Answers prepared by Leong Yee Pak

Current of Electricity

19.1 Electric current
19.2 Potential difference

****1 June 03 P1 Q29 B** p.d. V = energy transferred per unit charge = W/Q

*****2 June 03 P1 Q30 C** Charge = (average I) x t OR charge = area under the graph I-t

***3 Nov 03 P1 Q29 B** p.d. = energy transferred per unit charge = W/Q

*****4 Nov 03 P1 Q30 D** Current I = Q/t. I = Ne/t. Hence N = It/e = 2.0 x(1 x 60 x60) /e

****5 June 04 P1 Q32 B** Potential difference = energy transferred per unit charge. V = W/Q

****6 June 04 P1 Q34 A** Energy = VIT. 12 = 20 I x 15

***7 Nov 04 P1 Q31 C** Potential difference = energy transferred per unit charge. Divide top and bottom by time. Energy per unit time = power, and charge per unit time = current

****8 Nov 04 P1 Q32 B** Use the formula, power P = I^2R

****9 June 05 P1 Q32 C** I = $\frac{Q}{t}$, I = $\frac{Ne}{t}$. Hence $\frac{N}{t} = \frac{I}{e}$

****10 June 06 P1 Q31 C** Refer to **June 05 P1 Q32 C** I = $\frac{Q}{t}$, I = $\frac{Ne}{t}$. Hence $\frac{N}{t} = \frac{I}{e}$

*****11 Nov 06 P1 Q31 A** I = $\frac{Q}{t}$. For 1 rotation, Charge = 4Q. For N rotation, charge = 4QN.

Hence I = $\frac{4QN}{t}$ = 4Qf

****12 June 07 P1 Q32 A** Charge Q = It

***13 Nov 07 P1 Q28 B** potential difference = energy transferred per unit charge from electrical energy to non-electrical energy

****14 Nov 07 P1 Q29 D** Power = V^2 / R. Form 2 equations.

P = $12^2 / R_X$ ………………(1) and $6^2 / R_Y$ ………………………….(2)

Equating and solve:

****15 June 08 P1 Q32 B** Use power $P = I^2R$. For cable X, $P_X = I^2R$. For cable Y, $P_Y = (½I)^2 (2R)$. Take ratio

****16 June 08 P1 Q33 A** Uses energy W = VQ. V = 12 / 100 = 0.12 V

****17 June 08 P1 Q35 C** Use W = VQ = 12 x 4 = 48 J and Q = It. 4 = 2 t

****18 Nov 08 P1 Q34 D** For each time the starter motor run, charge supply Q = It = 200 x 2.0 = 400 C. Hence number of times the motor run = $(100 \times 10^3) / 400 = 250$

****19 June 09 P1 Q30 A** I = Q/t

Section B

1 Nov 03 P2 Q7 (a)(i) use P = VI

(ii) use $P = V^2 / R$ or V = IR

(b)(i) Apply V = IR, V = 5.0 x 4.0 = 20 V

(ii) Total V = 20 +240

(iii) Use $P = I^2 R = 5.0^2 \times 4.0 = 100$ W OR P = VI = 20 x 5 = 100 W

(c) Power dissipated at heater = 1.2×10^3 W.

Power input from supply = VI = 260 x 5 = 1300 W.

Efficiency = 1200 / 1300 = 0.923

2 Nov 07 P2 Q6 (a) Use P = VI. $10.5 \times 10^3 = 230$ I. I = 45.7 A

(b)(i) p.d. drop across cable = 230 – 225 = 5 V. Use V = IR. 5 = 46 R. Max R = 0.109 Ω

(ii) Use formula $R = \frac{\rho L}{A}$ and substitute values. Take note the L = 2 x 16 m = 32 m

(c) (i) power = V^2/R. power $\propto V^2$. Ratio of power = $210^2 / 230^2$

(ii) For smaller cross-sectional area of the cable, resistance is higher. Heat dissipated per second ∝ R. For the same current flow but with a higher resistance, heat per second dissipated in the cable is high. This may cause fire hazard.

19.3 Resistance and resistivity
19.4 Sources of electromotive force

***1 June 02 P1 Q30 B**

****2 June 02 P1 Q31 C** e.m.f. = energy per unit charge supplied to the whole circuit. E.m.f. = W/Q = E/Q. Current = rate of charge flow = Q/t

***3 Nov 02 P1 Q30 C** resistance = ratio of V to I. R = V/I

****4 Nov 02 P1 Q32 A** R = V/I. At V = +1.0 V, R = 1.0 / 50 x 10^{-3}; at V = -1.0 V, R = -1.0 / 0

****5 June 03 P1 Q32 B** terminal p.d. = p.d. across the external resistor. Apply V = IR to 15 ohm resistor. 7.5 = I x 15

****6 June 04 P1 Q31 D** $R = \frac{\rho l}{A}$. Hence $\frac{V}{I} = \frac{\rho l}{A}$. Area of cross-section for P = 4 times area of cross-section for Q. Form 2 equations and solve.

****7 June 04 P1 Q33** C

**** 8 June 04 P1 Q35 D** Apply Ohm's law: V = IR

****9 Nov 04 P1 Q34 C** When V increases, the increase in I causes heat dissipated at the thermistor. Temperature rises and the resistance of the thermistor decreases. This in turn causes a higher proportion of current to flow.

****10 June 05 P1 Q33 D** Apply R = $\frac{\rho l}{A}$. When *l* increases 2 times, *A* decreases 2 times. Hence *R* increases 4 times.

****11 June 05 P1 Q34 D** Power P = VI. For the same I, P $\propto$ V. Since V or P = 2.0 V and V or Q = 4.0, power dissipated at Q = 2 times power dissipated at P.

***12 Nov 05 P1 Q32 B**

***13 Nov 05 P1 Q33 D** R $\propto l$ and R $\propto$ 1/A

*****14 Nov 05 P1 Q34 C Nov 05 P1 Q34 C** R = V/I. Ratio of V to I at C is the smallest.

****15 June 06 P1 Q32 B**

*****16 June 06 P1 Q34 C** Apply E = I(R + r). 12 = I (3.0 + 1.0). I = 4.0 A.

Apply W = I^2 R = 4^2 x 3 = 48 W

***17 Nov 06 P1 Q32 D** As temperature of filament lamp increases, its resistance increases. Hence, as V increases, I increases with a smaller proportion. Ratio of V to I increases.

*****18 Nov 06 P1 Q33 B**

***19 June 07 P1 Q31 D**

****20 June 07 P1 Q35 C** e.m.f. = energy per unit charge supplied by cell to the whole circuit. Current = charge flow per unit time.

*****21 June 07 P1 Q36 C** Terminal p.d. = e.m.f. – p.d. across internal resistance. = p.d. across external resistance

p.d. across external resistor = $\frac{4}{6}$ x 3.0. Output power = power dissipated at 4.0 Ω = V^2 / R =

*****22 June 07 P1 Q37 C** Second wire: area reduced 7 times. Resistance of each length increases 7 times. 7 lengths connected in parallel, effective R reduced 7 times.

****23 Nov 07 P1 Q30 D** Apply V = IR to find the current. Then use Q = It to find the charge.

***24 Nov 08 P1 Q33 B** As V increases, heat dissipated increases. Temperature increases and resistance increases. The increase in I is proportionally smaller than that of V.

****25 June 09 P1 Q31 D** Apply W = VQ

***26 June 09 P1Q32 A**

Section B

1 June 03 P2 Q5 (a)(i) Apply R = V/I R = $6 / 40 \times 10^{-3}$ = 150 ohm

(ii) Find R at V = 8.0 V. R = $8/ 50\times10^{-3}$ = 160 ohm. Find the difference =

(b)(i) Apply R = V/I. Select V = 10 V, 200 = 10 / I . I = 50 mA. Plot the straight line graph from origin (0, 0) joining (10, 50)

(ii) Lamp operates normally at 6.0 V. At 6 V, current = 40 mA. Draw a horizontal line at I = 40 mA. Read off p.d. across R for current flow =40 mA. Sum up p.d. across lamp and p.d. across R

2 Nov 03 P2 Q7

7 (a) (i) $P = Vi$ C1
$1200 = 240 \times i$ M1
$i = 5.0$ A A0

(ii) $V = iR$
$240 = 5.0 \times R$ C1
R = 48Ω .... A1 [4]

(b)	**(i)**	p.d. = (5.0 x 4.0 =) 20 V	A1	
	(ii)	mains voltage = (240 + 20 =) 260 V	A1	
	(iii)	*P* = (20 x 5.0 =) 100 W	A1	[3]
(c)		power input = 1200 + 100 = 1300 W	C1	
		efficiency = 1200/1300 = 0.92	A1	[2]

3 June 04 P2 Q7

7	(a)	(i)	$P = VI$	C1	
			current = 60/240 = 0.25 A	A1	
		(ii)	$R\ (= V/I) = 240/0.25$	M1	
			$= 960\ \Omega$	A0	**[3]**
	(b)		$R = \rho L/A$ *(wrong formula, 0/3)*	C1	
			$960 = (7.9 \times 10^{-7} \times L)/(\pi \times \{6.0 \times 10^{-6}\}^2)$	C1	
			$L = 0.137$ m	A1	**[3]**
			(use of $A = 2\pi r$, then allow 1/3 marks only for resistivity formula)		
	(c)		e.g. the filament must be coiled/it is long for a lamp	B1	**[1]**
			(allow any sensible comment based on candidate's answer for L)		
			Total		**[7]**

4 Nov 04 P2 Q6 (a)(i) Resistance. Reason: for an increase in V, there is larger proportion increase in I.

(ii) Resistance R = V/I = 4.0 / 2.0 x 10^{-3} = 2000 ohm

(b)(i) If V = 6.0 V, 6.0 = I x 1500. I = 4 mA. For temperature, I $\propto$ V. Hence graph is a straight line passing through the origin. Draw a straight line passing through (0, 0) and (6, 4)

(ii) Resistor *R* and component C are connected in parallel. Hence the p.d. across them are the same. At V = 2.0 V, draw a vertical straight line to cut both lines. Read off the current I_R in resistor and the current I_C in component C. Current supplied by battery = $I_R + I_C$

(c) For series connection, the currents passing through both components are the same. Imagine that you to draw a line vertically upwards at V = 7.0 V, resistance for component C is larger than resistance for resistor. Apply heat dissipated per second = I^2R. For the same I, and $R_C > R_R$. Hence heat dissipated at C is larger.

5 June 05 P2 Q7 (a) Resistance = ratio of p.d. to the current flow

(b) (i) 1. max P = 1.13 W

2. V = 1.5 V

(ii) Use formula $P = V^2/R$. $1.13 = 1.5^2 / R$. R = 1.99 ohm

(iii) Apply V= IR. I = 0.7538 A. p.d. across internal resistance = 3.0 – 1.5 = 1.5 V. Apply V = Ir and find r.

OR Since current passing through R = current passing through the internal resistor, and p.d. across them are equal, their resistance are equal. Hence internal resistance = 1.99 ohm.

(c) p.d. across the internal resistance = 3.00 - V_R. When p.d. across R is higher, p.d. across internal resistance is lower and vice versa. Power $P = V^2 / r$. For P less, V_r is less. Hence p.d. across R is higher, which is 1.9 V.

6 Nov 06 P2 Q6 (a)(i) $R = \frac{\rho L}{A}$

(ii) $R = \frac{\rho L}{A}$ ....(1)

For A constant, $\Delta R = \frac{\rho}{A} \Delta L$ ………………….(2)

Equation (2) divided by (1): $\frac{\Delta R}{R} = \frac{\Delta L}{L}$ = strain, ε

(b) Young Modulus E = stress / strain. $E = \frac{F}{A}\frac{1}{\varepsilon}$ $. \varepsilon = \frac{F}{AE}$ =

Substitute into equation in (a)(ii) above, $\frac{\Delta R}{R} = \varepsilon$

7 June 07 P2 Q6 (a)(i) 1. Total R = 0.10 + 0.060 = 0.160 Ω

2. Total e.m.f. = 14 – E

(ii) Apply E = IR OR Kirchhoff's 2nd law: (14 – E) = 42 x 0.160. E = 7.28 V

(b) (i) Charge Q = It = 12.5 x (4.0 x 60 x 60) = 180000 C

(ii) Energy supplied by charger = VQ = 14 x 180000 J = 2.52×10^6 J

(iii) Energy dissipated in resistance = I^2Rt. Total energy dissipated in the internal resistance = $12.5^2 \times 0.160 \times (4.0 \times 60 \times 60) = 3.60 \times 10^5$ J

(c) Energy stored in battery = energy supplied by charger - energy dissipated at the internal resistance. Efficiency = (energy stored in battery / energy supplied by charger) x 100%