Nuclear Physics

Set 6: Nuclei and Radiation

6.1	(a)	8 protons and (17 - 8) = 9 neutrons oxygen-17
	(b)	19 protons and (40 - 19) = 21 neutrons potassium-40
	(c)	92 protons and (234 - 92) = 142 neutrons uranium-234
	(d)	95 protons and (241 - 95) = 146 neutrons americium-241
6.2	(a)	$^{27-26=1}_{13-12=1}\mathrm{H}$ or $^{1}_{1}\mathrm{p}$ - it could be hydrogen-1 or a proton
	(b)	$^{239-0=239}_{93-(-1)=94}\mathrm{Pu}$ - it is plutonium-239
	(c)	$^{22-22=0}_{11-10=1}\mathrm{e}$ - it is a positron
	(d)	$^{131+0=131}_{53=0=53}\mathrm{I}$ - it is iodine-131
	(e)	$^{(7+1)\div 2=4}_{(3+1)\div 2=2}\mathrm{He}$ or $^{4}_{2}\alpha$ - it could be helium-4 or an alpha particle
6.3	(a)	$^{10}_{5}\mathrm{B} + ^{1}_{0}\mathrm{n} \rightarrow ^{11-4=7}_{5-2=3}\mathrm{Li} + ^{4}_{2}\mathrm{He}$
	(b)	lithium
6.4		$^{234}_{92}\mathrm{U} \rightarrow ^{234-4=230}_{92-2=90}\mathrm{Th} + ^{4}_{2}\mathrm{He}$
6.5		$^{42}_{19}\mathrm{K} \rightarrow ^{42-0=42}_{19-(-1)=20}\mathrm{Ca} + ^{0}_{-1}\mathrm{e}$ - the product formed is calcium-42
6.6		$^{141}_{56}\mathrm{Ba} \rightarrow ^{141}_{55}\mathrm{Cs} + ^{0}_{1}\mathrm{e}$ - a positron is also produced in the decay
6.7		$^{151}_{53}\mathrm{I} \rightarrow ^{151-0=42}_{53-(-1)=54}\mathrm{Xe} + ^{0}_{-1}\mathrm{e}$ - the product formed is xenon-131
6.8		$^{99}_{42}\mathrm{Mo} \rightarrow ^{99}_{42-(-1)=43}\mathrm{Tc} + ^{0}_{-1}\mathrm{e}$ - an electron or beta particle is also produced
6.9		$^{222}_{86}\mathrm{Rn} \rightarrow ^{222-4=218}_{86-2=84}\mathrm{Po} + ^{4}_{2}\mathrm{He}$ - the product formed is polonium-218
6.10	(a)	$^{2}_{1}\mathrm{H} + ^{3}_{1}\mathrm{H} \rightarrow ^{4}_{2}\mathrm{He} + ^{1}_{0}\mathrm{n}$
	(b)	It has to be a particle with an atomic number = 0, so it must be a neutron
6.11		$^{14}_{7}\mathrm{N} + ^{1}_{0}\mathrm{n} \rightarrow ^{14}_{6}\mathrm{C} + ^{1}_{1}\mathrm{p}$ It has to be a particle with an atomic number = 0, so it must be a neutron
6.12		$^{239}_{94}\mathrm{Pu} \rightarrow ^{239-4=235}_{94-2=92}\mathrm{U} + ^{4}_{2}\mathrm{He}$ $^{235}_{92}\mathrm{U} \rightarrow ^{235-4=231}_{92-2=90}\mathrm{Th} + ^{4}_{2}\mathrm{He}$

		$^{231}_{90}\text{Th} \rightarrow {}^{231-0=231}_{90-(-1)=91}\text{Pa} + {}^{0}_{-1}\text{e}$
6.13		$^{232}_{90}\text{Th} \rightarrow {}^{232-4=228}_{90-2=88}\text{Ra} + {}^{4}_{2}\text{He}$ $^{228}_{88}\text{Ra} \rightarrow {}^{228-0=228}_{88-(-1)=89}\text{Ac} + {}^{0}_{-1}\text{e}$ $^{228}_{89}\text{Ac} \rightarrow {}^{228-0=228}_{89-(-1)=90}\text{Th} + {}^{0}_{-1}\text{e}$ $^{228}_{90}\text{Th} \rightarrow {}^{228-4=224}_{90-2=88}\text{Ra} + {}^{4}_{2}\text{He}$ $^{224}_{88}\text{Ra} \rightarrow {}^{224-4=220}_{88-2=86}\text{Rn} + {}^{4}_{2}\text{He}$
6.14		$^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{141}_{56}\text{Ba} + {}^{92}_{36}\text{Kr} + 3{}^{1}_{0}\text{n}$ since the atomic number has to be zero, the other product formed has to be a neutron and in order that the mass numbers balance, there must be three of them.
6.15	(a)	$^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{134}_{51}\text{Sb} + {}^{95}_{39}\text{Y} + 3{}^{1}_{0}\text{n} + {}^{235+1-(134+95+3)=4}_{92-(51+39)=2}\text{He}$
	(b)	The additional particle formed is an alpha particle
6.16		$^{238}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{239}_{92}\text{U}$ $^{239}_{92}\text{U} \rightarrow {}^{239-0=239}_{92-(-1)=93}\text{Np} + {}^{0}_{-1}\text{e}$ $^{239}_{93}\text{Np} \rightarrow {}^{239-0=239}_{93-(-1)=94}\text{Pu} + {}^{0}_{-1}\text{e}$
6.17		$^{11}_{5}\text{B} + {}^{4}_{2}\text{He} \rightarrow {}^{14}_{7}\text{N} + {}^{11+4-14=1}_{5+2-7=0}\text{n}$ It has to be a particle with an atomic number = 0, so it must be a neutron