

6(a)	series charges: $Q_s = Q_1 = Q_2$
	series p.d.s: $V_s = V_1 + V_2$
	parallel charges: $Q_s = Q_1 + Q_2$
	parallel p.d.s: $V_s = V_1 = V_2$
6(b)(i)	$E = \frac{1}{2} CV^2$
	p.d. = $[(2 \times 19 \times 10^{-3}) / (470 \times 10^{-6})]^{1/2}$ $= 9.0 \text{ V}$
6(b)(ii)	$E = Q^2 / 2C$ or $C = Q / V$
	$Q = (19 \times 10^{-3} \times 2 \times 470 \times 10^{-6})^{1/2}$
	or $Q = 470 \times 10^{-6} \times 9.0$
	$Q = 4.2 \times 10^{-3} \text{ C}$
6(b)(iii)	total charge unchanged
	total capacitance = $(470 + 180) \times 10^{-6} \text{ (F)}$
	$E = Q^2 / 2C = (4.23 \times 10^{-3})^2 / (2 \times 650 \times 10^{-6}) \text{ (= 0.014 J)}$
	$E = 14 \text{ mJ}$

4(a)	combined capacitance of parallel capacitors = $30 \text{ (}\mu\text{F)}$
	total capacitance = $(1 / 45 + 1 / 30)^{-1}$ $= 18 \text{ }\mu\text{F}$
4(b)	$E = \frac{1}{2} CV^2$
	$\Delta E = \frac{1}{2} \times 45 \times 10^{-6} (9.6^2 - 8.0^2)$ $= 6.3 \times 10^{-4} \text{ J}$
4(c)(i)	gaps in circuit closed and correct symbol for capacitor shown in parallel with load resistor
4(c)(ii)	two correct pairs of values of t and V read off from within same discharge cycle, e.g. (5.0, 4.0) and (13.0, 3.2)
	correct substitution of values of V , V_0 and Δt into $V = V_0 \exp(-\Delta t / \tau)$ e.g. $3.2 = 4.0 \exp(-8.0 / \tau)$
	$\tau = 36 \text{ ms}$
4(d)(i)	8.0 W
4(d)(ii)	4.0 W

5(a)	from graph $\ln Q = 2.9$ (so $Q = 18.2 \mu\text{C}$)
	$C = Q / V$
	$= 18.2 / 12 = 1.5 \mu\text{F}$
5(b)	gradient $= -0.25$
	gradient $= -1 / RC$
	$R = 1 / (0.25 \times 1.5 \times 10^{-6})$ $= 2.7 \times 10^6 \Omega$
	or $\frac{Q}{Q_0} = e^{-t/CR}$ or $\ln Q - \ln Q_0 = \frac{-t}{CR}$
	e.g. $\frac{4.95}{18.2} = e^{-5.2 / (1.5 \times 10^{-6} R)}$ or $1.6 - 2.9 = 5.2 / (1.5 \times 10^{-6} R)$
	$R = 2.7 \times 10^6 \Omega$
5(c)	$W = \frac{1}{2} QV$
	$= \frac{1}{2} \times 18.2 \times 10^{-6} \times 12$ $= 1.1 \times 10^{-4} \text{ J}$
	or $W = \frac{1}{2} CV^2$
	$= \frac{1}{2} \times 1.5 \times 10^{-6} \times 12^2$ $= 1.1 \times 10^{-4} \text{ J}$
	or $W = \frac{1}{2} Q^2 / C$
	$= \frac{1}{2} \times (18.2 \times 10^{-6})^2 / 1.5 \times 10^{-6}$ $= 1.1 \times 10^{-4} \text{ J}$
5(d)	straight line with different negative gradient starting from (0, 2.9)
	straight line between $t = 0$ and at least $t = 5.0\text{s}$ with twice the gradient of the original line