Quiz 19.1C

An explosive charge launches a 4.70-kg model rocket vertically with an initial velocity of 37.2 m/s. Once launched, the rocket's engines kick in, providing a constant upward-pointing applied force of 113 Newtons. 5.00 seconds after launch, the rocket passes through an altitude of 448 meters, still moving upwards. The rocket carries an unknown charge q and is immersed in a uniform electric field of 4.20×10^6 N/C that points in the +y direction. After launch, the only forces acting on the rocket are the applied force of the engines, gravity and the electric force. During this 5.00 second time interval…

a) How much work is done by gravity on the rocket?
b) How much work is done by the applied force on the rocket?
c) What is the change in kinetic energy of the rocket?
d) How much work is done by the electric force on the rocket?
e) What is the charge q that the rocket carries?
f) If the voltage at ground level is 0 Volts, what is the voltage at y = 448 meters?

a) $W_{grav} = -mg\Delta y = -(4.70)(9.8)(448) = \boxed{-20600\ J}$

b) $W_{App} = |F_{App}||\Delta s|\cos 0° = (113)(448)(1) = \boxed{50600\ J}$

$\Delta y = 448$
$v_{0y} = 37.2\ m/s$
$v_y = ?$
$a = ?$
$t = 5.00s$

$\Delta y = \frac{1}{2}(v + v_0)t$
$448 = \frac{1}{2}(v + 37.2)(5)$
$\Rightarrow 179.2 = v + 37.2$
$\Rightarrow v = 142$

c) $\Delta K = \frac{1}{2}(4.70)(142)^2 - \frac{1}{2}(4.70)(37.2)^2 = \boxed{44100\ J}$

d) $W_g + W_{App} + W_E = \Delta K$
$-20600 + 50600 + W_E = 44100 \Rightarrow \boxed{W_E = 14100\ J}$

e) Since W_E +, F_E points ↑. Since E ↑, F_E ↑, q is +

$W_E = +qE\Delta y$ $\quad 14100 = q(4.2 \times 10^6)(448)$

V_F negative since $\vec{E}$ points up $\Rightarrow \boxed{q = 7.49 \times 10^{-6}\ C}$

f) $\Delta V = -Ed = -(4.2 \times 10^6)(448)$

$\boxed{V_F = -1.88 \times 10^9\ Volts}$