

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 $3D^{10}$

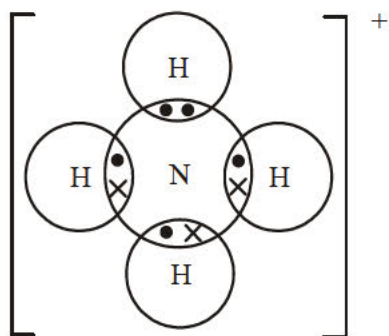
ALLOW answers with $1s^2 2s^2 2p^6 3s^2 3p^6$ appearing twice

[1]

3. (i) $1s^2 2s^2 2p^6 3s^2 3p^6$ ✓

ALLOW subscripts

(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 ✓

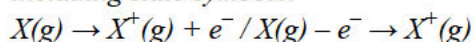
ALLOW 3 marks for:

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) 1
- (iii) $(1s^2)2s^22p^63s^23p^63d^{10}4s^24p^5$ (1) 1

[4]

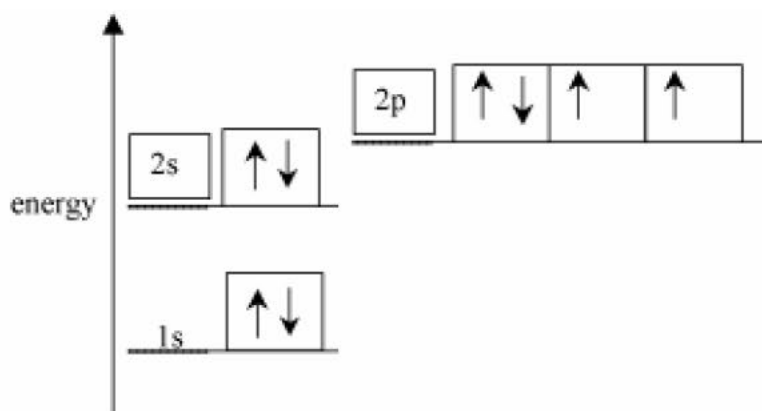
8. (a) 2



1, 2 or 3 p orbitals are OK

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

(i)



(ii)

2

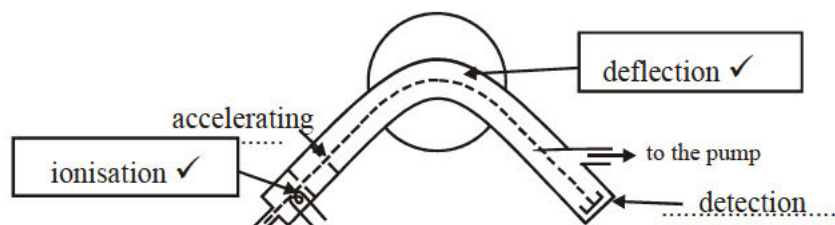
2s and 2p labels ✓ Ignore any superscripted numbers.
8 electrons in correct levels with arrows correctly shown ✓

[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) $1s^2 2s^2 2p^6 3s^2$ ✓ 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✓
- watch for distinction between nuclear **attraction** and
 nuclear **charge** in candidates' scripts.
 Also watch for confusion between shell and subshell.*

7

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✓

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

3

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' ✓
- (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✓
- (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)
- increased nuclear charge is outweighed / despite increased nuclear
 charge by at least one of the factors above ✓

2

1

3

[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 <i>pull</i> / 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) ✓ $Ra(g) \rightarrow Ra^+(g) + e^-$ ✓✓ 1 mark for equation 1 mark for state symbols '-' not required on 'e'	2 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) $1s^2 2s^2 2p^6 3s^2 3p^6 \dots 3d^{10} 4s^2 4p^5$ ✓✓ Award 1 mark for p^5 .	2	
	(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 ✓
loses an electron ✓ (to form 1 mole of gaseous 1+ ions).

3

(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]