

1. Xe has a bigger atomic radius **OR** Xe has more shells ✓

ALLOW Xe has more energy levels
ALLOW Xe has electrons in higher energy level
ALLOW Xe has electrons further from nucleus
IGNORE Xe has more orbitals OR more sub-shells
DO NOT ALLOW 'different shell' or 'new shell'

Xe has **more** shielding ✓

ALLOW More screening
*There must be a clear comparison ie **more** shielding **OR** increased shielding.*
*i.e. **DO NOT ALLOW** Xe 'has shielding'*
*ALLOW Xe has **more** electron repulsion from inner shells*

The nuclear attraction decreases

OR Outermost electrons of Xe experience less attraction (to nucleus)

OR Increased shielding / distance outweighs the increased nuclear charge ✓

ORA throughout

ALLOW Xe has less nuclear pull
IGNORE Xe has less effective nuclear charge
***DO NOT ALLOW** nuclear charge for nuclear attraction*

[3]

2. $3d^{10} 4s^2 4p^5$ ✓

ALLOW $4s^2 3d^{10} 4p^5$
ALLOW subscripts or $3D^{10}$
ALLOW answers with $1s^2 2s^2 2p^6 3s^2 3p^6$ appearing twice

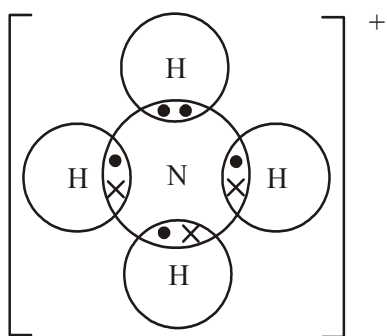
[1]

3. (i) $1s^2 2s^2 2p^6 3s^2 3p^6$ ✓

ALLOW subscripts

1

(ii)



‘Dot-and-cross’ diagram to show four shared pairs of electrons one of which is a dative covalent bond (which must consist of the same symbols) ✓

IGNORE inner shells

IGNORE ‘+’ sign **BUT DO NOT ALLOW** a ‘-’ sign.

Brackets and circles not required

1

(iii) tetrahedral ✓

109.5° ✓

ALLOW 109 – 110°

2

(iv) ions **OR** electrons cannot move in a solid ✓

ions can move **OR** are mobile in solution ✓

ALLOW ions can move in liquid

DO NOT ALLOW ions can move when molten

ALLOW 1 mark for:

‘Ions can only move in solution’

2

[6]

4. the energy required to remove one electron ✓ from each atom in one mole ✓ of gaseous atoms ✓

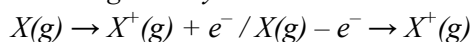
ALLOW 3 marks for:

the energy required to remove one mole of electrons ✓

from one mole of atoms ✓

atoms in the gaseous state ✓

If no definition, **ALLOW** one mark for the equation below, including state symbols.



ALLOW e for electron

IGNORE state symbol for electron

[3]

5. (i) $O^+(g) \rightarrow O^{2+}(g) + e^-$ ✓
answer must have state symbols
ALLOW e for electron
ALLOW $O^+(g) - e^- \rightarrow O^{2+}(g)$
DO NOT ALLOW $O^+(g) + e^- \rightarrow O^{2+}(g) + 2e^-$
IGNORE state symbol for electron

1

- (ii) the O^+ ion, is smaller than the O atom
OR
 the electron repulsion/shielding is smaller
OR
 the proton : electron ratio in the 2+ ion is greater than in
 the 1+ ion ✓
*ALLOW the outer electrons in an O^+ ion are closer to the
 nucleus than an O atom*
DO NOT ALLOW 'removed from next shell down'

1

[2]

6. (i) number of protons (in the nucleus) ✓
ALLOW proton number
ALLOW number of protons in an atom
IGNORE reference to electrons

1

- (ii) $(1s^2)2s^22p^63s^23p^63d^24s^2$ ✓
ALLOW $1s^2$ written twice
ALLOW subscripts
ALLOW $4s^2$ before $3d^{2+}$

1

- (iii) Mn / manganese **and** d ✓
ALLOW D

1

[3]

7. (i) atoms of the same element with different numbers of neutrons/different masses (1) 1
- (ii) ^{79}Br 35 protons, 44 neutrons, 35 electrons (1) 2
 ^{81}Br 35 protons, 46 neutrons, 35 electrons (1)
- (iii) $(1s^2)2s^22p^63s^23p^63d^{10}4s^24p^5$ (1) 1

[4]

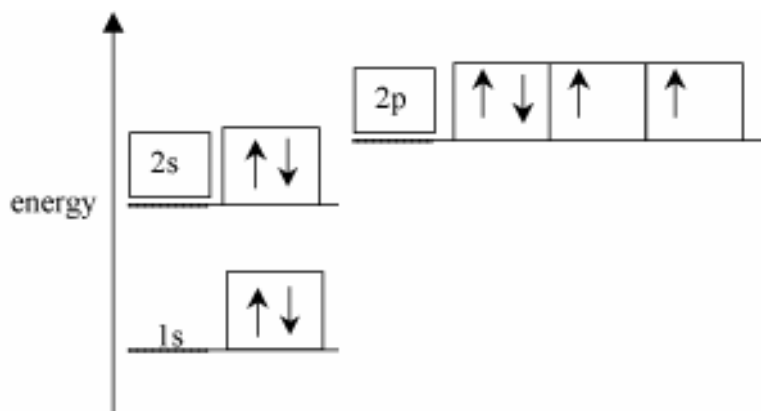
8. (a) 2



1, 2 or 3 p orbitals are OK

- (b) d orbital 2 ✓
 p sub-shell 6 ✓
 3rd shell 18 ✓ 3

(i)



- (ii) 2

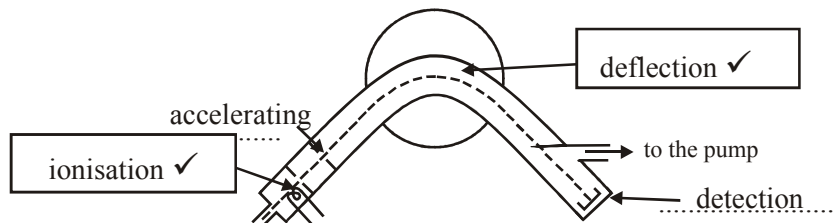
2s and 2p labels ✓ Ignore any superscripted numbers.
 8 electrons in correct levels with arrows correctly shown ✓

[7]

9. (i) Energy change when each atom in 1 mole ✓
of gaseous atoms ✓
loses an electron ✓ (to form 1 mole of gaseous 1+ ions). 3
- (ii) $O^{2+}(g) \rightarrow O^{3+}(g) + e^{-}$ ✓✓ 2
1 mark for correct species; 1 mark for state symbols
No charge required on electron.
Ignore (g) on e
- (iii) Large difference between 6th and 7th IEs ✓ 2
marking a different shell (closer to nucleus) ✓
allow 'inner shells'/new shell/full shell/first shell
marking points independent.
not sub-shell or orbital

[7]

10. (i)



	protons	neutrons	electrons	
^{25}Mg	12	13	12	✓
^{26}Mg	12	14	12	✓

- (ii) $1s^2 2s^2 2p^6 3s^2$ ✓
 $24 \times 78.60/100 + 25 \times 10.11/100 + 26 \times 11.29/100$ ✓ 1
- (iii) = 24.33 ✓ (calc value: 24.3269. This scores one mark)
24.32 with no working, award 1 mark only.
24.3 with no working, no marks (Periodic Table value) 2

[5]

11. (a) Energy change when **each atom in 1 mole** ✓
of gaseous **atoms** ✓
loses an electron ✓ (to form 1 mole of gaseous 1+ ions). 3

- (b) From Li → N, ionisation energy increases✓
 number of protons/nuclear charge increases✓
 nuclear attraction increases / shell drawn in by increased
 nuclear charge/ atomic radius decreases✓
 across period, electrons added to same shell✓

Not same subshell

From Be → B, ionisation energy decreases✓
 for B, electron is removed from a p sub-shell/p
 orbital/different sub-shell✓
 which has a higher energy✓

7

*watch for distinction between nuclear **attraction** and
 nuclear **charge** in candidates' scripts.*

Also watch for confusion between shell and subshell.

Al✓

Sharp rise in successive ionisation energy between 3rd and
 4th IE✓

marking a change to a new or different shell / there are 3
 electrons in the outer shell✓

3

*mention of 'orbital' or 'sub-shell cancels 'shell mark' Each
 marking point for Al is independent*

QoWC: links together two pieces of information
 correctly within two of the sections below:

1. General trend across period

2. Be to B

Successive ionisation energies✓

[13]

12. (i) $\text{Ca}^+(\text{g}) \rightarrow \text{Ca}^{2+}(\text{g}) + \text{e}^-$
 Equation with correct charges and 1 electron lost ✓
 state symbols ✓
 '−' not required on 'e'

2

- (ii) same number of protons or same nuclear charge attracting
 less electrons/
 electron removed from an ion/
 less electron-electron repulsion (**not** less shielding)/
 ion is smaller✓

1

- (iii) atomic radii of Sr > atomic radii of Ca/
 Sr has electrons in shell further from nucleus than Ca/
 Sr has electrons in a higher energy level/
 Sr has more shells ✓
 Therefore less attraction ✓
 Sr has **more** shielding than Ca ✓
 ('more' is essential)

3

increased nuclear charge is outweighed / despite increased nuclear
 chargeby at least one of the factors above ✓

[6]

13. $1s^2 2s^2 2p^2$ ✓ [1]
14. (i) Energy change when each atom in 1 mole ✓
of gaseous atoms ✓
loses an electron ✓ (to form 1 mole of gaseous 1+ ions). 3
- (ii) increasing nuclear charge/number of protons ✓
electrons experience greater attraction or *pull* / atomic
radius decreases / electrons added to same shell /same or
similar shielding ✓ 2
- (iii) In B, electron being removed is at a higher energy /
In Be, electron being removed is at a lower energy ✓
An s electron is lost in Be AND a p electron is lost in B ✓ 2
- [7]
15. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$ ✓ [1]
16. (i) First ✓ ionisation (energy) ✓ 2
 $Ra(g) \rightarrow Ra^+(g) + e^-$ ✓✓
1 mark for equation
1 mark for state symbols
'-' not required on 'e' 2
- (ii) atomic radii of Ra > atomic radii of Ca/
Ra has electrons in shell further from nucleus than Ca/
Ra has more shells ✓
Ra has **more** shielding than Ca ✓
: '**more**' is essential
Ra electron held less tightly/less attraction on electron ✓ 3
- [7]
17. (i) $1s^2 2s^2 2p^6 3s^2 3p^6 \dots \dots \dots 3d^{10} 4s^2 4p^5$ ✓✓ 2
Award 1 mark for p^5 .
- (ii) Highest energy sub-shell/sub-shell/being filled is the p
sub-shell/outer electrons are in a p (sub-shell/orbital/shell) ✓ 1
- [3]

18. (a) Energy change when each atom in 1 mole ✓
of gaseous atoms ✓ 3
loses an electron ✓ (to form 1 mole of gaseous 1+ ions).
- (b) increasing nuclear charge/number of protons ✓
electrons experience greater attraction or *pull*/atomic
radius decreases/electrons added to same shell/same or
similar shielding ✓ 2

[5]