IB · SL · Chemistry

58 mins 8 questions

Structured Questions

Electronic Configurations

The Electromagnetic Spectrum / Emission Spectra / Energy Levels, Sublevels & Orbitals / Writing Electron Configurations

Easy (4 questions)	/29
Medium (3 questions)	/26
Hard (1 question)	/3
Total Marks	**/58**

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Easy Questions

1 (a) Describe what is meant by the term orbital.

.....

(1 mark)

(b) Draw the shapes of the s, p_x, p_y and p_z orbitals.

.....

.....

(2 marks)

(c) State the maximum number of orbitals in the n = 4 energy level.

.....

(1 mark)

(d) List the d, f, p and s orbitals in order of decreasing energies.

.....

.....

(2 marks)

2 (a) Write the full electronic configurations for the following species

i) K

[1]

ii) Sr^{2+}

[1]

.....

.....

(2 marks)

(b) Write the condensed electronic configurations for the following species

i) Na

[1]

ii) Al^{3+}

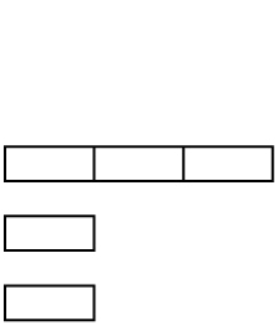
[1]

.....

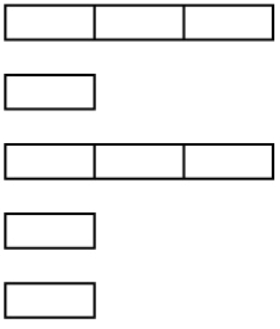
.....

(2 marks)

(c) Complete the orbital diagrams of phosphorus and fluorine as shown in the diagram below.



Fluorine



Phosphorus

.....

.....

(2 marks)

(d) Give the number of each type of orbital in the first four energy levels.

.....

.....

(2 marks)

3 (a) Using sections 1 and 5 of the data booklet describe how the following change in moving from the infrared region of the electromagnetic spectrum to the radio region of the electromagnetic spectrum.

i) Wavelength

[1]

ii) Frequency

[1]

iii) Energy

[1]

.....

.....

.....

(3 marks)

(b) Describe the process occurring in an atom to produce a single line on an emission spectrum.

.....

.....

.....

(3 marks)

(c) Distinguish between a *continuous spectrum* and a *line spectrum*.

.....

.....

(2 marks)

Describe the emission spectrum of hydrogen. Outline how this spectrum is related to the energy levels in the hydrogen atom.

.....

(d) **(3 marks)**

4 (a) The first ionisation energy of aluminium is lower than magnesium. Write the full electron configurations of aluminium and magnesium.

.....

.....

(2 marks)

(b) Using the electron configurations from part (a), explain why the first ionisation energy of aluminium is lower than magnesium.

.....

.....

(2 marks)

Medium Questions

1 (a) The element chromium has several naturally occurring isotopes whose abundances are shown in **Table 1**.

Table 1

Mass number	% abundance
50	4.345
52	83.789
53	9.501
54	2.365

Calculate the relative atomic mass of chromium to two decimal places.

.....

.....

(2 marks)

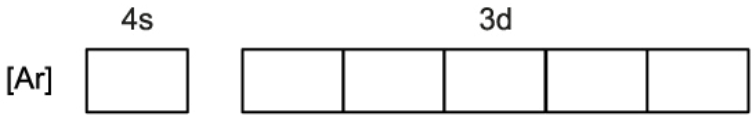
(b) State the full electron configuration for chromium.

.....

(1 mark)

(c) State the meaning of **[Ar]** and complete the orbital diagram shown below for chromium.

Figure 1



.....

.....

(2 marks)

(d) This question is about the chromium(III) ion, $^{52}_{24}Cr^{3+}$.

i) State the number of protons, electrons, and neutrons in the chromium(III) ion.

[1]

ii) Write the full electron configuration for the chromium(III) ion.

[1]

.....

.....

(2 marks)

2 (a) This question is about line emission spectra of elements.

i) Explain the difference between a *continuous spectrum* and a *line spectrum.*

[2]

ii) Draw a labelled diagram that shows electron transitions in a hydrogen atom in the ultraviolet and visible regions of the electromagnetic spectrum. Include three electron transitions for each region.

[4]

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.....

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.....

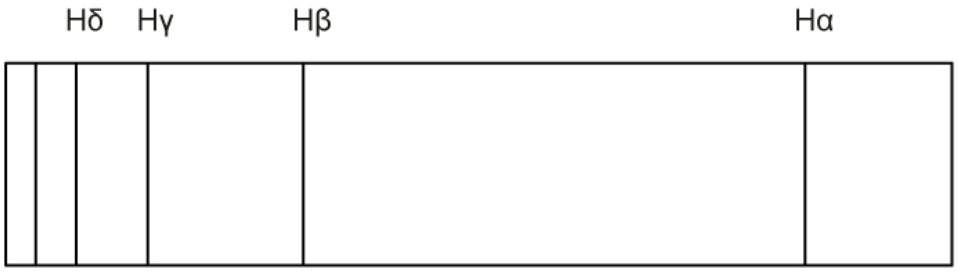
(6 marks)

(b) The visible line emission spectrum of hydrogen is shown below in **Figure 1** and the wavelengths of the first four lines are listed in **Table 1**.

i) Use the information provided and Sections 1 and 2 of the IB data booklet to determine the frequency of the red line.

[1]

Figure 1



The visible line emission spectrum hydrogen

Table 1

Balmer spectral line	Wavelength in nm	Colour
Hα	656	Red
Hβ	486	Blue(cyan)
Hγ	434	Blue
Hδ	410	Violet

ii) Which spectral line carries more energy, Hα or Hδ?

[1]

.....

.....

(2 marks)

(c) Draw the shape of a 1s atomic orbital and 2p atomic orbital.

.....

(1 mark)

(d) Describe the relationship between colour, energy, frequency, and wavelength in the visible spectrum.

.....

.....

(2 marks)

3 (a) Electron configurations give you a summary of where you can find an electron around the nucleus of an atom. They can also be determined for an ion after an atom loses or gains electrons.

i) State the full electron configuration of the rubidium ion, $^{85}_{37}Rb^{+}$.

[1]

ii) State and explain the relative size of a rubidium ion compared to a krypton atom.

[2]

.....

.....

.....

(3 marks)

(b) The element rubidium has two naturally occurring isotopes of ^{85}Rb and ^{87}Rb. The relative atomic mass of rubidium is 85.47. Calculate the percentage abundance of each isotope.

.....

.....

(2 marks)

(c) The electrons in an atom are found in orbitals around the nucleus, which have different energy levels sometimes called shells.

i) The fourth shell consists of the atomic orbitals 4d, 4f, 4p and 4s. List these orbitals in order of increasing energy.

[1]

ii) State the number of atomic orbitals present in 4d, 4f, 4p and 4s.

[1]

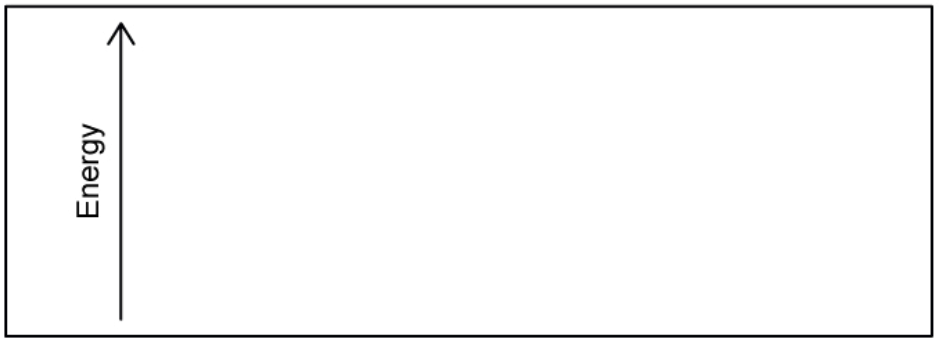
.....

.....

(2 marks)

(d) Rubidium forms an ionic compound with selenium, Rb_2Se. Using boxes to represent orbitals and arrows to represent electrons, sketch the orbital diagram of the **valence shell** of selenium on the axis provided.

Figure 1



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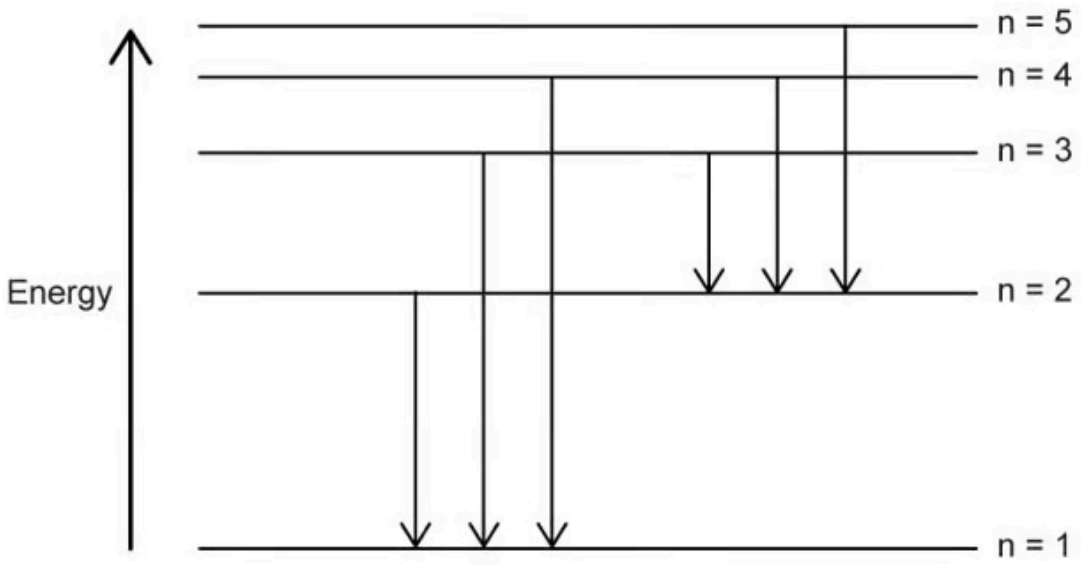
(1 mark)

Hard Questions

1 (a) The diagram below shows electron transitions in a hydrogen atom in two regions of the electromagnetic spectrum.



Using section 5 of the Data booklet, predict which electron transition is most likely to correspond to the emission of red light.

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(1 mark)

(b) Using sections 1 and 5 of the data booklet, predict which electron transition will correspond to the greatest frequency of light emitted.

.....

(1 mark)

(c) The wavelengths of the first four lines for the Balmer series are shown below.

Balmer spectral line	Wavelength in nm	Colour
H_α	656	red
H_β	486	cyan(blue)
H_γ	434	blue
H_δ	410	violet

Using section 1 of the Data booklet, determine the ratio of the frequencies H_α to H_γ to 2 decimal places.

.....

(1 mark)