Electric Potential

① $V = \frac{kQ}{r}$

$-6.4 \times 10^4 = \frac{(9 \times 10^9) Q}{0.25}$

$Q = \frac{0.25(-6.4 \times 10^4)}{9 \times 10^9} = \boxed{-1.8 \times 10^{-6}\ C}$

② $V = \frac{kQ}{r} = \frac{(9 \times 10^9)(4.5 \times 10^{-4})}{0.5} = \boxed{8\ 100\ 000\ V}$

③ $W = \Delta PE_e$

$= \frac{kQq}{r'} - \frac{kQq}{r}$

$= kQq\left(\frac{1}{r'} - \frac{1}{r}\right)$

$= (9 \times 10^9)(1 \times 10^{-6})(3.2 \times 10^{-3})\left(\frac{1}{0.4} - \frac{1}{1}\right)$

$W = \boxed{43.2\ J}$

④ $W = q\Delta V$

$4.2 \times 10^{-3} = 1.2 \times 10^{-6}\ \Delta V$

$\Delta V = \boxed{3500\ V}$

⑤ $\Delta PE_e = q\Delta V$

$= (1.6 \times 10^{-19})(2.5 \times 10^{4})$

$\Delta PE_e = \boxed{4.0 \times 10^{-15}\ J}$

⑥ $W = \Delta PE_e$ (note $PE_e = 0$ @ infinity)

$= \frac{kQq}{r} - 0$

$= \frac{(9 \times 10^{9})(1.6 \times 10^{-19})(1.6 \times 10^{-19})}{1.0 \times 10^{-15}}$

$W = \boxed{2.3 \times 10^{-13}\ J}$

⑦ $E = \frac{\Delta V}{d} = \frac{300\ V}{0.005\ m} = \boxed{60\,000\ V/m}$

⑧ $E = \frac{\Delta V}{d} = \frac{450}{0.02} = \boxed{22\,500\ V/m}$

⑨ $E = \frac{\Delta V}{d}$

$1.5 \times 10^{4} = \frac{\Delta V}{0.012}$

$\Delta V = \boxed{180\ V}$

(10) $\Delta V = E\,d$

$= (2.5 \times 10^3)(0.08)$

$\Delta V = \boxed{200\ V}$

(11) $E = \dfrac{\Delta V}{d}$

$d = \dfrac{\Delta V}{E} = \dfrac{600}{1.2 \times 10^4} = \boxed{0.05\ m}$ (5 cm)