Atomic Structure

Chemistry Past Exam Questions

Higher Level

2013

Section B - Question 4 B

(*b*) Define *relative atomic mass*.

Section B - Question 4 B

(*c*) How many neutrons are there in 0.14 g of carbon–14?

Section B - Question 5

5. (*a*) The 350th anniversary of Robert Boyle's discovery of the relationship between the pressure and the volume of a fixed mass of gas at constant temperature is commemorated in this Irish stamp issued in 2012.

Boyle also contributed to the development of the use of the term *element* in Chemistry.

What was his understanding of this term? (5)

(*b*) Use Bohr's atomic theory of 1913 to account for the emission spectrum of the hydrogen atom. (15)

Explain, in terms of atomic structure, why different flame colours are observed in flame tests using salts of different metals. (6)

What colour is observed in a flame test on lithium chloride?

Describe the testing procedure. (9)

(*c*) Further research and scientific discoveries, including Heisenberg's uncertainty principle (1927), led to significant modification of Bohr's original atomic structure theory of 1913.

Explain the underlined term.

Give **one** other factor that also contributed to the need for modification of Bohr's 1913 theory.

These modifications included the introduction of the idea of atomic orbitals.
What is an *atomic orbital*? (15)

2012

Section B - Question 4 C

(*c*) Define *relative atomic mass*.

Section B - Question 4 C

11. Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) In 1909 Rutherford bombarded a very thin sheet of gold foil with alpha particles, most of which passed straight through it undeflected. Some alpha particles, however, were deflected at large angles and a very small number were reflected back along their original paths. The first of these observations was not inconsistent with the 'plum pudding' model of the atom that had been proposed by Thomson in 1904, but Rutherford had to formulate a new model of atomic structure to account for the other two observations.

(*i*) What are alpha particles? (4)

(*ii*) Describe the structure of Thomson's 'plum pudding' model of the atom. (6)

(*iii*) Explain why some alpha particles were deflected at large angles as they passed through the gold foil. (6)

(*iv*) Why were some alpha particles reflected back along their original paths?
Why did this happen to only a very small number of alpha particles? (6)

(*v*) Draw a labelled diagram to show the new structure of the atom proposed by Rutherford. (3)

2009

Section B - Question 5

5. (*a*) Define *first ionisation energy* of an element. (8)

(*b*) Use the values on page 45 of the Mathematics Tables to plot a graph on graph paper of first ionisation energy *versus* atomic number for the elements with atomic numbers from 10 to 20 inclusive. (12)

(*c*) Account fully for

(*i*) the general increase in ionisation energy values across the third period of the Periodic Table,

(*ii*) the peaks which occur in your graph at elements 12 and 15,

(*iii*) the sharp decrease in ionisation energy value between elements 18 and 19. (18)

(*d*) Write the *s*, *p* electron configuration for the potassium atom.

Hence state how many (*i*) energy sub-levels, (*ii*) individual orbitals, are occupied by electrons in a potassium atom.

Explain why there are electrons in the fourth main energy level of potassium although the third main energy level is incomplete. (12)

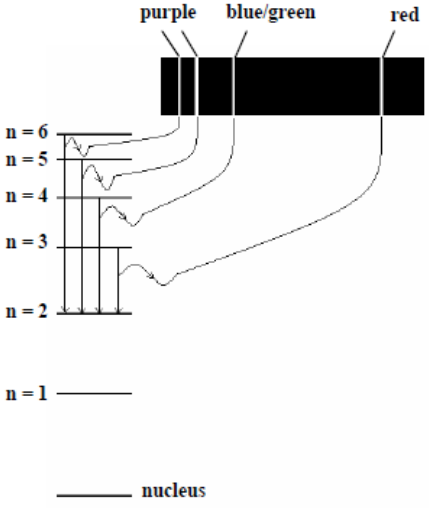
2008

Section B - Question 10 C

(*c*) (*i*) Define *energy level*. (4)

(*ii*) Distinguish between *ground state* and *excited state* for the electron in a hydrogen atom. (6)

The diagram shows how Bohr related the lines in the hydrogen emission spectrum to the existence of atomic energy levels.



(*iii*) Name the series of lines in the visible part of the line emission spectrum of hydrogen. (3)

(*iv*) Explain how the expression $E_2 - E_1 = hf$ links the occurrence of the visible lines in the hydrogen spectrum to energy levels in a hydrogen atom. (12)

2007

Section B - Question 5

5. (*a*) Define *energy level*. (5)

Write the electron configuration (*s*, *p*) for the sulfur atom in its ground state, showing the arrangement in atomic orbitals of the highest energy electrons. (6)
State how many (*i*) energy levels, (*ii*) orbitals, are occupied in a sulfur atom in its ground state. (6)

(*b*) Use electronegativity values (Mathematical Tables p 46) to predict the type of bond expected between hydrogen and sulfur.
Write the chemical formula for hydrogen sulfide.
Use clear dot and cross diagrams to show the bonding in hydrogen sulfide. (15)

Would you expect the hydrogen sulfide molecule to be *linear* or *non-linear* in shape?
Justify your answer. (6)

(*c*) Hydrogen sulfide has a boiling point of 212.3 K and water has a boiling point of 373 K.
Account for the difference in the boiling points of these substances. (6)
Would you expect hydrogen sulfide to be soluble in water? Explain your answer. (6)

Section B – Question 11 A

11. Answer any **two** of the parts (*a*), (*b*) and (*c*). (2 × 25)

(*a*) In 1910 Rutherford (pictured right) and his co-workers carried out an experiment in which thin sheets of gold foil were bombarded with alpha particles. The observations made during the experiment led to the discovery of the atomic nucleus.

(*i*) Describe the model of atomic structure which existed immediately *prior* to this experiment. (7)

(*ii*) In this experiment it was observed that most of the alpha particles went straight through the gold foil. Two other observations were made. State these other observations and explain how each helped Rutherford deduce that the atom has a nucleus. (12)

In November 2006 former Soviet agent, Alexander Litvinenko, died in London. The cause of his death was identified as radiation poisoning by polonium-210.

(*iii*) Polonium-210 decays emitting an alpha particle.
Copy and complete the equation for the alpha-decay of polonium-210, filling in the values of *x* (atomic number), *y* (mass number) and **Z** (elemental symbol). (6)

$$^{210}_{84}\mathbf{Po} \rightarrow {}^{y}_{x}\mathbf{Z} + {}^{4}_{2}\mathbf{He}$$

2006

Section B - Question 5 A

5. (*a*) (*i*) Describe how you would carry out a flame test on a sample of potassium chloride. (8)

(*ii*) Why do different elements have unique atomic spectra? (6)

(*iii*) What instrumental technique is based on the fact that each element has unique atomic spectra? (3)

Bohr's model of the atom explained the existence of energy levels on the basis of atomic spectra. Bohr's theory was later modified to incorporate the idea of *orbitals* in recognition of the wave nature of the electron and Heisenberg's uncertainty principle.

(*iv*) Define *atomic orbital*. (6)

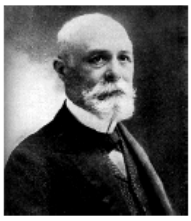
(*v*) What does Heisenberg's uncertainty principle say about an electron in an atom? (6)

2005

Section B - Question 5

5. (*a*) What are *isotopes*? (5)

Name the scientist pictured on the right who is credited with the discovery in 1896 that uranium salts emit radiation. (3)



Give an example of a radioactive isotope and state **one** common use made of this isotope. (9)

(*b*) Define *atomic radius* (*covalent radius*). (6)

Describe and account for the trend in atomic radii (covalent radii) of the elements

(*i*) across the second period, (*ii*) down any group, of the periodic table. (15)

(*c*) Define *covalent bond*. (6)

Distinguish between a sigma (σ) and a pi (π) covalent bond. (6)