1

$$E = nh\nu = nh\frac{c}{\lambda} \Rightarrow 1 = n \times 6.626 \times 10^{-34} \times \frac{2.998 \times 10^{8}}{550 \times 10^{-9}} \Rightarrow 2.77 \times 10^{18}\ \text{photons}$$

2

$$E_e = h\nu - \phi$$

$$h\nu = 6.626 \times 10^{-34} \times \frac{2.998 \times 10^{8}}{700 \times 10^{-9}} = 2.84 \times 10^{-19}\ J$$

$$\phi = 2.14\ eV \times 1.602 \times 10^{-19} \frac{J}{eV} = 3.43 \times 10^{-19}\ J$$

Since $\phi > h\nu$, no electron will be emitted.

3

$$d = 0.375\ cm, \qquad b = ?$$

$$sin\theta = \frac{d}{\sqrt{d^2 + b^2}} = \frac{\lambda}{a}$$

$$\lambda = \frac{h}{p} = \frac{6.626 \times 10^{-34}}{9.109 \times 10^{-31} \times 4.75 \times 10^{4}} = 1.53 \times 10^{-8} m$$

$$\frac{3.75 \times 10^{-3}}{\sqrt{(3.75 \times 10^{-3})^2 + b^2}} = \frac{1.53 \times 10^{-8}}{2.35 \times 10^{-7}} \Rightarrow 5.76 \times 10^{-2} = \sqrt{(3.75 \times 10^{-3})^2 + b^2}$$

$$b = 5.75\ cm$$

4

In a set of wave functions, only those that satisfy the eigen value equation are considered eigen functions.

5

$$\frac{\partial^2}{\partial x^2}\ e^{-i(3x+2y)} = 9i^2 e^{-i(3x+2y)} \Rightarrow EV = -9$$

$$\frac{1}{x}(x^2 + y^2)\frac{\partial}{\partial x}(x^2 + y^2)^{\frac{1}{2}} = \frac{1}{x}(x^2 + y^2) \times \frac{1}{2} 2x (x^2 + y^2)^{-\frac{1}{2}} = (x^2 + y^2)^{\frac{1}{2}} \Rightarrow EV = 1$$

$$\left(sin\theta\frac{d}{d\theta}\left(sin\theta\frac{d}{d\theta}\right)+6\sin^2\theta\right)(\sin\theta\cos\theta)=\left(sin\theta\frac{d}{d\theta}\left(sin\theta\frac{d}{d\theta}\right)\right)(\sin\theta\cos\theta)+6\sin^3\theta\cos\theta$$

$$\Rightarrow sin\theta\frac{d}{d\theta}(sin\theta)(\cos^2\theta-\sin^2\theta)+6\sin^3\theta\cos\theta$$

$$=sin\theta\frac{d}{d\theta}(sin\theta)(1-2\sin^2\theta)+6\sin^3\theta\cos\theta$$

$$=\ sin\theta\frac{d}{d\theta}(\sin\theta-2\sin^3\theta)+6\sin^3\theta\cos\theta$$

$$=\sin\theta(\cos\theta-6\cos\theta\sin^2\theta)+6\sin^3\theta\cos\theta=\sin\theta\cos\theta\Rightarrow EV=1$$

Note that: $\cos^2\theta-\sin^2\theta=(1-\sin^2\theta)-\sin^2\theta=1-2\sin^2\theta$.

6

$$\int_{-1}^{1}a_0^2dx=a_0^2x]_{-1}^{1}\ \Rightarrow a_0^2-(-a_0^2)=2a_0^2$$

$$2a_0^2=1\Rightarrow a_0=\pm\frac{1}{\sqrt{2}}$$

$$\int_{-1}^{1}a_0(a_1+b_1x)dx\Rightarrow\int_{-1}^{1}(a_0a_1+a_0b_1x)\,dx\Rightarrow a_0a_1x+a_0b_1\frac{x^2}{2}]_{-1}^{1}$$

$$\Rightarrow\left(a_0a_1+\frac{1}{2}a_0b_1\right)-\left(-a_0a_1+\frac{1}{2}a_0b_1\right)=2a_0a_1$$

$$\frac{2}{\sqrt{2}}a_1=0\Rightarrow a_1=0$$

$$\int_{-1}^{1}(b_1x)(b_1x)dx\ \Rightarrow\int_{-1}^{1}b_1^2x^2\,dx\Rightarrow b_1^2\frac{x^3}{3}]_{-1}^{1}\ \Rightarrow\left(\frac{1}{3}b_1^2\right)-\left(-\frac{1}{3}b_1^2\right)=\frac{2}{3}b_1^2$$

$$\frac{2}{3}b_1^2=1\Rightarrow b_1=\pm\sqrt{\frac{3}{2}}$$

$$\int_{-1}^{1}a_0\,(a_2+b_2x+c_2x^2)dx\Rightarrow\int_{-1}^{1}(a_0a_2+a_0b_2x+a_0c_2x^2)\,dx\Rightarrow a_0a_2x+a_0b_2\frac{x^2}{2}+a_0c_2\frac{x^3}{3}]_{-1}^{1}$$

$$\Rightarrow\left(a_0a_2+\frac{1}{2}a_0b_2+\frac{1}{3}a_0c_2\right)-\left(-a_0a_2+\frac{1}{2}a_0b_2-\frac{1}{3}a_0c_2\right)=2a_0a_2+\frac{2}{3}a_0c_2$$

$$2a_0a_2+\frac{2}{3}a_0c_2=0\Rightarrow\frac{2}{\sqrt{2}}a_2+\frac{2}{3\sqrt{2}}c_2=0\Rightarrow a_2=-\frac{1}{3}c_2$$

$$\int_{-1}^{1}(a_1+b_1x)(a_2+b_2x+c_2x^2)dx \Rightarrow \int_{-1}^{1}(a_1a_2+a_1b_2x+a_1c_2x^2+a_2b_1x+b_1b_2x^2+b_1c_2x^3)\,dx$$

$$\Rightarrow a_1a_2x+a_1b_2\frac{x^2}{2}+a_1c_2\frac{x^3}{3}+a_2b_1\frac{x^2}{2}+b_1b_2\frac{x^3}{3}+b_1c_2\frac{x^4}{4}]_{-1}^{1}$$

$$\Rightarrow \left(a_1a_2+\frac{1}{2}a_1b_2+\frac{1}{3}a_1c_2+\frac{1}{2}a_2b_1+\frac{1}{3}b_1b_2+\frac{1}{4}b_1c_2\right)$$

$$-\left(a_1a_2+\frac{1}{2}a_1b_2-\frac{1}{3}a_1c_2+\frac{1}{2}a_2b_1-\frac{1}{3}b_1b_2+\frac{1}{4}b_1c_2\right)=2a_1a_2+\frac{2}{3}a_1c_2+\frac{2}{3}b_1b_2$$

$$2a_1a_2+\frac{2}{3}a_1c_2+\frac{2}{3}b_1b_2=0 \Rightarrow \frac{2}{3}b_1b_2=0 \Rightarrow b_2=0$$

$$\int_{-1}^{1}(a_2+c_2x^2)(a_2+c_2x^2)dx \Rightarrow \int_{-1}^{1}(a_2^2+2a_2c_2x^2+c_2^2x^4)dx \Rightarrow a_2^2x+a_2c_2\frac{2x^3}{3}+c_2^2\frac{x^5}{5}]_{-1}^{1}$$

$$\Rightarrow \left(a_2^2+\frac{2}{3}a_2c_2+\frac{1}{5}c_2^2\right)-\left(-a_2^2-\frac{2}{3}a_2c_2-\frac{1}{5}c_2^2\right)=\left(2a_2^2+\frac{4}{3}a_2c_2+\frac{2}{5}c_2^2\right)$$

$$2a_2^2+\frac{4}{3}a_2c_2+\frac{2}{5}c_2^2=1 \Rightarrow \frac{2}{9}c_2^2-\frac{4}{9}c_2^2+\frac{2}{5}c_2^2=1 \Rightarrow \left(-\frac{2}{9}+\frac{2}{5}\right)c_2^2=1 \Rightarrow c_2=\pm\sqrt{\frac{45}{8}}=\pm\frac{3}{2}\sqrt{\frac{5}{2}}$$

$$a_2=-\sqrt{\frac{45}{72}}=\pm\frac{1}{2}\sqrt{\frac{5}{2}}$$

$$\pm\frac{1}{\sqrt{2}},\pm\sqrt{\frac{3}{2}}x,-\sqrt{\frac{45}{72}}\pm\sqrt{\frac{45}{8}}x^2$$