Solutions

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

2.1

- $W = \frac{1}{2}QV = \frac{1}{2}CV^2 = Q^2/(2C)$

2.2

- $W = \frac{1}{2}CV^2$

$$W = \tfrac{1}{2}(100 \times 10^{-6}\text{ F})(12\text{ V})^2 = \mathbf{7.2 \times 10^{-3}}\text{ J}$$

2.3

- the **energy stored** in the capacitor

3.1 B

- $W = \frac{1}{2}QV$

3.2

- $W = \frac{1}{2}CV^2 \Rightarrow V = \sqrt{2W/C}$

$$V = \sqrt{\frac{2 \times 4.0 \times 10^{-3}\text{ J}}{220 \times 10^{-6}\text{ F}}} = \mathbf{6.0}\text{ V}$$

3.3

- as the capacitor charges, the p.d. rises from 0 to V
- the **average** p.d. is $V/2$, so the work done is $Q \times (V/2) = \frac{1}{2}QV$, not QV

3.4

(a) $E = \frac{1}{2}CV^2$

$$E = \tfrac{1}{2}(32 \times 10^{-6}\text{ F})(2500\text{ V})^2 = \mathbf{100}\text{ J}$$

(b) $Q = CV$

$$Q = (32 \times 10^{-6}\text{ F})(2500\text{ V}) = \mathbf{8.0 \times 10^{-2}}\text{ C}$$

(c) energy delivered $= 0.75 \times 100\text{ J} = 75\text{ J}$

$$P = \frac{E}{t} = \frac{75\text{ J}}{8.0 \times 10^{-3}\text{ s}} = \mathbf{9.4 \times 10^{3}}\text{ W}$$

(d) new energy $= \frac{1}{2}(32 \times 10^{-6}\text{ F})(1800\text{ V})^2 = 51.8\text{ J}$

$$\frac{100\text{ J} - 51.8\text{ J}}{100\text{ J}} = \mathbf{48\%}$$

- the p.d. fell by only 28%, because $E \propto V^2$, so the fractional change in energy is roughly **twice** the fractional change in p.d.

(e) charge: a **straight line through the origin**, since $Q = CV$

- energy: a **curve through the origin** getting steeper, since $E \propto V^2$
- both labelled, with axes labelled