



# **A-Level Chemistry**

## **Atomic Structure (Multiple Choice)**

### **Question Paper**

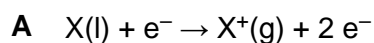
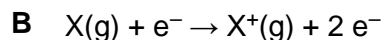
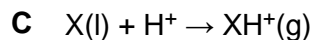
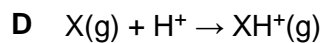
**Time available: 35 minutes**

**Marks available: 30 marks**

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**1.**

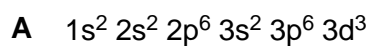
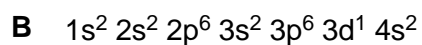
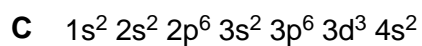
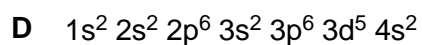
In a time of flight mass spectrometer, molecule X is ionised using electrospray ionisation. What is the equation for this ionisation?

☐☐☐☐

(Total 1 mark)

**2.**

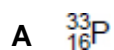
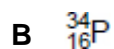
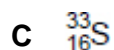
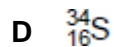
What is the electron configuration of  $V^{2+}$  in the ground state?

☐☐☐☐

(Total 1 mark)

**3.**

Which atom has one more proton and two more neutrons than  $^{31}_{15}\text{P}$ ?

☐☐☐☐

(Total 1 mark)

4.

Which element has a first ionisation energy lower than that of sulfur?

A Chlorine

☐

B Oxygen

☐

C Phosphorus

☐

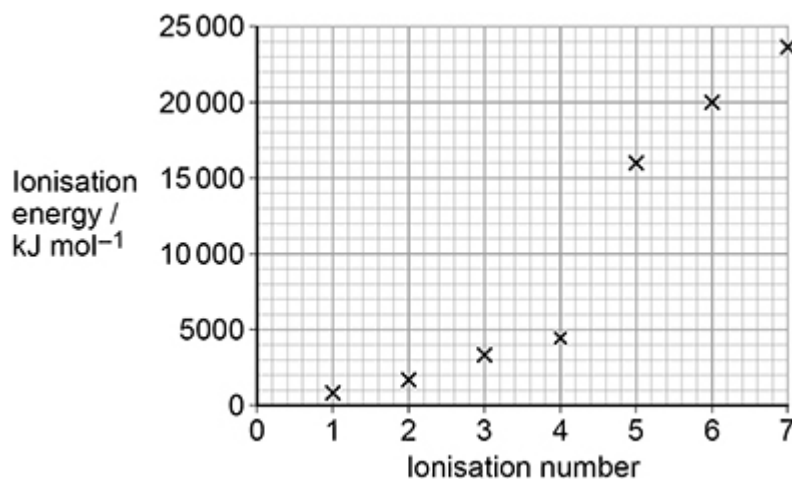
D Selenium

☐

(Total 1 mark)

5.

The first seven successive ionisation energies for element Z are shown.



What is element Z?

A Carbon

☐

B Nitrogen

☐

C Silicon

☐

D Phosphorus

☐

(Total 1 mark)

6.

Which has the electron configuration of a noble gas?

A  $\text{H}^+$ ☐B  $\text{O}^-$ ☐C  $\text{Se}^{2-}$ ☐D  $\text{Zn}^{2+}$ ☐

(Total 1 mark)

7.

Which atom has the smallest number of neutrons?

A  $^3\text{H}$ ☐B  $^4\text{He}$ ☐C  $^5\text{He}$ ☐D  $^4\text{Li}$ ☐

(Total 1 mark)

8.

Which is the electron configuration of an atom with **only two** unpaired electrons?A  $1s^2 2s^2 2p^3$ ☐B  $1s^2 2s^2 2p^4$ ☐C  $1s^2 2s^2 2p^6 3s^2 3p^5$ ☐D  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ ☐

(Total 1 mark)

9.

Which shows the electron configuration of an atom of a transition metal?

A  $[\text{Ar}] 4s^2 3d^0$ ☐B  $[\text{Ar}] 4s^2 3d^8$ ☐C  $[\text{Ar}] 4s^2 3d^{10}$ ☐D  $[\text{Ar}] 4s^2 3d^{10} 4p^1$ ☐

(Total 1 mark)

**10.**

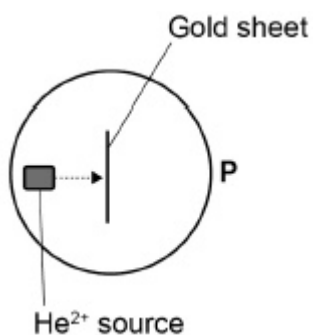
Which atom has the greatest first ionisation energy?

- A H ☐
- B He ☐
- C Li ☐
- D Ne ☐

(Total 1 mark)

**11.**

In the early twentieth century the apparatus shown in the diagram was used to investigate atomic structure. When  $\text{He}^{2+}$  particles were fired at a thin sheet of gold, most of the particles were detected at point **P**.



What conclusion can be drawn from the detection of  $\text{He}^{2+}$  particles at point **P**?

- A Gold atoms contain electrons. ☐
- B Gold atoms contain protons. ☐
- C Gold atoms contain neutrons. ☐
- D Gold atoms are mainly empty space. ☐

(Total 1 mark)

**12.**

Which statement about time of flight mass spectrometry is correct?

- A** The current in the detector is proportional to the ion abundance
- B** Sample particles gain electrons to form positive ions
- C** Particles are detected in the order of their kinetic energies
- D** Ions are accelerated by a magnetic field

☐☐☐☐

(Total 1 mark)

**13.**

Chlorine exists as two isotopes  $^{35}\text{Cl}$  and  $^{37}\text{Cl}$  in the ratio 3:1

Which statement about peaks in the mass spectrum of  $\text{Cl}_2$  is correct?

- A** Peaks at  $m/z = 70$  and  $74$  in the ratio 3:1
- B** Peaks at  $m/z = 70, 72$  and  $74$  in the ratio 9:6:1
- C** Peaks at  $m/z = 70, 72$  and  $74$  in the ratio 9:3:1
- D** Peaks at  $m/z = 70$  and  $72$  in the ratio 3:1

☐☐☐☐

(Total 1 mark)

**14.**

Which of these has the highest first ionisation energy?

**A** Na

☐

**B** Al

☐

**C** Si

☐

**D** Cl

☐

(Total 1 mark)

15.

Which of these correctly shows the numbers of sub-atomic particles in a  $^{41}\text{K}^+$  ion?

A

	Number of electrons	Number of protons	Number of neutrons
A	19	19	20
B	18	20	21
C	18	19	22
D	19	18	23

☐

B

☐

C

☐

D

☐

(Total 1 mark)

16.

Bromine exists as two isotopes  $^{79}\text{Br}$  and  $^{81}\text{Br}$ , which are found in almost equal abundance.

Which of the statements is correct?

A

The first ionisation energy of  $^{79}\text{Br}$  is less than the first ionisation energy of  $^{81}\text{Br}$

☐

B

The atomic radius of  $^{79}\text{Br}$  is less than the atomic radius of  $^{81}\text{Br}$

☐

C

The mass spectrum of  $\text{C}_3\text{H}_7\text{Br}$  has two molecular ion peaks at 122 and 124

☐

D

$^{79}\text{Br}$  is more reactive than  $^{81}\text{Br}$

☐

(Total 1 mark)

17.

Which species has the same number of electrons as the radical  $\bullet\text{CH}_3$ ?

A

$\text{CH}_2$

☐

B

$\text{CH}_3^+$

☐

C

$\text{CH}_3^-$

☐

D

$\text{CH}_4^+$

☐

(Total 1 mark)

**18.** What are the numbers of neutrons and electrons in the  $^{57}\text{Fe}^{2+}$  ion?

	Neutrons	Electrons	
A	31	24	<input type="checkbox"/>
B	57	24	<input type="checkbox"/>
C	31	26	<input type="checkbox"/>
D	57	28	<input type="checkbox"/>

(Total 1 mark)

**19.** What is the electron configuration of  $\text{Cu}^{2+}$ ?

- A  $[\text{Ar}]3d^94s^2$  ☐
- B  $[\text{Ar}]3d^{10}4s^1$  ☐
- C  $[\text{Ar}]3d^9$  ☐
- D  $[\text{Ar}]3d^{10}$  ☐

(Total 1 mark)

**20.** An atom in which the number of protons is greater than the number of neutrons is

- A  $^{234}\text{U}$
- B  $^6\text{Li}$
- C  $^3\text{He}$
- D  $^2\text{H}$

(Total 1 mark)

**21.** Assuming that chlorine exists as two isotopes, and that hydrogen and carbon exist as one isotope each, how many molecular ion peaks will be shown in the mass spectrum of  $\text{C}_4\text{H}_6\text{Cl}_4$ ?

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

(Total 1 mark)

**22.**

Which one of the following ionisations requires less energy than the first ionisation energy of oxygen?

- A  $\text{S(g)} \rightarrow \text{S}^+\text{(g)} + \text{e}^-$
- B  $\text{O}^+\text{(g)} \rightarrow \text{O}^{2+}\text{(g)} + \text{e}^-$
- C  $\text{N(g)} \rightarrow \text{N}^+\text{(g)} + \text{e}^-$
- D  $\text{F(g)} \rightarrow \text{F}^+\text{(g)} + \text{e}^-$

(Total 1 mark)

**23.**

Which one of the following is the electronic configuration of an element with a maximum oxidation state of +5?

- A  $1s^2 2s^2 2p^5$
- B  $1s^2 2s^2 2p^6 3s^2 3p^1$
- C  $1s^2 2s^2 2p^6 3s^2 3p^3$
- D  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$

(Total 1 mark)

**24.**

In which one of the following pairs is the first ionisation energy of element Y greater than that of element X?

	electronic configuration of element X	electronic configuration of element Y
A	$1s^1$	$1s^2$
B	$1s^2 2s^2$	$1s^2 2s^2 2p^1$
C	$1s^2 2s^2 2p^3$	$1s^2 2s^2 2p^4$
D	$1s^2 2s^2 2p^6$	$1s^2 2s^2 2p^6 3s^1$

(Total 1 mark)

**25.**

Which atom has an incomplete sub-shell?

- A Be
- B Ca
- C Ge
- D Zn

(Total 1 mark)

**26.**

Which statement about isotopes of an element is **not** correct?

A They have the same chemical properties.

☐

B They have the same number of electrons in ions of the same charge.

☐

C They have the same number of neutrons.

☐

D They have the same number of protons.

☐

(Total 1 mark)

**27.**

Which atom in the ground state contains at least one unpaired p electron?

A Na

☐

B Ne

☐

C O

☐

D Sc

☐

(Total 1 mark)

**28.**

Which ionisation needs less energy than this process?



A  $\text{Al(g)} \rightarrow \text{Al}^{\text{+}}(\text{g}) + \text{e}^{-}$

☐

B  $\text{Ar(g)} \rightarrow \text{Ar}^{\text{+}}(\text{g}) + \text{e}^{-}$

☐

C  $\text{Be(g)} \rightarrow \text{Be}^{\text{+}}(\text{g}) + \text{e}^{-}$

☐

D  $\text{Mg}^{\text{+}}(\text{g}) \rightarrow \text{Mg}^{\text{2+}}(\text{g}) + \text{e}^{-}$

☐

(Total 1 mark)

**29.**

Which of these ions has the largest ionic radius?

**A**  $S^{2-}$ ☐**B**  $Cl^{-}$ ☐**C**  $K^{+}$ ☐**D**  $Ca^{2+}$ ☐**(Total 1 mark)****30.**In which pair is the first ionisation energy of atom **Y** greater than that of atom **X**?

	Electron configuration of atom <b>X</b>	Electron configuration of atom <b>Y</b>	
<b>A</b>	$1s^22s^2$	$1s^22s^22p^1$	<input type="radio"/>
<b>B</b>	$1s^22s^22p^3$	$1s^22s^22p^4$	<input type="radio"/>
<b>C</b>	$1s^22s^22p^5$	$1s^22s^22p^6$	<input type="radio"/>
<b>D</b>	$1s^22s^22p^6$	$1s^22s^22p^63s^1$	<input type="radio"/>

**(Total 1 mark)**