

1.

Drinking water may contain dissolved calcium hydrogencarbonate, $\text{Ca}(\text{HCO}_3)_2$.

How many electrons are present in a hydrogencarbonate anion?

A 30 B 31 C 32 D 33

Ans: C

Number of electrons in H = 1

Number of electrons in C = 6

Number of electrons in $\text{O}_3 = 3 \times 8 = 24$

Charge on anion = -1 (deduced from the formula)

So total number of electrons in the anion = $1+6+24+1 = 32$

2.

Beams of charged particles are deflected by an electrical field. The angle of deflection of a particle is proportional to its charge/mass ratio.

In an experiment protons are deflected by an angle of $+15^\circ$. In another experiment under identical conditions ${}^2\text{H}^-$ ions are deflected by an angle of Y° .

What is the value of Y?

A -30.0 B -7.5 C +7.5 D +30.0

Ans: B

charge/mass ratio of proton = $1/1 = 1$

charge/mass ratio of ${}^2\text{H}^- = 1/-2 = -0.5$

Thus deflection will be negative and half of the original = -7.5

3.

Sodium azide, NaN_3 is an explosive used to inflate airbags in cars when they crash. It consists of positive sodium ions and negative azide ions.

What are the numbers of electrons in the sodium ion and the azide ion?

	sodium ion	azide ion
A	10	20
B	10	22
C	12	20
D	12	22

Ans: B

Charge on Na = $1+$

So no of electrons = $11 - 1 = 10$

Charge on $N_3 = 1-$

So no of electrons = $(3 \times 7) + 1 = 22$

4.

The ^{68}Ge isotope is medically useful because it undergoes a natural radioactive process to give an isotope of a different element, ^{68}X , which can be used to detect tumours. This transformation of ^{68}Ge occurs when an electron enters the nucleus and changes a proton into a neutron.

Which statement about the composition of an atom of ^{68}X is correct?

- A It has 4 electrons in its outer p orbitals.
- B It has 13 electrons in its outer shell.
- C It has 37 neutrons.
- D Its proton number is 32.

Ans: C

NOTE: group 15 = 3 electrons in outermost shell, because it needs 3 to become 18.

5.

What is the electronic configuration of an isolated Ni^{2+} ion?

- A $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
- B $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^1$
- C $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2$
- D $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$

Ans: D

First write out the configuration of Ni, then remove 2 electrons from the outermost shell (from 4s before 3d)!!

6.

In which pair does each species have the same number of unpaired electrons?

- A Al and Cu^{2+}
- B Ca and Cr^{3+}
- C Ca and Ni^{2+}
- D Fe^{3+} and O^{2-}

Ans: A

7.

The electronic arrangement for atoms of four elements is given.

Which element is the strongest oxidising agent?

- A $1s^2 2s^2 2p^5$
- B $1s^2 2s^2 2p^6 3s^2$
- C $1s^2 2s^2 2p^6 3s^2 3p^5$
- D $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Ans: A

Strongest oxidising agent = gets reduced = accepts electrons easily

8.

Which of these elements has the highest fifth ionisation energy?

- A C
- B N
- C P
- D Si

Ans: A

9.

The fifth to eighth ionisation energies of four elements in Period 3 of the Periodic Table are shown.

Which row refers to chlorine?

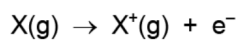
	ionisation energies / kJ mol^{-1}			
	fifth	sixth	seventh	eighth
A	6280	21 200	25 900	30 500
B	6990	8 490	27 100	31 700
C	6540	9 330	11 000	33 600
D	7240	8 790	12 000	13 800

Ans: C

10.

The eight elements sodium to argon are in the same period of the Periodic Table.

The equation corresponding to the first ionisation energy is shown.



For which of these eight elements is the electron in this equation removed from a filled orbital?

- A Mg, Al, Si, P, S, Cl and Ar
- B Al, Si, P, S, Cl and Ar only
- C Mg, S, Cl and Ar only
- D S, Cl and Ar only

Ans: C

The electron is removed from whichever orbital has 2 electrons; not dependent on order from the end.

11.

The first four ionisation energies for element X are shown in the table.

ionisation energy	1st	2nd	3rd	4th
value / kJ mol ⁻¹	577	1980	2960	6190

Which ion of X is produced by removing an electron from a filled shell?

- A X⁺
- B X²⁺
- C X³⁺
- D X⁴⁺

Ans: D

12.

Why is the second ionisation energy of sodium larger than the second ionisation energy of magnesium?

- A The attraction between the nucleus and the outer electron is greater in Na⁺ than in Mg⁺.
- B The nuclear charge of Na⁺ is greater than that of Mg⁺.
- C The outer electron of Na⁺ is more shielded than the outer electron of Mg⁺.
- D The outer electron of Na is in the same orbital as the outer electron of Mg.

A

13.

Elements X and Y are in the same group of the Periodic Table.

The table shows the first six ionisation energies of X and Y in kJ mol^{-1} .

	1st	2nd	3rd	4th	5th	6th
X	800	1600	2400	4300	5400	10400
Y	1000	1800	2700	4800	6000	12300

What could be the identities of X and Y?

	X	Y
A	antimony, Sb	arsenic, As
B	arsenic, As	antimony, Sb
C	selenium, Se	tellurium, Te
D	tellurium, Te	selenium, Se

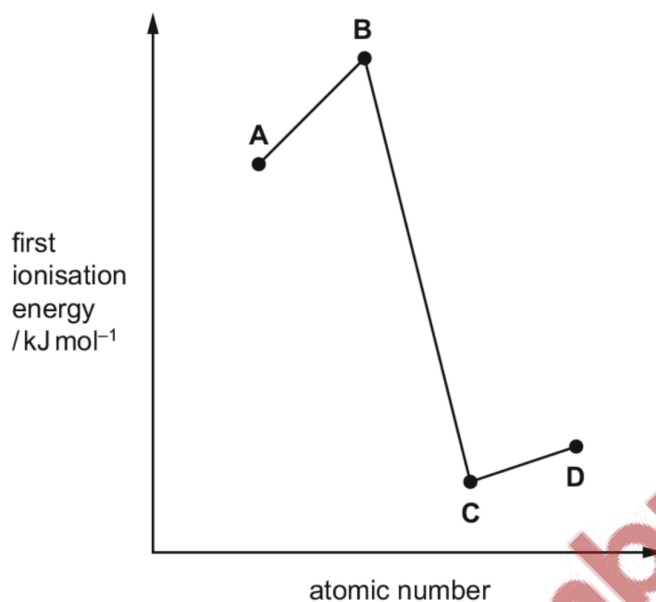
Ans: A

14.

The relative first ionisation energies of four elements with consecutive atomic numbers below 20 are shown on the graph.

One of the elements reacts with hydrogen to form a covalent compound with formula HX.

Which element could be X?



Ans: A

15.

Element X has six more protons than element Y.

Which statement **must** be correct?

- A Atoms of element Y are smaller than atoms of element X.
- B Element X has a full shell of electrons.
- C Element X and element Y are in the same group.
- D Element X and element Y are in the same period.

Ans: B

16.

Which statement explains why calcium has a higher melting point than barium?

- A Calcium cations are smaller than barium cations and have a stronger attraction to the delocalised electrons.
- B The structure of calcium is partly giant molecular.
- C There are more delocalised electrons in calcium than in barium as it has a lower ionisation energy.
- D There is greater repulsion between barium atoms as they have more complete electron shells than calcium atoms.

Ans: A

17.

Four successive ionisation energies (IE) of element E are shown.

Element E is in Period 3 of the Periodic Table.

fifth IE /kJ mol ⁻¹	sixth IE /kJ mol ⁻¹	seventh IE /kJ mol ⁻¹	eighth IE /kJ mol ⁻¹
16 000	20 000	24 000	29 000

In which group of the Periodic Table is E?

- A** 14 **B** 15 **C** 16 **D** 17

Ans: A

18.

Element X has the second largest atomic radius in its period. An atom of X has three occupied electron shells only.

The oxide of X is shaken with water.

What could be the pH of the resulting solution?

- A 5 B 7 C 9 D 14

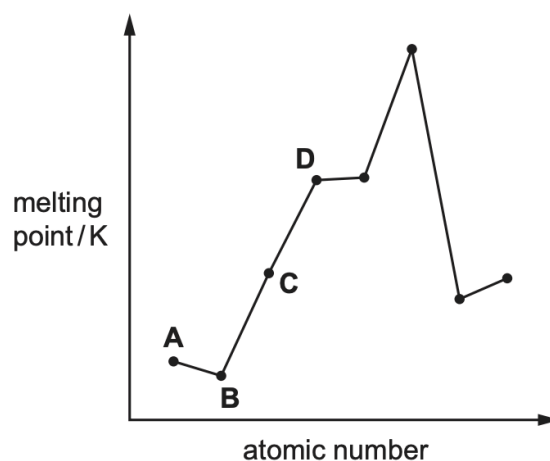
Ans: C

- 2nd largest atomic radius = group 2
- 3 shells = period 3
- Thus magnesium. Mg(OH)_2 is weakly basic, so pH 9

19.

The diagram shows the melting points of eight elements with consecutive atomic numbers.

Which element could be sodium?



Ans: C

- Strength of metallic bond: $\text{Na} < \text{Mg} < \text{Al}$
- B is likely to be noble gas because it has lowest bp
- Jump from 2+ to 3+ is not as high (between Mg and Al)

20.

X, Y and Z are elements all found within Groups 13, 14 and 15 of the Periodic Table.

X is in the same group in the Periodic Table as Y.

Y and Z are in Period 3.

The first ionisation energy of X is greater than the first ionisation energy of Y.

The melting point of Z is less than the melting point of Y.

Y and Z both form chlorides which are white solids. These white solids react with water to produce solutions with a pH of less than 4.

Which row of the table shows the possible identities of X and Y?

	X	Y
A	B	Al
B	Ge	Si
C	As	P
D	N	P

Ans: A

- First IE of X > first IE of Y = X has fewer shells than Y = period above Y. this rules out B and C.
- SiCl₄ is a liquid, so Y and Z must be Al and P.
- Mp of P is less than mp of Al, so P = Z and Al = Y.

21.

The second ionisation energy of oxygen is greater than the second ionisation energy of fluorine.

Which factor explains this difference?

- A The atomic radius of an oxygen atom is smaller than that of fluorine.
- B The covalent bond in a fluorine molecule is weaker than the bond in an oxygen molecule.
- C A spin-paired electron is removed from fluorine but **not** from oxygen.
- D Fluorine has more electrons in total than oxygen. This causes a greater shielding of the nuclear attraction in fluorine.

Ans: C