TL 7-32 (Stern - Gerlach experiment)

a) How many lines if use potassium atoms?

The Stern - Gerlach experiment separates beam of atoms according to their magnetic dipole moment, which is acted on by the magnetic field gradient in the apparatus.

$$\vec{F} = -\vec{\nabla}(-\vec{\mu}\cdot\vec{B})$$

The magnetic dipole moment is determined by the total angular momentum $\vec{J} = \vec{L} + \vec{S}$. So what is the total angular momentum of a potassium atom? This is where term symbols come in handy.

Potassium is $[Ar]4s^1$. It has a single 1s electron in its valence shell. So its term symbol is $^2S_{1/2}$ ← $j = 1/2$

$2s+1 = 2$ → $s = 1/2$

$l = 0$

There are $2j+1$ lines produced by the Stern Gerlach apparatus. So: **2 lines**

b) Calcium atoms? $[Ar]4s^2$. So $l = 0$, $s = 1, 0$, $j = 1, 0$

Ground state: $^1S_0$

Since $j=0$, there is **1 line**

c) Oxygen atoms? $[He]2s^2 2p^4$. Term symbol $^3P_2$

So $l = 1$, $s = 1$, $j = 2$

there are thus $2j+1 =$ **5 lines**

d) Tin atoms? $[Kr]4d^{10}5s^2 5p^2$. Term symbol $^3P_0$

So $l = 1$, $s = 1$, $j = 0$ for ground state and

There are $2j+1 =$ **1 line**