

Q1.

5	(a)	the (value of the) direct current that dissipates (heat) energy at the same rate (in a resistor) <i>allow 'same power' and 'same heating effect'</i>	M1 A1	[2]
	(b)	$\sqrt{2}I_{rms} = I_0$	B1	[1]
	(c)	(i) power $\propto I^2$ or $P = I^2R$ or $P = VI$ ratio = 2.0 (allow 1 s.f.)	C1 A1	[2]
		(ii) advantage: e.g. easy to change the voltage disadvantage: e.g. cables require greater insulation rectification – with some justification	B1	[2]
	(d)	(i) 3.0 A (allow 1 s.f.) (ii) 3.0 A (allow 1 s.f.)	A1 A1	[2]
			Total	[9]

Q2.

4	(a)	r.m.s. output = $9/\sqrt{2}$ or peak input = $230\sqrt{2}$ $N_S/N_P = V_S/V_P$ $N_S = 138 \rightarrow 140$ turns	C1 C1 A1	[3]
	(b)	(i) four diodes correctly positioned regardless of output polarity giving correct output polarity (<i>all 'point to left'</i>)	M1 A1	[2]
		(ii) capacitor shown in parallel with R	B1	[1]
	(c)	(i) time t_1 to time t_2	B1	[1]
		(ii) sketch: same peak values ripple reduced and reasonable shape	M1 A1	[2]

Q3.

6	(a)	all four diodes correct to give output, regardless of polarity connected for correct polarity	M1 A1	[2]
	(b)	$N_S / N_P = V_S / V_P$ $V_0 = \sqrt{2} \times V_{rms}$ ratio = $9.0 / (\sqrt{2} \times 240)$ = 1/38 or 1/37 or 0.027	C1 C1 A1	[3]

Q4.

7	(a) <i>either</i> the value of steady / constant voltage that produces same power (in a resistor) as the alternating voltage <i>or</i> if alternating voltage is squared and averaged the r.m.s. value is the square root of this averaged value	M1 A1 (M1) (A1)	[2]
	(b) (i) 220 V	A1	[1]
	(ii) 156 V	A1	[1]
	(iii) 60 Hz	A1	[1]
	(c) power = V_{rms}^2 / R $R = 156^2 / 1500$ $= 16 \Omega$	C1 A1	[2]

Q5.

6	(a) (i) to concentrate the (magnetic) flux / reduce flux losses	B1	[1]
	(ii) changing flux (in core) induces current in core currents in core give rise to a heating effect	M1 A1	[2]
	(b) (i) e.m.f. induced proportional to rate of change of (magnetic) flux (linkage)	M1 A1	[2]
	(ii) magnetic flux in phase with / proportional to e.m.f. / current in primary coil e.m.f. / p.d. across secondary proportional to rate of change of flux so e.m.f. of supply not in phase with p.d. across secondary	M1 M1 A0	[2]
	(c) (i) for same power (transmission), high voltage with low current with low current, less energy losses in transmission cables	B1 B1	[2]
	(ii) voltage is easily / efficiently changed	B1	[1]

Q6.

6	(a) (i) $2\pi f = 380$ frequency = 60 Hz	C1 A1	[2]
	(ii) $I_{RMS} \times \sqrt{2} = I_0$ $I_{RMS} = 9.9 / \sqrt{2}$ $= 7.0 \text{ A}$	C1 A1	[2]
	(b) power = $I^2 R$ $R = 400 / 7.0^2$ $= 8.2 \Omega$	C1 A1	[2]

Q7.

6 (a) (i)	peak voltage = 4.0 V	A1	[1]
(ii)	r.m.s. voltage (= $4.0/\sqrt{2}$) = 2.8 V	A1	[1]
(iii)	period $T = 20$ ms	M1	
	frequency = $1 / (20 \times 10^{-3})$	M1	
	frequency = 50 Hz	A0	[2]
(b) (i)	change = $4.0 - 2.4 = 1.6$ V	A1	[1]
(ii)	$\Delta Q = C\Delta V$ or $Q = CV$	C1	
	= $5.0 \times 10^{-6} \times 1.6 = 8.0 \times 10^{-6}$ C	A1	[2]
(iii)	discharge time = 7 ms	C1	
	current = $(8.0 \times 10^{-6}) / (7.0 \times 10^{-3})$	M1	
	= $1.1(4) \times 10^{-3}$ A	A0	[2]
(c)	average p.d. = 3.2 V	C1	
	resistance = $3.2 / (1.1 \times 10^{-3})$		
	= 2900Ω (allow 2800Ω)	A1	[2]

Q8.

6 (a) (i)	to reduce power loss in the core due to eddy currents/induced currents	B1 B1	[2]
(ii)	<i>either</i> no power loss in transformer <i>or</i> input power = output power	B1	[1]
(b) <i>either</i>	r.m.s. voltage across load = $9.0 \times (8100 / 300)$	C1	
	peak voltage across load = $\sqrt{2} \times 243$		
	= 340 V	A1	[2]
<i>or</i>	peak voltage across primary coil = $9.0 \times \sqrt{2}$	(C1)	
	peak voltage across load = $12.7 \times (8100/300)$		
	= 340 V	(A1)	

Q9.

- 6 (a) (induced) e.m.f. proportional to rate
of change of (magnetic) flux (linkage) M1
A1 [2]
- (b) (i) positive terminal identified (upper connection to load) B1 [1]
- (ii) $V_P = \sqrt{2} \times V_{RMS}$
ratio = $240 \sqrt{2} / 9$
= 38 C1
C1
A1 [3]
($V_P = V_{RMS} / \sqrt{2}$ gives ratio = 18.9 and scores 1/3)
(ratio = $240 / 9 = 26.7$ scores 1/3)
(ratio = $9 / (240 / \sqrt{2}) = 0.0265$ is inverted ratio and scores 1/3)
- (c) (i) e.g. (output) p.d. / voltage / current does not fall to zero
e.g. range of (output) p.d. / voltage / current is reduced (*any sensible answer*) B1 [1]
- (ii) sketch: same peak value at start of discharge M1
correct shape between one peak and the next A1 [2]

Q10.

- 4 (a) single diode.....M1
in series with R OR in series with a.c. supply..... A1 [2]
- (b) (i)1 5.4 V (allow ± 0.1 V)..... A1
- (i)2 $V = iR$
 $I = 5.4 / 1.5 \times 10^3$ C1
 $= 3.6 \times 10^{-3}$ A..... A1
- (i)3 time = 0.027 s A1 [4]
- (ii)1 $Q = it$
 $= 3.6 \times 10^{-3} \times 0.027$ C1
 $= 9.72 \times 10^{-5}$ C..... A1
- (ii)2 $C = \Delta Q / \Delta V$ (allow C – Q/V for this mark) C1
 $= (9.72 \times 10^{-5}) / 1.2$
 $= 8.1 \times 10^{-5}$ F A1 [4]
- (c) line: reasonable shape with less ripple..... B1 [1]

Q11.

- 6 (a) (i) peak voltage = $6\sqrt{2}$
peak voltage = 8.48 V C1
A1 [2]
- (ii) zero because *either* no current in circuit (and $V = IR$)
or all p.d. across diode B1 [1]
- (b) waveform: half-wave rectification B1
peak height at about 4.25 cm B1
half-period spacing of 2.0 cm B1 [3]
(allow $\pm 1/4$ square for height and half-period)
- (c) (i) capacitor shown in parallel with resistor B1 [1]
- (ii) *either* energy = $\frac{1}{2}CV^2$ or = $\frac{1}{2}QV$ and $Q = CV$ C1
= $\frac{1}{2} \times 180 \times 10^{-6} \times (6\sqrt{2})^2$ C1
= 6.48×10^{-3} J A1 [3]
- (iii) *either* fraction = 0.43^2 or final energy = 1.2 mJ C1
fraction = 0.18 A1 [2]

Q12.

- 6 (a) (i) *either* prevent loss of magnetic flux
or improves flux linkage with secondary B1 [1]
- (ii) reduces eddy current (losses) B1
reduces losses of energy (in core) B1 [2]
- (b) (i) (induced) e.m.f. proportional to / equal to
rate of change of (magnetic) flux (linkage) M1
A1 [2]
- (ii) changing current in primary gives rise to (1)
changing flux in core (1)
flux links with the secondary coil (1)
changing flux in secondary coil, inducing e.m.f. (1)

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Page 4	Mark Scheme	Syllabus	Paper
	GCE A/AS LEVEL – October/November 2008	9702	04

- (any three, 1 each to max 3) B3 [3]
- (c) e.g. can change voltage easily / efficiently
high voltage transmission reduces power losses
(any two sensible suggestions, 1 each) B2 [2]

Q13.

- 7 (a) e.g. more (output) power available
 e.g. less ripple for same smoothing capacitor
any sensible suggestion B1 [1]
- (b) (i) curve showing half-wave rectification B1 [1]
 (ii) similar to (i) but phase shift of 180° B1 [1]
- (c) (i) correct symbol, connected in parallel with R B1 [1]
 (ii) 1 larger capacitor / second capacitor in parallel with R B1 [1]
 (not increase R)
 2 same peak values B1
 correct shape giving less ripple B1 [2]

[Total: 7]

Q14.

- 6 (a) (i) e.g. prevent flux losses / improve flux linkage B1 [1]
 (ii) flux in core is changing B1
 e.m.f. / current (induced) in core B1
 induced current in core causes heating B1 [3]
- (b) (i) that value of the direct current producing same (mean) power / heating
 in a resistor M1
 A1 [2]
- (ii) power in primary = power in secondary M1
 $V_P I_P = V_S I_S$ A1 [2]

Q15.

- 6 (a) power / heating depends on I^2
 so independent of current direction M1
 A1 [2]
- (b) *either* maximum power = $I_0^2 R$ or average power = $I_{RMS}^2 R$ M1
 $I_0 = \sqrt{2} \times I_{RMS}$ M1
 maximum power = 2 × average power
 ratio = 0.5 A1 [3]

Q16.

- 6 (a) (i) period = $1/50$
 $t_1 = 0.03 \text{ s}$ C1
A1 [2]
- (ii) peak voltage = 17.0 V A1 [1]
- (iii) r.m.s. voltage = $17.0/\sqrt{2}$
= 12.0 V A1 [1]
- (iv) mean voltage = 0 A1 [1]
- (b) power = V^2/R C1
= $12^2/2.4$
= 60 W A1 [2]

Q17.

- 5 (a) supply connected correctly (to left & right)
load connected correctly (to top & bottom) B1
B1 [2]
- (b) e.g. power supplied on every half-cycle
greater average/mean power
(any sensible suggestion, 1 mark) B1 [1]
- (c) (i) reduction in the variation of the output voltage/current B1 [1]
- (ii) larger capacitance produces more smoothing
either product RC larger
or for the same load M1
A1 [2]

Q18.

- 6 (a) (i) connection to 'top' of resistor labelled as positive B1 [1]
- (ii) diode B and diode D B1 [1]
- (b) (i) $V_p = 4.0 \text{ V}$ C1
mean power = $V_p^2/2R$ C1
= $4^2 / (2 \times 2700)$
= $2.96 \times 10^{-3} \text{ W}$ A1 [3]
- (ii) capacitor, correct symbol, connected in parallel with R B1 [1]
- (c) graph: half-wave rectification M1
same period and same peak value A1 [2]

Q19.

- 7 (a) (i) *either* heating effect in a resistor \propto (current)² B1
square of value of an alternating current is always positive B1
so heating effect A0
or current moves in opposite directions in resistor during half-cycles (B1)
heating effect is independent of direction (B1) [2]
- (ii) that value of the direct current M1
producing the same heating effect (as the alternating current) in a resistor A1 [2]
- (b) (i) induced e.m.f. proportional to the rate M1
of change of (magnetic) flux (linkage) A1 [2]
- (ii) flux in core is in phase with current in the primary coil B1
(induced) e.m.f. in secondary because coil cuts the flux B1
flux and rate of change of flux are not in phase B1 [3]

