Chpt 11: # 12, 32

(12) (a)
$$I = \int_{t_1}^{t_2} F\,dt$$

$$= \int_0^3 (at - bt^2)\,dt$$

$$= \frac{at^2}{2}\Big|_0^3 - \frac{bt^3}{3}\Big|_0^3$$

$$= \frac{9}{2}a - 9b$$

$$= \frac{9}{2}(1200) - 9(400)$$

$$\Rightarrow \boxed{I = 1800\ kg \cdot \frac{m}{s}}$$

(b) $F_{average} = \frac{I}{\Delta t} = \frac{1800}{3} = 600N$

12 c $\Delta p = p_f - p_i$

$$= m v_f - 0$$

$$\Rightarrow \Delta p = I = 1800 = (.059) v_f$$

$$\Rightarrow v_f = \frac{1800}{.059} = 3.05 \times 10^4 \frac{m}{s}$$

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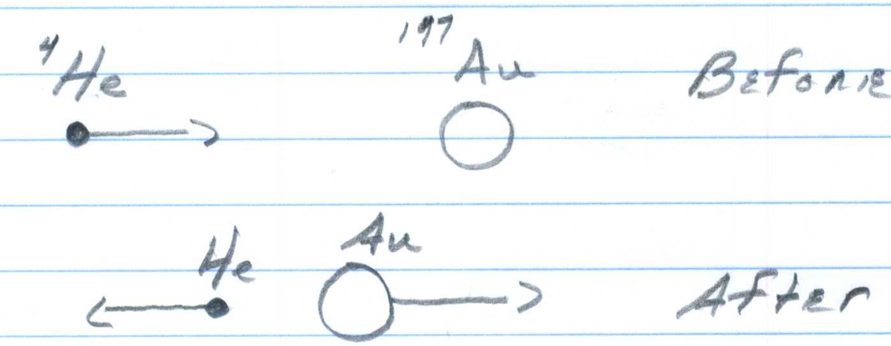

- Let $m_{He} = 4m$ and $M_{Au} = 197m$

- Alpha particles initial KE is:

$$KE_i = \frac{1}{2}(4m)v_i^2$$

- Need to find final kinetic energy of gold nucleus →

- USE CONSERVATION OF ENERGY:

$$KE_i = KE_f$$

$$\frac{1}{2}(4m)V_i^2 = \frac{1}{2}(4m)V_f^2 + \underbrace{\frac{1}{2}(197m)V_g^2}_{KE_g}$$

V_i = initial velocity of He
V_f = final velocity of He
V_g = final velocity of gold nucleus

- For a head on one dimensional collision:

$$|\vec{V_f}| = \left(\frac{4m - 197m}{4m + 197m}\right)|\vec{V_i}|$$

$$= \frac{193}{201}|\vec{V_i}|$$

$\Rightarrow$ Back to kinetic energy equation:

$$\frac{1}{2}(4m)V_i^2 = \frac{1}{2}(4m)\left(\frac{193}{201}\right)^2 V_i^2 + KE_g$$

$$KE_g = \frac{1}{2}(4m)v_i^2 - \left(\frac{193}{201}\right)^2 \frac{1}{2}(4m)v_i^2$$

$$= \frac{1}{2}(4m)v_i^2\left(1 - \left(\frac{193}{201}\right)^2\right)$$

$$= KE_i\left(1 - .922\right)$$

$$= KE_i(.078)$$

Final Kinetic Energy of gold is 7.8% of initial kinetic energy of alpha particle.