1) C
2) C
3) B
4)

(a) (i)	e.m.f. = energy / charge	C1	
	= $(1.6 \times 10^5) / (1.8 \times 10^4)$		
	= 8.9 V	A1	
(ii)	current = $\Delta Q / \Delta t$	C1	
	= $(1.80 \times 10^4) / (1.3 \times 10^5)$		
	= 0.14 A	A1	[4]
(b) (i)	energy $\propto R$ (or formula)	C1	
	energy = $(15 / 45) \times 1.14 \times 10^5$	C1	
	= 3.7×10^4 J	A1	
(ii)	energy dissipated in internal resistance (of battery) OR in extra resistance in circuit	B1	[4]

5)

(a)	potential difference/current	B1	**[1]**
(b) (i)	**1)** 1.13 W **2)** 1.50 V	B1	**[1]**
(ii)	power = V^2 / R or power = VI and $V = IR$	C1	
	$R = 1.50^2/1.13$		
	$= 1.99\ \Omega$	A1	**[2]**
(iii)	either $E = IR + Ir$ or voltage divided between R and r	C1	
	$I = 1.5 / 2.0$ (=0.75 A) p.d. across R = p.d. Across r = 1.5	C1	
	$3.0 = 1.5 + 0.75r$		
	$r = 2.0\ \Omega$ so $R = r = 1.99\ \Omega$	A1	**[3]**
(c)	larger p.d. across R means smaller p.d. across r	M1	
	smaller power dissipation at larger value of V	A1	
	since power is VI and I is same for R and r	A1	**[3]**

6)

(a)	both measure (energy / work) / charge	B1	
	for e.m.f., transfer of chemical energy to electrical energy	B1	
	for p.d., transfer of electrical energy to thermal energy / other forms	B1	[3]
(b) (i)	$I_1 + I_2 = I_3$	B1	[1]
(ii)	**1.** $E_2 = I_2R_2 + I_3R_3$	B1	[1]
	2. $E_1 - E_2 = I_1R_1 - I_2R_2$	B1	[1]

7)

(a) **(i)** **1** total resistance = 0.16 Ω	A1	
2 e.m.f. = *either* $(14 - E)$ *or* $(E - 14)$	A1	[2]
(ii) *either* $14 - E = 42 \times 0.16$ *or* $(E - 14) = -42 \times 0.16$	C1	
$E = 7.3$ V	A1	[2]
(b) **(i)** charge = It	C1	
$= 12.5 \times 4 \times 60 \times 60$		
$= 1.8 \times 10^5$ C	A1	[2]
(ii) *either* energy = EQ *or* energy = Eit	C1	
either energy = $14 \times 1.8 \times 10^5$ *or* energy = $14 \times 12.5 \times 4 \times 3600$		
$= 2.52 \times 10^6$ J	A1	[2]
(iii) energy = I^2Rt *or* Vit and $V = IR$	C1	
$= 12.5^2 \times 0.16 \times 4 \times 3600$		
$= 3.6 \times 10^5$ J	A1	[2]
(c) efficiency = $(2.52 \times 10^6 - 3.6 \times 10^5)/(2.52 \times 10^6)$	C1	
= 86%	A1	[2]