EXAM PAPERS PRACTICE

Boost your performance and confidence with these topic-based exam questions

Practice questions created by actual examiners and assessment experts

Detailed mark scheme

Suitable for all boards

Designed to test your ability and thoroughly prepare you

Time allowed
121 Minutes

Score /101

Percentage %

CHEMISTRY

OCR
AS & A LEVEL

Mark Scheme

Module 3: Periodic table and energy

EXAM PAPERS PRACTICE

F321: Atoms, Bonds and Groups
Periodicity – Mark Scheme

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. (i) Potassium **AND** argon ✓

__ALLOW__ K and Ar

1

(ii) They are arranged in increasing atomic number
OR
Neither would show properties **OR** trends of rest of group
OR
Neither would show properties **OR** trends of rest of period
OR
They are arranged by electron configuration ✓

__ALLOW__ any correct property difference
e.g. This would place a reactive metal in the same group as noble gases

__ALLOW__ they do not fit in with the rest of the group

1

[2]

3. (a) (i) Magnesium ions have a greater charge✓

Magnesium has more
(delocalised **OR** outer) **electrons**✓

Magnesium has greater attraction between **ions** and
electrons OR has stronger **metallic** bonds ✓

USE annotations with ticks, crosses, ecf, etc for this part.

ALLOW REVERSE ARGUMENT
e.g. sodium ions have a smaller charge
ALLOW *Mg^{2+} / Mg ion / Na ion / Na^{+} ion*
ALLOW *'charge density' as alternative to 'charge'*

ALLOW REVERSE ARGUMENT
e.g. sodium has fewer electrons

ALLOW REVERSE ARGUMENT
e.g. sodium has less attractions between ***ions*** *and* ***electrons***
OR *has weaker* ***metallic*** *bonds* ✓

3

(ii) Cl_2 **OR** S_8 has intermolecular **OR** van der Waals' forces ✓

S_8 has stronger intermolecular forces **OR** van der Waals' forces than Cl_2

OR
S_8 has more electrons ✓

ALLOW REVERSE ARGUMENT *ie Cl_2 has weaker intermolecular forces* ***OR*** *van der Waals' forces*
DO NOT ALLOW *comparison involving covalent bonds*

ALLOW REVERSE ARGUMENT
Cl_2 has fewer electrons

2

(b) nuclear charge increases/ protons increase ✓

electrons added to the same shell
OR
screening **OR** shielding remains the same ✓

greater attraction **OR** greater pull ✓

USE annotations with ticks, crosses, ecf, etc for this part.

Nuclear OR proton(s) OR nucleus spelt correctly ONCE

IGNORE *'atomic number increases'*
IGNORE *'nucleus gets bigger'*
'charge increases' is not sufficient
ALLOW *'effective nuclear charge increases'* ***OR*** *'shielded nuclear charge increases'*

IGNORE *reference to atomic radius staying the same*

ALLOW *shielding is similar*
DO NOT ALLOW *extra shielding*

A comparison ***must*** *be included:*
i.e. ***'greater*** *pull',* ***'more*** *pull', 'held* ***more*** *tightly';*

3

[8]

4. (i) outer electrons closer to nucleus **OR** radii decreases ✓

nuclear charge increases
OR protons increase ✓

electrons added to the same shell
OR
screening **OR** shielding remains the same ✓

IGNORE *'atomic number increases'*
IGNORE *'nucleus gets bigger'*
'charge increases' is not sufficient
ALLOW *'effective nuclear charge increases'* ***OR*** *'shielded nuclear charge increases'*

ALLOW *shielding is similar*

3

(ii) atomic radii increase **OR**
there are more shells ✓

there is **more** shielding **OR more** screening ✓

the nuclear attraction decreases
OR
Increased shielding / distance outweigh the increased
nuclear charge ✓

ALLOW *electrons in higher energy level*
ALLOW *electrons are further from the nucleus*
DO NOT ALLOW *more orbitals* ***OR*** *more sub-shells*
DO NOT ALLOW *different shell or new shell*

*There must be a clear comparison: e.g. '****more*** *shielding', '****increased*** *shielding'. i.e.* ***DO NOT ALLOW*** *just 'shielding'.*
ALLOW *'****more*** *electron repulsion from inner shells'*

Nuclear OR proton(s) OR nucleus spelt correctly ONCE
ALLOW *'nuclear pull'*
IGNORE *any reference to 'effective nuclear charge'*

3

[6]

5. (i) S **(1)** 1

(ii) A*l* **(1)** 1

(iii) B **(1)** 1

(iv) Ca **(1)** 1

(v) K **(1)** 1

(vi) K **(1)** 1

[6]

indent3;mark;Default;header;**TOCI;**Answer;Part lines;question(a)(i);indent2;**indent1(a);BoxL;Bottom;heading 1;heading 2;heading 3;heading 4;heading 5;*heading 6;heading 7;heading 9;ex;ex2;graph;Hyperlink;right;Box;BoxR;annotation reference;***✓ ☐☐☐☐☐☐ ***6.***

(i) atomic radii decrease /s
number of protons in the nucleus increases **(1)**
nuclear attraction increases **(1)** 3

(ii) $Na^{2+}(g) \rightarrow Na^{3+}(g) + e^-$: equation and state symbols **(1)** 1

(iii) large jump (in energy) between the 4th and 5th ionisation energies **(1)**
four electrons in outer shell so element is Si **(1)** 2

[6]

7. atomic radii of Rb > atomic radii of elements above/
Rb has electrons in shell further from nucleus /
Rb has more shells ✓

Rb has **more** shielding ✓ (***'more'*** *is essential*)

(increased) nuclear charge is outweighed /
despite increased nuclear charge …..by at least one of the factors above/
less attraction/ held less tightly ✓

[3]

8. (i) They have different numbers of protons/
Ba has one more proton/Ba has 56 p^+; Cs has 55 p^+ ✓ 1
(ignore electrons: any mention of 'neutrons' is wrong)

(ii) s ✓ 1

(iii) Cs to Ba: nuclear charge increases/more protons ✓
electrons are in: the same shell/sub-shell/orbital /similar shielding/same shielding ✓ 3
attraction increases/pull increases ✓ …….ORA

(iv) smaller ✓ 2
shell has been lost/less shielding/less electron repulsion/proton : electron ratio larger ✓
mark separately

[7]

9. (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]

10. High boiling point **or** difficult to break linked to strong bonds in the right context within Li **or** C ✓ 1

Li conducts by delocalised/free/mobile electrons ✓ structure: giant ✓metallic ✓ 3

or '+ ions with a sea of electrons' for giant mark

C conducts by delocalised/free/mobile electrons ✓ structure: giant ✓covalent with layers ✓ 4

N No mobile charge carriers/electrons/ions to conduct electricity ✓

simple molecular structure/made of N_2 molecules✓

low boiling point **or** easily broken due to intermolecular forces/ van der Waals' forces ✓ 3

QWC: At least 2 complete sentences in which the meaning is clear. ✓ 1

[12]

11. (i) O ✓ 1

(ii) AI ✓ 1

(iii) P ✓ 1

(iv) C/Si ✓ 1

(v) N/P ✓ 1

(vi) Mg ✓ 1

(vii) Na ✓ 1

(viii) Si ✓ 1

[8]

12. (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]

13. (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]

14. N has less protons than O (ora) ✓
electrons are in same shell
/have same or similar shielding ✓
weaker nuclear attraction in N (ora) ✓
shell drawn in less by nuclear charge in N (ora) ✓

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

QoWC: links together two statements in at least two of the sections (a)(ii), (b) and (c) ✓

[4]

15. (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]

16. (From 2 →10 →18 / down group)

1st ionisation energies decrease/easier to remove electrons ✓
electron is further from nucleus/ atomic radius increases/

electron in a different shell/ atoms increase in size ✓
*(**not** sub-shell or orbital)*

electron experiences **more** shielding ✓
*(**more** is essential here)*

distance and shielding outweigh the increased nuclear charge ✓
NOT: attraction/pull; effective nuclear charge

[4]