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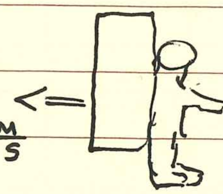
Chapter 8 Homework Problem.

Ex. 61 A 70-kg astronaut floating in space in a 110 kg MMU .....

$M = 70\text{ kg} + 110\text{ kg} = 180\text{ kg}$



$V = -490\ \frac{m}{s}$ $\Longleftarrow$ $\Longrightarrow$ $a = 0.029\ \frac{m}{s^2}$

b.) What is the thrust?

$$\text{Thrust} = F = Ma = (180\text{ kg})(0.029\text{ m/s}^2) = \boxed{5.22\text{ N}}$$

a.) How much gas is used? ($\Delta t = 5.0$ seconds)

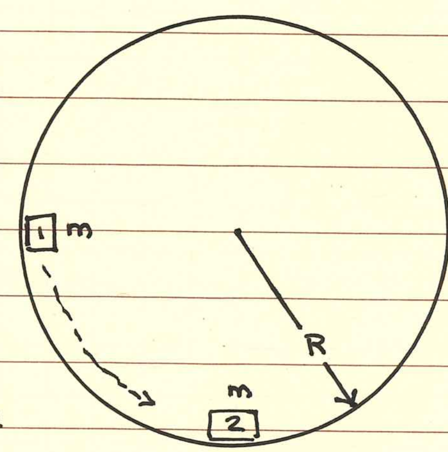
$$\text{Thrust} = V_{ex}\frac{dm}{dt} \qquad \frac{dm}{dt} = \frac{\text{Thrust}}{V_{ex}} = \frac{5.22\text{ N}}{490\text{ m/s}} = 0.01065\ \frac{kg}{sec}$$

$$\Delta m = \text{mass of gas used in } (\Delta t = 5.0\text{ sec}) = \frac{dm}{dt}\Delta t$$

$$\Delta m = 0.01065\text{ kg/sec}\ (5.0\text{ sec}) = 0.053\text{ kg} \Rightarrow \boxed{53\text{ grams}}$$

Ex. 82 This is a 2-part problem:

1.) Use conservation of momentum to find V_f after the "completely inelastic collision.



The velocity of m ~~at~~ when it reaches the bottom is:

$$V = \sqrt{2gh} = \sqrt{2gR}$$

It strikes and "sticks" to the 2^{nd} mass.

Cons. of Mom $\Longrightarrow$

$$m_1V_1 = (m_1+m_2)V_f = m\sqrt{2gR} = 2mV_f$$

$$\boxed{V_f = \sqrt{\frac{gR}{2}}}$$

velocity at the bottom for both masses once they're "stuck" together.

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Ex. 82 (Cont'd)

2.) Use conservation of energy to see how high the 2 blocks rise.

$$W_{TOT} = \Delta K = \underset{=0}{K_f} - K_i = -K_i$$

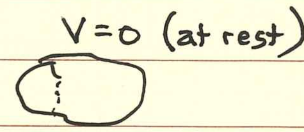
$$-\text{"}m\text{"}gy_f = -\frac{1}{2}\text{"}m\text{"}v_i^2 \qquad \text{where "}m\text{"} = 2m$$

$$gy_f = \frac{1}{2}v_i^2 \qquad y_f = \frac{v_i^2}{2g} = \frac{\left(\sqrt{gR/2}\right)^2}{2g} = \frac{gR}{4g}$$

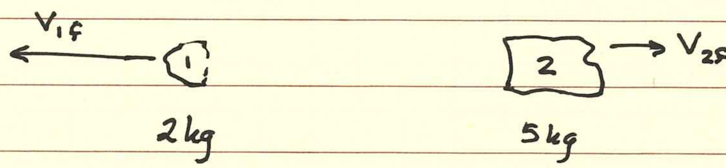
$$\boxed{y_f = \frac{R}{4}}$$

Ex. 95 A 7.0-kg shell at rest explodes into two fragments

Initial: $\Rightarrow$



Final: $\Rightarrow$



$K_1 = ??\ J$ $\qquad$ $K_2 = 100\ J$

$P_2 = \sqrt{2m_2K}$ $\qquad$ However, from cons. of momentum, $P_1 = P_2$

$$P_1 = P_2 = \sqrt{2m_2K_2}$$

$$K_1 = \frac{P_1^2}{2m_1} = \frac{2m_2K_2}{2m_1} = \frac{m_2}{m_1}K_2 = \frac{5\text{ kg}}{2\text{ kg}}(100\text{ J}) = 250\text{ J}$$

$$\boxed{K_1 = 250\text{ J}}$$

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Chapter 8 Homework

Δv for Rocket Propulsion

$$\boxed{\Delta v = V_{ex} \ln\left(\frac{M_i}{M_f}\right)}$$

where $\Delta v = V_f - V_i$ $\quad V_{ex}$ = exhaust velocity w.r.t. the rocket.

M_i = initial mass of the rocket

M_f = final mass of the rocket

8.63 If the rocket ejects gas at a relative speed of 1900 m/s .....

$V_i = 0$ m/s

$V_f = \frac{1}{1{,}000}$ (speed of light) $= 3.00 \times 10^5$ m/s

$$\ln\left(\frac{M_i}{M_f}\right) = \frac{\Delta v}{V_{ex}} \qquad \boxed{\ln\left(\frac{M_f}{M_i}\right) = -\frac{\Delta v}{V_{ex}} = -158}$$

$$\left(\frac{M_f}{M_i}\right) = e^{-\frac{\Delta v}{V_{ex}}} = 2.67 \times 10^{-69} \qquad \boxed{\frac{M_f}{M_i} = 2.67 \times 10^{-69}}$$

b.) what is the fraction if the final speed is 3200 m/s

$$\frac{M_f}{M_i} = e^{-\frac{\Delta v}{V_{ex}}} = e^{-3200\text{ m/s}/1900\text{ m/s}} = 0.186$$

$$\boxed{\frac{M_f}{M_i} = 0.186}$$