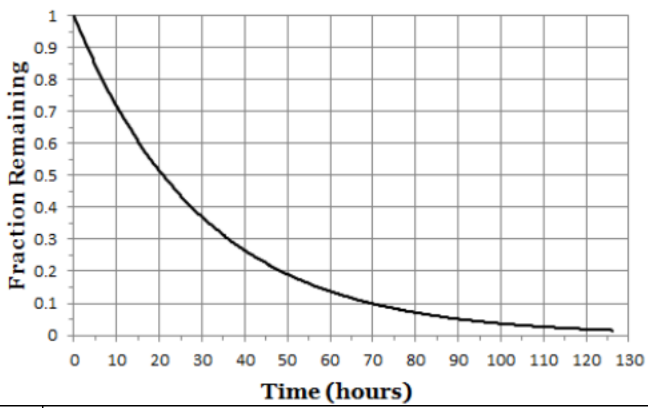
UNIT 6 - RADIOACTIVITY AND NUCLEAR CHEMISTRY

6.3 HONORS CLASS WORKSHEET – HALF-LIVES AND USES OF RADIATION

1. Calculating and using half-lives

(a) Magnesium-28 is radioactive. A sample of magnesium-28 was monitored over several days and its rate of decay is shown in the graph below:



(i) What type of radiation is magnesium-28 likely to emit? Give a reason for your answer and complete the nuclear equation for the decay of magnesium-28.

It will be a beta-emitter as it has too many neutrons

Mg has an average mass of 24.3, so 28 is far too many neutrons

$^{28}_{12}\text{Mg} \rightarrow ^{28}_{13}\text{Al} + ^{0}_{-1}\beta$

(ii) Use the graph above to note the time taken for:

	Time
50% of the sample to decay	20 hrs
75% of the sample to decay	40 hrs (two half-lives)
87.5% of the sample to decay	60 hrs (three half-lives)

(iii) Hence estimate the half-life of magnesium-28

20 hrs

(b)	(i)		Uranium-238 has a half-life of 160,000 years. Ife has 2000 atoms of uranium-238.
		(α)	How many uranium-238 atoms will she have after 480,000 years?
			n = 480,000/160,000 = 3 $0.5^3 = 0.125$ 0.125 x 2000 = 250
		(β)	How many uranium-238 atoms will she have after 100,000 years?
			$\log(\frac{N_i}{N}) = \frac{t\log 2}{t_{1/2}} = \frac{100{,}000 \times 0.301}{160000} = 0.188$ $(\frac{N_i}{N}) = \frac{2000}{N} = 10^{0.188} = 1.54$ 2000 = 1.54N so N = 2000/1.54 = 1300 (3sf)
	(ii)		Harry has some radium-224. It is radioactive. He notices that after 14.5 days his sample is emitting radiation at 6.25% of its original rate. What is the half-life of radium-224?
			6.25% = four half-lives = 14.5 days Half-life = 14.5/4 = 3.625 days
	(iii)		JaNiece has 500 atoms of iodine-131. It is radioactive. She notices that after 1 day, she only has 459 atoms remaining. What is the half-life of iodine-131?
			$\log(\frac{N_i}{N}) = \log(\frac{500}{459}) = 0.0372 = \frac{t\log 2}{t_{1/2}} = \frac{1 \times 0.301}{t_{1/2}}$ $0.0372 \times t_{1/2} = 0.301$ so $t_{1/2} = \frac{0.301}{0.0372} = 8.1$ days

2. Uses of radiation

(a)	An engineer needs to locate a blockage in an underground pipe.	
	(i)	Describe briefly how she would use a radioactive material to do this.
		Pour some radioactive material into the pipe upsteam Track radiation emitted; find location at which radiation stops moving/accumulates
	(ii)	State and explain what type of radiation the material should emit.
		Gamma – it needs to be detectable through the pipe/earth
	(ii)	State and explain whether the material should have a long or a short half-life.
		Short – you do not want radioactive material to stay in the pipe

(b)	Smoke alarms monitor the progress of radiation across 5 mm of air. If the air is smoky the radiation cannot pass through it and this triggers the smoke alarm.	
	(i)	State and explain what type of radiation the material should emit.
		Alpha – it needs to be stopped by 5 mm of smoke
	(ii)	State and explain whether the material should have a long or a short half-life.
		Long – you do not want to have to replace the smoke alarm regularly