Foundation

GCSE

Physics A Gateway

J249/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 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.

MARKING INSTRUCTIONS

PREPARATION FOR MARKING

RM ASSESSOR

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: *RM 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 available in RM Assessor.
3. Log-in to RM Assessor and mark the **required number** of practice responses ("scripts") and the **required number** of standardisation responses.

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 RM Assessor 50% and 100% (traditional 50% 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, email or via the RM Assessor messaging system.

5. Work crossed out:

   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks

   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects 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 the annotation SEEN to confirm that the work has been read.

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 any way 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 email.

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

10. For answers marked by levels of response:

Read through the whole answer from start to finish, using the Level descriptors to help you decide whether it is a strong or weak answer. The indicative scientific content in the Guidance column indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the skills and science content evidenced within the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer.

Once the level is located, award the higher or lower mark:

The higher mark should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.

The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing.

In summary:

The skills and science content determines the level.

The communication statement determines the mark within a level.

Level of response questions on this paper is **20(b)**.

11. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
	Benefit of doubt given
	Contradiction
	Rounding error
	Error in number of significant figures
	Error carried forward
	Level 1
	Level 2
	Level 3
	Benefit of doubt not given
	Noted but no credit given
	Ignore

12. Abbreviations, annotations and conventions used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
✓	Separates marking points
DO NOT ALLOW	Answers which are not worthy of credit
IGNORE	Statements which are irrelevant
ALLOW	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
ECF	Error carried forward
AW	Alternative wording
ORA	Or reverse argument

13. **Subject-specific Marking Instructions**

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet **Instructions for Examiners**. If you are examining for the first time, please read carefully **Appendix 5 Introduction to Script Marking: Notes for New Examiners**.

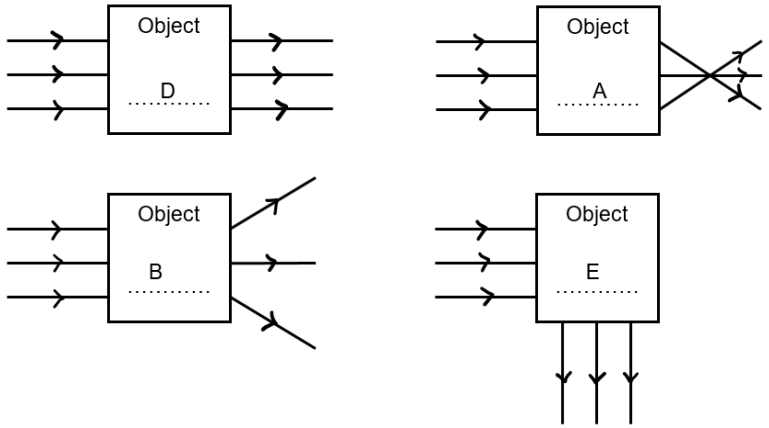
Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.

The breakdown of Assessment Objectives for GCSE (9-1) in Physics A:

	Assessment Objective
AO1	**Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.**
AO1.1	Demonstrate knowledge and understanding of scientific ideas.
AO1.2	Demonstrate knowledge and understanding of scientific techniques and procedures.
AO2	**Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.**
AO2.1	Apply knowledge and understanding of scientific ideas.
AO2.2	Apply knowledge and understanding of scientific enquiry, techniques and procedures.
AO3	**Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.**
AO3.1	Analyse information and ideas to interpret and evaluate.
AO3.1a	Analyse information and ideas to interpret.
AO3.1b	Analyse information and ideas to evaluate.
AO3.2	Analyse information and ideas to make judgements and draw conclusions.
AO3.2a	Analyse information and ideas to make judgements.
AO3.2b	Analyse information and ideas to draw conclusions.
AO3.3	Analyse information and ideas to develop and improve experimental procedures.
AO3.3a	Analyse information and ideas to develop experimental procedures.
AO3.3b	Analyse information and ideas to improve experimental procedures.

For answers to Section A if an answer box is blank ALLOW correct indication of answer e.g. circled or underlined.

Question	Answer	Marks	AO element	Guidance
1	B	1	1.1	
2	D	1	2.1	**ALLOW** 4.8 (s)
3	A	1	1.1	
4	B	1	1.1	**ALLOW** 10 (ms)
5	A	1	1.1	
6	C	1	1.1	
7	C	1	2.1	
8	B	1	2.2	
9	D	1	1.1	
10	C	1	1.1	
11	D	1	2.1	
12	D	1	2.1	**ALLOW** 1250 (MJ)
13	C	1	2.1	**ALLOW** 0.060 (m)
14	A	1	1.1	
15	B	1	2.1	**ALLOW** 6.0 (m / s^2)

Question			Answer	Marks	AO element	Guidance
16	(a)		D ✓ A ✓ B ✓ E ✓ 	4	4 × 1.2	
	(b)		**First check the answer on answer line** **If answer = 4.6 × 10^{14} (Hz) award 4 marks** Rearrange to give: (f =) v ÷ λ ✓ (f =) 2 × 10^{8} ÷ (4.33 × 10^{-7}) ✓ (f =) 4.62… × 10^{14} (Hz) ✓ (f =) 4.6 × 10^{14} (Hz) (2sf) ✓	4	 1.2 2.1 2.1 1.2	 **ALLOW** 1 mark for correct substitution into unrearranged equation e.g., 2 x 10^{8} = f x 4.33 x 10^{-7} **ALLOW** 4.62… × 10^{n} for 2 marks **ALLOW** 4.6 × 10^{n} for 3 marks **ALLOW** this mark for clear evidence of an incorrect answer (correctly rounded) to two significant figures (not a bald incorrect answer to 2 s.f.)

16	**(c)**	**(i)**	(shirt) Black (number) Blue ✓	**1**	**2.1**	Both required for 1 mark
		(ii)	(White) number (and shirt) reflects red (light only) / (white) number (and shirt) looks red / (white) number and shirt look the same colour ✓	**1**	**2.1**	**ALLOW** (idea that) both look red / whole shirt looks red / both look the same colour **DO NOT ALLOW** red is absorbed by shirt/number / both look any incorrect colour **IGNORE** they blend in **IGNORE** any other colours absorbed

Question			Answer	Marks	AO element	Guidance
17	(a)	(i)	(Idea that half-life is short enough) so water/surroundings don't remain radioactive for too long ✓ (Idea that half-life is long enough) to allow repeat readings / for examination to take place ✓	2	2 × 3.1b	**ALLOW** so it doesn't contaminate/irradiate/emit radiation/stay unstable for too long **IGNORE** less damage/harm **ALLOW** (idea that) it stays in pipe long enough to detect the leak / enough time to be detected / enough time to reach leak **IGNORE** it lasts for a long time / long enough to be used/useful
		(ii)	(tracer/radiation/beta/gamma) can be detected above earth/ground ✓	1	1.2	**ALLOW** beta/gamma can penetrate/pass through/get through the ground/earth **IGNORE** beta/gamma are very penetrating **IGNORE** ideas about alpha
		(iii)	(Stable isotope) does not emit (ionising) radiation / **ORA** ✓	1	3.2b	**ALLOW** (stable isotope) is not radioactive / does not contaminate/irradiate/decay / **ORA** **IGNORE** so it is no longer dangerous / so it becomes safe
	(b)		**Any two from:** Tracer is added to pipe/water / detector is moved along the surface of the ground ✓ Reading (on the detector) will increase (above the leak) ✓ (Reading on the detector will increase when the detector is) above/around the leak ✓	2	2 × 2.2	 **ALLOW** detector is placed above the ground/pipe **ALLOW** more radiation is detected (above the leak) **ALLOW** (more radiation is detected) above/around the leak

17	**(c)**		**First check the answer on answer line** **If answer = 3 (mg) award 2 marks** (30 ÷ 15 =) 2 (half-lives) ✓ (Mass remaining = 12 × $(0.5)^2$ =) 3 (mg) ✓	**2**	 **2.1** **2.1**	 **ALLOW** any indication of two halvings shown, e.g., of 24 or 15

Question			Answer	Marks	AO element	Guidance
18	(a)	(i)	<table><tr><td>2</td></tr><tr><td>2</td></tr><tr><td>0</td></tr></table> ✓✓	2	2 x 1.1	All 3 correct = 2 marks 2 correct = 1 mark
		(ii)	Alpha cannot penetrate body/skin **OR** alpha is absorbed by the body/skin ✓	1	1.2	**ALLOW** skin blocks alpha **IGNORE** alpha is highly ionising / not very penetrating
	(b)	(i)	Isotopes ✓	1	1.1	
		(ii)	e ✓ $^{0}_{-1}$ ✓	2	2 × 2.2	**ALLOW** β for e Both 0 as mass number **and** -1 as proton number required for the mark
	(c)		**First check the answer on answer line** **If answer = 1.7 × 10^8 (Bq) award 3 marks**	3		
			(1 μg =) 1 × 10^{-6} g **OR** 0.000001 g ✓		1.2	**ALLOW** 1 mark for 2.1 x 10^8 (μg)
			(activity =) 3.57 × 10^{16} ÷ (2.10 x 10^8) **Or** 3.57 × 10^{16} x 10^{-6} ÷ 210 **Or** 170 000 000 (Bq) ✓		2.2	**ALLOW** 1 mark for 3.57 x 10^{16} ÷ 2.10 x 10^n **OR** 3.57 × 10^{16} x 10^n ÷ 210 **OR** 170…… i.e., in non standard form (where there is no/incorrect unit change)
			(activity =) 1.7 × 10^8 (Bq) ✓		1.2	**ALLOW** 2 marks for 1.7 x 10^n (no/incorrect unit change) **ALLOW** this mark for clear evidence of an incorrect answer written in standard form (not a bald incorrect answer written in standard form)

18	**(d)**	**(i)**	69, 13 ✓	**1**	**2.2**	**BOTH** needed for 1 mark **ALLOW** tolerance of +/- 1
		(ii)	Calculates any one correct ratio from the table ✓ **BUT** Calculates at least two correct ratios **and** states the values are approximately the same / the teacher is correct ✓ ✓	**2**	**2 × 2.2**	**ALLOW ECF** from **(d)(i)** e.g.: $M_0 \div M_{200}$ or 160 ÷ 69 = 2.32 $M_{200} \div M_{400}$ or 69 ÷ 30 = 2.30 $M_{400} \div M_{600}$ or 30 ÷ 13 = 2.31 **ALLOW** ratios calculated over 400 days, e.g., $M_0 \div M_{400}$ or 160 ÷ 30 = 5.3 and $M_{200} \div M_{600}$ or 69 ÷ 13 = 5.3

Question			Answer	Marks	AO element	Guidance
19	(a)	(i)	Arrow with direction vertically upwards ✓ Arrow from lowest energy level to highest energy level ✓	2	2 × 2.1	 **ALLOW** to above the highest energy level
		(ii)	Excited **and** absorbed ✓ Higher than ✓	2	2 × 1.1	**BOTH** required for first mark
	(b)		**Any four from:** (Both lines show) redshift ✓ Redshift for galaxy B > redshift for galaxy A / **ORA** ✓ (Redshift means that) galaxy/galaxies are moving away (from the Earth) ✓ Galaxy B is further away (from the Earth than galaxy A) / **ORA** ✓ Galaxy B is moving faster (than galaxy A) / **ORA** ✓ Galaxy B is moving away from galaxy A ✓	4	 3.1a 3.1a 1.1 3.2b	**ALLOW** galaxy with longest wavelength for galaxy B throughout answer **DO NOT ALLOW** one galaxy moving towards (the Earth) **ALLOW** the more distant galaxy is moving faster / **ORA** **ALLOW** galaxy B is moving away faster (than galaxy A) / **ORA** for 2 marks (mp3 and mp5)

Question			Answer	Marks	AO element	Guidance
20	(a)		**Any three from:** (Formed by clouds of) dust/gas ✓ Drawn together by gravitational force ✓ Gravitational potential energy transferred to kinetic energy ✓ The core becomes very hot/dense ✓ A protostar forms ✓ (Nuclear) fusion began ✓	3	3 × 1.1	 **ALLOW** nebula / formed from hydrogen **ALLOW** gravity for gravitational force **ALLOW** nuclei start to fuse

Question			Answer	Marks	AO element	Guidance
20	(b)	*	Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question. **Level 3 (5–6 marks)** Detailed descriptions of fission **and** fusion **AND** Detailed explanation of why power stations use nuclear fission *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** Detailed description of fission **or** fusion **AND** Clear explanation of why power stations use nuclear fission **OR** Clear description of fission **and** fusion **AND** Clear explanation of why power stations use nuclear fission **OR** Clear description of fission **or** fusion **AND** Detailed explanation of why power stations use nuclear fission *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*	**6**	**4 × 1.1** **2 × 3.2a**	**AO1.1 – Demonstrates knowledge and understanding of nuclear fission and fusion reactions.** • fusion involves joining two lighter/smaller nuclei together into a heavier nucleus to release large amounts of energy • fission involves splitting a heavier/larger nucleus, when hit by a neutron, into two lighter/smaller nuclei to release large amounts of energy • fission releases (2 or 3) neutrons • fusion releases more much energy than fission • fission produces dangerous waste / fusion would not • fission can lead to an uncontrolled chain reaction **AO3.2a – Analyses information and ideas to make judgements about nuclear fusion power stations.** • there is a range of temperatures over which fusion can occur • the probability of fusion happening is very low at low temperatures/temperatures less than 10 million °C • fusion requires very high temperatures/pressures to occur / **ORA** for fission • the highest probability of fusion happening is at approximately 1000 million °C • difficult to contain gases/plasma at very high temperatures for fusion

			Level 1 (1–2 marks) Basic description of fission **and** fusion **OR** Basic description of fission **AND** basic explanation of why power stations use nuclear fission **OR** Basic description of fusion **AND** basic explanation of why power stations use nuclear fission *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant***.** **0 marks** *No response or no response worthy of credit.*			• hard to achieve the high temperatures/pressures needed for fusion on the Earth • more energy is required to make fusion work than is produced at present • more expensive to make fusion work • fusion reactors would be safer

Question			Answer	Marks	AO element	Guidance
21	(a)		**Any four from:** Wrap coil(s) around a (soft iron) rod ✓ Connect a voltmeter across secondary coil / measure p.d. across secondary coil ✓ Connect (a.c. power) supply to primary coil ✓ Change the number of turns in the secondary coil ✓ Keep p.d. of the a.c. supply/primary p.d. constant ✓ Keep number of turns in the primary coil constant ✓	4	4 × 3.3a	**ALLOW** marks awarded from a clear diagram **ALLOW** coils side by side or on top of one another **ALLOW** dependent variable is p.d. across secondary coil **DO NOT ALLOW** d.c. power supply or cell/battery in diagram **ALLOW** independent variable is number of turns **ALLOW** p.d. of a.c. supply/primary p.d. is a control variable **ALLOW** control variable is number of turns in primary coil

Question			Answer	Marks	AO element	Guidance
21	(b)	(i)	**First check the answer on answer line** **If answer = 19.5 (V) award 3 marks**	3		**ALLOW** 19 (V) or 19.49 (V)
			Rearrangement: (V_s =) V_p x (N_s ÷ N_p) ✓		1.2	
			(V_s =) 230 × (300 ÷ 3540) ✓		2.1	**ALLOW** 1 mark for correct substitution into unrearranged equation, e.g., 230 / V_s = 3540 / 300
			(V_s =) 19.5 (V) ✓		2.1	
		(ii)	**First check the answer on answer line** **If answer = 0.39 (A) award 3 marks**	3		**ALLOW ECF** from **(c)(i)**
			Rearrangement: (I_p =) (I_s × V_s)÷ V_p ✓		1.2	**ALLOW** (I_p =) (I_s × N_s)÷ N_p
			(I_p =) 4.62 × 19.5 ÷ 230 ✓		2.1	**ALLOW** (I_p =) 4.62 × 300 ÷ 3540 **ALLOW** 1 mark for correct substitution into unrearranged equation, e.g., 230 x I_p = 4.62 x 19.5 **OR** 3540 x I_p = 4.62 x 300
			(I_p =) 0.39 (A) ✓		2.1	
	(c)	(i)	Candidate states turns ratios from 2 different points on the graph ✓	2	3.1a	e.g., at a ratio of 5, power loss = 0.08 (W) but at a ratio of 10, power loss = 0.02 (W) **ALLOW** tolerance of +/- ½ small square
			Candidate concludes that as turns ratio doubles then power loss is not half / power loss decreases by a factor of 4 / × ¼ / quarters ✓		3.1a	**ALLOW** e.g., power loss at a ratio of 10 should be 0.04 (W)

21	**(c)**	**(ii)**	**Any two from:** Transformers increase voltage/p.d. (before national grid) / AW ✓ Transformers decrease current ✓ Transformers decrease power/energy losses ✓	**2**	**2 × 1.2**	**ALLOW** energy losses are proportional to the current squared / less heat lost to the surroundings / high current causes large energy losses / more efficient energy transfer **DO NOT ALLOW** stops power/energy losses

Question			Answer	Marks	AO element	Guidance
22	(a)		Bar for kinetic energy higher than zero ✓ Bar for thermal energy higher than previous bar ✓ Sum of the heights of the bars = 5 ✓	3	3 × 2.2	**DO NOT ALLOW** this mark if candidate has drawn a kinetic energy bar which is higher in Fig. 22.2
	(b)	(i)	**Any one from:** Insulate the tube ✓ Repeat (the experiment) **and** take an average (temperature rise) ✓	1	3.3b	**ALLOW** use a tube made of a more insulating material
		(ii)	So pellets do not rub against side of tube / to reduce friction / to reduce thermal energy transfer (to tube)	1	2.2	**ALLOW** pellets to fall (more) vertically / to reduce the cooling of the pellets
		(iii)	**First check the answer on answer line** **If answer = 0.45 (J) award 2 marks** (GPE =) 0.03 × 10 × 1.5 ✓ (GPE =) 0.45 (J) ✓	2 2.1 2.1		**ALLOW** 0.44 (J) **ALLOW** use of 9.8(1) N / kg **ALLOW** 0.44 (J)

Question			Answer	Marks	AO element	Guidance
22	(b)	(iv)	**First check the answer on answer line** **If answer = 140 J / kg °C award 4 marks**	4		**ALLOW** 0.14 J / g °C for 4 marks **ALLOW** K for °C
			Rearrange to give: c = E / (m × Δθ) ✓		2.1	
			(c =) 21 / (0.03 × 5) ✓		2.1	**ALLOW** 1 mark for correct substitution into unrearranged equation, e.g., 21 = 0.03 x c x 5
			(c =) 140 ✓		2.1	
			J / kg °C ✓		1.1	Unit mark is independent **ALLOW** J / kg / °C
		(v)	**Any three from:** Student A: A higher SHC would lead to a lower temperature rise/change ✓ (small) temperature rise/change is more difficult to measure ✓ Student B: More turns mean more energy dissipated as thermal energy (in the tube or surroundings) ✓ a larger SHC value is obtained ✓	3	3 × 3.1b	

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.