Physics 30 – Lesson 16
Electric Potential Energy

/40

Practice problems

1. $\Delta E = 50J$
$q = 0.50C$
$\Delta V = ?$

$$\Delta V = \frac{\Delta E}{q}$$
$$\Delta V = \frac{50J}{0.50C}$$
$$\boxed{\Delta V = 100V}$$

2. $\Delta V = 500V$
$q = 1.60\times10^{-19}C$
$m = 9.11\times10^{-31}kg$

$$\Delta E_p = \Delta E_k$$
$$q\Delta V = \tfrac{1}{2}mv^2$$
$$v = \sqrt{\frac{2q\Delta V}{m}}$$
$$v = \sqrt{\frac{2(1.60\times10^{-19}C)(500V)}{9.11\times10^{-31}kg}}$$
$$\boxed{v = 1.33\times10^{7}\ {}^{m}\!/_{s}}$$

3. For a completely ionized atom all of the electrons have been stripped away. The charge is the number of protons (i.e. atomic number) times the charge per proton.
$q = 13(+1.60\times10^{-19}C) = 2.08\times10^{-18}C$

$\Delta V = 0.25\times10^{6}V$

The atomic mass is the number of protons and neutrons combined. We look on the periodic table - for aluminum it is 26.98 rounded to 27. Therefore aluminum has 27 protons and neutrons.
$m = 27(1.67\times10^{-27}kg) = 4.509\times10^{-26}kg$

$$\Delta E_p = \Delta E_k$$
$$q\Delta V = \tfrac{1}{2}mv^2$$
$$v = \sqrt{\frac{2q\Delta V}{m}}$$
$$v = \sqrt{\frac{2(2.08\times10^{-18}C)(2.5\times10^{5}V)}{4.509\times10^{-26}kg}}$$
$$\boxed{v = 4.8\times10^{6}\ {}^{m}\!/_{s}}$$

Assignment

1) /3

$\Delta E = 0.020J$

$q = 80\mu C$

$\Delta V = ?$

$$\Delta V = \frac{\Delta E}{q}$$

$$\Delta V = \frac{0.020J}{80\mu C}$$

$$\boxed{\Delta V = 250V}$$

2) /4

$V = 6500V$

$q = 3.20\times10^{-19}C$

$m = 6.65\times10^{-27}kg$

$$\Delta E_p = \Delta E_k$$

$$q\Delta V = \tfrac{1}{2}mv^2$$

$$v = \sqrt{\frac{2q\Delta V}{m}}$$

$$v = \sqrt{\frac{2(3.20\times10^{-19}C)(6500V)}{6.65\times10^{-27}kg}}$$

$$\boxed{v = 7.9\times10^5\ {}^{m}\!/_{s}}$$

3) /6

$q = 9(+1.60\times10^{-19})C = 1.44\times10^{-18}C$

$V = 0.60\times10^6V$

$m = 19(1.67\times10^{-27}kg) = 3.17\times10^{-26}kg$

$$\Delta E_p = \Delta E_k$$

$$q\Delta V = \tfrac{1}{2}mv^2$$

$$v = \sqrt{\frac{2q\Delta V}{m}}$$

$$v = \sqrt{\frac{2(1.44\times10^{-18}C)(6.0\times10^5V)}{3.173\times10^{-26}kg}}$$

$$\boxed{v = 7.4\times10^6\ {}^{m}\!/_{s}}$$

4) /4

$q = 3.20\times10^{-19}C$

$m = 6.65\times10^{-27}kg$

$v = \frac{1}{10}\times3.00\times10^8\ {}^{m}\!/_{s}$

$v = 3.00\times10^7\ {}^{m}\!/_{s}$

$$E_p = \Delta E_k$$

$$qV = \tfrac{1}{2}mv^2$$

$$V = \frac{mv^2}{2q}$$

$$V = \frac{6.65\times10^{-27}kg(3.0\times10^7\ {}^{m}\!/_{s})^2}{2(3.20\times10^{-19}C)}$$

$$\boxed{V = 9.35MV}$$

5)

$q = 1.60\times10^{-19} C$

$m = 1.67\times10^{-27} kg$

$v = 20.0\times10^{3} V$

$E_k = E_p$

$\frac{1}{2} mv^2 = qV$

$v = \sqrt{\frac{2qV}{m}}$

$v = \sqrt{\frac{2(1.6\times10^{-19} C)(20.0\times10^{3} V)}{1.67\times10^{-27} kg}}$

$v = 1.96\times10^{6} \frac{m}{s}$

$p = mv$

$p = (1.67\times10^{-27} kg)(1.96\times10^{6} \frac{m}{s})$

$\boxed{p = 3.27\times10^{-31} \frac{kg\cdot m}{s}}$

/5

6)

a) $\Delta V = 80 - 20 = 60V$

$W = qV$

$W = 3.20\times10^{-19} C(60V)$

$\boxed{W = 1.92\times10^{-17} J}$

b) $\Delta V = 100 - 60 = 40V$

$W = qV$

$E_k = \frac{1}{2} mv^2$

$v = \sqrt{\frac{2qV}{m}}$

$v = \sqrt{\frac{2(1.60\times10^{-19} C)(40V)}{9.31\times10^{-31} kg}}$

$\boxed{v = 3.7\times10^{6} \frac{m}{s}}$

c) $\Delta V = 140 - 80 = 60V$

$W = qV$

$W = 1.60\times10^{-19} C(60V)$

$\boxed{W = 9.6\times10^{-18} J}$

d) $q = 0 \quad \therefore \boxed{W = 0}$

/11

7)

$q = 1.60\times10^{-19} C$

$V = 500V$

$v = ?$

$W = qV = \frac{1}{2} mv^2$

$v = \sqrt{\frac{2qV}{m}}$

$v = \sqrt{\frac{2(1.60\times10^{-19} C)(500V)}{9.11\times10^{-31} kg}}$

$\boxed{v = 1.32\times10^{7} \frac{m}{s}}$

/3

8)

$$W = \Delta E = qV$$

$$E_{k_2} - E_{k_1} = qV$$

$$\tfrac{1}{2}mv_2^{\,2} - \tfrac{1}{2}mv_1^{\,2} = qV$$

/4

$$\tfrac{1}{2}m(v_2^{\,2} - v_1^{\,2}) = qV$$

$$V = \tfrac{1}{2}\left(\frac{m}{q}\right)(v_2^{\,2} - v_1^{\,2})$$

$$V = \tfrac{1}{2}\left(\frac{9.11\times10^{-31}kg}{1.60\times10^{-19}C}\right)\left[(1.0\times10^{6}\ {}^{m}\!/_{s})^2 - (5.0\times10^{6}\ {}^{m}\!/_{s})^2\right]$$

$$\boxed{V = 68V}$$