

Electronics

Advanced GCE **A2 7826**

Advanced Subsidiary GCE **AS 3826**

Mark Schemes for the Units

June 2007

3826/7826/MS/R/07

OCR (Oxford, Cambridge and RSA Examinations) is a unitary awarding body, established by the University of Cambridge Local Examinations Syndicate and the RSA Examinations Board in January 1998. OCR provides a full range of GCSE, A level, GNVQ, Key Skills and other qualifications for schools and colleges in the United Kingdom, including those previously provided by MEG and OCEAC. It is also responsible for developing new syllabuses to meet national requirements and the needs of students and teachers.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2007

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 870 6622
Facsimile: 0870 870 6621
E-mail: publications@ocr.org.uk

CONTENTS

Advanced GCE Electronics (7826)

Advanced Subsidiary GCE Electronics (3826)

MARK SCHEMES FOR THE UNITS

Unit	Content	Page
2526	Foundations of Electronics	1
2527	Signal Processing Circuits	13
2529	Communications Circuits	25
2530	Control Circuits	39
*	Grade Thresholds	50

Mark Scheme 2526
June 2007

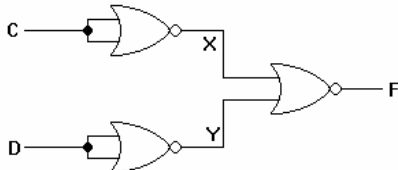
ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

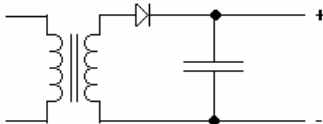
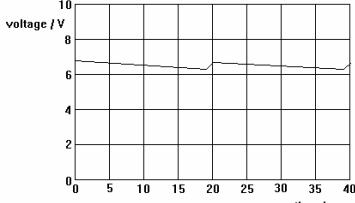
- 1 Please ensure that you use the **final** version of the Mark Scheme.
You are advised to destroy all draft versions.
- 2 Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. Ticks should **not** be placed in the right-hand margin. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks ($\frac{1}{2}$) should never be used.
- 3 The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

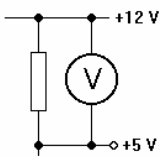
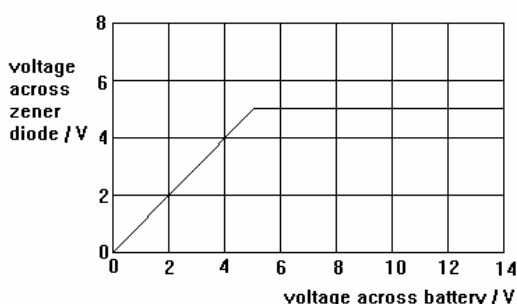
×	= incorrect response (errors may also be underlined)
^	= omission of mark
bod	= benefit of the doubt (where professional judgement has been used)
ecf	= error carried forward (in consequential marking)
con	= contradiction (where candidates contradict themselves in the <u>same</u> response)
sf	= error in the number of significant figures
up	= omission of units with answer
- 4 The marks awarded for each part question should be indicated in the right-hand margin. The mark total for each question should be ringed at the bottom right-hand side. These totals should be added up to give the final total on the front of the paper.
- 5 In cases where candidates are required to give a specific number of answers, mark the first answers up to the total required. Strike through the remainder.
- 6 The mark awarded for Quality of Written Communication in the margin should equal the number of ticks under the phrase.
- 7 Correct answers to calculations should obtain full credit even if no working is shown, unless indicated otherwise in the mark scheme.
- 8 Strike through all blank spaces and pages to give a clear indication that the whole of the script has been considered.

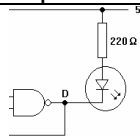
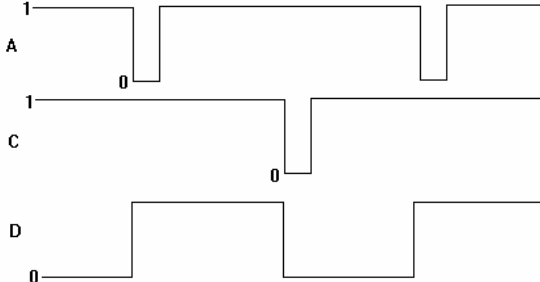
The following abbreviations and conventions are used in the mark scheme:

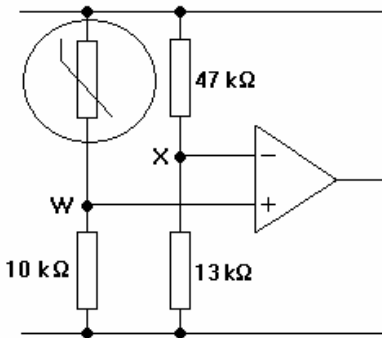
wttee	= words to that effect
/	= alternative correct answers
;	= separates marking points
NOT	= answers which are not worthy of credit
()	= words which are not essential to gain credit
_____	= (underlining) key words which must be used to gain credit
ecf	= error carried forward
ora	= or reverse argument
eor	= evidence of rule

question	grade	expected answer	mark																									
1 (a)	E	first row Q = 1, last three rows Q = 0	1																									
1 (b) (i)	D	last row CD = 10	1																									
	D	ecf incorrect CD: correct column for E	1																									
	D	ecf incorrect CD: correct column for F	1																									
	C	ecf incorrect E or F: correct column for P no ecf incorrect 1 (a)	1																									
		<table><tr><th>C</th><th>D</th><th>E</th><th>F</th><th>P</th></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr></table>	C	D	E	F	P	0	0	1	0	0	0	1	0	0	1	1	1	0	1	0	1	0	0	0	1	
C	D	E	F	P																								
0	0	1	0	0																								
0	1	0	0	1																								
1	1	0	1	0																								
1	0	0	0	1																								
1 (b) (ii)	C	Exclusive OR / EOR ecf incorrect P in truth table	1																									
1 (c) (i)	E	NOR gate to generate F	1																									
	D	NOR gate as a NOT gate at inputs (one input low / joined inputs)	1																									
	C	correct in all details, eg symbol for 2-input NOR (labels optional)	1																									
																												
1 (c) (ii)	E	no ecf incorrect circuit : four different combinations of input states	1																									
	E	X = NOT C	1																									
	E	ecf no labels : Y = NOT D	1																									
	D	F = C AND D	1																									
		<table><tr><th>C</th><th>D</th><th>X</th><th>Y</th><th>F</th></tr><tr><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td></tr></table>	C	D	X	Y	F	0	0	1	1	0	0	1	1	0	0	1	0	0	1	0	1	1	0	0	1	
C	D	X	Y	F																								
0	0	1	1	0																								
0	1	1	0	0																								
1	0	0	1	0																								
1	1	0	0	1																								

question	grade	expected answer	mark
2 (a)	E	transformer reduces size / steps down	1
	D	of (mains) <u>voltage</u>	1
	D	rectifier converts ac to dc NOT rectifies	1
	C	only one polarity of voltage / direction of current at output	1
	C	smoother removes / reduces variations NOT smooths	1
	B	in <u>voltage</u> across load / at output	1
2 (b)	E	recognisable symbols for transformer, diode, capacitor	1
	D	diode functions as a rectifier (ACCEPT diode bridge)	1
	D	capacitor functions as a smoother	1
	C	output terminals either side of capacitor	1
	C	correct polarity indicated (ecf diode direction)	1
			
2 (c) (i)	D	Show: $V = IR$	1
	C	$I = 0.25 \text{ A}$, $250 \times 10^{-3} \text{ A}$ (units conversion)	1
	C	$V = 0.25 \times 27 = 6.75 \text{ V}$ (ACCEPT 6.8 V) NOT just 6.75 V	1
2 (c) (ii)	E	Show: $T = 1/f$	1
	D	$T = 1/50 = 0.02$ / 2.0×10^{-2} ...	1
2 (c) (iii)	E	fast charge, slow discharge	1
	D	peak voltage about 7 V	1
	C	consistent ripple about 0.5 V (1/4 square by eye)	1
	B	one cycle per 20 ms (by eye)	1
		ACCEPT charges from 0 V for first cycle	
			
2 (c) (iv)	C	$V_r = It/C$ (or equivalent rule)	1
	B	$C = 0.25 \times 0.02 / 0.5$ (units conversion and substitution)	1
	A	ecf incorrect units conversion : $C = 10\,000 \mu\text{F}$ ACCEPT 10 370 μF	1

question	grade	expected answer	mark
3 (a) (i)	D	downwards arrow	1
3 (a) (ii)	D	no current / doesn't conduct at low voltage	1
	C	until 5 V / breakdown voltage / threshold voltage	1
	B	when current rises (rapidly) / current independent of voltage	1
3 (b) (i)	D	Show: $P = VI$ or $I = P/V$	1
	E	$I = 1.2/5 = 0.24 \text{ A}$	1
	B	units conversion: eg 240 mA ACCEPT reverse calculation	1
3 (b) (ii)	C	To prevent overheating NOT damage / breaking (wtte)	1
3 (c) (i)	E	correct symbol	1
	D	in parallel with resistor	1
			
3 (c) (ii)	D	$(12 - 5) = 7 \text{ V}$	1
3 (c)(iii)	D	$R = V/I$ (eor)	1
	C	units conversion: eg 150 mA = 0.15 A OR $0.047 \text{ k}\Omega = 47 \Omega$	1
	C	ecf incorrect V: $R = 7/0.15 = 47 \Omega$ NOT 46Ω	1
3 (d)	A	straight line rising at 45 degrees up to 5 V	1
	A	horizontal line at 5 V from 5 V battery voltage	1
			

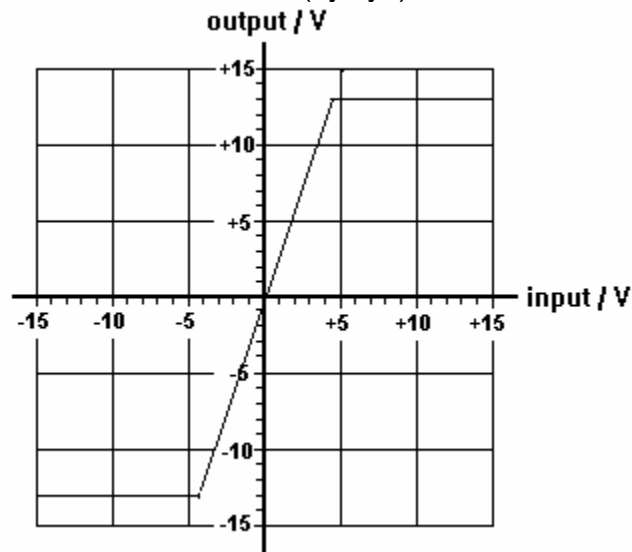
question	grade	expected answer	mark															
4 (a) (i)	E		1															
4 (a) (ii)	C	between 1.5 V and 2.5 V	1															
4 (a) (iii)	D	$I = V/R$ (eor)	1															
	B	ecf voltage drop across LED: $V = 5 - 2 = 3$ V	1															
	C	ecf incorrect V : $I = 3 / 220 = 1.4 \times 10^{-2}$ A = 14 mA	1															
4 (b)	C	open switch: resistor connects / pulls A up to 5 V supply rail	1															
	C	closed switch: switch connects A to 0 V supply rail NOT pulls down ACCEPT correct voltage divider argument	1															
4 (c) (i)	D	all combinations of input states	1															
	E	D = 1 for any 0 at inputs, D = 0 for no 0 at inputs	1															
		<table border="1" data-bbox="430 804 593 1072"><tr><th>A</th><th>B</th><th>D</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table>	A	B	D	0	0	1	0	1	1	1	0	1	1	1	0	
A	B	D																
0	0	1																
0	1	1																
1	0	1																
1	1	0																
4 (c) (ii)	E	A goes low	1															
	D	D goes high	1															
	B	so no <u>voltage</u> drop across LED (wtte) IGNORE current in LED	1															
4 (d)	E	D rises and stays there when A is pulsed consistently	1															
	C	D falls and stays there when C is pulsed	1															
	C	D changes only on falling edge of A and C (by eye)	1															
																		

question	grade	expected answer	mark
5 (a)	E	$R_{\text{total}} = 47 + 13 = 60 \text{ k}\Omega$	1
	D	EITHER $I = V/R$	1
	C	$I = 15/60 = 0.25 \text{ mA}$	1
		$V = IR = 0.25 \times 10^{-3} \times 13 \times 10^3 = \underline{3.25 \text{ V}}$ OR $V_{\text{out}} = V_{\text{in}} \times R_b / (R_t + R_b)$ $V_{\text{out}} = 15 \times 13 / 60 = \underline{3.25 \text{ V}}$ OR 15 V across 60 k Ω means 0.25 V across 1 k Ω so $0.25 \times 13 = \underline{3.25 \text{ V}}$ across 13 k Ω	
5 (b) (i)	E		1
5 (b) (ii)	C	resistance of thermistor decreases (with increasing temperature)	1
	B	increasing its current / reducing share of supply voltage	1
	A	so increasing voltage across 10 k Ω resistor / reducing voltage across thermistor	1
5 (b) (iii)	E	(voltage at) W rises above (voltage at) X	1
	D	so Y rises to +13 V / <u>saturates</u> at a positive voltage (owtte)	1
	C	current in the relay coil ACCEPT magnetises / activates NOT turn on	1
	B	closes the switch	1
	A	allowing current in / voltage across the motor NOT turns on motor	1

question	grade	expected answer	mark
5 (c)	C	<u>opamp</u> can't supply enough current/power for the motor NOT voltage	1
5 (d) (i)	E	EITHER	
	D	current in only one direction	1
	C	until forward bias of 0.7 V (owtte) current rises steeply for higher voltage	1
5 (d) (ii)		OR	
		won't conduct / high resistance	
		until forward bias of 0.7 V (owtte)	
		then resistance falls steeply for higher voltage	
	B	D1: stop relay energising	1
	B	for negative voltages at Y	1
	A	D2: prevent damage to <u>op-amp</u>	1
	A	by cutting out voltage spikes/back emf across coil	1

question	grade	expected answer	mark																																																														
6 (a)	E	$E = A \text{ OR } B$ (award [1] if only one error)	2																																																														
	E	ecf incorrect E: $F = \text{NOT } E$	1																																																														
	E	ecf incorrect F: $D = F \text{ AND } C$ (award [1] if only one error)	2																																																														
	D	ecf incorrect E: $R = C \text{ NOR } E$ (award [1] if only one error)	2																																																														
	D D D C	<table><tr><th>A</th><th>B</th><th>C</th><th>E</th><th>F</th><th>D</th><th>R</th></tr><tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td></tr></table>	A	B	C	E	F	D	R	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	1	0	1	0	0	0	0	1	1	1	0	0	0	1	0	0	1	0	0	0	1	0	1	1	0	0	0	1	1	0	1	0	0	0	1	1	1	1	0	0	0
A	B	C	E	F	D	R																																																											
0	0	0	0	1	0	1																																																											
0	0	1	0	1	1	0																																																											
0	1	0	1	0	0	0																																																											
0	1	1	1	0	0	0																																																											
1	0	0	1	0	0	0																																																											
1	0	1	1	0	0	0																																																											
1	1	0	1	0	0	0																																																											
1	1	1	1	0	0	0																																																											
6 (b)	E	A, B and C are all low / 0 / 0 V	1																																																														
	D	so R is 1	1																																																														
	C	and (therefore) Q is 0	1																																																														
6 (c)	D	ecf incorrect D: press 3 only ACCEPT press C	1																																																														
	C	so that D is 1	1																																																														
	B	and <u>then</u> press 4	1																																																														
	A	to provide a clock pulse / copy D to Q (owtte)	1																																																														
		ecf incorrect truth table: accept any condition which has DR = 10																																																															

question	grade	expected answer	mark
7 (a)	D	non-inverting	1
7 (b)	E	$G = 1 + R_f/R_d$ (eor)	1
	D	$G = 1 + 20/10$	1
	C	$G = 3$ IGNORE units ecf: ACCEPT -2 if inverting, +1 for voltage follower for [1]	1
7 (c)	E	ecf: incorrect G: straight line through the origin	1
	C	correct gradient (by eye)	1
	B	correct saturation levels (by eye)	1



question	grade	expected answer	mark
8 (a)	E	$T = RC$ (eor)	1
	D	units conversion: $2200 \mu\text{F} = 2.2 \times 10^{-3} \text{ F}$, $47 \text{ k}\Omega = 4.7 \times 10^4 \Omega$	1
	C	ecf incorrect units conversion: $T = 103 \text{ s}$ (accept 100 s)	1
8 (b)	E	D immediately before E anywhere	1
	E	E immediately before A anywhere	1
	D	A immediately before H anywhere	1
	C	H immediately before C anywhere	1
	B	C immediately before F anywhere	1
	A	F immediately before B anywhere	1
		DEAIHCFB = [6] Does ✓ Each ✓ Amp ✓ (Instantly) Have ✓ Chips ✓ For ✓ Breakfast?	

Quality of Written Communication

- 3 The candidate expresses complex ideas extremely clearly and fluently. Sentences and paragraphs follow on from one another smoothly and logically. Arguments are consistently relevant and well structured. There will be few, if any, errors of grammar, punctuation and spelling.
- 2 The candidate expresses straightforward ideas clearly, if not always fluently. Sentences and paragraphs may not always be well connected. Arguments may sometimes stray from the point or be weakly presented. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.
- 1 The candidate expresses simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weaknesses in these areas.
- 0 The language has no rewardable features.

Mark Scheme 2527
June 2007

INSTRUCTIONS ON MARKING SCRIPTS

All page references relate to the Instructions to Examiner booklet (revised June 2006)

For many question papers there will also be subject or paper specific instructions which supplement these general instructions. The paper specific instructions follow these generic ones.

1 Before the Standardisation Meeting

Before the Standardisation Meeting you must mark a selection of at least 10 scripts. The selection should be drawn from several Centres. The preliminary marking should be carried out **in pencil** in strict accordance with the mark scheme. In order to help identify any marking issues which might subsequently be encountered in carrying out your duties, **the marked scripts must be brought to the meeting.** (*Section 5c, page 6*)

2 After the Standardisation Meeting

- a) Scripts must be marked in **red**, including those initially marked in pencil for the Standardisation Meeting.
- b) All scripts must be marked in accordance with the version of the mark scheme agreed at the Standardisation Meeting.
- c) **Annotation of scripts**

The purpose of annotation is to enable examiners to indicate clearly where a mark is earned or why it has not been awarded. Annotation can, therefore, help examiners, checkers, and those remarking scripts to understand how the script has been marked.

Annotation consists of:

- the use of ticks and crosses against responses to show where marks have been earned or not earned;
- the use of specific words or phrases as agreed at standardisation and as contained in the final mark scheme either to confirm why a mark has been earned or indicate why a mark has not been earned (eg indicate an omission);
- the use of standard abbreviations eg for follow through, special case etc.

Scripts may be returned to Centres. Therefore, any comments should be kept to a minimum and should always be specifically related to the award of a mark or marks and be taken (if appropriate) from statements in the mark scheme. General comments on a candidate's work must be avoided.

Where annotations are put onto the candidates' script evidence, it should normally be recorded in the body of the answer or in the margin immediately adjacent to the point where the decision is made to award or not award the mark.

d) Recording of marking: the scripts

- i) Marked scripts must give a clear indication of how marks have been awarded, as instructed in the mark scheme.
- ii) All numerical marks for responses to part questions should be recorded unringed in the right-hand margin. The total for each question (or, in specified cases, for each page) should be shown as a single ringed mark in the right-hand margin at the end of each question.
- iii) The ringed totals should be transferred to the front page of the script, where they should be totalled.
- iv) Every page of a script on which the candidate has made a response should show evidence that the work has been seen.
- v) Every blank page should be crossed through to indicate that it has been seen. (*Section 8a – d, page 8*)

e) Handling of unexpected answers

The Standardisation Meeting will include a discussion of marking issues, including:

- a full consideration of the mark scheme in the context of achieving a clear and common understanding of the range of acceptable responses and the marks appropriate to them, and comparable marking standards for optional questions;
- the handling of unexpected, yet acceptable answers. (*Section 6a, bullet point 5, page 6*)

There will be times when you may not be clear how the mark scheme should be applied to a particular response. In these circumstances, a telephone call to the Team Leader should produce a speedy resolution to the problem. (*Appendix 5, para 17, page 26*)

Question 1

- (a) Resistors
- R_2
- are pull down resistors

To hold inputs at logic 0 until switch is pushed

To avoid short circuits across power supply lines

Prevents input from floating until a switch is pushed

(any two sensible points)

[2]

- (b) Resistor
- R_1
- is to limit the current in the LED

Do not award mark for voltage limitation in LED on its own, but allow mark for some comment on (3V) voltage dropper

[1]

(c) $X = \bar{A} \cdot B \cdot C$ (1)

$Y = A \cdot \bar{B} \cdot C$ (1)

$Z = A \cdot B \cdot \bar{C}$ (1)

[3]

(d) $M = \bar{A} \cdot B \cdot C + A \cdot \bar{B} \cdot C + A \cdot B \cdot \bar{C}$
or $= X + Y + Z$

[1]

- (e)

A	B	C	M
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	0

(1)

(1)

(1)

[3]

- (f) The LED lights when two switches are pushed (only worth 1 mark)

Any two switches pushed at the same timeOnly lights when two switches pushed

(any two points)

[2]

Question 2

(a) Integrator or Ramp Generator (do not allow filter or amplifier) [1]

(b) (i) For an input of +5V $V_{out}/time = -V_{in}/RC$ (1)
 $= -5/330 \times 10^3 \times 2 \times 10^{-6}$ (1)
 $= -7.58 \text{ Vs}^{-1}$ (1 mark for negative sign) (1)
[3]

(ii) For an input of -5V $V_{out}/time = +7.58 \text{ Vs}^{-1}$ (1)
 (must be appropriate sign for (i) answer) **[1]**

(c) Any linear ramping voltage

Linear ramp with gradient approximately 7.5 Vs^{-1}

First ramp saturates at -13V for a fraction of a second before rising back to +2V

Thereafter ramp oscillates between +2V and -13V

[4]

(d) If input became a +5V/0V pulse then

output would saturate (at -13V on the first pulse) (1)

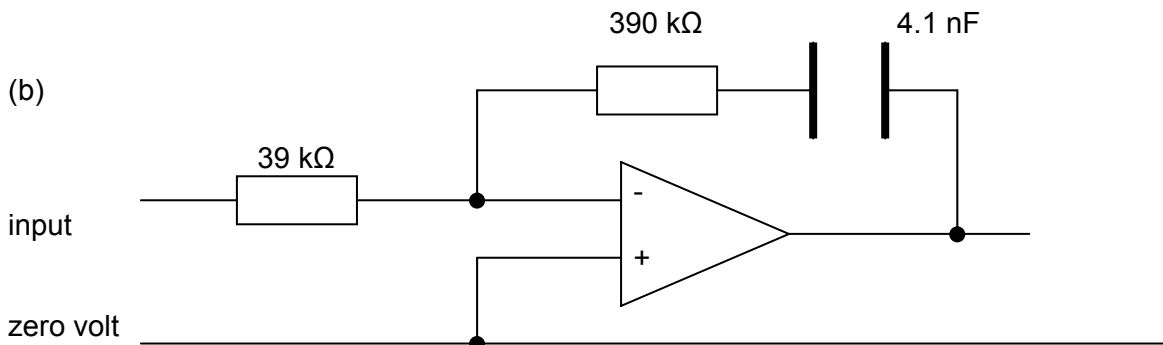
and thereafter **stay there** (1)

[2]

Question 3

(a) Bass boost

[1]



0V line drawn and labelled (allow earth / ground)	(1)
non-inverting input (+) connected to 0V line	(1)
correct inverting amplifier circuit (regardless of capacitor position)	(1)
capacitor drawn in correct position (in series with feedback R)	(1)
voltage gain = - R_f/R_i (ignore -ve sign)	(1)
input resistor R_i = 39 kΩ	(1)
feedback resistor R_f = 390 kΩ	(1)
break frequency = $1/2\pi RC$	(1)
capacitance C = $1/2\pi \times 100 \times 390 \times 10^3$	(1)
= 4.08×10^{-9} F	
= 4.1 nF (allow 4nF)	(1)

[10]

(c) Equipment needed	Signal generator	(1)
	Dual trace/beam oscilloscope	(1)
	(allow <u>AC</u> voltmeter)	

Block diagram	Sig gen connected to filter input	
	Cro connected to input and to output of filter	(1)

Explanation	<u>Measure V_{input} and V_{output} on cro</u>	
	<u>At various frequencies</u>	
	Over the range 0.1 Hz to 100 kHz	
	Ensure output is not saturated	
	<u>Calculate V_{out}/V_{in} = gain at each frequency</u>	(3)

Question 4

[6]

- (a) Logic signals have only two values (any comment on binary) (1)
(allow any relevant points)

+5V represents logic 1 and 0V represents logic 0 (1)

[2]

- (b) (i)

A	C	E	Q
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	0

(1)

(1)

Allow 1 mark for correct expression for each Q=1

Allow 1 mark for correct combination with OR

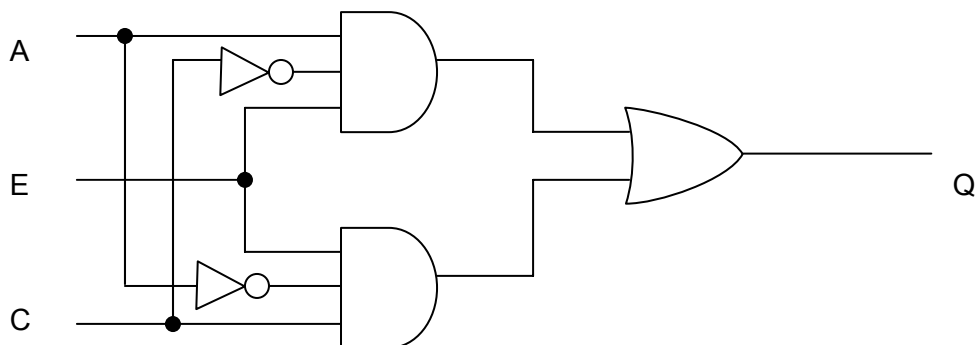
[2]

(ii) $Q = \bar{A} \cdot C \cdot E \text{ (1)} + A \cdot \bar{C} \cdot E \text{ (1)}$

[2]

- (iii) Any correct working circuit (deduct 1 mark per error)

[3]



could use EOR and AND

$Q = E \text{ AND } (A \text{ EXOR } C)$

Question 5

(a) Potential / voltage divider [1]

(b) (i) Current = $30 (1) / (2000 + 400) (1)$
= 12.5 mA [2]

(ii) Voltage = $12.5 \times 10^{-3} (1) \times 400 (1)$
= 5V [2]

(iii) V_{out} = 15 - 5V across the LDR
= 10V [1]

(c) (i) Graph shows any hysteresis shape (1)
Symmetrical switching at $\pm 10V$ (1)
Saturation at $\pm 13V$ (1)
Correct non-inverting shape (1)
[4]

(ii) Schmitt needed to produce clear/sharp counting edges
Light levels from sky do not change smoothly over a typical day
 V_{out} would rise and fall during cloudy days
Comparator would produce multiple pulses (from passing clouds etc.)
(any two relevant points) [2]

Question 6

- (a) Each D-type output must be set up to change state (or toggle) on the rising edge of the clock pulse

So that each D-type divides the frequency of the less significant bit before it by two (for 2 marks)

[2]

- (b) A changes state on the rising edge of clock input
(deduct 1 mark per error) (2)

B changes state on the falling edge of A output
(deduct 1 mark per error) (2)

C changes state on the falling edge of B output
(deduct 1 mark per error) (2)

[6]

- (c) Maximum number of output states = 2^3 (1)

$$= 8 \quad (1)$$

(allow 1 out of 2 if answer 7)

[2]

- (d) (i) Counter outputs are in order shown below (1)

1 2 4 8 16 32 64 128 256 512 (1)

[2]

Thus to count to 365 we require a 9-bit system
Or 8 bits only $2^8 = 256$ so need $2^9 = 512$

- (ii) 365_{decimal}

= 1 0 4 8 0 32 64 0 256

= 1 0 1 1 0 1 1 0 1 (1)

lsb

(1)

[2]

- (iii) To reset on the 365 pulse

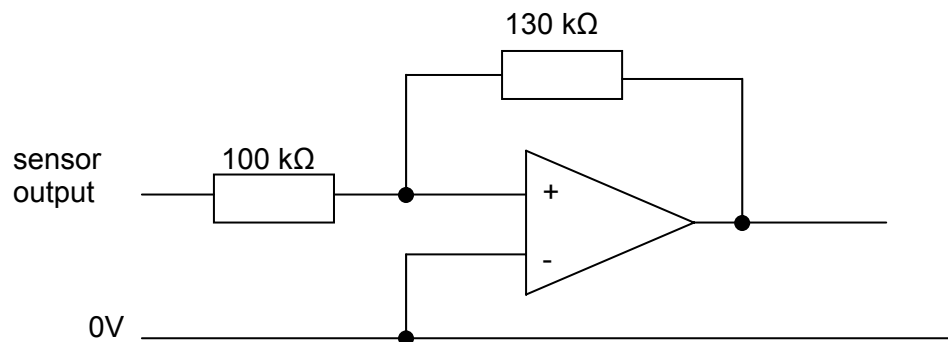
(6-input) AND gate output to reset (1)

with inputs ACDFGI connected to reset system (1)

[2]

Question 7

- (a) 0V line drawn and labelled (allow earth/ground) (1)
- 0V line connected to Schmitt (1)
- Potential divider sensor correctly connected to Schmitt input (1)
- Op-amp has positive feedback (1)
- Non-inverting Schmitt trigger circuit correctly drawn (1)
- Resistor values quoted to allow $\pm 10\text{V}$ switching (1)
- Resistor values chosen in range $1\text{ k}\Omega$ to $10\text{M}\Omega$ (1)



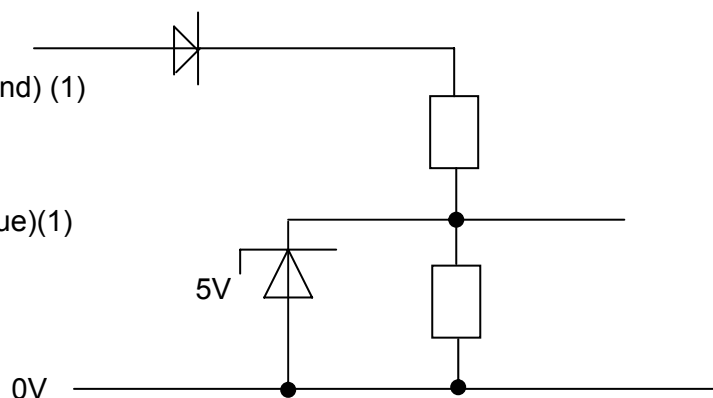
[7]

- (b) Any working circuit should score three marks

eg diode (correct way round) (1)

resistors (1)

Zener (must quote value)(1)



[3]

Specification Grid for AS Electronics (Signal Processing)								
Unit Name		Signal Processing		Code	2527	Session	June	2007
Question Number	AO1 Know + Und	AO2 Application		Target Grades			Q.o.W.C.	Totals
				A/B	B/C/D	D/E		
1 (a)	2				1	1		
(b)	1					1		
(c)	3				3			
(d)	1				1			
(e)	3					3		
(f)		2		1	1			
2 (a)	1					1		
(b)	4			1	2	1		
(c)	4			1	1	2		
(d)		2		1	1			
3 (a)	1					1		
(b)	5	5		2	2	6		
(c)	6				1	5		
4 (a)	2					2		
(b)	4	3			5	2		
5 (a)	1					1		
(b)		5			3	2		
(c)	4	2		2	1	3		
6 (a)	2					2		
(b)	6				2	4		
(c)	2					2		
(d)	4	2		2	2	2		
7 (a)	5	2		2	2	3		
(b)	3			2	1			
Totals	64	23		14	29	44		
Targets	64	23		14	29	44	+3	90

Mark Scheme 2529
June 2007

INSTRUCTIONS ON MARKING SCRIPTS

All page references relate to the Instructions to Examiner booklet (revised June 2006)

For many question papers there will also be subject or paper specific instructions which supplement these general instructions. The paper specific instructions follow these generic ones.

1 Before the Standardisation Meeting

Before the Standardisation Meeting you must mark a selection of at least 10 scripts. The selection should be drawn from several Centres. The preliminary marking should be carried out **in pencil** in strict accordance with the mark scheme. In order to help identify any marking issues which might subsequently be encountered in carrying out your duties, **the marked scripts must be brought to the meeting.** (*Section 5c, page 6*)

2 After the Standardisation Meeting

- a) Scripts must be marked in **red**, including those initially marked in pencil for the Standardisation Meeting.
- b) All scripts must be marked in accordance with the version of the mark scheme agreed at the Standardisation Meeting.
- d) **Annotation of scripts**

The purpose of annotation is to enable examiners to indicate clearly where a mark is earned or why it has not been awarded. Annotation can, therefore, help examiners, checkers, and those remarking scripts to understand how the script has been marked.

Annotation consists of:

- the use of ticks and crosses against responses to show where marks have been earned or not earned;
- the use of specific words or phrases as agreed at standardisation and as contained in the final mark scheme either to confirm why a mark has been earned or indicate why a mark has not been earned (eg indicate an omission);
- the use of standard abbreviations eg for follow through, special case etc.

Scripts may be returned to Centres. Therefore, any comments should be kept to a minimum and should always be specifically related to the award of a mark or marks and be taken (if appropriate) from statements in the mark scheme. General comments on a candidate's work must be avoided.

Where annotations are put onto the candidates' script evidence, it should normally be recorded in the body of the answer or in the margin immediately adjacent to the point where the decision is made to award or not award the mark.

d) Recording of marking: the scripts

- i) Marked scripts must give a clear indication of how marks have been awarded, as instructed in the mark scheme.
- ii) All numerical marks for responses to part questions should be recorded unringed in the right-hand margin. The total for each question (or, in specified cases, for each page) should be shown as a single ringed mark in the right-hand margin at the end of each question.
- iii) The ringed totals should be transferred to the front page of the script, where they should be totalled.
- iv) Every page of a script on which the candidate has made a response should show evidence that the work has been seen.
- v) Every blank page should be crossed through to indicate that it has been seen. (*Section 8a – d, page 8*)

e) Handling of unexpected answers

The Standardisation Meeting will include a discussion of marking issues, including:

- a full consideration of the mark scheme in the context of achieving a clear and common understanding of the range of acceptable responses and the marks appropriate to them, and comparable marking standards for optional questions;
 - the handling of unexpected, yet acceptable answers.
- (*Section 6a, bullet point 5, page 6*)

There will be times when you may not be clear how the mark scheme should be applied to a particular response. In these circumstances, a telephone call to the Team Leader should produce a speedy resolution to the problem.

(*Appendix 5, para 17, page 26*)


ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

- 1 Please ensure that you use the **final** version of the Mark Scheme.
You are advised to destroy all draft versions.
- 2 Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. Ticks should **not** be placed in the right-hand margin. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks ($\frac{1}{2}$) should never be used.
- 3 The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

×	= incorrect response (errors may also be underlined)
^	= omission of mark
bod	= benefit of the doubt (where professional judgement has been used)
ecf	= error carried forward (in consequential marking)
con	= contradiction (where candidates contradict themselves in the <u>same</u> response)
sf	= error in the number of significant figures
up	= omission of units with answer
- 4 The marks awarded for each part question should be indicated in the right-hand margin. The mark total for each question should be ringed at the bottom right-hand side. These totals should be added up to give the final total on the front of the paper.
- 5 In cases where candidates are required to give a specific number of answers, mark the first answers up to the total required. Strike through the remainder.
- 6 The mark awarded for Quality of Written Communication in the margin should equal the number of ticks under the phrase.
- 7 Correct answers to calculations should obtain full credit even if no working is shown, unless indicated otherwise in the mark scheme.
- 8 Strike through all blank spaces and pages to give a clear indication that the whole of the script has been considered.

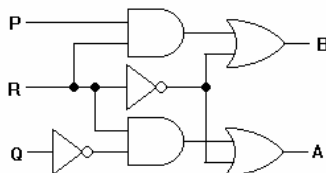
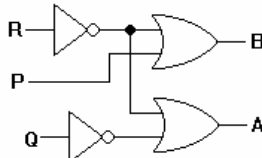
The following abbreviations and conventions are used in the mark scheme:

wttee	= words to that effect
/	= alternative correct answers
;	= separates marking points
NOT	= answers which are not worthy of credit
()	= words which are not essential to gain credit
_____	= (underlining) key words which must be used to gain credit
ecf	= error carried forward
ora	= or reverse argument
eor	= evidence of rule

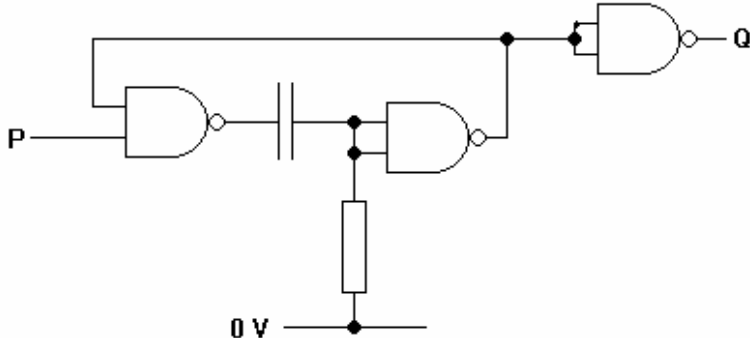
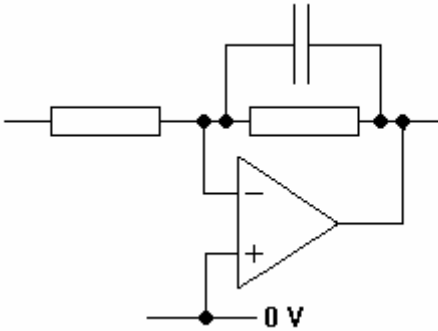
question	grade	expected answer	mark
1 (a)	E	input labelled	1
	E	output labelled	1
			
1 (b) (i)	E	$R_{\text{total}} = 30 + 120 = 150 \text{ k}\Omega$	1
	D	EITHER	
	D	Show: $I = V/R$	1
		$I = 15/150 = 0.1 \text{ mA}$, $V = 0.1 \times 10^{-3} \times 30 (= 3 \text{ V})$	1
		OR	
		Show: $V_{\text{out}} = V_{\text{in}} \times R_b / (R_t + R_b)$	
		$V_{\text{out}} = 15 \times 30 / 150 (= 3 \text{ V})$	
		OR	
		$15/150 \text{ V} = 0.1 \text{ V across } 1 \text{ k}\Omega$	
		so $0.1 \times 30 (= 3 \text{ V})$ across $30 \text{ k}\Omega$	
1 (b) (ii)	C	7 V to 8 V / about halfway between supply voltages	1
	B	allows large amplitude of output signal before distortion / saturation / clipping (wtte)	1
1 (c) (i)	E	drain current = 2.5 mA	1
	D	$V = IR$ (eor)	1
	C	ecf incorrect drain current: $V = 2.5 \times 10^{-3} \times 2.2 \times 10^3 = 5.5 \text{ V}$	1
	B	ecf incorrect V: drain voltage = $15 - 5.5 = 9.5 \text{ V}$	1
		ACCEPT 5.5 V for [3]	

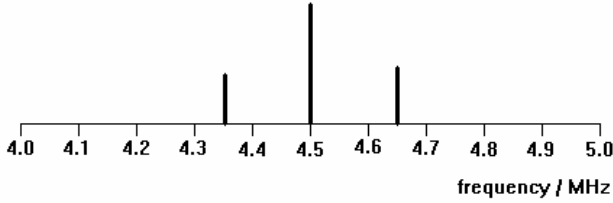
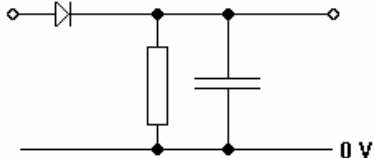
question	grade	expected answer	mark
1 (c) (ii)	C	increasing <u>gate voltage</u> increases <u>drain current</u>	1
	A	which increases <u>voltage drop</u> across drain resistor ACCEPT decreasing gate voltage decreasing voltage drop [2]	1
1 (c) (iii)		EITHER	
	C	when gate is at 4.0 V, drain current is 4.5 mA	1
	B	voltage drop across 2.2 k Ω is 9.9 V	1
	A	so drain <u>falls</u> by 9.9 - 5.5 = 4.4 V	1
		OR	
		when gate is at 2.0 V, drain current is 0.5 mA	
		voltage drop across 2.2 k Ω is 1.1 V	
		so drain <u>ris</u> es by 5.5 - 1.1 V = 4.4 V	
		ACCEPT clearly explained calculations for [3]	
		ACCEPT $G = (-)g_m R_L [1] = -2 \times 10^{-3} [1] \times 2.2 \times 10^3 = -4.4 [1]$	

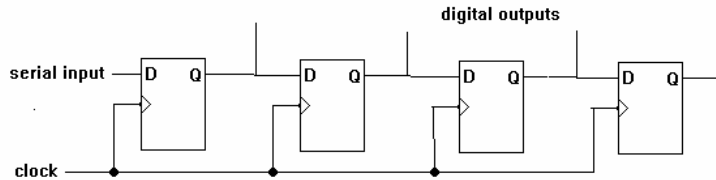
question	grade	expected answer	mark
2 (a) (i)	E E	any of the following, maximum [2] <ul style="list-style-type: none"> voltage drop across each diode independent of current three diodes gives $3 \times 0.7 = 2.1$ V diodes are forward biased / conducting NOT just each diode has 0.7 V across it	2
2 (a) (ii)	D D C	Show: $P = VI$ rearrangement, units conversion, substitution: $I = P/V = 15 \times 10^{-3} / 0.7$ $I = \underline{2.1} \times 10^{-2}$ A ACCEPT reverse calculation: 20 mA gives 14 mW	1 1 1
2 (a) (iii)	B D E E	voltage drop = $15 - 2.1 = 12.9$ V ecf incorrect voltage drop or current: $R = V/I$ (eor) $R = 12.9 / 2.1 \times 10^{-2}$ $R = 610 \Omega$ 20 mA gives 645Ω [4] 15 V , 20 mA gives 750Ω [3] 2.1 V, 20 mA gives 105Ω [3]	1 1 1 1

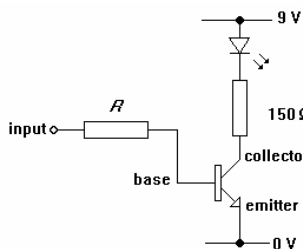
question	grade	expected answer	mark																									
2 (b)	C	5.7 V	1																									
	E	5 V	1																									
	C	-0.7 V	1																									
	E	0 V	1																									
2 (c) (i)	C	[1] per correct row <table><tr><th>P</th><th>Q</th><th>R</th><th>B</th><th>A</th></tr><tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td></tr></table> ACCEPT 1 instead of 0 throughout, if consistent with wrong answers in 2 (b)	P	Q	R	B	A	0	0	0	1	1	0	0	1	0	1	0	1	1	0	0	1	1	1	1	0	4
	P		Q	R	B	A																						
	0		0	0	1	1																						
	0		0	1	0	1																						
	0		1	1	0	0																						
1	1	1	1	0																								
C																												
C																												
C																												
C																												
2 (c) (ii)	C	ecf incorrect truth table: [1] per correct term in each initial expression ACCEPT correct equivalents, including reduced expressions [2]+[2] IGNORE incorrect reductions $B = \overline{P}.Q.\overline{R} + P.Q.R (= \overline{R} + P.R = \overline{R} + P)$ $A = \overline{P}.Q.\overline{R} + \overline{P}.Q.R (= \overline{R} + R.Q = \overline{R} + Q = \overline{Q})$	4																									
	A																											
	C																											
	A																											
2 (c) (iii)		ecf incorrect expressions: correct circuits earn [5] NOT gate to invert an input signal (eg \overline{X}) AND gate to generate a term (eg $X.Y$) OR gate to combine terms and generate an output (eg $X+Y$) correct circuit for B correct circuit for A eg  	1 1 1 1 1																									
	D																											
	D																											
	E																											
	B																											
	B																											

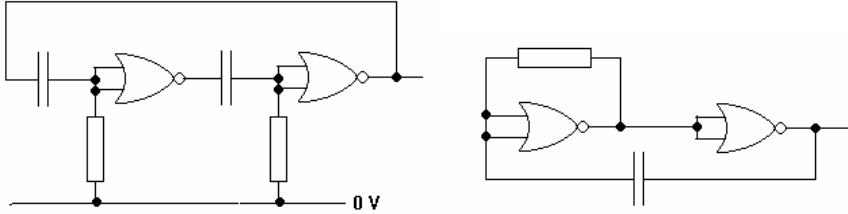
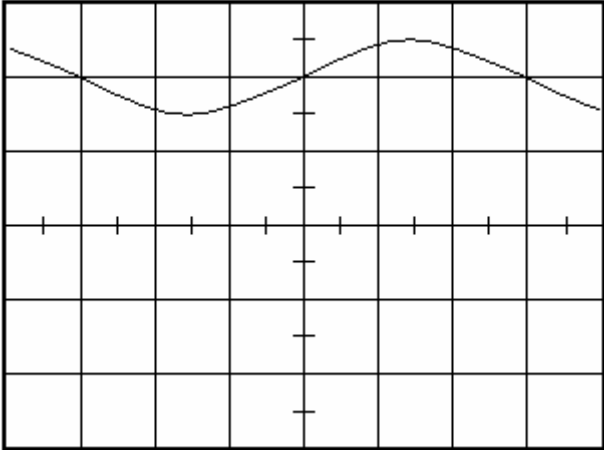
question	grade	expected answer	mark
3 (a) (i)	C	any of the following statement and explanation pairs, maximum [2+2] output less affected by noise or interference (wtte) because digital signals can be restored (by Schmitt trigger) information is easy to store or process in digital memory system / computer reduce transmission time can be reduced by compressing signal information can be encrypted to increase security	4
	C		
	C		
	B		
3 (a) (ii)	E	any of the following statement and explanation pairs, maximum [2+2] information is not lost through the sampling process more channels available as bandwidth is smaller cheaper / smaller / needs less power as circuitry is simpler	1
	D		1
	C		1
	B		1
3 (b) (i)		[1] for each stage explained: $160 \times 240 = 38\,400$ <u>pixels per frame</u> $8 \times 3 = 24$ <u>bits per pixel</u> ecf incorrect bits per pixel: $38\,400 \times 24 = 921\,600$ <u>bits per picture</u> ACCEPT just $160 \times 240 \times 8 \times 3 = 921\,600$ for [1] ACCEPT use of start and stop bits (ie 26 bits per pixel) for [3]	
	E		1
	E		1
	D		1
3 (b) (ii)	D	maximum bit rate = $2 \times$ bandwidth (eor) time = bits / bit rate (eor) ecf incorrect bit rate: time = $1\,000\,000 / 128\,000 = 7.8$ s ACCEPT $1\,000\,000 / 64\,000 = 15.6$ s [2]	1
	C		1
	A		1
3 (b) (iii)	E	any of the following, [1] each, maximum [3] • reduce bits per pixel • reduce number of pixels in the image / reduce image resolution • increase the bandwidth / bit rate • compress the image (before transmission) NOT smaller screen, analogue transmission.	3
	D		
	C		

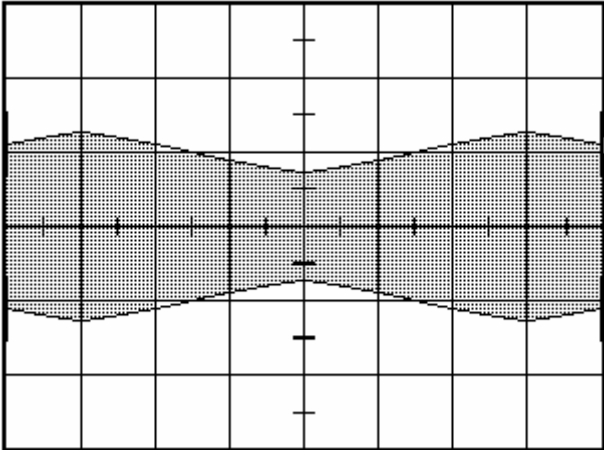
question	grade	expected answer	mark
4 (a)	C	signal voltage changes	1
	E	the frequency of the carrier in f.m.	1
	E	the amplitude of the carrier in a.m.	1
4 (b)	C	changed into square wave / digital output / constant amplitude IGNORE effect of inversion	1
4 (c)	E	spike generator from RC	1
	D	NAND gates at input and output of spike generator	1
	C	feedback loop for correct monostable behaviour	1
	C	third NOT gate for Q	1
	B	R at least $10\text{ k}\Omega$	1
	A	$T = 0.7RC$: $RC = 3 \times 10^{-6}\text{ s}$	1
			
4 (d)	B	$f_0 = 1/2\pi RC$ (eor)	1
	E	resistors between $1\text{ k}\Omega$ and $1\text{ M}\Omega$	1
	C	$R_f / R_{in} = 10$	1
	A	$RC = 8\text{ }\mu\text{s}$ for R in series / parallel with C	1
	E	inverting amplifier	1
	D	capacitor in parallel with feedback resistor	1
			

question	grade	expected answer	mark
5 (a) (i)	C	carrier <u>spike</u> at 4.5 MHz	1
	C	smaller sideband spikes on either side of the carrier	1
	B	at 4.35 MHz and 4.65 MHz (by eye)	1
			
5 (a) (ii)	D	300 kHz apply ecf from (a)(i) if necessary	1
5 (b)	E	input (on the left) through diode	1
	D	output (on the right) across resistor in parallel with capacitor	1
	C	bottom rail tied to 0V / earth	1
			
	B		1
	A	<p>EITHER</p> $T = 1/150 \times 10^3 = 6.7 \times 10^{-6} \text{ s}$ $RC < 6.7 \times 10^{-6} \text{ s and } > 2.2 \times 10^{-7} \text{ s}$ <p>OR</p> $f_0 = 1/2\pi RC \text{ (eor)}$ $f_0 = 150 \text{ kHz gives } RC = 1 \times 10^{-6} \text{ s}$ <p>ACCEPT f_0 up to 300 kHz</p> <p>ACCEPT any value for R</p>	1

question	grade	expected answer	mark
6 (a)	E	D connected to Q of next flip-flop	1
	D	clocks in parallel and labelled appropriately (eg CLOCK / CK)	1
	D	serial input to D of first flip-flop	1
	C	Q outputs labelled appropriately as digital outputs	1
			
6 (b)	B	so that the <u>start</u> of a new word (wtte) NOT start and end	1
	C	can be recognised by the <u>receiver</u> NOT end of a word can be recognised	1

question	grade	expected answer	mark
7 (a)	E	all three correct ACCEPT b, c, e	1
			
7 (b)	E	Show: $I = V/R$	1
	D	$V = 9 - 1.2 = 7.8 \text{ V}$	1
	E	ecf incorrect V: $I = 7.8/150 = 5.2 \times 10^{-2} \text{ A}$	1
7 (c) (i)	E	$I_b = I_c/h_{FE}$ (eor)	1
	D	$I_b = 52 \times 10^{-3} / 180 = 2.9 \times 10^{-4} \text{ A}$ 50 mA gives $2.8 \times 10^{-4} \text{ A}$ [2]	1
7 (c) (ii)	E	$R = V/I$ (eor)	1
	B	$V = 5 - 0.7 = 4.3 \text{ V}$	1
	D	ecf incorrect V and I: $R = 4.3 / 2.9 \times 10^{-4} = 1.5 \times 10^4 \Omega = 15 \text{ k}\Omega$	1

question	grade	expected answer	mark
8 (a)	E	correct circuit (deduct [1] per error or omission)	2
	D	R at least $5\text{ k}\Omega$	1
	C	$T = 1/4.3 \times 10^6 = 0.23\text{ }\mu\text{s}$	1
	B	RC between $0.10\text{ }\mu\text{s}$ and $0.25\text{ }\mu\text{s}$	1
	A		
8 (b)	C	$f_0 = \frac{1}{2\pi\sqrt{LC}}$ (eor)	1
	B	$C = 1/4\pi^2 f_0^2 L = 1/4\pi^2 (4.3 \times 10^6)^2 \times 100 \times 10^{-6}$	1
	A	$C = 1.4 \times 10^{-11}\text{ F}$	1
8 (c) (i)	E	Show: $T = 1/f$	1
	D	units conversion: $3.2\text{ kHz} = 3.2 \times 10^3\text{ Hz}$	1
	C	$T = 1/3.2 \times 10^3 = \underline{3.1} \times 10^{-4}\text{ s}$	1
8 (c) (ii)	E	sine wave shape, any phase	1
	D	period 6 divisions	1
	D	dc value two divisions up from centre	1
	C	amplitude half a division	1
			

question	grade	expected answer	mark
8 (c) (iii)	C	sinusoidally varying a.m. high frequency signal	1
	C	symmetrical about 0 V line	1
	C	period of modulation 6 divisions	1
		 <p>ACCEPT any amplitude or depth of modulation</p>	

Quality of Written Communication

- 3 The candidate expresses complex ideas extremely clearly and fluently. Sentences and paragraphs follow on from one another smoothly and logically. Arguments are consistently relevant and well structured. There will be few, if any, errors of grammar, punctuation and spelling.
- 2 The candidate expresses straightforward ideas clearly, if not always fluently. Sentences and paragraphs may not always be well connected. Arguments may sometimes stray from the point or be weakly presented. There may be some errors of grammar, punctuation and spelling, but not such as to suggest a weakness in these areas.
- 1 The candidate expresses simple ideas clearly, but may be imprecise and awkward in dealing with complex or subtle concepts. Arguments may be of doubtful relevance or obscurely presented. Errors in grammar, punctuation and spelling may be noticeable and intrusive, suggesting weaknesses in these areas.
- 0 The language has no rewardable features.

Mark Scheme 2530
June 2007

INSTRUCTIONS ON MARKING SCRIPTS

All page references relate to the Instructions to Examiner booklet (revised June 2006)

For many question papers there will also be subject or paper specific instructions which supplement these general instructions. The paper specific instructions follow these generic ones.

1 Before the Standardisation Meeting

Before the Standardisation Meeting you must mark a selection of at least 10 scripts. The selection should be drawn from several Centres. The preliminary marking should be carried out **in pencil** in strict accordance with the mark scheme. In order to help identify any marking issues which might subsequently be encountered in carrying out your duties, **the marked scripts must be brought to the meeting.** (*Section 5c, page 6*)

2 After the Standardisation Meeting

- a) Scripts must be marked in **red**, including those initially marked in pencil for the Standardisation Meeting.
- b) All scripts must be marked in accordance with the version of the mark scheme agreed at the Standardisation Meeting.
- e) **Annotation of scripts**

The purpose of annotation is to enable examiners to indicate clearly where a mark is earned or why it has not been awarded. Annotation can, therefore, help examiners, checkers, and those remarking scripts to understand how the script has been marked.

Annotation consists of:

- the use of ticks and crosses against responses to show where marks have been earned or not earned;
- the use of specific words or phrases as agreed at standardisation and as contained in the final mark scheme either to confirm why a mark has been earned or indicate why a mark has not been earned (eg indicate an omission);
- the use of standard abbreviations eg for follow through, special case etc.

Scripts may be returned to Centres. Therefore, any comments should be kept to a minimum and should always be specifically related to the award of a mark or marks and be taken (if appropriate) from statements in the mark scheme. General comments on a candidate's work must be avoided.

Where annotations are put onto the candidates' script evidence, it should normally be recorded in the body of the answer or in the margin immediately adjacent to the point where the decision is made to award or not award the mark.

d) Recording of marking: the scripts

- i) Marked scripts must give a clear indication of how marks have been awarded, as instructed in the mark scheme.
- ii) All numerical marks for responses to part questions should be recorded unringed in the right-hand margin. The total for each question (or, in specified cases, for each page) should be shown as a single ringed mark in the right-hand margin at the end of each question.
- iii) The ringed totals should be transferred to the front page of the script, where they should be totalled.
- iv) Every page of a script on which the candidate has made a response should show evidence that the work has been seen.
- v) Every blank page should be crossed through to indicate that it has been seen. (*Section 8a – d, page 8*)

e) Handling of unexpected answers

The Standardisation Meeting will include a discussion of marking issues, including:

- a full consideration of the mark scheme in the context of achieving a clear and common understanding of the range of acceptable responses and the marks appropriate to them, and comparable marking standards for optional questions;
- the handling of unexpected, yet acceptable answers. (*Section 6a, bullet point 5, page 6*)

There will be times when you may not be clear how the mark scheme should be applied to a particular response. In these circumstances, a telephone call to the Team Leader should produce a speedy resolution to the problem. (*Appendix 5, para 17, page 26*)

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

- 1 Please ensure that you use the **final** version of the Mark Scheme.
You are advised to destroy all draft versions.
- 2 Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. Ticks should **not** be placed in the right-hand margin. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks ($\frac{1}{2}$) should never be used.
- 3 The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

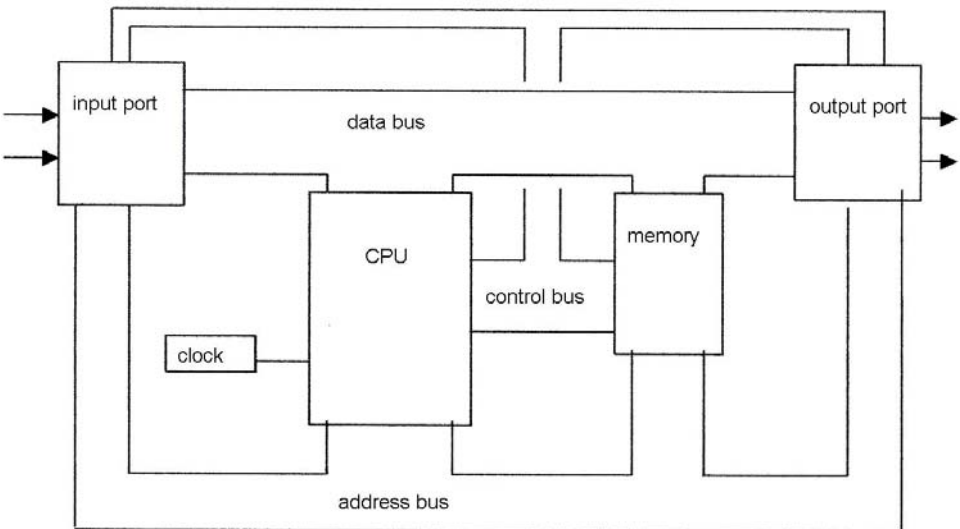
×	= incorrect response (errors may also be underlined)
^	= omission of mark
bod	= benefit of the doubt (where professional judgement has been used)
ecf	= error carried forward (in consequential marking)
con	= contradiction (where candidates contradict themselves in the <u>same</u> response)
sf	= error in the number of significant figures
up	= omission of units with answer
- 4 The marks awarded for each part question should be indicated in the right-hand margin. The mark total for each double page should be ringed at the bottom right-hand side. These totals should be added up to give the final total on the front of the paper.
- 5 In cases where candidates are required to give a specific number of answers, mark the first answers up to the total required. Strike through the remainder.
- 6 The mark awarded for Quality of Written Communication in the margin should equal the number of ticks under the phrase.
- 7 Correct answers to calculations should obtain full credit even if no working is shown, unless indicated otherwise in the mark scheme.
- 8 Strike through all blank spaces and pages to give a clear indication that the whole of the script has been considered.

The following abbreviations and conventions are used in the mark scheme:

wtte	= words to that effect
/	= alternative correct answers
;	= separates marking points
NOT	= answers which are not worthy of credit
()	= words which are not essential to gain credit
—	= (underlining) key words which must be used to gain credit
ecf	= error carried forward
ora	= or reverse argument
eor	= evidence of rule

Question	Expected answer	Mark
1 (a) (i)	Subroutine is an area of memory containing a program segment Which is accessed within main program by a coded jump At the end of the program segment a coded instruction allows return to main program	1
	An Interrupt is an area of memory containing a program segment Which is accessed by activating an external pin on microprocessor At the end of the program segment a coded instruction allows return to main program	1
	(ii) Subroutine is normally a program segment which is used repeatedly (eg time delay) which is accessed at predictable times within main program To save writing out the program segment over and over again	2
	(iii) Interrupt is usually a program segment which is accessed at unknown times which is accessed by activating an external pin on microprocessor To save writing software which repeatedly monitors some input	2
	(b) On detecting Interrupt the μP finishes its current fetch-execute cycle then it stores all important registers (especially the program counter) on the Stack	1
	The Stack is an area of memory operated on a First In Last Out basis	1
	storing / recovering the program counter means the μP can return to where it left off	1
	then it jumps to a new area of memory where it finds an interrupt routine / program at the end of the interrupt program is a code to initiate return to main program	1
	the μP then recovers important register contents from Stack and returns to where it left off in main program	1
2 (a) (i)	Triac	1
(ii)	A = gate	1
	B = main terminal (2)	1
	C = main terminal (1)	1
	(allow mark even if 1 and 2 mixed up)	
(iii)	Triac does not conduct	
	unless a sufficiently large voltage / current pulse is applied to gate	1
	thereafter ceases to have any further control	1
	conduction can only be stopped by reducing current to zero (or below holding current)	1

Question	Expected answer	Mark
(b)	Pulse transformer operates by transformer action – changing current in primary causes changing current in secondary (or vice versa)	1
	Rapid change of voltage level from pulse generator causes rapid switch on of Triac	
	This allows complete isolation between two circuits	1
	No electrical connection between high voltage mains and low voltage control	
(c)	Makes for greater safety for users of control circuit	1
	Voltage across lamp is zero until firing pulse appears	1
	Then rapid rise to mains value at that instant	1
	Voltage across lamp returns to zero when mains crosses zero and stays there	1
(d) (i)	Until next pulse causes rapid switch on	1
	rms current = mean power / rms voltage	1
	= 450 / 230	1
	= 1.96 A	1
(ii)	Peak current I_{peak} = $I_{\text{rms}} \times \sqrt{2}$	
	= 2.77 A	1
3 (a)	Correct op-amp symbol used	
	Op-amp correctly set up as a summing / difference amp	1
	Master wiper correctly used as input	1
	Slave wiper correctly used as other input	1
	Op-amp output connected to buffer / power amp	1
	Other terminal of motor connected to labelled 0V line	1
	Master pot has power line voltages labelled as +ve and -ve	1
	Slave pot has power line voltages labelled as -ve and +ve	
	(to obtain full marks the candidate's circuit must work)	1
(b)	If master and slave wiper voltages are different then op-amp produces non-zero output	
	Op-amp output reduces as the two wiper voltages become closer	
	The buffer / power amp provides the necessary current drive for motor	
	The gain of the amplifier is made low to avoid oscillations / hunting	
4 (a)	When the two wiper voltages are equal the op-amp output is zero and motor stops	
	(any four points)	4
	Fetch-execute cycle	
	Contents of Program counter places on address bus	
	That memory location is activated and read	
	Contents of that memory address placed on bus	
	Microprocessor fetches / reads data into register	
	Instruction is decoded / executed	
	This may or may not involve accessing further memory cells	
		3

Question	Expected answer	Mark
(b)	 <p> CPU Memory Clock Input port Output port Control bus Address bus Data bus </p> <p>(all suitably positioned and sensibly interconnected)</p>	1 1 1 1 1 1 1 1 1
5 (a)	BCD <u>Binary Coded Decimal</u> A <u>4-bit word</u> is made to represent any decimal number 0 to 9	1 1
(b)	Four lines of output made into a common BCD bus All four data inputs of BCD to 7-segment drivers connected to this common bus Any output line connected to 7-segment common Remaining four output lines connected to common lines	1 1 1 1

(c)	<p>Say four least significant output lines are common data bus $O_0O_1O_2O_3$</p> <p>So numbers 1234 become outputs ?1 ?2 ?3 ?4</p> <p>Now if O7 is connected to far right hand display showing 4</p> <p>And O6 is connected to adjacent display to show 3 and so on,</p> <p>Then the microprocessor must output the states E1 D2 B3 74 because common cathode is active zero</p> <p>Rapidly, over and over again</p> <p>So that flashing is too fast for eye and displays appear to be permanently lit</p>	<p>1</p> <p>1</p> <p>1</p> <p>1</p>
-----	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------

Question	Expected answer	Mark
(d)	Address Contents Explanation	
	40 3E 01 move 01 to accumulator and output	1
		1
	42 32 FF in order to reset D-type and latch the counters and then afterwards reset counters	1
(e)	44 C3 00 Jump back to beginning to unfreeze D-type and restart for sensible explanations	1
		1
(e)	Maximum reading is $2^6 - 1 = 63$	2
(f)	The μ P outputs an ever increasing stepped ramp and a counter pulse for each new step	1
	Until the output of the comparator switches over once ramp is just greater than input	1
	The number of counter pulses represents the analogue input voltage level	1

Specification Grid for A2 Electronics (Control circuits)								
Unit Name		Control Circuits		Code	2530	Session	June	2007
Question Number	AO1 Know = Un	AO2 Application	AO4 Synoptic	Target grades			Q.W.C	Totals
				A/B	B/C/D	D/E		
1 (a)	6			1	2	3		
(b)	5			1	1	3		
2 (a)	6				2	4		
(b)			3		1	2		
(c)		4			4			
(d)			4	1	1	2		
3 (a)			7	1	2	4		
(b)			4	1	1	2		
4 (a)	3				1	2		
(b)	8				2	6		
5 (a)			2			2		
(b)			4	2	2			
(c)		2	2	1	1	2		
6 (a)			3			3		
(b)			2		2			
(c)		12		2	2	8		
(d)		5		2	3			
(e)			2	1	1			
(f)		3		1	1	1		
Totals	28	26	33	14	29	44		
Targets	24	24	39	14	29	44	3	90

**Advanced GCE Electronics (3826, 7826)
2007 Assessment Series**

Unit Threshold Marks

Unit		Maximum Mark	a	b	c	d	e	u
2526	Raw	120	86	77	68	60	52	0
	UMS	120	96	84	72	60	48	0
2527	Raw	90	68	60	53	46	39	0
	UMS	90	72	63	54	45	36	0
2528	Raw	78	62	55	48	41	34	0
	UMS	90	72	63	54	45	36	0
2529	Raw	120	95	85	75	65	56	0
	UMS	120	96	84	72	60	48	0
2530	Raw	90	65	57	49	42	35	0
	UMS	90	72	63	54	45	36	0
2531	Raw	90	70	64	58	52	46	0
	UMS	90	72	63	54	45	36	0

Specification Aggregation Results

Overall threshold marks in UMS (i.e. after conversion of raw marks to uniform marks)

	Maximum Mark	A	B	C	D	E	U
3826	300	240	210	180	150	120	0
7826	600	480	420	360	300	2400	0

The cumulative percentage of candidates awarded each grade was as follows:

	A	<u>B</u>	C	D	E	U	Total Number of Candidates
3826	22.90	37.52	55.10	68.69	82.57	100	723
7826	31.54	51.35	70.17	83.86	96.09	100	417

1140 candidates aggregated this series

For a description of how UMS marks are calculated see;
http://www.ocr.org.uk/exam_system/understand_ums.html

Statistics are correct at the time of publication

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

(General Qualifications)

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity



OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553