

You Are a Rocket Scientist!

What we will do

- Design a rocket with a payload
- Figure out the cost
- Test your design!

How we will do it

- Calculate the mass of the payload
- Pick a rocket engine
- Calculate the mass of the rocket
- Calculate the cost of the rocket
- Test your rocket in a simulation
- Types of spacecraft
 - Manned
 - Scientific
 - Weather
 - Scientific

- Payload cost
 - Manned spacecraft: 1,000 kg/person and cost is \$100,000 x mass of the payload
 - Weather satellite: payload is 300 kg and the cost is \$20,000 x mass of the payload
 - Scientific satellite: payload is 500 kg and the cost is \$50,000 x mass of the payload
 - Direc TV satellite: payload is 1,000 kg and the cost is \$10,000 x mass of the payload
- Rocket engine cost
 - Hydrogen/Oxygen engine cost = \$10,000 x mass of the payload
 - Kerosene engine cost = \$2,000 x mass of the payload
 - Solid rocket engine = \$1,000 x mass of the payload
- Fuel cost
 - Hydrogen/Oxygen fuel cost = \$10 x mass of the fuel
 - Kerosene fuel cost = \$2 x mass of the fuel
 - Solid rocket fuel cost = \$1 x mass of the fuel

The Rocket Equation

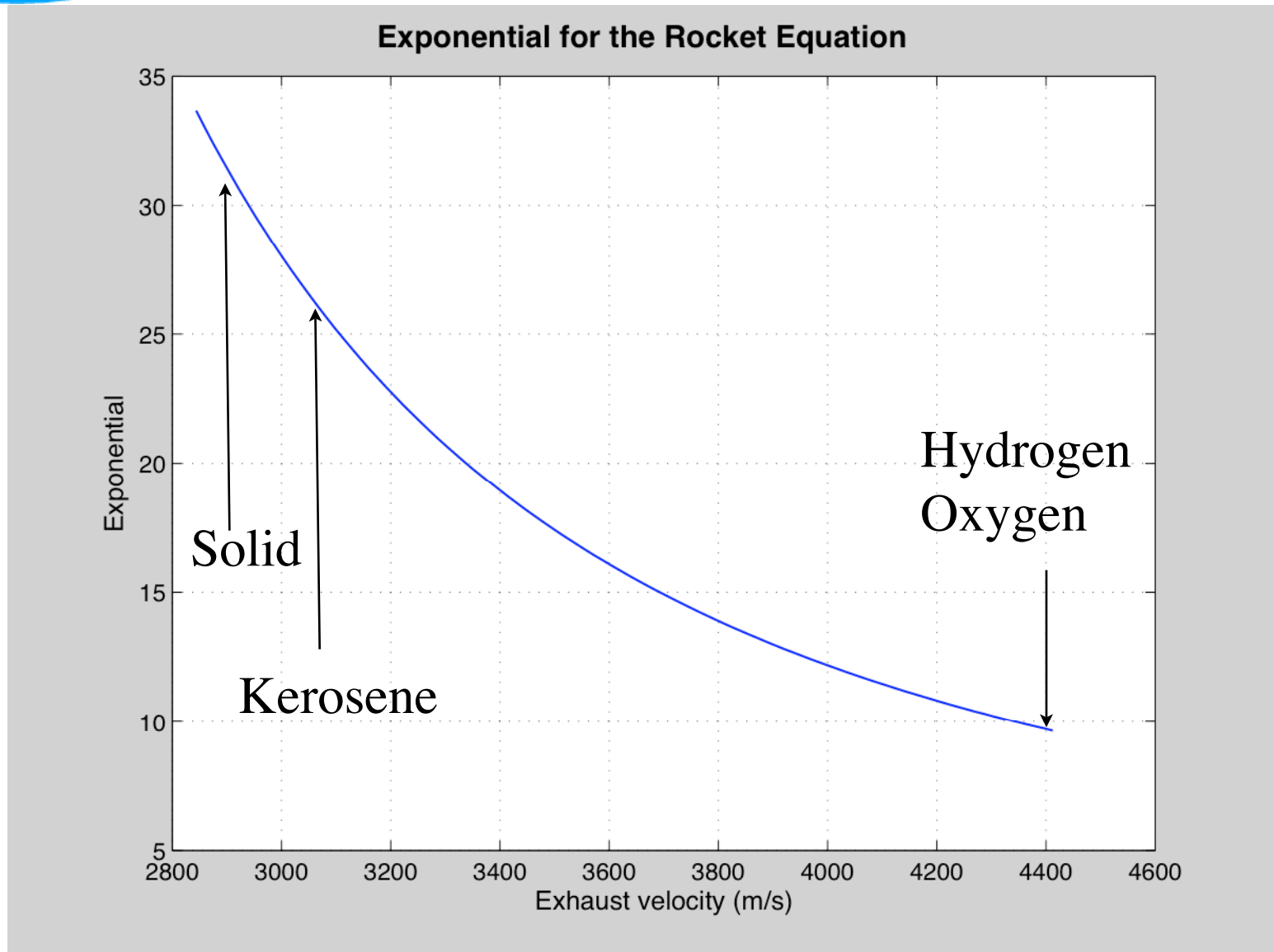
- This is the equation you need to know to be a rocket scientist!

$$m_f = m_p (e^{\Delta V / u_e} - 1)$$

- e is a special number equal to 2.718281828459046...
- The ... means it has an infinite number of digits!
- e^x means take e to the x^{th} power like $10^2 = 10 \times 10 = 100$
- u_e is the exhaust velocity - depends on the rocket engine
- ΔV is the change in velocity to get you into orbit 10 km/sec!!!!!!

$$e^{\Delta V / u_e}$$

Chart for Calculating



- 2 Person Spacecraft
 - mass payload = $2 \times 1,000 = 2,000$ kg
 - cost of payload = $2,000 \times \$100,000 = \$200,000,000$
 - pick the hydrogen/oxygen engine
 - get the value for “e” from the chart - 9.5
 - mass of the fuel = $2,000 \times (9.5 - 1) = 17,000$ kg
 - cost of the engine = $2,000 \times \$10,000 = \$20,000,000$
 - cost of the fuel = $17,000 \times \$10 = \$170,000$
 - total vehicle cost = $\$200,000,000 + \$20,000,000 + \$170,000 = \$220,170,000$