# Physics I

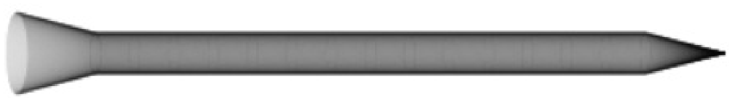
## Rockets

$$F_{thrust} = v_{gases} \left| \frac{dm}{dt} \right|$$

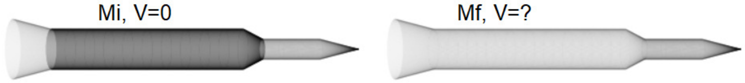
**Problem 1.-** A solid rocket booster (SRB) has a thrust of $13.2\times10^6$ N. The total mass of the fuel is 500,000 kg and it is spent in 75 seconds.

(a) Calculate the speed of the gases expelled by the rocket.

(b) Calculate the acceleration produced at lift-off if the total mass is the mass of fuel plus 91,000 kg of "inert weight."



**Problem 2.-** A rocket has an initial mass Mi= 100,000 kg out of which 86,500 kg is fuel. The speed of the gases generated by burning the fuel is 2,700 m/s. Calculate the final speed of the rocket after burning all its fuel starting from zero velocity. Only consider the thrust of the gases, no other forces.




A) 675 m/s B) 1,350 m/s C) 2,700 m/s D) 5,400 m/s E) 8,100 m/s

**Problem 3.-** Calculate the speed of the gases of the Space Shuttle solid rocket booster that produce a thrust of $F_{thrust} = 12.5\times10^6 N$ and burns 499,000 kg of fuel in 110 seconds.

**Problem 4.-** A rocket uses solid fuel whose burned gases have a speed of 2700 m/s. At what rate do you need to burn the fuel to generate a thrust of 14,400 N?

**Problem 5.-** A rocket has the following specs:

Initial mass = $M_o$ =21,000 kg Mass of fuel= $M_{fuel}$ = 15,000 kg

Relative velocity of gasses: $v_{gases}$ = 2800 m/s Rate of fuel burning: $\frac{dm}{dt}$ =-190kg/s

Find:

a) The thrust force
b) The initial acceleration

**Problem 6**.- Given the following conditions, find the height reached by a rocket just after burning all the fuel assuming a vertical trajectory.

Initial mass = $M_o$ = 21,000 kg Mass of fuel= $M_{fuel}$ = 15,000 kg

Relative velocity: $v_{rel}$ =-2800 m/s Rate of fuel burning: $\frac{dm}{dt}$ =-190kg/s