Solutions

Each answer shows the steps, then the **result**.

2.1

- parallel-plate capacitance, with $d = 1.0 \times 10^{-3}$ m:

$$C = \frac{\varepsilon_0 A}{d} = \frac{(8.85 \times 10^{-12}\ \mathrm{C^2\,N^{-1}\,m^{-2}})(0.020\ \mathrm{m^2})}{1.0 \times 10^{-3}\ \mathrm{m}}$$

- $C = \mathbf{1.8 \times 10^{-10}}$ F

2.2

- in parallel, capacitances add:

$$C = C_1 + C_2 = 4.0\ \mu\mathrm{F} + 4.0\ \mu\mathrm{F} = \mathbf{8.0}\ \mu\mathrm{F}$$

2.3

- energy stored in a capacitor:

$$U = \tfrac{1}{2}CV^2 = \tfrac{1}{2}(10 \times 10^{-6}\ \mathrm{F})(12\ \mathrm{V})^2$$

- $U = \mathbf{7.2 \times 10^{-4}}$ J

3.1 B

- $\dfrac{\varepsilon_0 A}{d}$.

3.2 B

- less than either one.

3.3

(a)

- charge stored:

$$Q = CV = (5.0 \times 10^{-6}\ \mathrm{F})(100\ \mathrm{V})$$

- $Q = \mathbf{5.0 \times 10^{-4}}$ C

(b)

- energy stored in a capacitor:

$$U = \tfrac{1}{2}CV^2 = \tfrac{1}{2}(5.0 \times 10^{-6}\ \mathrm{F})(100\ \mathrm{V})^2$$

- $U = \mathbf{0.025}$ J

3.4

(a)

- $C = \varepsilon_0 A/d$, so doubling d makes C **halve**

(b)

- $Q = C\Delta V$ with ΔV fixed by the battery, so Q **halves**

(c)

- $E = \Delta V/d$, so E **halves**

(d)

- $U = \frac{1}{2}C(\Delta V)^2$ with ΔV fixed, so U **halves**

3.5

- the field does work $e\Delta V$: $\frac{1}{2}m_p v^2 = e\Delta V$
- $v = \sqrt{\dfrac{2(1.6 \times 10^{-19})(500)}{1.67 \times 10^{-27}}} = \mathbf{3.1 \times 10^{5}}$ m s^{-1}

3.6 A

- with the separation small compared with the plates, the field between them is constant in magnitude and direction

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