11.29) For $2e^-$ with antiparallel spins, one in 1s. Other e^- has $\ell = 2$ in the upper level and $\ell = 3$ in lower. Atom is placed in B

a) Sketch the levels for all m.

b) Calculate all possible transitions & distinct energy differences

c) Show the allowed transitions

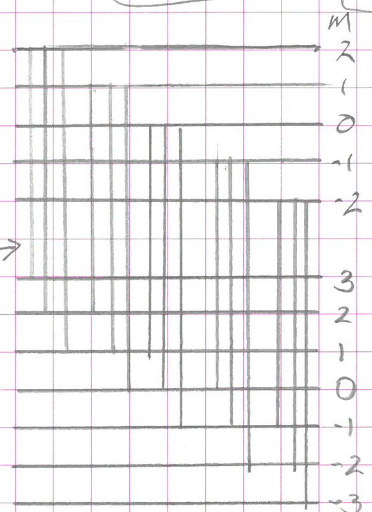
d) How many distinct photons will result?

a & c)

$\ell = 2$

c) Allowed $\Delta m = 0, \pm 1$

$\ell = 3$



b) Ignoring selection rules, the total number of possible transitions is

$$N_{possible} = (N_{\ell=2})(N_{\ell=3}) = (5)(7)$$

$$\boxed{N_{poss} = 35}$$

The energy differences from $m = 0$ are

$$\Delta E = m \mu_B B \qquad (9.16$$

$\Rightarrow$ For $E_{\ell,m}$, $E_{\ell=2} = E_{2,0} + m_2 \mu_B B$ and $E_{\ell=3} = E_{3,0} + m_3 \mu_B B$

So the energy change in each possible transition is

$$\Delta E = E_{\ell=2} - E_{\ell=3} = E_{2,0} - E_{3,0} + (m_2 - m_3)\mu_B B$$

$\Rightarrow$

$\Delta E = (2-3)\mu_B B$	$= -1$	$\mu_B B$		$\Delta E = (-2-3)\mu_B B$	$= -5$	$\mu_B B$	
$(2-2)$ "	$= 0$	"		$(-2-2)$ "	$= -4$	"	
$(2-1)$ "	$= 1$	"		$(-2-1)$ "	$= -3$	"	
$(2-0)$ "	$= 2$	"		$(-2-0)$ "	$= -2$	"	
$(2-(-1))$ "	$= 3$	"		$(-2-(-1))$ "	$= -1$	"	Repeats
$(2-(-2))$ "	$= 4$	"		$(-2-(-2))$ "	$= 0$	"	Repeats
$(2-(-3))$ "	$= 5$	"		$(-2-(-3))$ "	$= 1$	"	Repeats

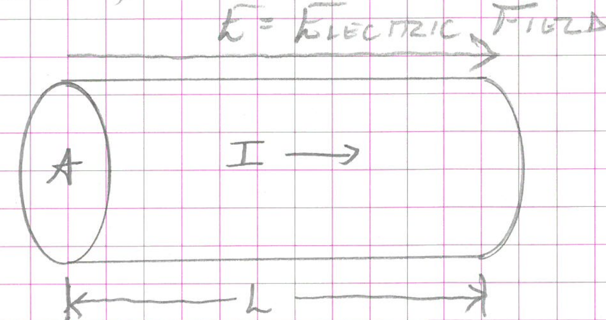
$\Rightarrow (m_2 - m_3) = 5, 4, 3, 2, 1, 0, -1, -2, -3, -4,$ or -5

$\Rightarrow$ **11 Possible Distinct Energy Differences**

d) Selection rules only allow $(m_2 - m_3) = 0$ or ± 1, so most of the above transitions can not occur!

$\Rightarrow$ **3 Photons for $\Delta m = -1, 0,$ or $+1$ Produced**

13.40) Consider a cylindrical resistor. Show that $V = IR$ is equivalent to $E = J\rho$ where $R = \rho L/A$.



For a cylindrical resistor, Ohm's law applies

$$V = IR \qquad (1)$$

And

$$R = \frac{\rho L}{A} \qquad (2)$$

The voltage across the resistor is the E-field times the length

$$V = EL \qquad (3)$$

Putting this together with (1) and (2),

$$EL = I\left(\frac{\rho L}{A}\right)$$

$$E = \rho \frac{I}{A}$$

Since the current density is the current divided by the area

$$J = \frac{I}{A}$$

Thus

$$\boxed{E = J\rho}$$ ← Equivalent to Ohm's Law!