Ex 3 a)

$$dPS_2 = \frac{d^3k_1}{(2\pi)^3 2E_1} \frac{d^3k_2}{(2\pi)^3 2E_2}(2\pi)^4 \delta^{(4)}(k_1 + k_2 - p_a - p_b) \tag{1}$$

$$dPS_2 = \frac{d^3k_1}{(2\pi)^3 2E_1} \frac{1}{(2\pi)^3} d^4k_2 \delta(k_2^2 - m_2^2)(2\pi)^4 \delta^{(4)}(k_1 + k_2 - p_a - p_b) \tag{2}$$

$$dPS_2 = \frac{d^3k_1}{(2\pi)^3 2E_1} \frac{1}{(2\pi)^3} \delta((p_a + p_b - k_1)^2 - m_2^2)(2\pi)^4 \tag{3}$$

$$dPS_2 = \frac{d|\vec{k}_1|d\cos\theta d\phi}{(2\pi)^3 2E_1} \frac{1}{(2\pi)^3} \delta((p_a + p_b - k_1)^2 - m_2^2)(2\pi)^4 |\vec{k}_1| \tag{4}$$

$$dE_1 \delta((p_a+p_b-k_1)^2 - m_2^2) \overset{\vec{p}_a = -\vec{p}_b; p_a^0 + p_b^0 = \sqrt{s}}{=} dE_1 \delta((\sqrt{s}-E_1)^2 - m_2^2 - |\vec{k}_1|^2) = \frac{1}{2|\sqrt{s}|} \tag{5}$$

$$|\vec{k}_1| = \sqrt{\lambda(s, m_1^2, m_2^2)}/2\sqrt{s} \implies \quad \square \tag{6}$$

Ex 3 b)

$$dPS_2 = \frac{1}{16\pi^2 2s} \sqrt{\lambda(s, m_1^2, m_2^2)} d\cos\theta d\phi \tag{7}$$

$$t = (p_a - k_1)^2 = m_a^2 - 2p_a k_1 + m_1^2 = m_a^2 - 2p_a k_1 + m_1^2 = m_a^2 + m_1^2 - 2(E_a E_1 - \vec{p}_a \vec{p}_1) = \tag{8}$$

$$= t = m_a^2 + m_1^2 - 2\left(\frac{2 + m_a^2 - m_b^2}{2\sqrt{s}} \frac{2 + m_1^2 - m_2^2}{2\sqrt{s}} - \frac{\sqrt{\lambda(s, m_a^2, m_b^2)\lambda(s, m_1^2, m_2^2)}}{4s} \cos\theta\right) = \tag{9}$$

$$t_{\pm} = t(\theta = 0 \text{ or } \theta = \pi) \tag{10}$$

$$\frac{dt}{d\cos\theta} = \frac{\sqrt{\lambda(s, m_a^2, m_b^2)\lambda(s, m_1^2, m_2^2)}}{2s} \implies \quad \square \tag{11}$$