Electron Structure

Total mark – 20

Question: 1

1. Modern plasma television screens emit light when mixtures of noble gases, such as neon and xenon, are ionised.

   The first ionisation energies of neon and xenon are shown in the table below.

element	1st ionisation energy / kJ mol^{-1}
neon	+2081
xenon	+1170

Explain why xenon has a lower first ionisation energy than neon.

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[Total 3 marks]

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]

Question: 2

2. The electron configuration of bromine contains outermost electrons in the 4th shell.

Using your knowledge of Group 7 elements, complete the electron configuration of bromine.

$1s^2 2s^2 2p^6 3s^2 3p^6$ .....

[Total 1 mark]

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]

Question: 3

3. Ammonia reacts with hydrogen chloride, HC*l*, to form ammonium chloride, NH_4Cl.

NH_4Cl is an ionic compound containing NH_4^+ and Cl^- ions.

(i) Complete the electron configuration of the Cl^- ion.

$1s^2$ .....

[1]

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in NH_4^+.

Show **outer** electrons only.

[1]

(iii) State the shape of, and bond angle in, an NH_4^+ ion.

shape: .....

bond angle: .....

[2]

(iv) A student investigated the conductivity of ammonium chloride.

She noticed that when the ammonium chloride was solid it did **not** conduct electricity. However, when ammonium chloride was dissolved in water, the resulting solution did conduct electricity.

Explain these observations.

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[2]

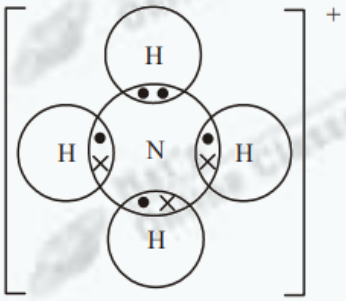
[Total 6 marks]

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'

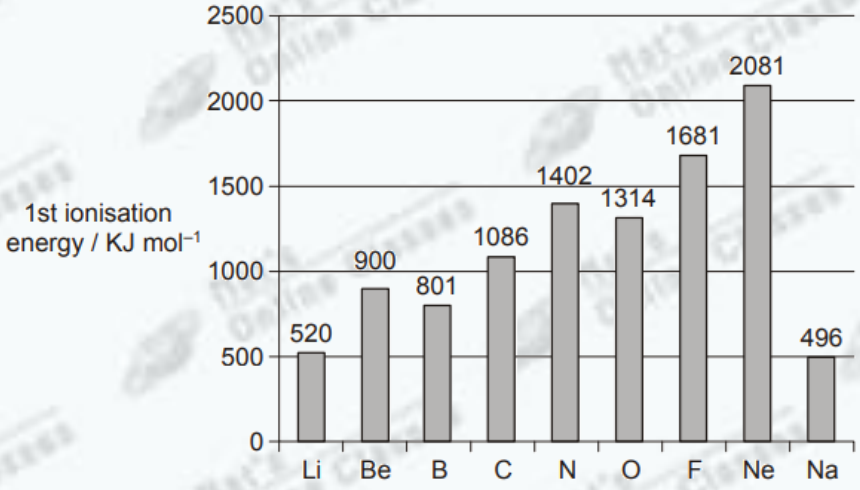
2

[6]

Question: 4

4. Ionisation energies have been used to develop the model of the atom.

The first ionisation energies of the elements Li to Na are shown in the figure below.



Define the term *first ionisation energy*.

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[Total 3 marks]

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.*

$X(g) \rightarrow X^{+}(g) + e^{-}$ / $X(g) - e^{-} \rightarrow X^{+}(g)$

***ALLOW** e for electron*

***IGNORE** state symbol for electron*

[3]

Question: 5

8. Electrons are arranged in energy levels.

(a) An orbital is a region in which an electron may be found.

Draw diagrams to show the shape of an s orbital and of a p orbital.

s orbital	p orbital

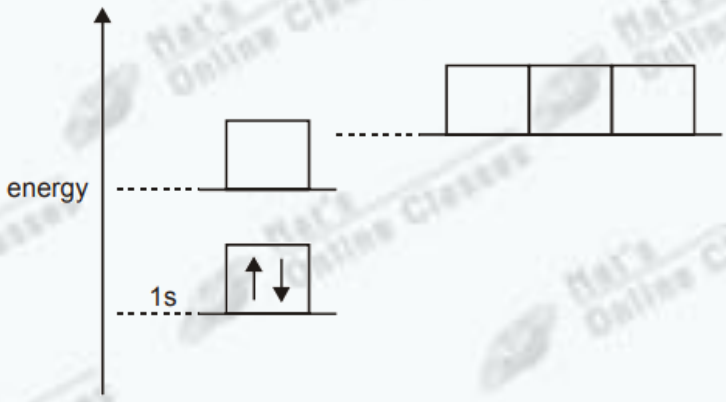
[2]

(b) Complete the table below to show how many electrons **completely** fill each of the following.

	number of electrons
a d **orbital**	
a p **sub-shell**	
the third **shell** (n = 3)	

[3]

(c) The energy diagram below is for the eight electrons in an oxygen atom. The diagram is incomplete as it only shows the two electrons in the 1s level.



Complete the diagram for the oxygen atom by:

(i) adding labels for the other sub-shell levels,

[1]

(ii) adding arrows to show how the other electrons are arranged.

[1]

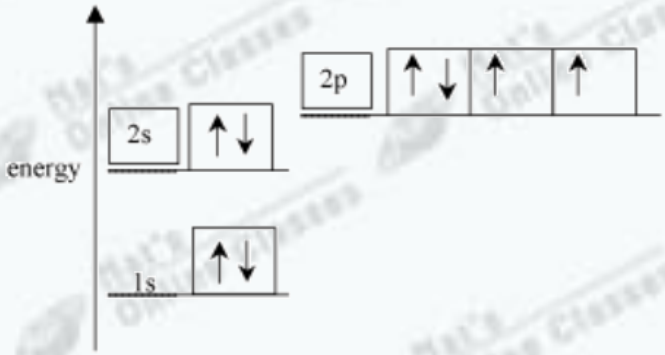
[Total 7 marks]

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]