Cambridge Technicals
Engineering

Unit 4: Principles of electrical and electronic engineering

Level 3 Cambridge Technical Certificate/Diploma in Engineering
05822 - 05825 & 05873

Mark Scheme for January 2023

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support, which keep pace with the changing needs of today's society.

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.

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM Assessor Assessor Online Training*; *OCR Essential Guide to Marking*.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **number of required** standardisation responses.

   YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the traditional 40% Batch 1 and 100% Batch 2 deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone or by email.

5. **Crossed Out Responses**
   Where a candidate has crossed out a response and provided a clear alternative then the crossed out response is not marked. Where no alternative response has been provided, examiners may give candidates the benefit of the doubt and mark the crossed out response where legible.

Multiple Choice Question Responses
When a multiple choice question has only a single, correct response and a candidate provides two responses (even if one of these responses is correct), then no mark should be awarded (as it is not possible to determine which was the first response selected by the candidate).
When a question requires candidates to select more than one option/multiple options, then local marking arrangements need to ensure consistency of approach.

Contradictory Responses
When a candidate provides contradictory responses, then no mark should be awarded, even if one of the answers is correct.

Short Answer Questions (requiring only a list by way of a response, usually worth only **one mark per response**)
Where candidates are required to provide a set number of short answer responses then only the set number of responses should be marked. The response space should be marked from left to right on each line and then line by line until the required number of responses have been considered. The remaining responses should not then be marked. Examiners will have to apply judgement as to whether a 'second response' on a line is a development of the 'first response', rather than a separate, discrete response. (The underlying assumption is that the candidate is attempting to hedge their bets and therefore getting undue benefit rather than engaging with the question and giving the most relevant/correct responses.)

Short Answer Questions (requiring a more developed response, worth **two or more marks**)
If the candidates are required to provide a description of, say, three items or factors and four items or factors are provided, then mark on a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space.)

Longer Answer Questions (requiring a developed response)
Where candidates have provided two (or more) responses to a medium or high tariff question which only required a single (developed) response and not crossed out the first response, then only the first response should be marked. Examiners will need to apply professional judgement as to whether the second (or a subsequent) response is a 'new start' or simply a poorly expressed continuation of the first response.

6. Always check the pages (and additional lined pages if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add an annotation to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in anyway relate to the question (e.g. 'can't do', 'don't know')
   - OR if there is a mark (e.g. a dash, a question mark) which isn't an attempt at the question

   Note: Award 0 marks - for an attempt that earns no credit (including copying out the question)

8. The RM Assessor **comments box** is used by your team leader to explain the marking of the practice responses.
Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
If you have any questions or comments for your team leader, use the phone, the RM Assessor messaging system, or e-mail.

9. Assistant Examiners will email a brief report on the performance of candidates to your Team Leader (Supervisor) by the end of the marking period. Your report should contain notes on particular strength displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.

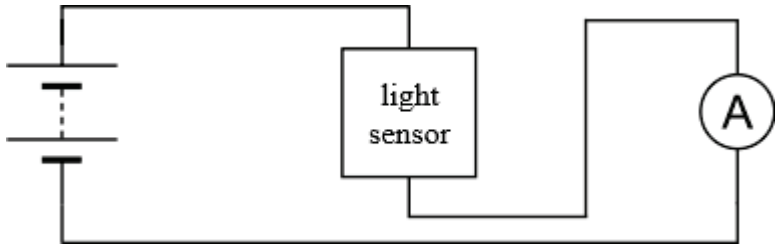
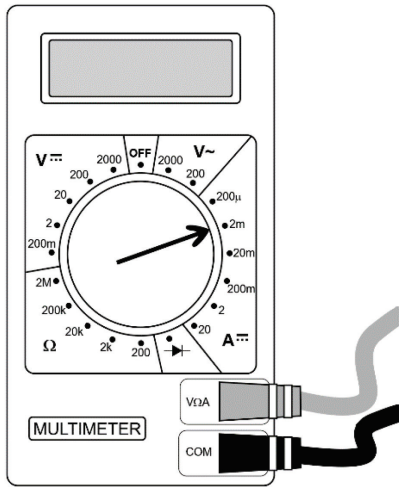
10. **Annotations**

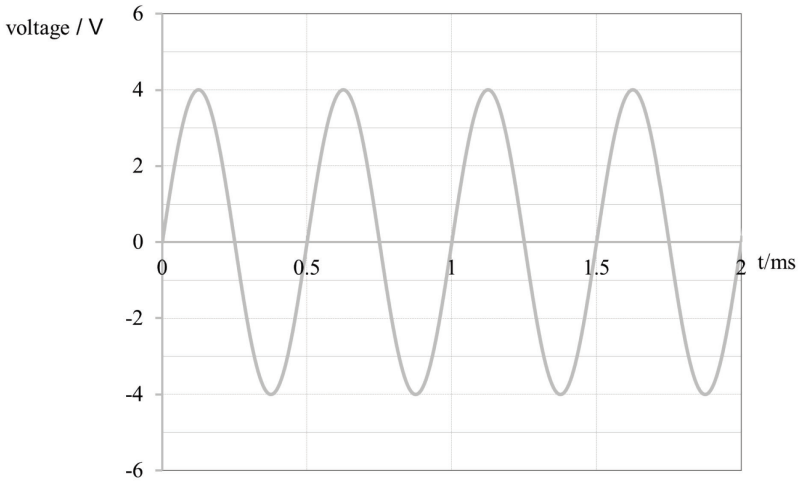
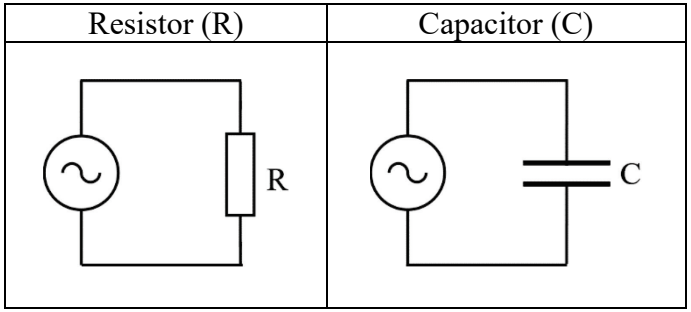
Annotation	Meaning
	Correct response worthy of a mark. Number of ticks = number of marks awarded.
	Incorrect response
	Missing something/incomplete response
	Error carried forward
	Benefit of doubt
	No benefit of the doubt
	Rounding error

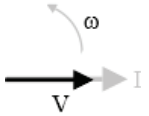
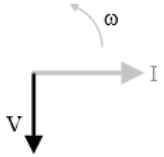
11. **Subject-specific marking instructions**

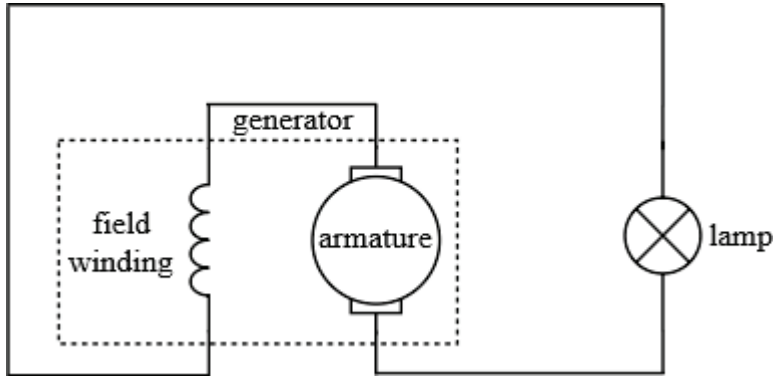
- In all numerical calculation questions a correct response will gain all marks unless specified otherwise.
- Rounding of answers should be to the same number of significant figures as the data in the question, or, otherwise, an answer will be correct provided it rounds to the correct answer.
- Symbols used in circuit diagrams must identify relevant components uniquely and unambiguously.

Question			Answer	Marks	Guidance
1	(a)		4.5 – 1.2 = 3.3 (V)	1	
1	(b)		I = V/R = 3.3 / 220 = 0.015 A OR 15 mA	2	1 mark for number, 1 mark for units Accept any valid units. Synoptic mark from Unit 2: 1.1 Units and value must match for 2 marks Allow ecf for their V from **(a)**
1	(c)		P = IV = 0.015 × 1.2 = 0.018 (W)	1	Allow 18 mW Allow ecf for their I from **(b)**
1	(d)		V = 4.5 – 1.2 = 3.3 V P = 250 mW = 0.25 W I = P/V = 0.25 / 3.3 = 0.0758 A R = V/I = 3.3 / 0.0758 OR R = $V^2/P = 3.3^2 / 0.25$ OR any other correct method R = 44 Ω	 1 1 1	 Evidence of correct conversion from mW to W Evidence of correct method. Synoptic mark from Unit 2: 3.8 Correct answer Allow ecf for their V from **(a)**

Question			Answer	Marks	Guidance
1	(e)			1	Light sensor and ammeter in series Battery providing current to light sensor
1	(f)			1	Arrow points to 2m in A range

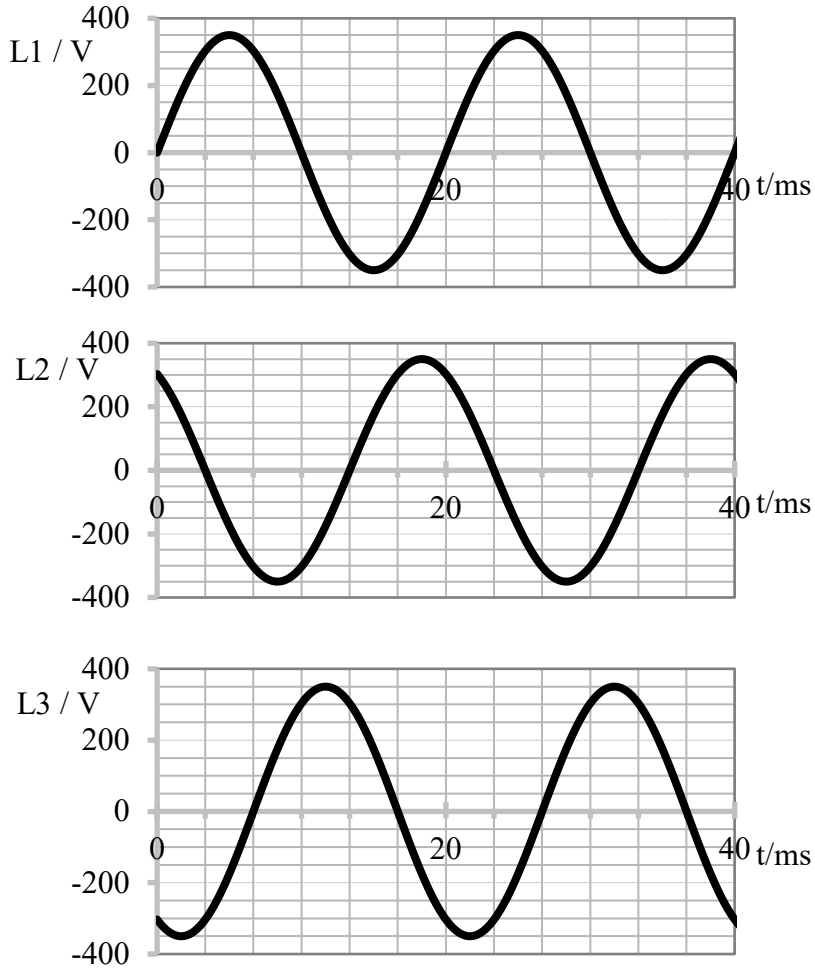
Question			Answer	Marks	Guidance
2	(a)			1 1 1	Sine wave (by eye) Oscillates between –4 V and +4 V Periodic signal, period 0.5 ms
2	(b)			1+1	1 mark for each correct circuit diagram

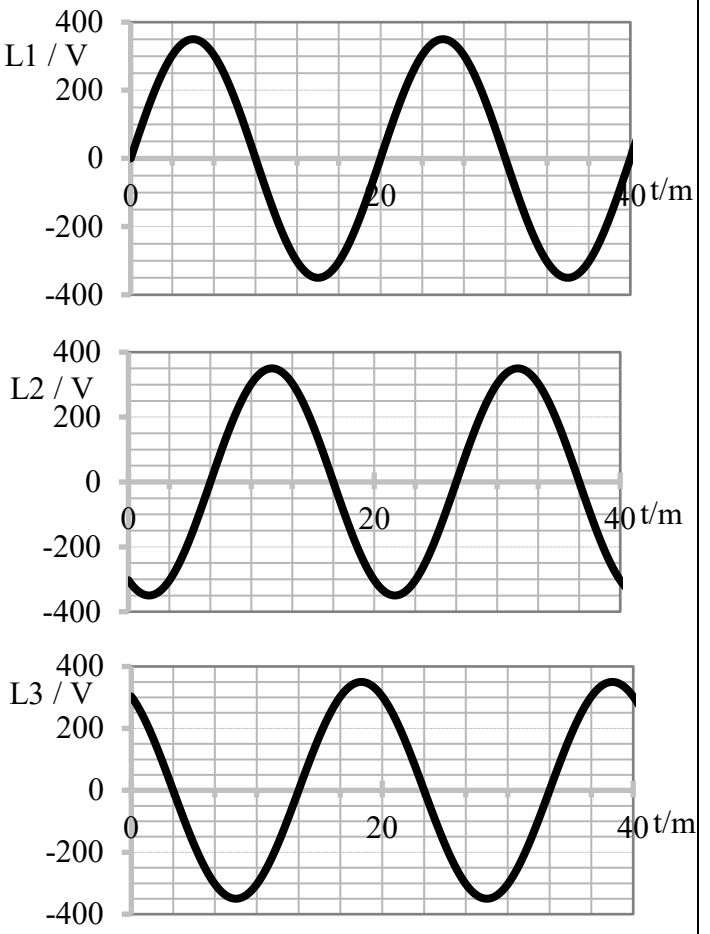
Question			Answer	Marks	Guidance
2	(c)		<table><tr><th>Resistor (R)</th><th>Capacitor (C)</th></tr><tr><td>  </td><td>  </td></tr></table>	1+1	1 mark for each correct phasor diagram
2	(d)		<table><tr><th>Resistor (R)</th><th>Capacitor (C)</th></tr><tr><td>R = 360 Ω</td><td>$Z=X_c=1/2\pi fC$ $C=1/2\pi fZ$ $C=1/(2\pi\times2000\times360)$ $C = 2.2\text{x}10^{-7}$ F OR C=220 nF OR C= 0.22 μF</td></tr></table>	2+2	In each case: 1 mark for correct units (Synoptic marks from Unit 2: 1.1), 1 mark for correct value matching units.

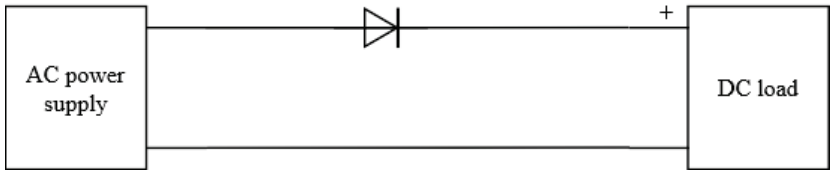
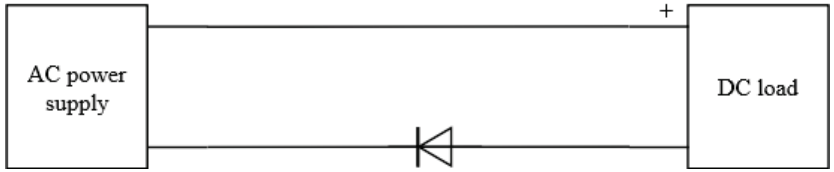
Question			Answer	Marks	Guidance
3	(a)		I_f = 12 / 21 = 0.57 (A)	1	
3	(b)	(i)	I=P/V = 65 / 24 = 2.71 (A)	1	
3	(b)	(ii)	$E=V+I_aR_a$ = 24 + (2.71 × 1.8) = 28.9 (V)	1 1	Evidence of use of correct equation Correct answer. Synoptic mark from 1: 1.1 Allow ecf for Ia from 3bi
3	(c)		Max 3 from: • Brightness reduces • Because reduced field winding voltage causes reduced current in field winding • Reduced magnetic field strength/flux in generator • Less torque required to turn generator • So reduced voltage/EMF from armature • Reduced current through lamp/armature current • So less power from/to lamp	3	
3	(d)			1 1	Armature in series with field winding Lamp powered by armature

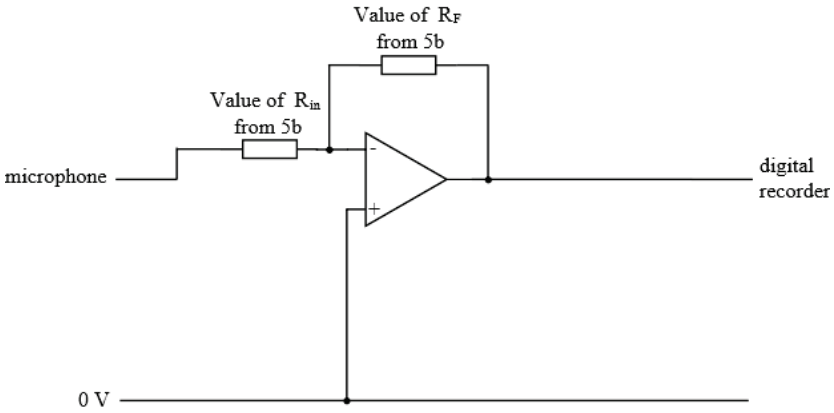
Question			Answer	Marks	Guidance
4	(a)	(i)	Simple/cheaper installation Appliances simpler/cheaper to manufacture	1	Accept any other valid advantage of using **a single phase 2-wire system**
4	(a)	(ii)	Less copper needed <u>for same power</u> as single phase More efficient motors Smoother motor operation Smoother or constant power 2 different voltages can be supplied	1	Accept any other valid advantage of using a **three phase 4-wire system**

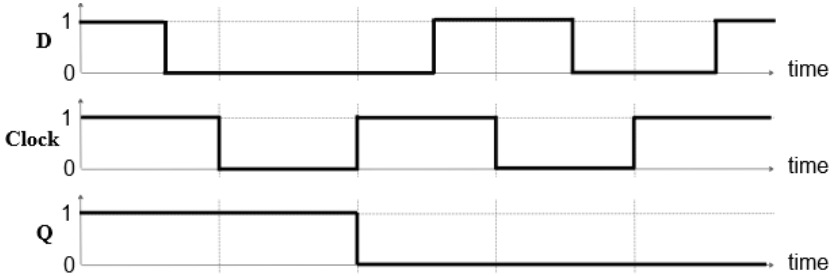
Question			Answer	Marks	Guidance
4	(a)	(iii)	L2 & L3 sine waves of same period and amplitude as L1 L2 120º out of phase with L1 L3 120º out of phase with L1 and L2	1 1 1	Synoptic mark from 1: 4.5 Or





Question			Answer	Marks	Guidance
4	(b)	(i)	Alternating current: changes direction periodically/moves one way then the other continually/keeps changing direction (owtte)	1	Do not accept 'flows in both directions'. Answer must express the idea that the change in direction of current flow changes with time.
4	(b)	(ii)	Direct current: only flows in one direction (owtte)	1	
4	(b)	(iii)	Circuit produces rectified DC at load Circuit produces correct polarity at load  OR 	1 1	
4	(b)	(iv)	Diode only conducts in one direction/only allows current to flow in one direction When current flows clockwise/during positive half of the wave cycle/when the top wire is at a higher voltage than the bottom wire the diode conducts to the load During the negative half of the wave cycle/when the bottom wire is at a higher voltage than the top wire the diode does not conduct and so the current cannot flow anti-clockwise	1 1 1	Correct description of diode behaviour How rectifier works when conducting How rectifier works when not conducting

Question			Answer	Marks	Guidance
5	(a)	(i)	G = Vout/Vin = 0.4/0.008 = <u>50</u>	1	
5	(a)	(ii)	$R_F = 50 \times R_{in}$	1	Accept any values for R_F and R_{in} where the values are in the ratio 50:1 Ignore any minus signs ecf from their 5ai
5	(b)	(i)	Input labelled 'microphone' Output labelled 'digital recorder' Non-inverting input on op-amp connected to 0 V Resistor from input to inverting input on op-amp labelled with value of R_{in} from 5b (ecf) Resistor from op-amp output to op-amp inverting input labelled with value of R_F from 5b (ecf)  	1 1 1 1 1	Allow 1 mark for last two marking points if both resistors in correct position but R_{in} and R_F values incorrectly transcribed from 5aii
5	(b)	(ii)	Increase the value of R_F (owtte) Reduce the value of R_{in} (owtte)	1 1	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td></td><td>Q stays high until first rising edge of Clock and then goes low
Q is low from first rising edge of Clock to end
 
</td><td>1
1</td><td></td></tr>
<tr><td>6</td><td>(b)</td><td>(i)</td><td>All combinations of L and M
S correct
<table><tr><th>L</th><th>M</th><th>S</th></tr><tr><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>1</td><td>1</td><td>0</td></tr></table></td><td>1
1</td><td>All combinations of L and M needed for this mark</td></tr>
<tr><td>6</td><td>(b)</td><td>(ii)</td><td>NOR</td><td>1</td><td>ecf for their 6bi</td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(b)</td><td>(iii)</td><td>  </td><td>1</td><td>ecf for their 6bi</td></tr>
<tr><td>6</td><td>(c)</td><td></td><td>
<table>
<tr><th>D</th><th>E</th><th>F</th><th>G</th></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><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></tr>
</table>
</td><td>4</td><td>1 mark for each correct column
ecf E from D
ecf G from E and F</td></tr>
</table>

Need to get in touch?

If you ever have any questions about OCR qualifications or services (including administration, logistics and teaching) please feel free to get in touch with our customer support centre.

Call us on

01223 553998

Alternatively, you can email us on

support@ocr.org.uk

For more information visit

ocr.org.uk/qualifications/resource-finder

ocr.org.uk

Twitter/ocrexams

/ocrexams

/company/ocr

/ocrexams

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

OCR is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

OCR operates academic and vocational qualifications regulated by Ofqual, Qualifications Wales and CCEA as listed in their qualifications registers including A Levels, GCSEs, Cambridge Technicals and Cambridge Nationals.

OCR provides resources to help you deliver our qualifications. These resources do not represent any particular teaching method we expect you to use. We update our resources regularly and aim to make sure content is accurate but please check the OCR website so that you have the most up-to-date version. OCR cannot be held responsible for any errors or omissions in these resources.

Though we make every effort to check our resources, there may be contradictions between published support and the specification, so it is important that you always use information in the latest specification. We indicate any specification changes within the document itself, change the version number and provide a summary of the changes. If you do notice a discrepancy between the specification and a resource, please contact us.

Whether you already offer OCR qualifications, are new to OCR or are thinking about switching, you can request more information using our Expression of Interest form.

Please get in touch if you want to discuss the accessibility of resources we offer to support you in delivering our qualifications.