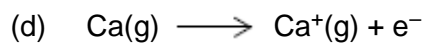


Mark schemes

1	<p>(a) $1s^22s^22p^63s^23p^1$</p>	1	
	<p>$1s^22s^22p^63s^23p^63d^3$</p>	1	
	<p><i>If noble gas core used correctly in both then scores 1</i> <i>Allow subscripts and capitals</i> <i>Ignore $4s^0$</i></p>		
	<p>(b) Sr^{2+}</p>		
	<p><i>Ignore name and correct proton/mass number</i> <i>Allow Sr^{+2}</i></p>	1	
	<p>(c) Ca_3P_2</p>		
	<p><i>Allow reversed or ionic formula</i> <i>Ignore name</i></p>	1	[4]
2	<p>D</p>		[1]
3	<p>(a) General increase</p>		
	<p><i>If not increase then CE</i></p>	1	
	<p>Greater nuclear charge / more protons</p>	1	
	<p>Same shielding / electrons added to same shell</p>	1	
	<p><i>Allow similar</i></p>		
	<p>Stronger <u>attraction</u> (from nucleus) for <u>outer electron(s)</u></p>	1	
	<p><i>Allow electron in outer shell</i></p>	1	

- (b) Aluminium / Al (lower than Mg)
CE if not Al or S 1
 (Outer) electron in (3)p orbital / sub-shell (level)
If 2p or 4p orbital lose M2 and M3 1
 (3p) higher in energy
Allow more shielded or weaker nuclear attraction
M3 is dependent on M2 1
 or
 Sulfur / S (lower than P)
 (Outer) electrons in (3)p orbital begin to pair
 Repel
If 2p or 4p orbital lose M2 and M3
Allow 2 electrons in (3)p
M3 is dependent on M2
- (c) Sulfur / S
CE if not S 1
 Large jump after 6th or between 6th and 7th
Do not allow M2 if atom/ion is removed 1
- (d) Silicon
CE if not Si 1
 Giant covalent structure / macromolecule 1
 Covalent (bonds) 1
Giant covalent scores M2 and M3 1
 Many / strong (covalent bonds) or
 (covalent bonds) need lots of energy to break
CE for M2-M4 if molecules / metallic / ionic / IMFs mentioned 1
- [13]
- 4 (a) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
Allow correct numbers that are not superscripted 1
- (b) $\text{Ca(s)} + 2\text{H}_2\text{O(l)} \longrightarrow \text{Ca}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) + \text{H}_2(\text{g})$
State symbols essential 1
- (c) Oxidising agent 1



State symbols essential

Allow 'e' without the negative sign

1

(e) Decrease

If answer to 'trend' is not 'decrease', then chemical error = 0 / 3

1

Ions get bigger / more (energy) shells

Allow atoms instead of ions

1

Weaker attraction of ion to lost electron

1

[7]

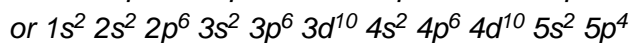
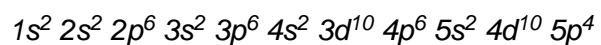
5 D

[1]

6 D

[1]

7



Allow any order but must finish with $5p^4$

1

(b) (i)
$$\frac{(124 \times 2) + (126 \times 4) + (128 \times 7) + (130 \times 6)}{19} \text{ or } \frac{2428}{19}$$

M1 for top line

1

127.8

M2 for correct denominator

1

127.8 with no working shown scores 3 marks

1

Or

$$\frac{(124 \times 10.5) + (126 \times 21.1) + (128 \times 36.8) + (130 \times 31.6)}{100}$$

1

Mark for 100 dependent on top line correct

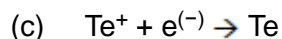
1

127.8

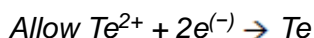
1

(ii) Other isotopes present / some isotopes absent / different abundances of isotopes

1



Ignore state symbols



1

(d) 128

Only

1

Most abundant ion (QoL – superlative)

M2 dependent on correct M1

1

(e) 2+ ion formed / 2 electrons removed

Due to $^{128}\text{Te}^{2+} = 2$ marks

1

From ^{128}Te

Mark independently

1

(f) Same

If not same CE = 0 / 2

1

(Each isotope has the) same number of protons / same nuclear charge and same number of electrons / electronic configuration

Ignore more neutrons in ^{130}Te

1

[12]

8

(a) Average / mean mass of 1 atom (of an element)

1/12 mass of one atom of ^{12}C

If moles and atoms mixed, max = 1

1

Mark top and bottom line independently.

All key terms must be present for each mark.

1

OR

Average / mean mass of atoms of an element

1/12 mass of one atom of ^{12}C

OR

Average / mean mass of atoms of an element $\times 12$

mass of one atom of ^{12}C

OR

(Average) mass of one mole of atoms

1/12 mass of one mole of ^{12}C

OR

(Weighted) average mass of all the isotopes

1/12 mass of one atom of ^{12}C

OR

Average mass of an atom / isotope (compared to C-12) on a scale in which an atom of C-12 has a mass of 12

This expression = 2 marks.

$$(b) \quad \frac{(70 \times 3) + (72 \times 4) + 73 + (74 \times 5)}{13} = \frac{941}{13}$$

1

1

$$= \underline{72.4}$$

72.4 only

1

(c) $^{72}\text{Ge}^+$ or germanium⁺
Must show '+' sign.
Penalise wrong mass number 1

(d) 70
If M1 incorrect or blank CE = 0/2
Ignore symbols and charge even if wrong. 1

Lowest mass / lowest m/z
Accept lightest.
Accept fewest neutrons. 1

(e) Electron(s) transferred / flow (at the detector)
M1 must refer to electron flow at the detector.
If M1 incorrect CE = 0/2 1

(From detector / plate) to the (+) ion
Do not allow from a charged plate. 1

(f) They do not have the same electron configuration / they have different number of electrons (in the outer shell)
Ignore electrons determine the properties of an atom.
Ignore they are different elements or different number of protons. 1

[11]

9

(a) $2\text{Ca}_5\text{F}(\text{PO}_4)_3 + 9\text{SiO}_2 + 15\text{C} \longrightarrow 9\text{CaSiO}_3 + \text{CaF}_2 + 15\text{CO} + 6\text{P}$ 1

(b) **M1** ($\text{P}_4 =$) **0**
M2 ($\text{H}_3\text{PO}_4 =$) **(+) 5**
Accept Roman numeral V for M2 2

(c) H_2SO_4

Both numbers required

$$M_r = 2(1.00794) + 32.06550 + 4(15.99491) \\ = \mathbf{98.06102 \text{ or } 98.0610 \text{ or } 98.061 \text{ or } 98.06 \text{ or } 98.1}$$

Calculations not required

and

H_3PO_4

$$M_r = 3(1.00794) + 30.97376 + 4(15.99491) \\ = \mathbf{97.97722 \text{ or } 97.9772 \text{ or } 97.977 \text{ or } 97.98 \text{ or } 98.0}$$

1

(d) (i) A substance that speeds up a reaction OR alters / increases the rate of a reaction **AND** is chemically unchanged at the end / not used up.

Both ideas needed

Ignore reference to activation energy or alternative route.

1

(ii) The addition of water (**QoL**) to a molecule / compound

QoL- for the underlined words

1

(iii) **M1** $\text{CH}_3\text{CH}=\text{CH}_2 + \text{H}_2\text{O} \longrightarrow \text{CH}_3\text{CH}(\text{OH})\text{CH}_3$

(C_3H_6)

For M1 insist on correct structure for the alcohol but credit correct equations using either C_3H_6 or double bond not given.

M2 propan-2-ol

2

[8]

10

(a) $\text{N}^{3-} / \text{N}^{-3}$

1

(b) F^- / fluoride

Ignore fluorine/F

Penalise FI

1

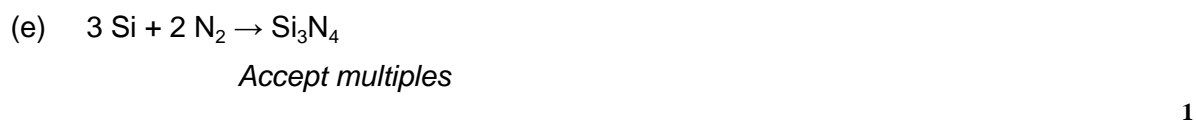
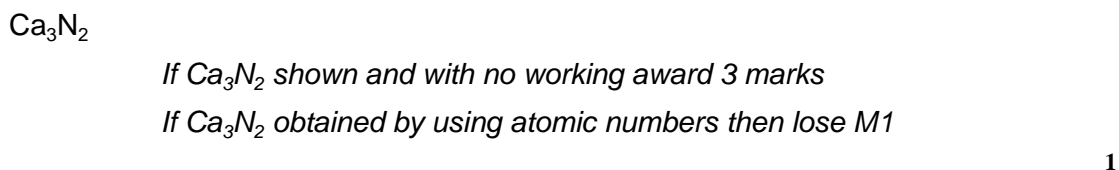
(c) $\text{Li}_3\text{N} / \text{NLi}_3$

1

(d) $\frac{81.1}{40.1} \quad \frac{18.9}{14}$
M1 for correct fractions 1

(=2.02 = 1.35)

1.5 1 or 3 : 2
M2 for correct ratio 1



[7]

11

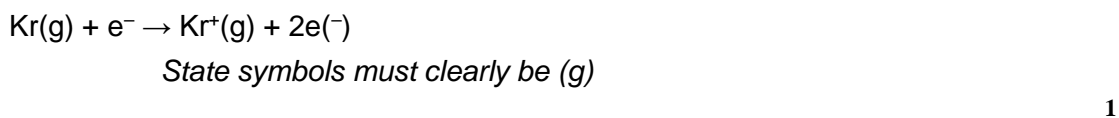
(a) $\frac{(82 \times 2) + (83 \times 2) + (84 \times 10) + (86 \times 3)}{17} \quad \frac{(1428)}{(17)}$
M1 for the top line
M2 is for division by 17 1

= 84.0
Not 84
No consequential marking from M1 or M2
Ignore units 1

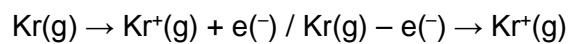
The A_r in the Periodic table takes account of the other isotopes / different amounts of isotopes (or words to that effect regarding isotopes)
Award independently
Comparison implied
Isotope(s) alone, M4 = 0 1

(b) (Beam of electrons from) an electron gun / high speed / high energy electrons 1

Knocks out electron(s) (to form a positive ion) 1



OR



The ^{84}Kr isotope

One mark for identifying the 84 isotope

1

Has 2 electrons knocked out / gets a 2+ charge

One mark for the idea of losing 2 electrons (from this isotope)

1

[9]

12

Mass number = number of protons + neutrons (in the nucleus/atom)

Not in a substance or compound or element

1

7 protons and 7 electrons

1

8 neutrons

1

[3]

13

(a) Average/mean mass of (1) atom(s) (of an element)

1

1/12 mass of one atom of ^{12}C

Accept answer in words

Can have top line $\times 12$ instead of bottom line $\div 12$

1

OR

(Average) mass of one mole of atoms

1/12 mass of one mole of ^{12}C

OR

(Weighted) average mass of all the isotopes

1/12 mass of one atom of ^{12}C

OR

Average mass of an atom/isotope compared to C-12
on a scale in which an atom of C-12 has a mass of 12

$$\frac{(95.12 \times 14) + (4.88 \times 15)}{100}$$

Allow 95.12 + 4.88 instead of 100

1

= 14.05

If not to 2 d.p. then lose last mark

Not 14.04

1

(b) ^{15}N is heavier/ ^{15}N has a bigger m/z/different m/z values

Not different no's of neutrons

Not ionisation potential

1

Electromagnet/electric field/magnet/accelerating
potential or voltage/electric current

1

(c) No difference

1

Same no of electrons (in outer orbital/shell/sub shell)/same electron configuration

M2 dependent on M1

Not just electrons determine chemical properties

Ignore protons

1

[8]

14

(a) Percentage of oxygen is 36.4%

% of oxygen stated or shown in calculation.

1

Correct calculation of ratios (C 4.54, H 9.10, O 2.28)

Mark is for correct method, dividing % by A_r

1

Empirical formula C_2H_4O

Allow consequential answer from wrong percentage of oxygen (max 2 marks).

1

(b) 88

Accept 88.0

Do not penalise correct answer in g.

1

(c) Ratio MF / EF of 2 ($88 / 44.0 = 2$)

If use $132 / 44 = 3$, molecular formula $C_6H_{12}O_3$ scores 2 marks.

1

Molecular formula is $C_4H_8O_2$

Accept consequential answers from (a) and (b)

1

[6]