CAMBRIDGE INTERNATIONAL AS & A LEVEL PHYSICS · 9702

PHYSICS



MARK SCHEME

21 ALTERNATING CURRENTS

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315. 9702_w16_MS_43 Q: 9

(a) (induced) e.m.f. proportional to rate M1
of change of (magnetic) flux (linkage) A1 [2]

(b) flux linkage $= BAN$

$= \pi \times 10^{-3} \times 2.8 \times \pi \times (1.6 \times 10^{-2})^2 \times 85 = 6.0 \times 10^{-4}$ Wb B1 [1]

(c) e.m.f. $= \Delta N\Phi / \Delta t$

$= (6.0 \times 10^{-4} \times 2) / 0.30$ C1

$= 4.0\,\text{mV}$ A1 [2]

(d) sketch: $E = 0$ for $t = 0 \rightarrow 0.3\,\text{s}$, $0.6\,\text{s} \rightarrow 1.0\,\text{s}$, $1.6\,\text{s} \rightarrow 2.0\,\text{s}$ B1

$E = 4$ mV for $t = 0.3\,\text{s} \rightarrow 0.6\,\text{s}$ (either polarity) B1

$E = 2$ mV for $t = 1.0\,\text{s} \rightarrow 1.6\,\text{s}$ B1

with opposite polarity B1 [4]

316. 9702_s21_MS_42 Q: 10

	Answer	Marks
(a)	the steady current **or** the direct current	**M1**
	that produces the same heating effect (as the alternating current)	**A1**
(b)(i)	peak current = 2.6 A **and** r.m.s. current = 1.8 A	**A1**
(b)(ii)	peak current = 2.0 A **and** r.m.s. current = 2.0 A	**A1**
(c)(i)	$k = 2\pi f$	**C1**
	$= 2\pi \times 50$ $= 310\,\text{rad s}^{-1}$	**A1**
(c)(ii)	power $= V_{RMS}^2 / R$ **or** power $= V_0^2 / 2R$	**C1**
	$R = (240 / \sqrt{2})^2 / 3200$ **or** $R = 240^2 / (2 \times 3200)$ $R = 9.0\,\Omega$	**A1**

317. 9702_w21_MS_41 Q: 9

	Answer	Marks
(a)	constant voltage	M1
	that produces/dissipates same power as (the mean power of) the alternating voltage	A1
(b)(i)	(maximum) rate of cutting of (magnetic) flux doubles	B1
	(peak and hence) r.m.s. induced e.m.f. doubles	B1
(b)(ii)	sketch: (sinusoidal) wave of period 10 ms	B1
	peak *E* shown as ± 34 V (*1 mark out of 2 awarded if peak E shown as* ± 17 V *or* ± 24 V)	B2
(c)	current in the coil results in forces that oppose its rotation **or** current in the resistor dissipates the energy of rotation	B1
	coil stops rotating	B1

318. 9702_w21_MS_43 Q: 9

	Answer	Marks
(a)	constant voltage	M1
	that produces/dissipates same power as (the mean power of) the alternating voltage	A1
(b)(i)	(maximum) rate of cutting of (magnetic) flux doubles	B1
	(peak and hence) r.m.s. induced e.m.f. doubles	B1
(b)(ii)	sketch: (sinusoidal) wave of period 10 ms	B1
	peak *E* shown as ± 34 V (*1 mark out of 2 awarded if peak E shown as* ± 17 V *or* ± 24 V)	B2
(c)	current in the coil results in forces that oppose its rotation **or** current in the resistor dissipates the energy of rotation	B1
	coil stops rotating	B1

319. 9702_m19_MS_42 Q: 8

	Answer	Marks
(a)(i)	*Either* Newton's third law *or* equal and opposite forces	B1
	force on magnet is upwards	B1
	so force on wire downwards	B1
(a)(ii)	using (Fleming's) left-hand rule	M1
	current from B to A	A1
(b)	sinusoidal wave with at least 1 cycle	B1
	peaks at +6.4 mN and –6.4 mN	B1
	time period 25 ms	B1

320. 9702_w19_MS_42 Q: 11

	Answer	Marks
(a)	(induced) e.m.f. proportional to rate	**M1**
	of change of (magnetic) flux (linkage)	**A1**
(b)(i)	any two from t_1, t_3, t_5, t_7	**A1**
(b)(ii)	t_2 **and** t_4 **or** t_4 **and** t_6	**A1**
(c)	e.m.f. = $N\Delta\Phi / \Delta t$	**C1**
	= $(2 \times 9.4 \times 10^{-4} \times 5.0 \times \pi \times (1.8 \times 10^{-2})^2 \times 63) / (6.0 \times 10^{-3})$	**C1**
	= 0.10 V	**A1**

321. 9702_w17_MS_41 Q: 10

	Answer	Marks
(a)	heating depends on current^2/I^2	**B1**
	and current^2/I^2 is always positive	**B1**
	or	
	a.c. changes direction (every half cycle)	**(B1)**
	but heating effect is independent of current direction	**(B1)**
	or	
	voltage and current are always in phase in a resistor	**(B1)**
	so $V \times I$ is always positive	**(B1)**
	or	
	sketch graph drawn showing power against time	**(B1)**
	comment that power is always positive	**(B1)**
(b)(i)	for same power (transmission, higher voltage) → lower current	**B1**
	lower current → less power loss in (transmission) cables	**B1**
(b)(ii)	• voltage can be (easily) stepped up/down • transformers only work with a.c. • generators produce a.c. • easier to rectify than invert *Two sensible suggestions, 1 mark each.*	**B2**

322. 9702_w17_MS_43 Q: 10

	Answer	Marks
(a)	heating depends on current^2/I^2	B1
	and current^2/I^2 is always positive	B1
	or	
	a.c. changes direction (every half cycle)	(B1)
	but heating effect is independent of current direction	(B1)
	or	
	voltage and current are always in phase in a resistor	(B1)
	so $V \times I$ is always positive	(B1)
	or	
	sketch graph drawn showing power against time	(B1)
	comment that power is always positive	(B1)
(b)(i)	for same power (transmission, higher voltage) → lower current	B1
	lower current → less power loss in (transmission) cables	B1
(b)(ii)	• voltage can be (easily) stepped up/down • transformers only work with a.c. • generators produce a.c. • easier to rectify than invert *Two sensible suggestions, 1 mark each.*	B2

323. 9702_m16_MS_42 Q: 3

(a) the (thermal) energy per unit mass to raise the temperature of a substance by one degree — M1 A1 [2]

(*If ratio not clear for M1 mark, allow 1/2 marks for an otherwise correct answer*)

(b) (i) to allow for / determine / cancel heat transfer to / from tube / surroundings — B1 [1]

(*do not allow 'to stop / prevent' heat loss*)

(ii) *either* $P = mc\Delta\theta \pm$ h
or $44.9 = 1.58 \times 10^{-3} \times c \times (25.5 - 19.5) \pm$ h
or $33.3 = 1.11 \times 10^{-3} \times c \times (25.5 - 19.5) \pm$ h — B1
$(44.9 - 33.3) = (1.58 - 1.11) \times 10^{-3} \times c \times (25.5 - 19.5)$ — C1
$c = 4100\ (4110)\ \text{J kg}^{-1}\text{K}^{-1}$ — A1 [3]

(*allow 1/3 for use of only 33.3 W, 1.11 g s^{-1} leading to 5000 J kg^{-1} K^{-1}*)
(*allow 1/3 for use of only 44.9 W, 1.58 g s^{-1} leading to 4740 J kg^{-1} K^{-1}*)

(c) $V_0 = 27$ *or* $V_{rms} = 19.1$ — C1
$33.3 = 27^2/2R$ *or* $33.3 = 19.1^2/R$ — C1
$R = 11\ \Omega$ — A1 [3]

324. 9702_w21_MS_42 Q: 10

	Answer	Marks
(a)(i)	to increase the magnetic flux linkage (between the coils)	B1
(a)(ii)	to reduce energy losses	B1
	by reducing induced currents	B1
(b)(i)	maximum V_{OUT} = 12 000 × (625 / 25 000) = 300 V	A1
(b)(ii)	r.m.s. current = 300 / (640 × √2) = 0.33 A	A1
(b)(iii)	sketch: sinusoidal shape in positive half of the graph, sitting with 'minima' resting on the time-axis (at P = 0)	B1
	each 'cycle' shown repeating every 20 ms	B1
	maximum P shown as 140 W	B1
(c)	power curve is symmetrical about the midpoint (on the power axis)	B1
	mean power is half the peak power	B1

325. 9702_m20_MS_42 Q: 9

	Answer	Marks
(a)(i)	9.0 / √2 = **6.4** V	A1
(a)(ii)	ω = 20 ω = 2π / T T = 2π / 20	C1
	T = **0.31** s	A1
(b)	the r.m.s. voltages are different, so no	B1
(c)(i)	P= $V_{r.m.s.} \times I_{r.m.s.}$	C1
	= 120 × 0.64 = 76.8 W	C1
	efficiency = (76.8 / 80) × 100 = **0.96** or **96** %	A1
(c)(ii)	Any one from: • heat losses due to resistance of windings / coils • heat losses in magnetising and demagnetising core / hysteresis losses in core • heat losses due to eddy currents in (iron) core • loss of flux linkage	B1

326. 9702_s20_MS_42 Q: 10

	Answer	Marks
(a)	(induced) electromotive force is proportional to rate	M1
	of change of (magnetic) flux (linkage)	A1
(b)(i)	to change magnitude of potential difference	B1
(b)(ii)	magnitude of e.m.f. varies as rate of change of flux changes	B1
	direction of e.m.f. changes when direction of change of flux reverses/when flux changes from increasing to decreasing	B1
	flux is continuously increasing and decreasing, so polarity of e.m.f. is continuously switching	B1
(b)(iii)	to reduce energy/power losses **or** to reduce eddy currents	B1

327. 9702_s19_MS_42 Q: 10

	Answer	Marks
(a)	(induced) e.m.f. proportional to rate	M1
	of change of (magnetic) flux (linkage)	A1
(b)	current in primary coil gives rise to magnetic flux	B1
	changing (magnetic) flux in core links with secondary coil	B1
	induced e.m.f. (in secondary coil) causes current in load/resistor	B1
(c)	correct application of turns ratio: to peak voltage ratio, giving (V_0 / 220) = (450 / 2700) **or** to r.m.s. voltage ratio, giving ($V_{r.m.s.}$ / 156) = (450 / 2700)	C1
	correct application of √2 factor: to peak applied e.m.f., giving 220 / √2 **or** to peak output em.f., giving 37 / √2	C1
	$V_{r.m.s.}$ = 26 V	A1

328. 9702_m17_MS_42 Q: 9

	Answer	Marks
(a)(i)	increase flux linkage (with secondary coil) / to reduce flux loss	B1
(a)(ii)	e.m.f. (induced only) when flux (in core/coil) is changing	B1
	constant / direct voltage gives constant flux / field	B1
(b)(i)	N_S / N_P = V_S / V_P	C1
	N_S = (52 / 150) × 1200 = 416 turns	A1
(b)(ii)	0 ms or 7.5 ms or 15.0 ms or 22.5 ms	A1
(c)(i)	*either*	
	mean power = V^2 / 2R and V = 52 (V)	C1
	R = 52^2 / (2 × 1.2) = 1100 (1127) Ω	A1
	or	
	mean power = V^2 / R and V = 52 / √2 (= 36.8 V)	(C1)
	R = 36.8^2 / 1.2 = 1100 Ω	(A1)
(c)(ii)	sinusoidal shape with troughs at zero power	B1
	only 3 ‘cycles’	B1
	each ‘cycle’ is 2.4 W high and zero power at correct times	B1

329. 9702_s17_MS_41 Q: 9

	Answer	Marks
(a)(i)	core reduces loss of (magnetic) flux linkage/improves flux linkage	B1
(a)(ii)	reduces (size of eddy) currents in core	B1
	(so that) heating of core is reduced	B1
(b)	alternating voltage gives rise to changing magnetic flux in core	M1
	(changing) flux links the secondary coil	A1
	induced e.m.f. (in secondary) only when flux is changing/cut	B1

330. 9702_s17_MS_43 Q: 9

	Answer	Marks
(a)(i)	core reduces loss of (magnetic) flux linkage/improves flux linkage	**B1**
(a)(ii)	reduces (size of eddy) currents in core	**B1**
	(so that) heating of core is reduced	**B1**
(b)	alternating voltage gives rise to changing magnetic flux in core	**M1**
	(changing) flux links the secondary coil	**A1**
	induced e.m.f. (in secondary) only when flux is changing/cut	**B1**

331. 9702_w16_MS_42 Q: 11

(a) (induced) e.m.f. proportional/equal to rate M1
of change of (magnetic) flux (linkage) A1 [2]

(b) (for same current) iron core gives large(r) (rates of change of) flux (linkage) B1
e.m.f induced in solenoid is greater (for same current) M1
induced e.m.f. opposes applied e.m.f. so current smaller/acts to reduce current A1 [3]

or

same supply so same induced e.m.f. balancing it (B1)
(rate of change of) flux linkage is same (M1)
smaller current for same flux when core present (A1)

e.g. (heating due to) eddy currents in core

(heating due to current in) resistance of coils

hysteresis losses/losses due to changing magnetic field in core

Any two of the above marking points, 1 mark each B2 [2]

332. 9702_m21_MS_42 Q: 10

	Answer	Marks
(a)	**230** V	**A1**
(b)	$\omega = 100\pi$ $T = \frac{2\pi}{\omega} = \frac{2\pi}{100\pi}$	**C1**
	$= 0.020\,s$	**A1**
(c)(i)	half-wave (rectification)	**B1**
(c)(ii)	sinusoidal half waves in positive V only or negative V only, peak at 320 V	**B1**
	line at zero for second half of cycle	**B1**
	two time periods shown, each of 0.020 s	**B1**
(c)(iii)	capacitor added in parallel with resistor	**B1**

333. 9702_s19_MS_41 Q: 10

	Answer	Marks
(a)	V_{MAX} = 15 V	A1
(b)	210 = 2π / T	C1
	T = 0.0299 s	C1
	($t_2 - t_1$) = 0.060 s	A1

334. 9702_s19_MS_43 Q: 10

	Answer	Marks
(a)	V_{MAX} = 15 V	A1
(b)	210 = 2π / T	C1
	T = 0.0299 s	C1
	($t_2 - t_1$) = 0.060 s	A1

335. 9702_w19_MS_41 Q: 10

	Answer	Marks
(a)(i)	lower right **and** upper left diodes circled	B1
(a)(ii)	maximum = 7.0√2 = 9.9 V	A1
(b)(i)	correct symbol for capacitor, shown connected in parallel with R	B1
(b)(ii)	**1.** (ripple) decreases	B1
	2. (ripple) increases	B1

336. 9702_w19_MS_43 Q: 10

	Answer	Marks
(a)(i)	lower right **and** upper left diodes circled	B1
(a)(ii)	maximum = 7.0√2 = 9.9 V	A1
(b)(i)	correct symbol for capacitor, shown connected in parallel with R	B1
(b)(ii)	**1.** (ripple) decreases	B1
	2. (ripple) increases	B1

337. 9702_w17_MS_42 Q: 11

	Answer	Marks
(a)(i)	circles drawn only around the top left and bottom right diodes	B1
(a)(ii)	B shown as (+)ve and A shown as (–)ve	B1
(b)(i)	$V_{r.m.s.}$ (= 5.6 / √2) = 4.0 V	A1
(b)(ii)	380 = 2π*f* **or** *f* = 60.5 Hz	C1
	number (= 2*f*) = 120	A1
(c)(i)	peak values (all) unchanged	B1
	(all) minima shown at 4.0 V	B1
	three lines from near peak showing concave curves after leaving dotted line not 'kinked' and not cutting the peak reaching candidate's minimum at the point where the decay meets the next dotted line	B1
	three lines drawn along the dotted lines showing rise in voltage from minima back to peak values	B1
(c)(ii)	mean p.d. is higher **or** r.m.s. p.d. is higher **or** capacitor supplies energy to resistor	M1
	so (mean) power increases	A1

338. 9702_s21_MS_41 Q: 12

	Answer	Marks
(a)	• frequency determines energy of photon • intensity determines number of photons (per unit time) • intensity does not determine energy of a photon *Any two points, 1 mark each*	B2
	kinetic energy (of the electron) depends on the energy of one photon	B1
(b)(i)	$E = hc / \lambda$ **or** $E = hf$ **and** $c = f\lambda$	C1
	$E = (6.63 \times 10^{-34} \times 3.00 \times 10^{8}) / (250 \times 10^{-9})$	C1
	$(= 7.96 \times 10^{-19}$ J) = 5.0 eV	A1
(b)(ii)	E_{MAX} = photon energy – work function	C1
	work function = 5.0 – 1.4 = 3.6 eV	A1

Q1.

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

Q2.

4	(a)		r.m.s. output = $9/\sqrt{2}$ or peak input = $230\sqrt{2}$	C1	
			$N_S/N_P = V_S/V_P$	C1	
			$N_S = 138 \rightarrow 140$ turns	A1	[3]
	(b)	(i)	four diodes correctly positioned regardless of output polarity	M1	
			giving correct output polarity (*all 'point to left'*)	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	M1	
			ripple reduced and reasonable shape	A1	[2]

Q3.

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

Q4.

7	(a)	*either*	the value of steady / constant voltage	M1	
			that produces same power (in a resistor) as the alternating voltage	A1	[2]
		or	if alternating voltage is squared and averaged	(M1)	
			the r.m.s. value is the square root of this averaged value	(A1)	
	(b)	(i)	220 V	A1	[1]
		(ii)	156 V	A1	[1]
		(iii)	60 Hz	A1	[1]
	(c)		power = V_{rms}^2 / R	C1	
			$R = 156^2 / 1500$		
			= 16 Ω	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	M1	
			currents in core give rise to a heating effect	A1	[2]
	(b)	(i)	e.m.f. induced proportional to	M1	
			rate of change of (magnetic) flux (linkage)	A1	[2]
		(ii)	magnetic flux in phase with / proportional to e.m.f. / current in primary coil	M1	
			e.m.f. / p.d. across secondary proportional to rate of change of flux	M1	
			so e.m.f. of supply not in phase with p.d. across secondary	A0	[2]
	(c)	(i)	for same power (transmission), high voltage with low current	B1	
			with low current, less energy losses in transmission cables	B1	[2]
		(ii)	voltage is easily / efficiently changed	B1	[1]

Q6.

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

Q7.

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

Q8.

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

Q9.

6 (a) (induced) e.m.f. proportional to rate M1
of change of (magnetic) flux (linkage) A1 [2]

(b) (i) positive terminal identified (upper connection to load) B1 [1]

(ii) $V_P = \sqrt{2} \times V_{RMS}$ C1
ratio = $240\sqrt{2} / 9$ C1
= 38 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 = $6\sqrt{2}$		C1	
		peak voltage = 8.48 V		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 ±¼ 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	
		= ½ x 180 x 10^{-6} x $(6\sqrt{2})^2$		C1	
		= 6.48 x 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		M1	
		rate of change of (magnetic) flux (linkage)		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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	(*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 M1
so independent of current direction 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	C1		
		t_1 = 0.03 s	A1	[2]	
	(ii)	peak voltage = 17.0 V	A1	[1]	
	(iii)	r.m.s. voltage = 17.0/√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)	B1		
		load connected correctly (to top & bottom)	B1	[2]	
	(b)	e.g. power supplied on every half-cycle			
		greater <u>average/mean</u> 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	M1		
		either product *RC* larger			
		or for the same load	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 V	C1		
		mean power = $V_P^2/2R$	C1		
		= 4^2 / (2 × 2700)			
		= 2.96×10^{-3} 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]