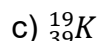
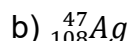
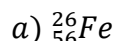


Atoms, Ions & Quanta Answers

Question 1: The structure of an atom 1

What is the atomic number and the mass number of the following elements?



- a) Fe has an atomic number of 26 and a mass number of 56.
- b) Ag has an atomic number of 47 and a mass number of 108.
- c) K has an atomic number of 19 and a mass number of 39.
- d) B has an atomic number of 5 and a mass number of 11.

Question 2: The structure of an atom 2

An atom of silicon has an atomic number of 14 and a mass number of 28.

- a) How many protons, neutrons and electrons does the atom of silicon have?

The atomic number is equal to the number of protons in the atom, therefore silicon has 14 protons. In a neutral species, the number of protons equals the number of electrons so silicon also has 14 electrons. The mass number is the number of protons plus neutrons, therefore $28 - 14$ protons equal 14 neutrons.

- b) How many electrons are there in the outer most shell of silicon and is it an s, p, d or f orbital?

Shells are filled 2, 8, 8, 18. Silicon contains 14 electrons, therefore the first two shells are filled leaving 4 electrons in the outer most shell, 2 of which are in the 3s orbital and 2 in the 3p orbital.

The actual electron configuration would be $\{1s^2 2s^2 2p^6 3s^2 3p^2\}$.

- c) Does the outer most electron experience the same nuclear force as the inner most? Why?

No, due to concepts called shielding and effective nuclear charge.

You can read up about this and Slater's rules over the summer, or wait and learn about it in your courses next year.

Question 3: The structure of an atom 3

Bromine has 35 protons and a mass number of 80.

a) How many neutrons does the atom of bromine have?

The mass number = protons + neutrons. Bromine has a mass number of 80 and 35 protons so $80 - 35 = 45$ neutrons.

b) How many electrons does the neutral atom of bromine have?

The neutral atom of bromine has 35 electrons because the number of electrons equals the number of protons.

c) Bromine gains an electron, what is the resulting ion called and is it positively or negatively charged?

When bromine gains an electron, the resulting ion is called an anion (the bromide ion) and is negatively charged.

d) What would it be called if bromine gained a neutron? What would happen to the atomic number and mass number?

It would be an isotope. The atomic number would not change, but the mass number would increase by 1.

Question 4: Spectroscopy and light 1

A spectroscopic experiment is carried out to look at the electronic structure of tin. The absorption spectrum was recorded giving an absorption maximum that corresponds to a frequency of $3.46 \times 10^{14} \text{ s}^{-1}$.

a) Calculate the wavelength of this transition.

$$\lambda = c / \nu$$

$$\lambda = 2.998 \times 10^8 \text{ m s}^{-1} / 3.46 \times 10^{14} \text{ s}^{-1}$$

$$\lambda = 8.665 \times 10^{-7} \text{ m}$$

$$1 \text{ nm} = 10^{-9} \text{ m}$$

$$\lambda = 866.5 \text{ nm}$$

b) Calculate the energy absorbed during the transition.

$$E = h\nu$$

$$E = 6.626 \times 10^{-34} \text{ J s} \times 3.46 \times 10^{14} \text{ s}^{-1}$$

$$E = 2.29 \times 10^{-19} \text{ J}$$

Question 5: Spectroscopy and light 2

A spectroscopic experiment is carried out to look at the electronic structure of a phosphorus atom. The emission spectrum was recorded with a wavelength of 565 nm.

a) Calculate the frequency of this transition.

$$\nu = c / \lambda \quad 565 \text{ nm} = 565 \times 10^{-9} \text{ m}$$

$$\nu = 2.998 \times 10^8 \text{ m s}^{-1} / 565 \times 10^{-9} \text{ m}$$

$$\nu = 5.306 \times 10^{14} \text{ s}^{-1}$$

b) Calculate the energy given out during the transition.

$$E = h\nu$$

$$E = 6.626 \times 10^{-34} \text{ J s} \times 5.306 \times 10^{14} \text{ s}^{-1}$$

$$E = 3.52 \times 10^{-19} \text{ J}$$