Chapter 2 – Answers to end of chapter questions

1

<table>
<thead>
<tr>
<th>Sub-atomic particle</th>
<th>Relative mass</th>
<th>Relative charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton</td>
<td>1</td>
<td>+1</td>
</tr>
<tr>
<td>Neutron</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Electron</td>
<td>1</td>
<td>-1</td>
</tr>
<tr>
<td></td>
<td>1840</td>
<td></td>
</tr>
</tbody>
</table>

2  

a  A – electrons; B – neutrons; C – protons  
b  A proton has a greater mass than an electron, so a proton is deflected less for a given charge.

3

<table>
<thead>
<tr>
<th></th>
<th>Number of protons</th>
<th>Number of neutrons</th>
<th>Number of electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>33</td>
<td>72</td>
<td>33</td>
</tr>
<tr>
<td>b</td>
<td>18</td>
<td>22</td>
<td>18</td>
</tr>
<tr>
<td>c</td>
<td>13</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>d</td>
<td>26</td>
<td>30</td>
<td>23</td>
</tr>
<tr>
<td>e</td>
<td>53</td>
<td>74</td>
<td>54</td>
</tr>
<tr>
<td>f</td>
<td>77</td>
<td>115</td>
<td>75</td>
</tr>
</tbody>
</table>

4  

a  25  
b  56  
c  E  
d  B and D  
e  A and E  
f  C and D or B and F  
g  E and F  
h  Manganese  
i  Fe  
j  A is Mn$^{3+}$, E is Mn$^{2+}$ and F is Fe$^{2+}$

5  

a  Te – 52, I – 53  
b  Te – 127.6, I – 126.9  
c  $^{128}\text{Te}$ has 52p, 76n, 52e; $^{127}\text{I}$ has 53p, 74n, 53e  
d  Because it has one proton fewer  
e  Te has 1 less proton but its common isotope has 2 more neutrons than the common isotope of I.  
f  Ar/K, Co/Ni, Th/Pa
6  a  1 – is untrue. Atoms are not indestructible as indicated by radioactive isotopes and atom smashing experiments.

  2 – is untrue. Atoms of elements beyond uranium in the periodic table have been created (synthesised). Atoms are destroyed in radio isotopes.

  3 – is untrue. Isotopes of the same element are not alike.

  4 – is true.

  5 – is true but atoms can combine in very large numbers, e.g. in proteins, carbohydrates and nucleic acids.

b  It provides a good summary for non-nuclear reactions.

7  a  i  9 ii  19

  b  \[
  \frac{19}{6 \times 10^{23}} \text{ g} = 3.17 \times 10^{-23} \text{ g}
  \]

  c  \[
  d = \frac{m}{v} = \frac{317 \times 10^{-23}}{\frac{3}{2} \pi \left(\frac{10^{-14}}{2}\right)^3} = 6 \times 10^{19} \text{ g m}^{-3}
  \]

  d  They are extremely strong.

  e  \[
  \left(\frac{10^{-10}}{2}\right)^3 = 10^{12}
  \]

8  a  i  28.0062 ii  28.0172 iii  27.9949 iv  28.0312 v  28.0282

  b  DCN

9  a

  b

10  1s  2s  2p  3s  3p  4s  3d  4p

11  a  N

  b  Na

  c  Cl

12  a  1s^2, 2s^1

  b  1s^2, 2s^2 2p^4
c 1s², 2s² 2p⁶, 3s² 3p⁵

d 1s², 2s² 2p⁶, 3s² 3p⁶, 4s¹

e 1s²

f 1s², 2s² 2p⁶, 3s² 3p⁶

g 1s², 2s² 2p⁶

h 1s², 2s² 2p⁶, 3s² 3p⁶

13 a A – First ionisation energy is relatively small, i.e. electron easily removed. Second ionisation energy is much larger (×9), i.e. second electron very difficult to remove due to breakage into a complete shell.

b B and D – Group II

c Group III – The first three ionisation energies are relatively low, i.e. three electrons are relatively easy to remove. The fourth ionisation energy, corresponding to the removal of a fourth electron is much larger due to the breakage into a new (full) shell.

d Element C, 630 + 1600 = 2230 kJ mol⁻¹

14

a

b 16

c

n = 3

n = 2

n = 1

15 a Any three of the following:

- The number of protons (+ charge) in the nucleus
- The distance of the outermost electron from the nucleus
- The shielding of inner shells of electrons
- The number of electrons in the outer shell

b From Li to Cs, the outermost electron is further from the nucleus and is shielded more effectively by inner shells of electrons. These two factors outweigh the increasing
positive charge on the nucleus from Li to Cs and therefore the first ionisation energy falls from Li to Cs.

c See sections 2.8 and 2.9

16  a Neon and argon have filled outer shells of electrons. It is difficult to break into these stable electron structures, so their first ionisation energies are relatively large. The elements sodium and potassium, immediately after Ne and Ar, have only one electron in their outer shells. This is easily removed, so their first ionisation energies are relatively low.

b In the outer shell, Mg has a filled 3s² sub-shell. This confers some partial stability on an atom. Aluminium, immediately after Mg, has the outer shell structure, 3s²3p¹. The single electron in the 3p sub-shell is removed relatively easily, so the first ionisation energy of Mg is greater than that of Al.

c The first ionisation energy involves removing an electron from an atom which is initially uncharged. The second ionisation energy involves removing an electron from an ion which is oppositely charged.

d The maxima of the graphs correspond to the removal of an electron from atoms or ions with filled and therefore more stable outer shells.