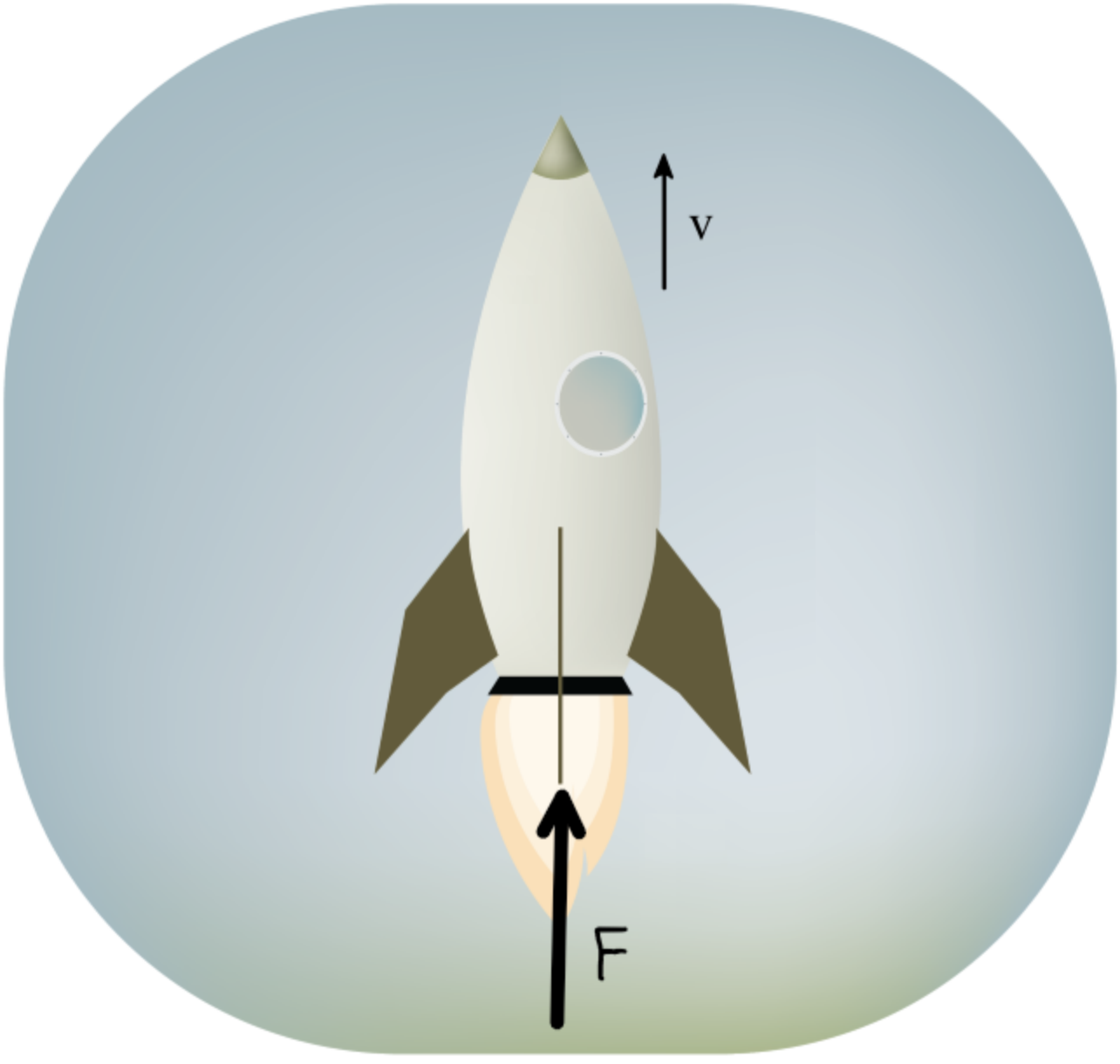
21-P-WE-GD-006



A rocket is taking off from a distant planet with no atmosphere. The rocket starts at rest, has a mass of $\underset{\sim}{M}$ kg and the booster provides a thrust force of $F = (\underset{\sim}{A} + \underset{\sim}{B}s^2)$ N.

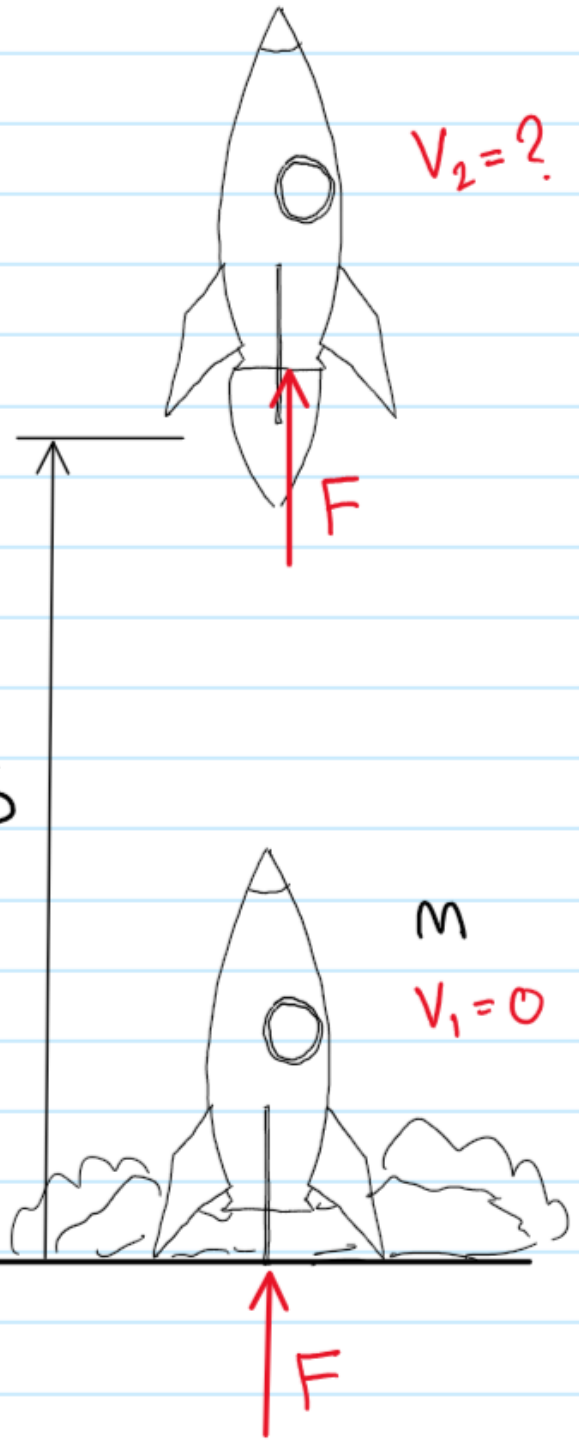
How fast is the rocket travelling when the rocket reaches a height of $\underset{\sim}{s}$ m?

(Assume $g = 4.905\ m/s^2$)

given A, B, g, s, m, v_1

find v_2

FBD



at $s = 0$

$mg < A + Bs^2$ (rocket moves)

Work Energy (from $0 \to s$)

$T_1 + \Sigma U_{1-2} = T_2$

F is a variable force so integrate

$$0 - mgs + \int_0^s (A + Bs^2)\,ds = \tfrac{1}{2} m v_2^2$$

$$-mgs + As + \tfrac{1}{3}Bs^3 = \tfrac{1}{2} m v_2^2$$

$$v_2 = \sqrt{\frac{2(As + \tfrac{1}{3}Bs^3 - mgs)}{m}}$$

sub in given s value