Answers to exam-style questions

Topic 2

1 B

2 B

3 A

4 B

5 C

6 B

7 C

8 C

9 C

10 A

11 a *Atomic number:* the number of protons in the nucleus of an atom; *isotopes:* different atoms of the same element with different mass numbers, i.e. different numbers of neutrons in the nucleus. **[3]**

b The number of protons is given by the atomic number, 26. The number of neutrons is the mass number − the atomic number, i.e. $57 - 26 = 31$. This is an atom, so the number of electrons equals the number of protons: 26. **[2]**

c **i** Mass spectrometer **[1]**

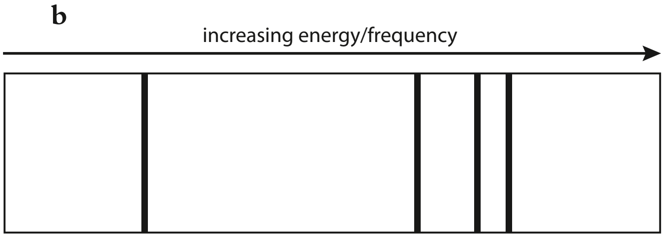
ii relative molecular mass =

$$\frac{(5.80 \times 54) + (91.16 \times 56) + (3.04 \times 57)}{100} = 55.91$$

[2]

12 a *Continuous spectrum:* all frequencies/wavelengths of light present; *line spectrum:* only certain frequencies/wavelengths of light present. **[2]**

b



[2]

c An electron is promoted to a higher energy level; the electron is unstable at this higher level and falls to a lower energy level; as it falls from a higher energy level to a lower one, the energy difference is given out in the form of a photon of light. This gives a line in the spectrum. **[3]**

d $E = h\nu$

Energy of photon emitted when electron falls from level 5 to level 3 is

$6.63 \times 10^{-34} \times 2.34 \times 10^{14}$

i.e. 1.55×10^{-19} J

Energy of photon emitted when electron falls from level 6 to level 3 is

$6.63 \times 10^{-34} \times 2.74 \times 10^{14}$

i.e. 1.82×10^{-19} J

In both cases the electron falls to the same lower level, so the difference in energy between these is the energy difference between level 6 and level 5. Therefore the energy difference between these levels is $1.82 \times 10^{-19} - 1.55 \times 10^{-19}$ i.e. 2.70×10^{-20} J (if more significant figures are carried through or the energy is calculated by subtracting the frequencies from each other the answer 2.65×10^{-20} J is obtained). **[2]**

13 a $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ **[1]**

b $K^+(g) \rightarrow K^{2+}(g) + e^-$ (gaseous symbols are essential) **[2]**

c There are various contributing factors here. The most important one is that when the first electron is removed, it is removed from the fourth shell (main energy level), but the second electron is removed from the third shell; an electron in the third shell is closer to the nucleus and therefore more strongly held.

Other factors may also be mentioned: the first electron is removed from a neutral atom, but the second is removed from a positive ion – it is more difficult to remove a negatively charged electron from a positive ion than from a neutral atom; once the first electron has been removed, there is less electron–electron repulsion – all electrons are pulled in more closely and the ion is smaller so all electrons are held more tightly. **[3]**

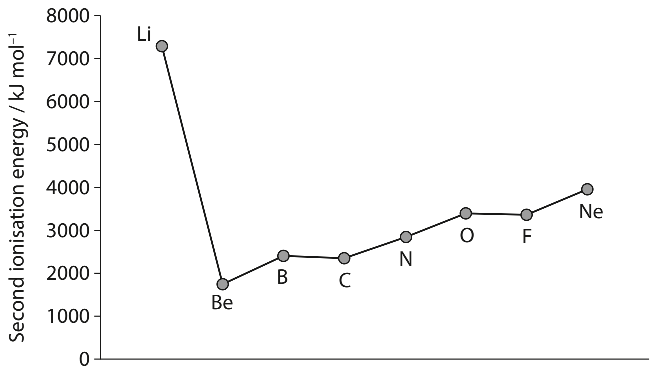
d The first ionisation of Ca is higher; in both cases the electron is removed from the same shell (main energy level) and subshell (4s), so the amount of shielding is approximately the same; Ca has a higher nuclear charge than K, so the outer electron is attracted more strongly to the nucleus. A calcium atom is also smaller than a potassium atom and so the outer electron is held closer to the nucleus and therefore more strongly attracted. **[3]**

14 a $1s^22s^22p^6$ **[1]**

b The atom is Ne; there are various ions: N^{3-}, F^-, Na^+, Mg^{2+}, Al^{3+}. (C^{4-} and Si^{4+} do not form under normal conditions.) **[2]**

c The electron configuration of O is $1s^22s^22p^4$; the electron configuration of N is $1s^22s^22p^3$;
O has two electrons paired up in the same p orbital, whereas nitrogen has only one electron in each p orbital; there is greater repulsion between two electrons in the same p orbital, so one of the electrons is easier to remove. **[2]**

d



Lithium has a very high value, as the second electron is removed from the first shell (main energy level). The rest of the graph is like that of the first ionisation energy graph except it is shifted one position to the right (see below), as all the ions have one fewer electron than the parent atom. There is a dip between the first ionisation energies of Be ($1s^22s^2$) and B ($1s^22s^22p^1$) because the electron is being removed from the 2p subshell for B but from the 2s subshell for Be. Once the 1+ ions are formed, the dip occurs between B^+ ($1s^22s^2$) and C^+ ($1s^22s^22p^1$). **[3]**