded assessment of the Quality of Written Communication (QWC). When marking with a Level of Response mark scheme:
    - Read the question in the question paper, and then the list of relevant points in the 'Additional guidance' column of the mark scheme, to familiarise yourself with the expected science. The relevant points are not to be taken as marking points, but as a summary of the relevant science from the specification.
    - Read the level descriptors in the 'Expected answers' column of the mark scheme, starting with Level 3 and working down, to familiarise yourself with the expected levels of response.
    - *For a general correlation between quality of science and QWC*: determine the level based upon which level descriptor best describes the answer; you may award either the higher or lower mark within the level depending on the quality of the science and/or the QWC.
    - *For high-level science but very poor QWC*: the candidate will be limited to Level 2 by the bad QWC no matter how good the science is; if the QWC is so bad that it prevents communication of the science the candidate cannot score above Level 1.
    - *For very poor or totally irrelevant science but perfect QWC*: credit cannot be awarded for QWC alone, no matter how perfect it is; if the science is very poor the candidate will be limited to Level 1; if there is insufficient or no relevant science the answer will be Level 0.

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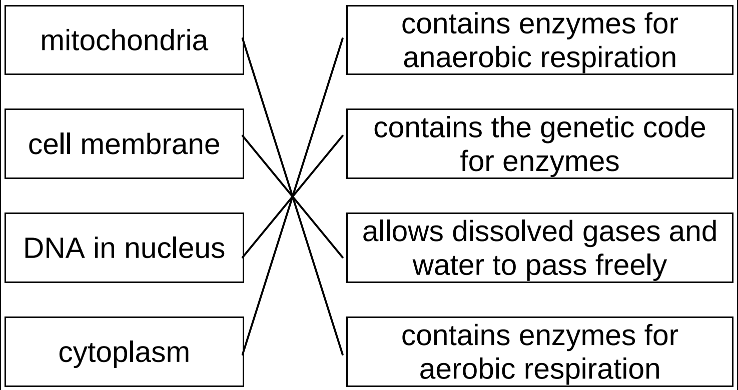
Question			Expected answers	Marks	Additional guidance
1	(a)		**any two from:** oxygen used in aerobic respiration / oxygen is not used in anaerobic respiration lactic acid/lactate/ethanol is produced in anaerobic respiration / lactic acid/lactate/ethanol is not produced in aerobic respiration aerobic respiration releases more energy per glucose molecule / anaerobic respiration releases less energy per glucose molecule	[2]	
	(b)		glucose $\longrightarrow$ lactic acid	[1]	**both** required for the mark **accept** "lactate" instead of lactic acid **reject** carbon dioxide and ethanol (as this is anaerobic respiration in muscle cells, not plant cells/microorganisms/yeast) **reject** formulae
	(c)		**structure in the muscle cell** **role in respiration** 	[1]	all four correct lines = 1 mark
			Total	**[4]**	

Question			Expected answers	Marks	Additional guidance
2	(a)		$6CO_2$ <u>and</u> $6O_2$	[1]	**both** correct response = 1 mark
	(b)		*for group **A** plants* carbon dioxide is a substrate for photosynthesis other factors (such as light) are also limiting and they restrict the rate of photosynthesis at high carbon dioxide levels *for group **B** plants* extra light means the rate can increase (above the plateau shown for group **A**) because light is not limiting (to the same extent as in group **A** plants) idea that the rate plateaus when light or other factors become limiting	[4]	OWTTE
			Total	**[5]**	

Question			Expected answers	Marks	Additional guidance
3	(a)		**[Level 3]** Answer correctly and clearly describes the lock and key model, notes that chips/potatoes contain starch and explains that substrate specificity is why digestion of starch molecules in the chips by salivary amylase will start in the mouth but digestion of protein molecules in the chicken will not. All information in the answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Answer correctly describes some aspects of the lock and key model, but may not use the appropriate terminology and may not make clear the importance of the specificity of the active site on the salivary amylase molecules for the shape of the starch molecule. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Answer demonstrates understanding that salivary amylase will start to digest starch in the chips but will not digest protein in the chicken, but does not clearly attribute this to the specificity of the enzyme's active site for the shape of the starch molecule. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** • chips/potatoes/plants contain starch (as an energy store) • salivary amylase has an active site • the shape of the active site complements the shape of a starch molecule • only a starch molecule will fit into the enzyme's active site and form an enzyme-substrate complex • this is the 'lock and key' model • chicken meat is made of protein, not starch • protein will not fit into the enzyme's active site • and will not form an enzyme-substrate complex • so will not be digested

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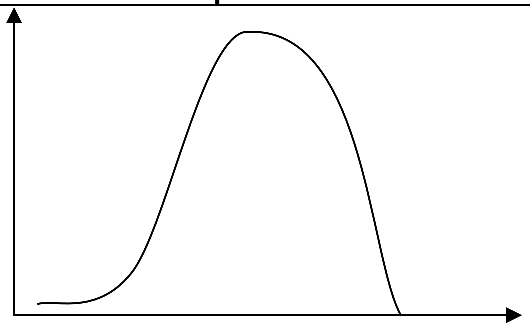
Question			Expected answers	Marks	Additional guidance
	(b)	**(i)**		**[1]**	as temperature increases the rate should climb to an optimum, then drop to zero
		(ii)	the optimum temperature for the enzyme / the maximum rate of reaction occurs at around 40 °C which is close to human body temperature	**[2]**	
		(iii)	lower/different pH will change the shape of the active site, which will affect the ability of the enzyme to form an enzyme-substrate complex this means the rate of reaction will be higher if the pH is closer to the enzyme's optimum pH, or lower if the pH is further from the enzyme's optimum pH	**[2]**	
			Total	**[11]**	

4			metals: conclusion supported, but Al only slightly higher mpt than Mg non-metals: conclusion supported for S, Cl and Ar but P is lower than S / not following trend evidence from other periods to support evaluation	**[3]**	**allow** S not following trend
			Total	**[3]**	

5			both have lines lines are different colours / places / in a different pattern	**[2]**	
			Total	**[2]**	

Question			Expected answers	Marks	Additional guidance
6		✎	**[Level 3]** Most of the properties are discussed with clear comparison made. Discusses nuclear content, electron configuration and ions using actual numbers of particles / shells. All information in the answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Compares structure of nucleus, electronic structure and ions. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Some structure described but clear comparison may not be made. Discusses structure of nucleus and / or electronic configuration. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** • sodium has one electron in the outer shell, fluorine has 7 • sodium has 3 electron shells, fluorine has 2 • sodium has 11 protons, fluorine has 9 • sodium has 12 neutrons, fluorine has 10 • when sodium forms an ion it loses an electron • when fluorine forms an ion it gains an electron • both ions have a stable electron arrangement / full outer shell **accept** for standard level accept 'different numbers of protons/ neutrons / electron shells'
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
7			orange gas at start and white solid at end reaction takes 8-12 s / slower than iodine but faster than chlorine	[2]	
			Total	**[2]**	

Question			Expected answers	Marks	Additional guidance
8	(a)		true / false … reacts with cold water. – true ✓ … to form compounds. – false ✓ … more quickly than potassium. – false ✓ … is very unstable. – false ✓	[2]	All 4 correct = 2 2 or 3 correct = 1 1 correct = 0 Accept other indications of choice (eg lines or crosses)
	(b)		Li and O_2 as reactants correct balancing	[2]	the completed equation will be: $4Li + O_2 \rightarrow 2Li_2O$
			Total	**[4]**	

Question			Expected answers	Marks	Additional guidance
9	(a)		Andi Di None of the scientists Bea	[2]	all four correct = 2 3/2 correct = 1 1 correct = 0
	(b)		**C E B**	[1]	
			Total	[3]	

10	(a)	(i)	speed = 250/20 = 12.5 m/s, so below the speed limit	[1]	
		(ii)	the calculated speed is an average (so lorry could have exceeded the limit at certain points in the journey) but the graph shows that the speed was constant during the time period	[2]	
	(b)		mean day one = 24.9 m/s, day two = 24.5 m/s minimum on day one less than maximum day two / ranges overlap difference in means (0.4) compared with each day's variation (0.3)	[3]	**ignore** final conclusion, award marks for processing
			Total	[6]	

Question			Expected answers	Marks	Additional guidance
11		✎	**[Level 3]** Answer includes all relevant points, with all four steps of the explanation, including correct directions and technical terms. All information in answer is relevant, clear, organised and presented in a structured and coherent format. Specialist terms are used appropriately. Few, if any, errors in grammar, punctuation and spelling. (5 – 6 marks) **[Level 2]** Answer includes most relevant points, perhaps omitting / confusing directional details. For the most part the information is relevant and presented in a structured and coherent format. Specialist terms are used for the most part appropriately. There are occasional errors in grammar, punctuation and spelling. (3 – 4 marks) **[Level 1]** Answer includes some relevant points, perhaps with some irrelevant details. No major errors of physics. Answer may be simplistic. There may be limited use of specialist terms. Errors of grammar, punctuation and spelling prevent communication of the science. (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	[6]	**relevant points include:** *to start the astronaut moving* • rocket pushes on gas to give it backwards momentum • gas and rocket are an interaction pair • gas applies equal forwards force on rocket • giving it and astronaut forward momentum astronaut moves at a steady speed when rocket switches off **reject** astronaut stops moving when rockets turned off (major error of physics) **ignore** references to kinetic energy, work and power
			Total	**[6]**	

Question			Expected answers	Marks	Additional guidance
12			momentum change = 1200×20 = 24 000 kg m s^{-1} force = 24 000 / 1.2 = 20 000 N	[2]	**allow** ecf on incorrect momentum change
			Total	**[2]**	

13	(a)		forwards 1 kN	[2]	
	(b)		**momentum** **kinetic energy**	[2]	
			Total	**[4]**	

14	(a)		☐ ☐ a seatbelt increases the time it takes … ✓ ☐	[1]	
	(b)		**D**	[1]	
			Total	**[2]**	

Assessment Objectives (AO) Grid

(includes quality of written communication ✎)

Question	AO1	AO2	AO3	Total
1(a)	2			**2**
1(b)	1			**1**
1(c)	1			**1**
2(a)	1			**1**
2(b)		2	2	**4**
3(a)✎	3	3		**6**
3(b)(i)		1		**1**
3(b)(ii)		1	1	**2**
3(b)(iii)		2		**2**
4			3	**3**
5	2			**2**
6✎	3	3		**6**
7	1	1		**2**
8(a)	2			**2**
8(b)	1	1		**2**
9(a)		2		**2**
9(b)	1			**1**
10(a)(i)		1		**1**
10(a)(ii)			2	**2**
10(b)		3		**3**
11✎	4	2		**6**
12		2		**2**
13(a)		2		**2**
13(b)		2		**2**
14(a)	1			**1**
14(b)		1		**1**
Totals	**23**	**29**	**8**	**60**

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