TL 7-66

Rigid body rotor has $KE = \frac{1}{2} I\omega^2$

$$KE = \frac{L^2}{2I}$$

For a quantum rotor, $E_l = \frac{l(l+1)\hbar^2}{2I}$, since $L^2 = \hbar^2 l(l+1)$

a) energy level diagram (in terms of $E_0 = \frac{\hbar^2}{2I}$

E	l	$l(l+1)$	E	ΔE	$= \Delta E$
E_5	5	30	$30E_0$		
				$10E_0$	$= 5E_1$
E_4	4	20	$20E_0$		
				$8E_0$	$= 4E_1$
E_3	3	12	$12E_0$		
				$6E_0$	$= 3E_1$
E_2	2	6	$6E_0$		
				$4E_0$	$= 2E_1$
E_1	1	2	$2E_0$		
				E_0	$= \frac{1}{2}E_1$
E_0	0	1	E_0		

b) If I take $E_1 = 2E_0$, I get the last column. This shows that the transitions between states with $\Delta l = \pm 1$ are integer multiples of $E_1 = \hbar^2/I$

c) For an H_2 molecule, $I = \frac{1}{2} m_p r^2 = 4.58\times10^{-48}\,kgm^2$

$\{ m_p = \qquad r = 0.074\,nm \}$

This means that $E_1 = \hbar^2/I = 2.43\times10^{-21}$ Joules

d) For the transition $l=1 \rightarrow l=0$

$$\frac{hc}{\lambda} = \frac{1}{2}E_1$$

$$\lambda = \frac{2hc}{E_1} = \boxed{164\,\mu m}$$