a)

$$\int_{-\infty}^{\infty} \psi(x,0)=1$$

$$\int_{-\infty}^{\infty} \psi(x,0)=\int_{0}^{a} A\frac{x}{a}+\int_{a}^{b} A\frac{(b-x)}{b-a}=A[\int_{0}^{a} \frac{x}{a}+\int_{a}^{b} \frac{(b-x)}{b-a}]=1$$

$$\int_{0}^{a} \frac{x}{a}=\left.\frac{x^2}{2a}\right|_{0}^{a}=\frac{a}{2}$$

$$\int_{a}^{b} \frac{(b-x)}{(b-a)}=\int_{a}^{b} \frac{b}{(b-a)}-\frac{x}{(b-a)}=\left.\frac{bx}{(b-a)}-\frac{x^2}{2(b-a)}\right|_{a}^{b}$$

$$\int_{a}^{b} \frac{(b-x)}{(b-a)}=[\frac{b^2}{(b-a)}-\frac{b^2}{2(b-a)}]-[\frac{ba}{(b-a)}-\frac{a^2}{2(b-a)}]=\frac{a^2}{2(b-a)}-\frac{ba}{(b-a)}-\frac{b^2}{2(b-a)}$$

$$\int_{a}^{b} \frac{(b-x)}{(b-a)}=\frac{a^2-2ba-b^2}{2(b-a)}=\frac{(a-b)^2}{2(b-a)}=-\frac{(a-b)^2}{2(a-b)}=\frac{b-a}{2}$$

$$A[\frac{a}{2}+\frac{(b-a)}{2}]=1$$

$$A\frac{b}{2}=1$$

$$A=\frac{2}{b}$$

b)

$$\psi(x,0) = \begin{cases} \frac{2x}{a} & if \quad 0 \le x \le a \\ 2\frac{(b-x)}{(b-a)} & if \quad a \le x \le b \\ 0 & otherwise \end{cases}$$

I'm not gonna graph this but...ya know...it would be a slanty line going up and to the right and would hit a/2 at x=a, followed by a slanty line going down and to the right and would hit 0 at x=b

c)

x=a

d)

$$\int_0^a A\frac{x}{a} = \frac{a}{b}$$

$$\int_a^b A\frac{(b-x)}{(b-a)} = \frac{b-a}{b}$$

$$C_1 = \frac{a}{b}$$

$$C_2 = \frac{(b-a)}{b}$$

$$p(x) = \psi(x,0)\psi*(x,0)$$

$$\psi(x,0) = C_1 + C_2$$

$$\psi*(x,0) = C_1* + C_2*$$

$$p(0 \text{ to a}) = C_1 \cdot C_1* = \frac{a \cdot a*}{b \cdot b*}$$

e)

$$\langle x\rangle = A\{\int_0^a x\frac{x}{a} + \int_a^b x\frac{(b-x)}{(b-a)}\} = \frac{2}{b}\{\int_0^a x\frac{x}{a} + \int_a^b x\frac{(b-x)}{(b-a)}\}$$

$$\int_0^a x\frac{x}{a} = \frac{x^3}{3a}\Big|_0^a = \frac{a^2}{3}$$

$$\int_a^b x\frac{(b-x)}{(b-a)} = \int_a^b \frac{bx}{(b-a)} - \frac{x^2}{(b-a)} = \frac{bx^2}{2(b-a)} - \frac{x^3}{3(b-a)}\Big|_a^b$$

$$\int_a^b x\frac{(b-x)}{(b-a)} = \frac{bx^2}{2(b-a)} - \frac{x^3}{3(b-a)}\Big|_a^b = \{\frac{b^3}{2(b-a)} - \frac{b^3}{3(b-a)}\} - \{\frac{ab^2}{2(b-a)} - \frac{a^3}{3(b-a)}\}$$

$$\int_a^b x\frac{(b-x)}{(b-a)} = \frac{b^3}{6(b-a)} - \frac{ab^2}{2(b-a)} - \frac{a^3}{3(b-a)} = \frac{b^3 - 3ab^2 - 2a^3}{6(b-a)}$$

$$\langle x\rangle = \frac{2}{b}\{\frac{a^2}{3} + \frac{b^3 - 3ab^2 - 2a^3}{6(b-a)}\} = \frac{2}{b}\{\frac{2a^2(b-a) + b^3 - 3ab^2 - 2a^3}{6(b-a)}\} = \frac{2}{b}\{\frac{2ba^2 - 2a^3 + b^3 - 3ab^2 - 2a^3}{6(b-a)}\}$$

$$\langle x\rangle = \frac{2}{b}\{\frac{b^3 + 2ba^2 - 3ab^2 - 4a^3}{6(b-a)}\} = \frac{b^3 + 2ba^2 - 3ab^2 - 4a^3}{3b(b-a)}$$

I don’t know if this can be further simplified but I do know I’m done trying