1. (a) $7.32 \times 10^{14}$ J/photon
   (b) $4.85 \times 10^{-19}$ J/photon

2. | Element      | Atomic No. | Mass No. | No. of neutrons | $^{a\ X}_{z\ X}$ |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>sodium</td>
<td>11</td>
<td>23</td>
<td>12</td>
<td>$^{23}_{11}\ Na$</td>
</tr>
<tr>
<td>krypton</td>
<td>36</td>
<td>84</td>
<td>48</td>
<td>$^{84}_{36}\ Kr$</td>
</tr>
<tr>
<td>nitrogen</td>
<td>7</td>
<td>14</td>
<td>7</td>
<td>$^{14}_{7}\ N$</td>
</tr>
</tbody>
</table>

3. $^{224}_{88}\ Ra \rightarrow ^{220}_{86}\ Rn + ^{4}_{2}\ He$

$\alpha$ and $\beta$ particles have measurable mass and cause an element to change to another element when they are emitted. $\gamma$ radiation is electromagnetic radiation - there is no gain or loss of protons and hence element does not change.

4. Add water to the mixture. The sugar will dissolve. Filter the mixture to recover the sand. Evaporate the water from the filtrate to recover the sugar.

5. Fe$_2$O$_3$  barium sulfate
   Co(NO$_3$)$_2$  arsenic(III) sulfide
   CaCO$_3$  potassium dichromate
   HNO$_3$  chromium(III) nitride
   Sr(CH$_3$CO$_2$)$_2$  potassium bromide
   ZnSO$_3$  lithium nitrite
   NH$_4$Fe(SO$_4$)$_2$  magnesium perchlorate
6.

\[
\begin{align*}
\text{H} & \cdot \text{F} : \\
\text{N} & : \text{N} : \\
\end{align*}
\]

7. 2.63 g

8. (i) \(2.06 \times 10^{22}\) ions
(ii) 46.8 g

9. \(\text{SO}_3\)

10. 0.2250 M

11. Atoms in metallic lattices are held in place by metallic bonds arising from mobile (delocalised) outer electrons. Metals are malleable and ductile because these bonds can reform if the atoms move relative to each other. The electrons are also free to move if a potential difference is applied - they flow easily with no change to the bonding configuration.

12. (i) Basic oxide reacts with acid to form salt plus water, eg \(\text{Na}_2\text{O}, \text{MgO}\)
(ii) Solution of the \(\text{CO}_2\) in water has a pH < 7. Use appropriate indicator or pH meter.

13. (i) translational, rotational, vibrational
(ii) By an increase in temperature (the particles move faster).
(iii) It has done work. Total energy change = change in internal energy + work done
(iv) \(E_{\text{nuclear}}\); the potential energy of the particles in the atomic nuclei.

14. (i) \(-820\) cal
(ii) \(-82\) cal
(iii) 37.7 kJ mol\(^{-1}\)

15. (i) Ion/dipole forces typically manifest themselves when ionic solids dissolve in polar solvents such as water. They are the forces that overcome the strong forces of attraction (ionic bonds) in the crystal lattice.
2001-J-3B

Yes, CaSO₄ would precipitate

2001-J-4B

+ IV
+ III
− I
+ V
Br⁻ + 3H₂O → BrO₃⁻ + 6H⁺ + 6e⁻
N₂O₄ + 2e⁻ → 2NO₂⁻
3N₂O₄ + Br⁻ + 3H₂O → 6NO₂⁻ + BrO₃⁻ + 6H⁺
3N₂O₄ + Br⁻ + 6OH⁻ → 6NO₂⁻ + BrO₃⁻ + 3H₂O
Both of the above processes are an example of Le Chatelier’s principle. They both involve changes in the concentration of CO$_2$. When CO$_2$ is added to the LHS of the equation, more limestone dissolves. In the cave, CO$_2$ is lost from the LHS of the equation. On its removal, the equilibrium shifts towards the left causing calcite to precipitate.

- NH$_3$ + NH$_3$ → NH$_4^+$ + NH$_2^-$

A proton, H$, is transferred from one solvent molecule to another.

- A strong acid is completely dissociated in water, e.g., HCl → H$^+$ (aq) + Cl$^-$ (aq)

A concentrated acid (whether weak or strong) has a high molarity, i.e., a large amount is dissolved in a given volume of water.

Rate = k[NO]²[Br$_2$]  

$1.2 \times 10^4$ L$^2$ mol$^{-2}$ s$^{-1}$

NOBr will appear twice as fast as Br$_2$ disappears, i.e., $\frac{d}{dt}$[Br$_2$] = $\frac{1}{2}$d[NOBr]

6.2 mol L$^{-1}$ s$^{-1}$