



Key Area: Nuclear Chemistry

Learning Statement			😊	😐	😞
Atoms of most elements have isotopes.					
The nuclei of some of these isotopes are unstable and emit particles or rays called radioactive emissions .					
3 types of radioactive emissions are possible:					
	Alpha (α)	Beta (β)	Gamma (γ)		
Alpha Particles (α) <ul style="list-style-type: none">Alpha particles are helium ions.Alpha particles can be represented by: $\begin{array}{ccc} 4 & & 4 \\ & \text{He} & \text{or} & & \text{He}^{2+} \\ 2 & & & & 2 \end{array}$They are heaviest type of radioactive emission.					
Beta Particles (β) <ul style="list-style-type: none">Beta particles are high-energy electrons.A beta particle can be represented by: $\begin{array}{c} 0 \\ e \\ -1 \end{array}$					
Gamma Radiation (γ) <ul style="list-style-type: none">Gamma radiation does not exhibit particle-like behaviour.Gamma radiation is a high-energy ray that can travel long distances and has a high penetration power.					
Properties of Radioactive Emissions					
Emission	Distance Travelled and Penetrating Power	Charge			
Alpha (α)	Few centimetres in air. Stopped by paper.	Positive			
Beta (β)	Few metres in air. Stopped by thin aluminium.	Negative			
Gamma (γ)	Travels kilometres in air. Stopped by thick lead or concrete.	No charge			
Radioactive isotopes are also called radioisotopes .					
Radioisotopes have uses in the home, in health and in industry. <ul style="list-style-type: none">Home: Smoke alarms contain the radioisotope Americium-241.Health: Cancer can be treated using the radioisotope Iodine-131Industry: Radioisotopes can be used to gauge the thickness of materials.					
The fear of radioactivity damaging healthy cells in our bodies, which can lead to cancer, is one of the main reasons people are concerned about the use of					

radioisotopes.																					
Radioactive decay is when unstable nuclei breakdown into smaller particles which are more stable.																					
Nuclear equations can be used to represent radioactive decay. For example: When plutonium-242 decays by an alpha emission, uranium-238 is formed.																					
$ \begin{array}{ccccccc} 242 & & & 238 & & & 4 \\ \text{Pu} & \rightarrow & & \text{U} & + & & \text{He} \\ 94 & & & 92 & & & 2 \end{array} $																					
Sometimes you will be given some of the values for a nuclear equation and will have to work the remaining ones. For example:																					
$ \begin{array}{ccccccc} 220 & & & a & & & 4 \\ \text{Rn} & \rightarrow & & \text{X} & + & & \text{He} \\ 86 & & & b & & & 2 \end{array} $																					
Answer: The masses on the top must add up to the same value on each side of the arrow. So $a = 220 - 4 = 216$. Hence, $a = 216$.																					
The atomic numbers on the bottom must add up to the same value on each side of the arrow. So $b = 86 - 2 = 84$. Hence, $b = 84$.																					
X is the element symbol. The element has atomic number 84 so is Polonium, Po.																					
The half-life ($t_{1/2}$) is time taken for the activity of a radioactive source to drop by a half.																					
A decay curve showing activity and time can be plotted to help work out half-life.																					
The mass of a radioisotope remaining after a certain period of time can also be calculated using half-life. Example: Sodium-24 has a half-life of 15 hours. A sample of 0.8 g of Sodium-24 was found. What mass of Sodium-24 would be left after 60 hours?																					
<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding: 5px;">0 h</td> <td style="padding: 5px;">→</td> <td style="padding: 5px;">15 h</td> <td style="padding: 5px;">→</td> <td style="padding: 5px;">30 h</td> <td style="padding: 5px;">→</td> <td style="padding: 5px;">45 h</td> <td style="padding: 5px;">→</td> <td style="padding: 5px;">60 h</td> </tr> <tr> <td style="padding: 5px;">0.8 g</td> <td></td> <td style="padding: 5px;">0.4 g</td> <td></td> <td style="padding: 5px;">0.2</td> <td></td> <td style="padding: 5px;">0.1 g</td> <td></td> <td style="padding: 5px;">0.05 g</td> </tr> </table>	0 h	→	15 h	→	30 h	→	45 h	→	60 h	0.8 g		0.4 g		0.2		0.1 g		0.05 g			
0 h	→	15 h	→	30 h	→	45 h	→	60 h													
0.8 g		0.4 g		0.2		0.1 g		0.05 g													
Radioisotopes can be used to date materials. Carbon dating of archaeological finds is a common example of this. Fossils can be dated using potassium-argon dating.																					