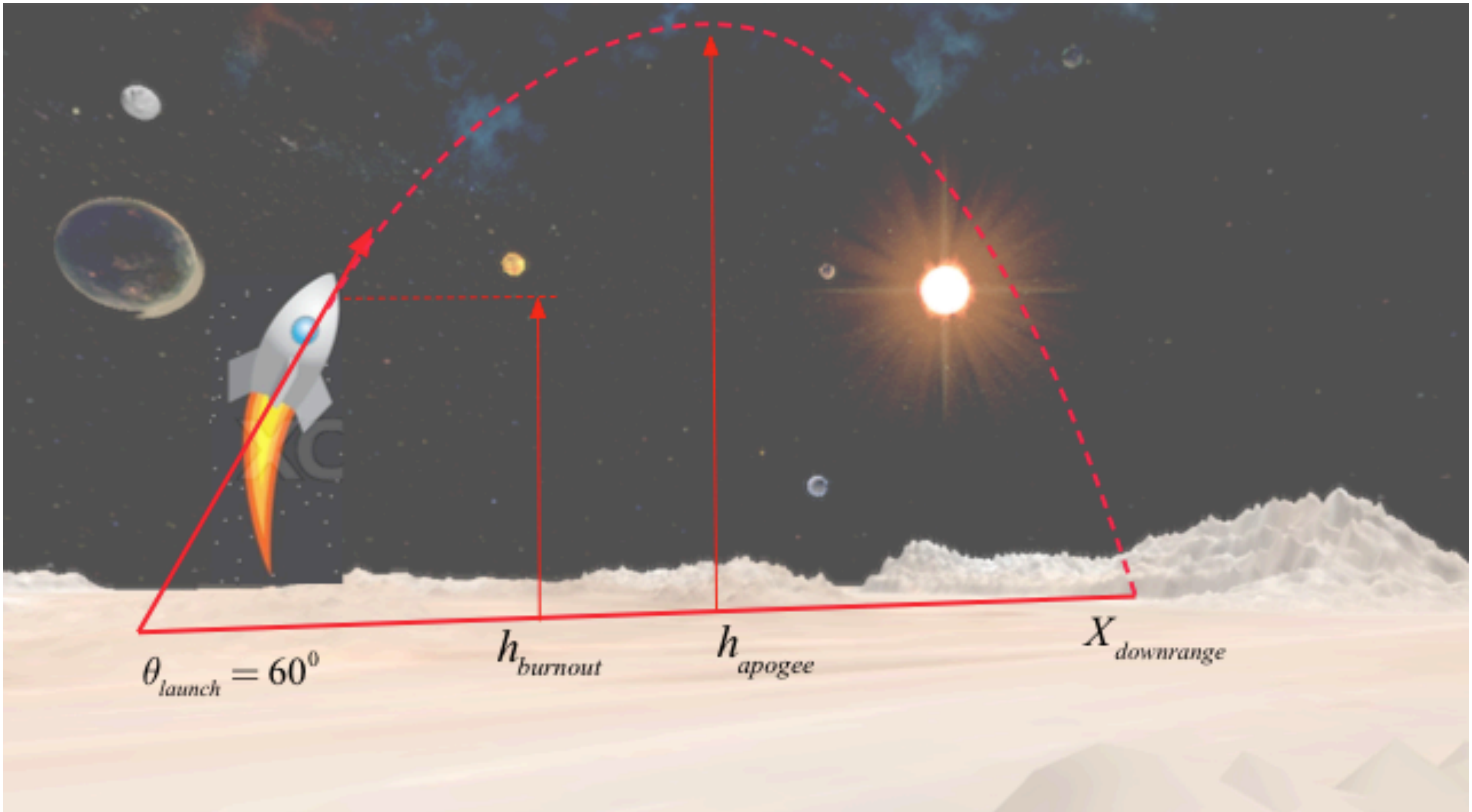
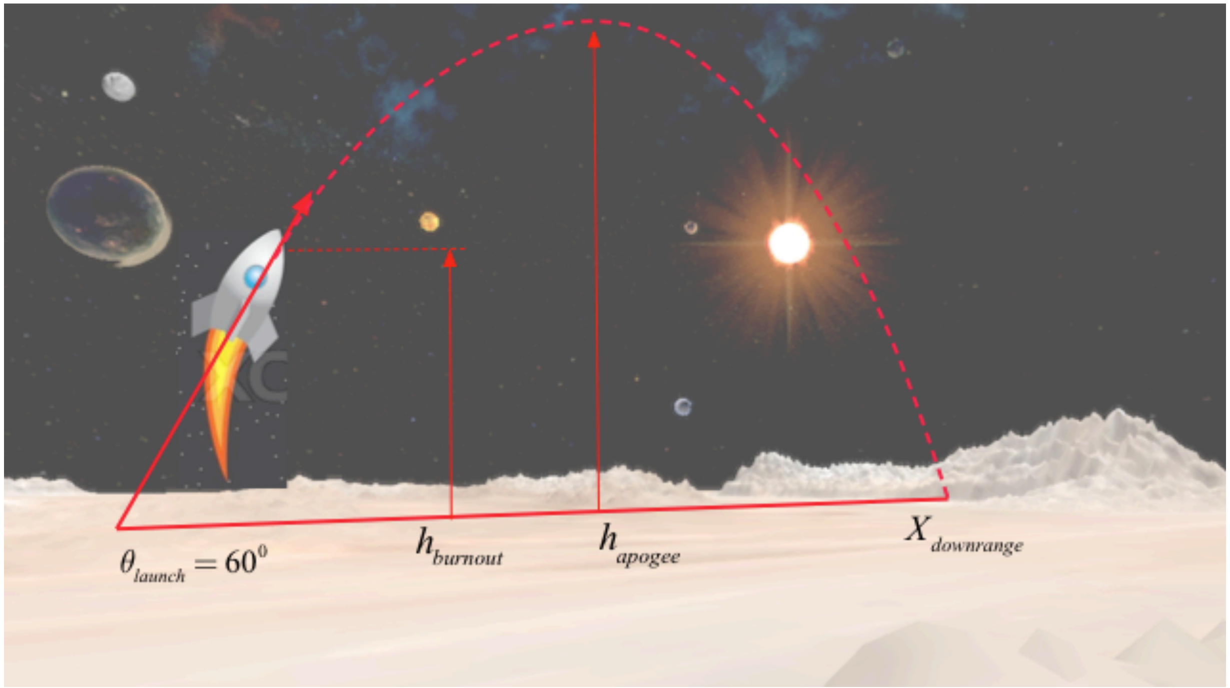
Homework 2



• Consider Sub-Orbital Rocket Launch on Moon's Surface

Homework 2



- Calculate:

1. Burnout Altitude and Velocity
2. Apogee Altitude (Note V_{apogee} != 0)
3. Impact Downrange (ignore surface curvature)
4. Time to Impact
5. Plot Flight Path Altitude vs Time & Downrange
6. Velocity vs Time & Downrange

Assume Point Mass Calculations

- Initial Launch **Angle 60 degrees** (consider constant while rocket is burning)
- **Total Launch Mass, 20 kg**
- **Initial Propellant Mass, 5 kg**
- **Thrust 1000 N**
- **Isp =250 sec**
- Acceleration of Lunar Gravity (assume Constant)

$$g_{moon} = 1.622 \frac{m}{\sec^2}$$

- Standard Earth Gravity Acceleration

$$g_{0_\oplus} = 9.8067 \frac{m}{\sec^2}$$

Applicable Equations

- During Burn

$$Assume\ \theta_{launch} = constant,\ V_0 = 0 \rightarrow at\ time\ t:$$

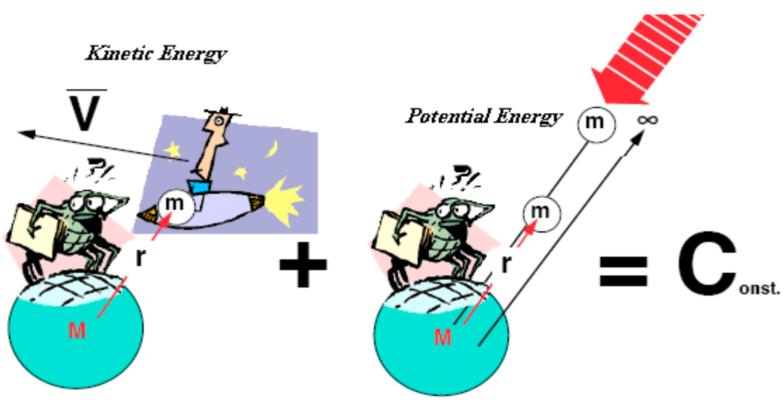
$$V(t) = \left(g_{0_\oplus} \cdot I_{sp} \ln\left(\frac{M_{initial}}{M_{initial} - \dot{m} \cdot t} \right) - g_{0_{moon}} \cdot \sin\theta_{launch} \cdot t \right)$$

$$t_{burn} = \frac{M_{prop} \cdot g_{0_\oplus} \cdot I_{sp}}{F} \qquad \frac{\partial h}{\partial t} = V(t) \cdot \sin\theta \qquad \frac{\partial X}{\partial t} = V(t) \cdot \cos\theta$$

- After Burnout

$$\frac{E_{mech}}{M_{final} \cdot g_0} = \frac{(V_{burnout})^2}{2 \cdot g_0} + h_{burnout} = Const \qquad \frac{\partial X}{\partial t} = Const$$

$$V_{horiz} \neq 0\ \ldots\ @\ \ apogee!$$



$$\frac{\partial \vec{V}}{\partial t} = \frac{\sum \vec{F}}{M_{burnout}}$$


Questions??