Rectification

Mark Scheme

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Alternating Currents
Sub Topic	Rectification
Paper Type	Theory
Booklet	Mark Scheme

Time Allowed: **90 minutes**

Score: **/75**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** (induced) e.m.f. <u>proportional to rate</u> M1
of change of (magnetic) flux (linkage) A1 [2]

(b) 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) 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]

2 **(a) (i)** connection to 'top' of resistor labelled as positive B1 [1]

(ii) diode B and diode D B1 [1]

(b) (i) $V_P = 4.0\,V$ C
mean power = $V_P^2/2R$ C1
$= 4^2 / (2 \times 2700)$
$= 2.96 \times 10^{-3}\,W$ A [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]

3	**(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	M1	
			frequency = 1 / (20 × 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 × 10^{-6} × 1.6 = 8.0 × 10^{-6} C	A1	[2]
		(iii)	discharge time = 7 ms	C1	
			current = (8.0 × 10^{-6}) / (7.0 × 10^{-3})	M1	
			= 1.1(4) × 10^{-3} A	A0	[2]
	(c)		average p.d. = 3.2 V	C1	
			resistance = 3.2 / (1.1 × 10^{-3})		
			= 2900 Ω *(allow 2800 Ω)*	A1	[2]

4	**(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]

5 **(a** e.g. more (output) power available
e.g. less ripple for same smoothing capacit
any sensible suggestion ..... B1 [1

(b) (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) 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]

6 (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]

7 **(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) $V = iR$
$I = 5.4/1.5 \times 10^{3}$ C1
$= 3.6 \times 10^{-3}$ A A1

(i) time = 0.027 s ..... A1 [4]

(ii) $Q = it$
$= 3.6 \times 10^{-3} \times 0.027$ C1
$= 9.72 \times 10^{-5}$ C A1

(ii) $C = \Delta Q/\Delta V$ (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]

8 **(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]

9 **(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
$= \frac{1}{2} \times 180 \times 10^{-6} \times (6\sqrt{2})^2$ C1
$= 6.48 \times 10^{-3}$ J A1 [3]

(iii) *either* fraction = 0.43^2 or final energy = 1.2 mJ C1
fraction = 0.18 A1 [2]