CAMBRIDGE TECHNICALS

OCR
Oxford Cambridge and RSA

CAMBRIDGE TECHNICALS LEVEL 3 (2016)

Examiners' report

ENGINEERING

05822–05825, 05873

Unit 4 January 2024 series

Version 1

Contents

Introduction

Our examiners’ reports are produced to offer constructive feedback on candidates’ performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates’ performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Would you prefer a Word version?

Did you know that you can save this PDF as a Word file using Acrobat Professional?

Simply click on **File > Export to** and select **Microsoft Word**

(If you have opened this PDF in your browser you will need to save it first. Simply right click anywhere on the page and select **Save as . . .** to save the PDF. Then open the PDF in Acrobat Professional.)

If you do not have access to Acrobat Professional there are a number of **free** applications available that will also convert PDF to Word (search for PDF to Word converter).

Unit 4 series overview

The majority of candidates were able to access the paper. However, although it followed a very similar format and structure to previous series, there were increased instances of non-response from candidates, including in those areas that previously scored well.

Candidates were able to recall key definitions and diagrams with the more successful candidates able to apply their knowledge to explain and annotate.

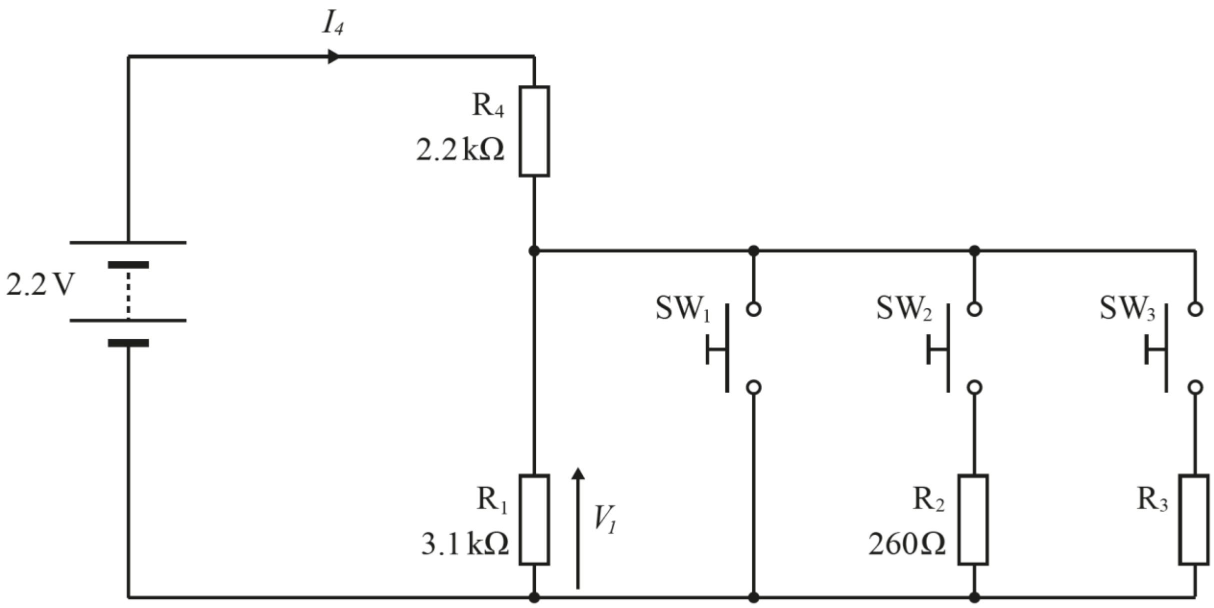
As stated in the mark scheme, "rounding of answers should be to the same number of significant figures as the data in the question, or, otherwise, an answer will be correct if it rounds to the correct answer." Candidates should be aware of this and take care not to over round, particularly when no working out is shown or the answer is given to 1sf when the question e.g. gives figures to 2sf.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• noted when a question contained prefixes and subsequently used the correct power of ten • performed algebraic computations clearly and correctly with full working • had learned diagrams for op amp and generator circuits.	• had not learned the function of key components e.g. a circuit breaker or generator • had not learned the correct units for a given quantity • showed little working out meaning it was often difficult to determine which equation was being used.

Question 1 (a)

1 The diagram in **Fig. 1** shows the circuit for the control switches on a mobile phone.

Fig. 1



(a) Draw on **Fig. 1** to show how an ohmmeter should be connected to measure the value of R_3.

[1]

Although the majority of candidates that attempted this question were successful there were a significant number not attempting the question at all, despite the similarity to questions in previous papers. The most common incorrect responses were to show the ohmmeter in series or in parallel across both R3 and SW3 (i.e. across an open circuit).

Question 1 (b)

(b) Give **one** reason why switch SW_3 should not be pressed when measuring the resistance of R_3 with an ohmmeter.

....

.... **[1]**

Despite this question appearing in a previous paper, only a small number of candidates gave the most important reason of the current going through the circuit damaging the ohmmeter.

Misconception

A significant minority of candidates described the switch "adding resistance" into the circuit, which is a misconception as the switch, like other wires in the circuit, would be assumed to have zero resistance.

Question 1 (c)

(c) Calculate the current I_4 when **no** switches are pressed.

$I_4 =$ .... A **[2]**

Many candidates were able to calculate the current with the most popular incorrect response being to exclude the 3.1kΩ resistor from the calculation.

Question 1 (d)

(d) Find the current I_4 when **only** switch SW_1 is pressed.

$I_4 =$ .... A **[1]**

Again this question was well attempted but a number of candidates believed the answer to be the same as Question 1(c) and did not seem to understand the effect of closing SW1.

Assessment for learning

Candidates should be familiar with circuits such as these with several switches including the effect of a short circuit.

Question 1 (e)

(e) Calculate the voltage V_1 when **only** switch SW_2 is pressed.

$V_1 =$ .... V **[3]**

Most candidates struggled with this calculation involving resistors in parallel, with marks being far more likely to be scored when clear working out was shown in this multi-step problem.

Question 1 (f)

(f) When **only** switch SW_3 is pressed the voltage V_1 is 0.387 V.

Calculate the value of R_3.

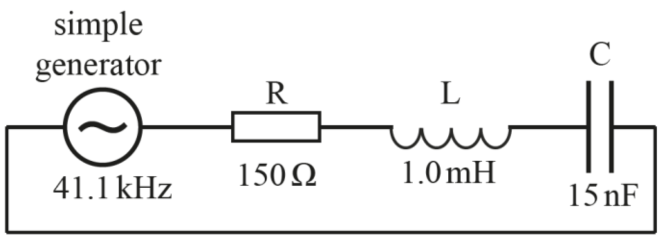
value of R_3 = ... Ω **[2]**

This question, including application of Kirchhoff's Laws and parallel resistor calculations was accessible only to the most able candidates with a significant amount not attempting a response.

Question 2 (a)

2 The diagram in **Fig. 2** shows a circuit connected to a simple generator. The AC waveform from the generator is a sine wave with amplitude $V = 0.6$ V and frequency $f = 41.1$ kHz.

Fig. 2



(a) State the function of a simple generator.

....

.... **[1]**

The majority of candidates answered this question successfully.

Question 2 (b)

(b) Calculate the period (T) of the signal from the simple generator.

period, $T =$ .... s **[1]**

Many candidates used 41.1 in the calculation instead of 41,100 for conversion from kHz to Hz. A significant number were unable to use the relationship between period and frequency to gain a correct answer, often selecting unrelated equations from the formula booklet.

Question 2 (c)

(c) Calculate the angular frequency (ω) of the signal from the simple generator.

Give the units for your answer.

angular frequency, $\omega =$ .... **[2]**

Those candidates that were able to select the correct equation from the formula booklet were likely to gain marks for the correct numerical response (although some continued to use the frequency in kHz or converted incorrectly). A very small number of candidates were able to recall the units of angular frequency with the most common incorrect response being Hz.

Question 2 (d)

(d) Use the equation $v = V \sin \omega \tau$ for an AC waveform to calculate the voltage at time $\tau = 14\,\mu s$ in the simple generator.

voltage, $v =$ .... V **[2]**

Even though the equation was given, a large number of candidates struggled to use it successfully.

Assessment for learning

Candidates should be shown how to change their calculator to work in radians and how to use brackets in their calculations – noting that the equation is Vsinωt which is the sin of ωt as opposed to the sin of ω then multiplied by t.

Question 2 (e)

(e) Calculate the reactance of each component in the circuit at $f = 41.1$ kHz.

Write your values in the table.

Component	**Reactance / Ω**
Capacitor	
Inductor	
Resistor	

[3]

Most candidates were able to calculate the reactance of the inductor, however, many made mistakes in the calculation of capacitive reactance and only a very small minority were able to state that the reactance of a resistor is zero Ohms. Again, many candidates neglected to convert kHz to Hz for their calculation and there was a disappointing level of working out shown.

Question 2 (f)

(f) Calculate the impedance of the circuit at $f = 41.1$ kHz.

impedance, $Z =$ .... Ω **[1]**

A large number of candidates were able to achieve this mark with ecf from their 2f with the most common incorrect response being to only include the reactance of the inductor or capacitor in their calculation and not both as required.

Question 2 (g)

(g) Calculate the phase angle (f) in degrees between the voltage and current from the simple generator on **Fig. 2.**

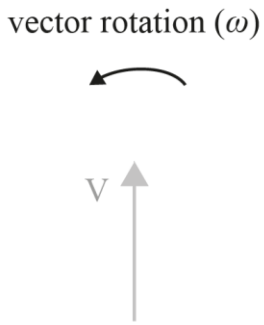
Phase angle, f= .... ° **[1]**

Again with ecf candidates were able to apply the equation in the formula booklet to obtain a value for phase angle, although several responses were seen of candidates using sin or, more commonly, tan, having first constructed their own right angled triangle.

Question 2 (h)

(h) Complete the phasor diagram below to show the phase relationship between the voltage and current from the simple generator.

Draw an arrow for the current vector, I.



[1]

Very few candidates demonstrated the knowledge that a phase angle of zero degrees would mean the voltage and current would be in phase and thus pointing in the same direction.

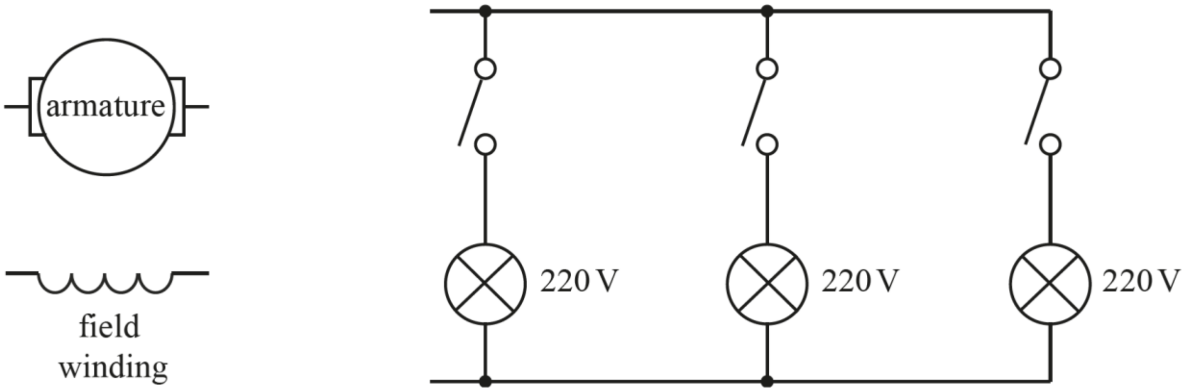
Question 3 (a)

3 A shunt-wound self-excited DC generator is used to provide power for a set of 220 V lamps.

The armature resistance is 4 Ω and the field winding resistance is 300 Ω.

(a) Complete the diagram in **Fig. 3** to show how the field winding, the armature and the lighting circuit are connected.

Fig. 3



[2]

Candidates struggled to connect the drawn armature and field winding correctly to the circuit to form a shunt wound generator even though this question is very similar to previous papers. Many short circuits were seen, or candidates attempting to redraw the armature and field winding in a more convenient location (which was not given).

Question 3 (b)

(b) The generator needs to supply 220 V to the lamps when one, two or three lamps are switched on.

Explain why a shunt-wound self-excited DC generator is suitable for this application.

....

....

....

.... **[2]**

Many candidates gave only one fact and neglected to fully explain or make an extra point for the second mark.

Assessment for learning

Candidates should be encouraged to look at the number or marks allocated to a question.

Question 3 (c)

(c) Calculate the current in the field winding (I_f) when the voltage from the generator is 220 V.

I_f= .... A **[2]**

This was a high scoring question attempted successfully by the vast majority of candidates.

Question 3 (d)

(d) Calculate the current in the armature (I_a) when the voltage from the generator is 220 V and the current to the lamps is 1.36 A.

I_a = ... A **[1]**

Most candidates were given this mark and those that showed clear working out could be given ecf from Question 3(c).

Question 3 (e)

(e) Calculate the EMF (E) generated in the armature when the voltage from the generator is 220 V and the current to the lamps is 1.36 A.

Give the units for your answer.

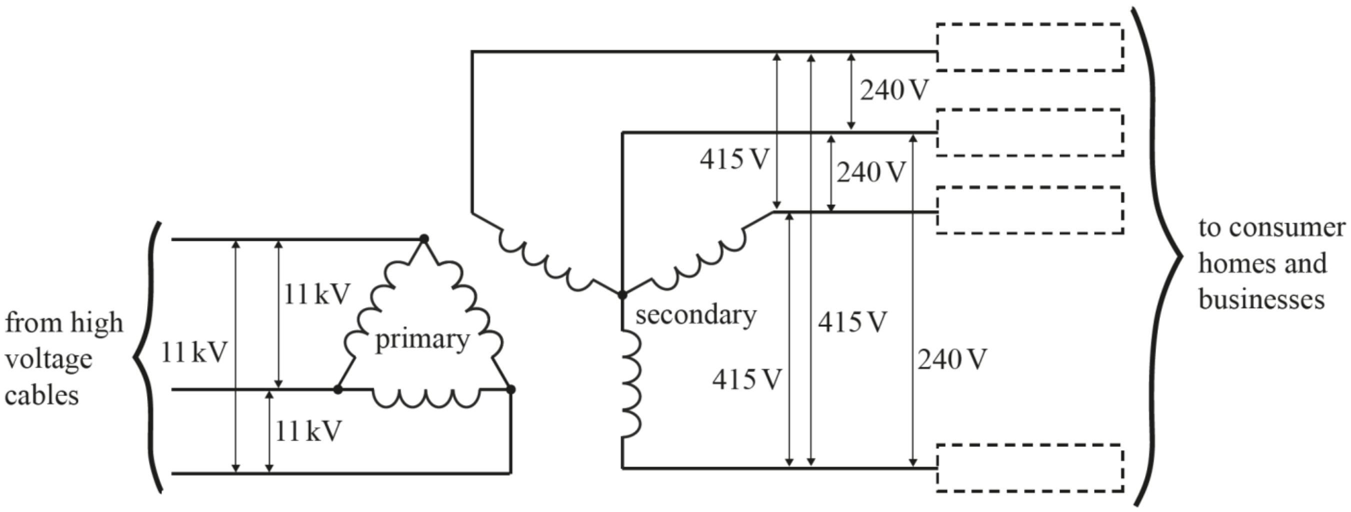
$E =$ .... **[3]**

Although this question remains difficult, many more candidates than in previous series were able to perform a successful rearrangement of this difficult EMF equation. However, the fact that the unit of EMF is the Volt is still not widely known and many candidates did not give a unit in their response despite it being asked for in the question.

Question 4 (a)

4 The diagram in **Fig. 4** shows a system for supplying electricity to a local area from the higher voltage supply power lines.

Fig. 4



(a) Correctly label the wires from the secondary windings in **Fig. 4** by writing 'neutral' or 'phase' in each box.

[1]

This question was well attempted with the most common incorrect responses including two neutral and two phase wires or the neutral wire being the third option.

Question 4 (b)

(b) Complete the sentences below about the system in **Fig. 4** using the most appropriate term in each gap.

Choose terms from the following list.

Each term may be used once, more than once or not at all.

bridge

delta

line

phase

star

The system has a ……………………...................... connected primary and

a ……………………...................... connected secondary.

The ……………………...................... voltage of the secondary is 415 V.

The ……………………...................... voltage of the secondary is 240 V.

[4]

Delta and star were commonly seen for the first responses and line and phase for the second (although candidates often got these the wrong way round). The distractor of bridge was selected by many and a large number of candidates crossed out and reselected options, giving the impression that this is not a well revised section.

Question 4 (c) (i)

(c) Circuit breakers are often used in electricity supply circuits.

(i) Describe the function of circuit breakers.

....

....

....

.... **[2]**

The vast majority of candidates were able to score here.

Question 4 (c) (ii)

(ii) Describe **one** advantage of a circuit breaker over a fuse.

....

....

....

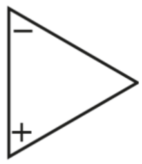
.... **[2]**

In describing the advantage of a circuit breaker over a fuse, candidates needed to explain the properties of the circuit breaker and the fuse to obtain 2 marks. However, many just stated a property of one and neglected to compare it to the other.

Question 5 (a)

5 Part of the circuit symbol of an op-amp is shown in **Fig. 5**.

Fig. 5



(a) Add connections to op-amp symbol in **Fig. 5** for:

- the inputs
- the output
- the power supply.

Label all the connections.

[3]

Although "how to draw a labelled diagram of an op amp" is explicitly stated in the specification, very few candidates seemed familiar with this. Many candidates drew out an attempt at an inverting or non-inverting op amp circuit.

Assessment for learning

When asked to draw/add to diagrams and label, candidates should label using the words given, in this case inputs, output, power supply. Far too many candidates were using alternative labels such as Vout or V+ which could be viewed as ambiguous and a clear result of not properly reading the question.

Question 5 (b)

(b) Draw components and connections on **Fig. 6** to show how to make a summing amplifier from an op-amp.

Connect the inputs to V_1 and V_2 and the output to V_{out}.

You do not need to show the power supply pins for the op-amp.

Fig. 6

[5]

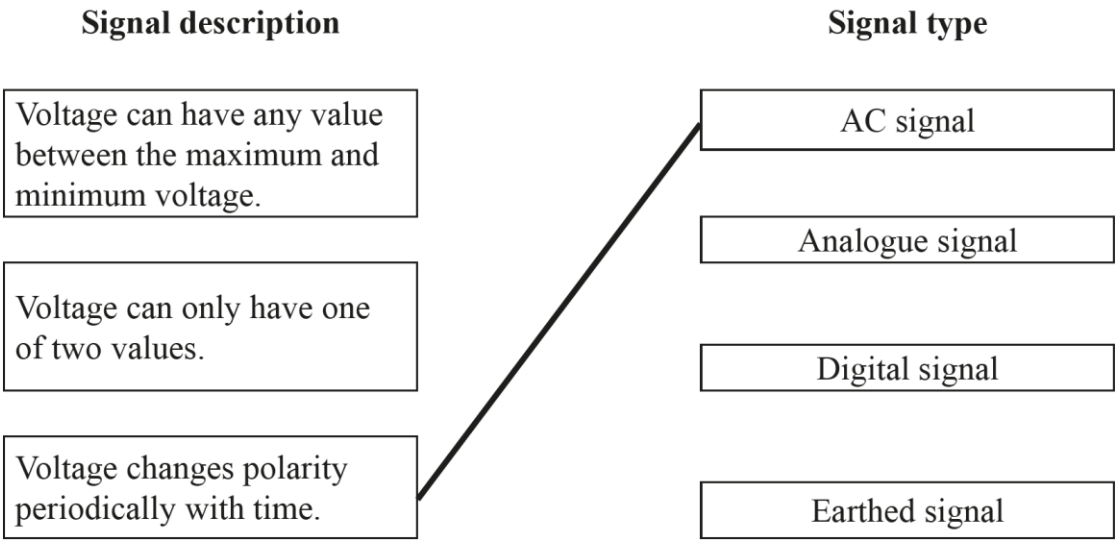
Although this has been a very common question over the past exam series, candidates still rarely achieve full marks with the most common mistakes being the feedback loop connecting to the non-inverting input and incorrect or incomplete inclusion of resistors.

Question 5 (c)

(c) Draw lines to join each signal description box to the most appropriate signal type box.

One of the lines has already been drawn for you.

You must only draw **two** lines.



[2]

Although the majority of candidates selected analogue and digital, many got them the wrong way round and the selection of earthed signal was also commonly seen.

Question 6 (a)

6

(a) Draw the symbol for a NOT gate.

[1]

Most candidates were able to draw the symbol with the most common incorrect responses being a triangle or showing two inputs.

Question 6 (b)

(b) Draw a truth table for the NOT gate.

[2]

This question was well attempted although a significant minority of candidates showed two inputs.

Question 6 (c)

(c) Describe the function of the NOT gate.

....

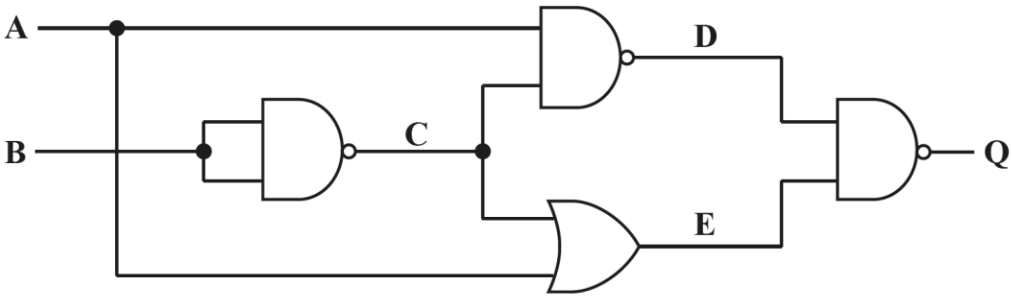
.... **[1]**

The majority of candidates gave a correct response to this question with the most successful explaining clearly, giving examples.

Question 6 (d) (i)

(d) A logic circuit is shown in **Fig. 7**.

Fig. 7



(i) Complete the truth table for the circuit in **Fig. 7**.

A	B	C	D	E	Q
0	0				
0	1				
1	0				
1	1				

[4]

C was the least likely to be given marks, with candidates struggling to determine the output when the two inputs were identical (i.e. both came from B each time). Candidates should learn all truth tables as it was clear the OR table was much better understood than the NAND.

Assessment for learning

Candidates should be shown how to score out their response clearly in a truth table before replacing it with an alternative. Truth tables with a 1 and a 0 on top of each other cannot be given as there is no way to determine which number was entered first and which has replaced it.

Question 6 (d) (ii)

(ii) The circuit in **Fig. 7** can be replaced by a single logic gate that would have the same function.

Draw the symbol of the single logic gate that could replace the circuit in **Fig. 7**.

Label the inputs **A** and **B** and label the output **Q**.

[1]

Candidates that achieved a correct Q column were likely to draw the correct XOR gate. Some marks were given for ecf for an incorrect Q.

Supporting you

Teach Cambridge

Make sure you visit our secure website **Teach Cambridge** to find the full range of resources and support for the subjects you teach. This includes secure materials such as set assignments and exemplars, online and on-demand training.

Don't have access? If your school or college teaches any OCR qualifications, please contact your exams officer. You can forward them this link to help get you started.

Reviews of marking

If any of your students' results are not as expected, you may wish to consider one of our post-results services. For full information about the options available visit the OCR website.

Keep up-to-date

We send a monthly bulletin to tell you about important updates. You can also sign up for your subject specific updates. If you haven't already, sign up here.

OCR Professional Development

Attend one of our popular CPD courses to hear directly from a senior assessor or drop in to a Q&A session. Most of our courses are delivered live via an online platform, so you can attend from any location.

Please find details for all our courses for your subject on **Teach Cambridge**. You'll also find links to our online courses on NEA marking and support.

Signed up for ExamBuilder?

ExamBuilder is the question builder platform for a range of our GCSE, A Level, Cambridge Nationals and Cambridge Technicals qualifications. Find out more.

ExamBuilder is **free for all OCR centres** with an Interchange account and gives you unlimited users per centre. We need an Interchange username to validate the identity of your centre's first user account for ExamBuilder.

If you do not have an Interchange account please contact your centre administrator (usually the Exams Officer) to request a username, or nominate an existing Interchange user in your department.

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**
- **facebook.com/ocrexams**
- **twitter.com/ocrexams**
- **instagram.com/ocrexaminations**
- **linkedin.com/company/ocr**
- **youtube.com/ocrexams**

We really value your feedback

Click to send us an autogenerated email about this resource. Add comments if you want to. Let us know how we can improve this resource or what else you need. Your email address will not be used or shared for any marketing purposes.

I like this **I dislike this**

Please note – web links are correct at date of publication but other websites may change over time. If you have any problems with a link you may want to navigate to that organisation's website for a direct search.

CAMBRIDGE
UNIVERSITY PRESS & ASSESSMENT

OCR acknowledges the use of the following content: N/A