02 Atomic Structure

Set B Competition Practice

Name	Time 45 minutes	Total 23 marks	Score ____ / 23

Marks by notes section For the marker: total each row. A score below the target means that section of the notes needs revising.

Notes section	Questions	Marks	Target	Score
1 The Atom	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	10	6	
2 Electrons in Atoms	11, 12, 13, 14, 15, 16, 17, 18, 19, 20	10	6	
3 Ionisation Energy	21, 22, 23	3	2	

A Competition questions

23 MARKS

1 The letters X, Y and Z represent different atoms.

$^{37}_{17}X$ $^{37}_{18}Y$ $^{38}_{18}Z$

Which statement is correct?

A X and Y are the same element.

B X and Y have same number of neutrons.

C Y and Z have the same number of electrons.

D Z has more neutrons than X.

/1

Answer ☐ [1]

Source: 2024 CHIJ O Prelim P1 Q5

2 Which ion has fewer electrons than neutrons and fewer neutrons than protons?

ion	neutrons	nucleons
W^-	18	37
X^{2+}	17	34
Y^{3+}	16	33
Z^{3-}	16	31

A W^- **B** X^{2+} **C** Y^{3+} **D** Z^{3-}

/1

Answer ☐ [1]

Source: 2020 VJC J2 Prelim P1 Q2

3 What do the ions $^{18}O^{2-}$ and $^{19}F^-$ have in common?

A They have more electrons than neutrons.

B They have 10 neutrons in their nuclei.

C They have an outer electronic configuration of $3s^2\ 3p^6$.

D They contain the same number of nucleons in their nuclei.

/1

Answer [1]

Source: 2024 RI J2 Prelim P1 Q3

4 Beams of charged particles are deflected by an electric field. Under identical conditions, 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° by an electric field. In another experiment under identical conditions, particle Y is deflected by an angle of −5°. What could be the composition of particle Y?

A 1 proton, 2 neutrons, 1 electron

B 3 protons, 3 neutrons, 5 electrons

C 4 protons, 5 neutrons, 1 electron

D 4 protons, 5 neutrons, 3 electrons

/1

Answer [1]

Source: 2022 DHS J2 Prelim P1 Q1

5 A sample of the element calcium was vaporised, ionised and passed through an electric field. It was observed that a beam of $^{40}Ca^{2+}$ particles gave an angle of deflection of +4°. Assuming an identical set of experimental conditions, by what angle would a beam of $^{19}F^{-}$ particles be deflected?

A +2° **B** −2° **C** +4° **D** −4°

/1

Answer [1]

Source: 2021 ACJC J2 Prelim P1 Q4

6 Which of the following species will produce the largest deflection when fired with equal velocity into an electric field?

A $^{7}Li^{+}$ **B** $^{9}Be^{2+}$ **C** $^{16}O^{2-}$ **D** $^{14}N^{3-}$

/1

Answer [1]

Source: 2020 EJC J2 Prelim P1 Q1

7 X, Y and Z are isotopes of three different elements. An isotope of argon has a mass number of 41 and the same number of neutrons in the nucleus as each of the isotopes X, Y and Z. The species Ar, X^{+}, Y^{2+} and Z^{3+} all contain the same number of electrons.

What are the mass numbers of X, Y and Z? Each option gives the mass numbers of X, Y and Z in that order.

A 42, 41, 40 **B** 40, 41, 42 **C** 44, 43, 42 **D** 42, 43, 44

/1

Answer [1]

2021 ACJC J2 Prelim P1 Q5

8 A stream of gaseous $^{16}_{8}O^{2-}$ ions was passed between two oppositely charged plates. Analysis of the deflection shows that these ions deflected at an angle of 10.0°. Under the same electric field, an unknown gaseous ion Z^{-} is deflected at an angle of 2.58°. What is the isotopic mass of Z?

A 8 **B** 15 **C** 16 **D** 31

/1

Answer [1]

2021 TMJC J2 Prelim P1 Q2

9 In a particular experiment, a beam of $^{9}Be^{2+}$ ions is deflected by an electric field through an angle of +10°. Which one of the following particles, when passed through the same electric field, will be deflected through an angle half the magnitude of $^{9}Be^{2+}$?

	proton number	neutron number	electronic configuration
A	6	8	$1s^2\ 2s^2\ 2p^6$
B	8	10	$1s^2\ 2s^2\ 2p^6$
C	12	8	$1s^2\ 2s^2\ 2p^6$
D	15	20	$1s^2\ 2s^2\ 2p^6$

A row A **B** row B **C** row C **D** row D

/1

Answer [1]

2020 VJC J1 Promo P1-P2 Q1

10 Scientists have discovered the use of an isotope of lead, Pb, which can treat non-cancerous eye disorders. ^{210}Pb is an isotope of ^{207}Pb. Which statement about these isotopes is correct?

A ^{210}Pb atom has 210 neutrons but ^{207}Pb atom has 207 neutrons.

B ^{210}Pb atom and ^{207}Pb atom have 125 protons each.

C ^{210}Pb atom has 3 neutrons more than ^{207}Pb atom.

D ^{210}Pb atom has 3 protons more than ^{207}Pb atom.

/1

Answer [1]

2024 MSHS O Prelim P1 Q8

11 Which statement about the electrons in a ground state carbon atom is correct?

A The occupied orbital of highest energy is spherical.

B The occupied orbital of lowest energy is spherical.

C There are more electrons in p orbitals than there are in s orbitals.

D Electrons are present in four different energy levels.

/1

Answer [1]

Source: 2020 YIJC J2 Prelim P1 Q1

12 The shape of each p orbital is represented as two lobes. How many electrons does Cu have in orbitals with four lobes?

A 7 **B** 8 **C** 9 **D** 10

/1

Answer [1]

Source: 2021 RI J2 Prelim P1 Q1

13 The shape of each p orbital is represented as two lobes. How many 3d orbitals have four lobes?

A 2 **B** 3 **C** 4 **D** 5

/1

Answer [1]

2022 ACJC J2 Prelim P1 Q2

14 An ion X^{2+} contains 24 protons. What is the electronic configuration of X^{3+}?

A $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3$

B $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4$

C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1\ 4s^2$

D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

/1

Answer ☐ [1]

Source: 2021 ACJC J2 Prelim P1 Q3

15 Which particle contains the most number of unpaired electrons?

A Cr **B** Cu^{2+} **C** Mn^{2+} **D** Te^{2-}

/1

Answer ☐ [1]

Source: 2020 VJC J2 Prelim P1 Q1

16 A cation G^{2+} is isoelectronic with PH_3. What is the ground state electronic configuration of G?

A $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$

B $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2$

D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

/1

Answer ☐ [1]

Source: 2017 RI J1 Promo P1-P3 Q2

17 Which electronic configuration represents an atom of an element, at ground state, that forms a stable ion with a charge of +3?

A $1s^2\ 2s^2\ 2p^3$

B $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

C $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

D $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^2\ 4s^1$

/1

Answer ☐ [1]

Source: 2021 EJC J2 Prelim P1 Q1

18 Which of the following about calcium and copper is correct?

A The outermost orbital of the atoms of both elements has the same shape.

B Atoms of both elements have orbitals of only 2 different shapes of various sizes.

C Atoms of both elements have the same number of electrons in the outermost shell.

D Both elements form ions of 2+ charge with the electronic configuration of [Ar].

/1

Answer ☐ [1]

Source: 2025 EJC J2 Prelim P1 Q2

19 There are occupancies of another type of subshell, beyond the s, p, d and f. This would be a g subshell, which is predicted to be found in the 5th shell of an atom, that is, the 5g subshell.

How many electrons in the 5g subshell would the element of atomic number 122 be expected to have?

A 1 **B** 2 **C** 3 **D** 4

/1

Answer [1]

Source: SJChO Mock 3 P1 Q12

20 Element Z, nucleon number 31, forms an ion Z^{3-}. Where is Z found in the Periodic Table?

A Group 13 **B** Group 15 **C** Period 4 **D** Period 5

/1

Answer [1]

2024 SKSS O Prelim P1 Q6

21 The successive ionisation energies of the gaseous ion G^{+} are given in the table.

number of electrons removed	1	2	3	4	5	6
ionisation energy / kJ mol^{-1}	1907	2914	4964	6274	21 267	25 431

Which group in the Periodic Table does G belong to?

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

/1

Answer [1]

Source: 2021 HCI J2 Prelim P1 Q1

22 The table shows the fifth, sixth, seventh, eighth and ninth ionisation energies of an element in the third period.

	5th	6th	7th	8th	9th
ionisation energy / kJ mol^{-1}	6270	21 270	25 430	29 870	35 920

Which element has these ionisation energy values?

A P **B** S **C** Cl **D** Ar

/1

Answer [1]

Source: 2022 YIJC J2 Prelim P1 Q1

23 Which of the following statements best explains why the first ionisation energy of argon is higher than that of sulfur?

A Sulfur is more electronegative than argon.

B Argon has a complete octet, while sulfur does not.

C The nuclear charge in argon is greater than that in sulfur.

D The electron removed from sulfur is unpaired, while that removed from argon is paired.

/1

Answer [1]

Source: 2020 ACJC J2 Prelim P1 Q5

10 The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0											5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –