OCR
Oxford Cambridge and RSA

Higher

GCSE

Physics B Twenty First Century Science

J259/04: Depth in physics (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2022

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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. **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.

Rubric Error Responses – Optional Questions
Where candidates have a choice of question across a whole paper or a whole section and have provided more answers than required, then all responses are marked and the highest mark allowable within the rubric is given. Enter a mark for each question answered into RM assessor, which will select the highest mark from those awarded. *(The underlying assumption is that the candidate has penalised themselves by attempting more questions than necessary in the time allowed.)*

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 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 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 a tick to confirm that the work has been seen.

7. Award No Response (NR) if:
   - there is nothing written in the answer space.

   Award Zero '0' if:
   - anything is written in the answer space and is not worthy of credit (this includes text and symbols).

   Team Leaders must confirm the correct use of the NR button with their markers before live marking commences and should check this when reviewing scripts.

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 are **2** and **7**

11. Annotations available in RM Assessor

Annotation	Meaning
	Correct response
	Incorrect response
	Omission mark
BOD	Benefit of doubt given
CON	Contradiction
RE	Rounding error
SF	Error in number of significant figures
ECF	Error carried forward
L1	Level 1
L2	Level 2
L3	Level 3
NBOD	Benefit of doubt not given
SEEN	Noted but no credit given
I	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 B:

	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.

Question			Answer	Marks	AO element	Guidance
1	(a)		(Changing temperature) changes (kinetic) energy/speed of particles/internal energy✓ (Hence) a change in the number of collisions with (the area of) piston✓	2	1.1 2.1	**IGNORE** particles vibrate more/less **ALLOW** increase/decrease for change **IGNORE** reference to rates of reaction
	(b)		Arrow drawn perpendicular to piston surface pointing left✓	1	2.1	**ALLOW** a correct arrow drawn near or in the piston
	(c)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 16.8 (N) award 3 marks** Select: Pressure = Force ÷ Area **OR** Force = 4.2(N) at V=8.0(cm^3)✓ Force = 4.2 x 4 ✓ Force = 16.8 (N) ✓	3	 1.2 2.1 x 2	
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 34 (Ncm) award 3 marks** Constant = 4.0 x 8.4 ✓ = 33.6 ✓ = 34 (to 2sf) ✓	3	 2.1 x 2 1.2	 **ALLOW** any pair of volumes from table **ALLOW** an incorrect calculated value to 2sf
		(iii)	As volume increases the pressure decreases ✓ As volume doubles the pressure halves/PV = constant ✓ Supporting data e.g. when volume = 4cm^3 pressure = 8.4N/cm^2 and when volume = 8cm^3 pressure = 4.2N/cm^2 **OR** PV = 33.6(Ncm) for at least two pairs of values ✓	3	3.2b	**ALLOW** Volume is inversely proportional to pressure 2 marks

Question			Answer	Marks	AO element	Guidance
2	*		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)** An evaluation of the choice of radioisotopes to use as a tracer **AND** Description of a risk and a benefit of radioisotopes in medicine *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)** A simple evaluation of the choice of a radioisotope to use as a tracer **AND** Description of a risk or a benefit of using radioisotopes in medicine *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** A simple evaluation of the choice of a radioisotope to use as a tracer **OR** Stated a risk or a benefit of using radioisotopes in medicine *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.*	**6**	**2 x 1.1** **2 x 2.1** **2 x 3.2a**	**AO3.2a Analyse information and ideas to make judgements on what type of radiation each isotope emits** • A and D = Gamma as only reduced by lead • B and E = Beta as stopped by aluminium • C = Alpha as stopped by skin **AO2.1 Apply knowledge and understanding of the properties of radioisotopes** • radioisotope D best choice with reasons e.g. requires short Half-life (B-D) so does not remain active for long but long enough to be used and must be able to pass out of skin easily to be detected so ideally Gamma/ not stopped by skin or aluminium (AD) • Beta would be partially absorbed so could cause damage to tissues / might not exit to give an image **AO1.1 Demonstrate understanding of associated risks and benefits of radiation** • All radiation is ionising • Damages/mutates living cells • Increased exposure increases the risk • Risk greater inside body than outside • No need for exploratory surgery (non invasive) • Increase in life expectancy potentially • Diagnosis • **ALLOW** benefits in terms of minimising the risk

Question			Answer	Marks	AO element	Guidance
3	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 658 (kg) award 3 marks** Select Weight = Mass x gravitational field strength ✓ Weight = 6580 ÷ 10✓ Mass = 658 (kg) ✓	3	**1.2** **2.1 x 2**	
		(ii)	6580 (N) ✓	1	1.1	
		(iii)	Resultant force = 400(N) ✓	1	2.2	**IGNORE** direction
	(b)		(Magnitude of) the resultant force decreases✓ (As there is an) increase in Frictional Forces✓ (Maximum speed reached when) Resultant force = 0/acceleration = 0m/s^2✓	3	2.1	 **ALLOW** drag/air resistance **ALLOW** forces are balanced **IGNORE** constant speed

Question			Answer	Marks	AO element	Guidance
4	(a)		Curved line of best fit through all the points ✓	1	1.2	**IGNORE** lines drawn beyond (0.4, 50) and before (0.1, 2) **ALLOW** 1 square tolerance
	(b)	(i)	Rheostat/variable resistor✓ (Changing resistance of component R) changes <u>both</u> current and pd✓ Measure/record/plot different values of current and pd ✓	3	1.1	 **ALLOW** measurements from ammeter and voltmeter
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 11 (Ohm) award 4 marks** Conversion of 27mA – 0.027A ✓ Select V= IR ✓ R= 0.3 ÷ 0.027 ✓ = 11.111 (ohm) ✓	4	 1.2 x 2 2.2 x 2	**ECF** from 4a reading value of current at 0.3V **ALLOW** If wrong value of current but converted and calculated correctly award 3 marks Incorrect or no conversion e.g., 27mA gives R = 0.01(1) award 3marks
	(c)		Graph is curved/not linear/gradient not constant✓ Use of calculations e.g., R=0.2/0.01=20(ohm) and R=0.3/0.027=11(ohm) ✓	2	3.1a	**ALLOW** straight line but not through the origin ecf from 4a **IGNORE** incorrect conversions

Question			Answer	Marks	AO element	Guidance
5	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 8 (m) award 2 marks** Height = $\frac{7600}{95 \times 10}$ ✓ =8.0 (m) ✓	2	2.1	
		(ii)	Energy transferred to thermal energy store ✓ to the surroundings ✓ Due to work done against resistive forces ✓	3	2.1	**ALLOW** heat energy **IGNORE** reference to other energy stores **ALLOW** friction/drag/air resistance for resistive forces
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.84 award 2 marks** (7600 ÷ 9000) ✓ = 0.84/84%✓	2	2.1	**ALLOW** 0.8
	(b)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 12.6 (m/s) award 3 marks** v = √(7600/ 0.5 x 95) ✓ v=12.64911064… (m/s) ✓ v=12.6 (m/s) 1 d.p. ✓	3	**2.1x2** **1.2**	**ALLOW** v=13.8(m/s) for KE=9000J 2 marks **ALLOW** an incorrect v to 1dp
	(c)		**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 1080 (J) award 4 marks** Energy = Vit ✓ =24 x 11 x 30 ✓ = 7920 ✓ Energy needed = 9000 – 7920 = 1080J ✓	4	2.1	**Alternative** Calculating power = 24 x11 = 264 (W) ✓ Or Energy = 264 x 30 ✓ = 7920 ✓ **OR** Total Power = 9000/30 = 300(W) ✓ Difference in power = 36(W) ✓ Energy needed = 9000 – 7920 = 1080J ✓
	(d)		Time will increase (as speed is slower) ✓ (So)Power=energy/time/rate of energy transferred is less due to longer time✓ (But) energy/work needed (against gravity) would still be the same✓	3	3.1a	**ALLOW** efficiency may have increased due to less heat generated in the body or reduced air resistance/friction work done in moving horizontally would be less **IGNORE** any reference to the battery

Question			Answer	Marks	AO element	Guidance
6	(a)		B✓	1	1.1	
	(b)	(i)	Refraction on entering and leaving lens upwards✓ Crosses axis at same point as other ray ✓	2	2.2	Judge by eye
		(ii)	Wave speed slows as enters glass at **X**/ Wave speed increases on leaving glass at **Y** ✓ Causes decrease in wavelength at **X**/ Causes increase in wavelength at **Y** ✓ Bend closer to normal/refracts downwards at **X**/ Bend away from normal/refracts downwards at **Y** ✓	3	1.1	**IGNORE** reference to frequency
	(c)		Red light shows less refraction ✓ Red light would be above blue ray/ crosses axis further out AW✓	2	3.2a	**IGNORE** less deviation

Question			Answer	Marks	AO element	Guidance
7	*		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)** Correctly interprets the information from both diagrams and explains red shift **AND** Explains how the evidence leads to the idea of a Big Bang *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)** Correctly interprets the information from one of the diagrams **AND** Gives a partial explanation of how the evidence leads to the idea of a Big Bang *There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.* **Level 1 (1–2 marks)** Correctly interprets some information from either of the diagrams **OR** Gives a partial explanation of how the evidence leads to the Idea of the Big bang *There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.* **0 marks**	**6**	**2 x 1.1** **2 x 2.1** **2 x 3.2b**	**AO1.1 Demonstrate knowledge and understanding of Red shift** • red shift is the moving of spectral lines to the right/red end of spectrum. • The Sun is not red-shifted because it's in our galaxy. • This is caused by the stretching of light emitted from galaxies. • The greater the speed that the galaxies recede the greater the red shift. • This gives evidence for all galaxies moving out from point (the Big Bang) **AO2.1 Apply knowledge and understanding of Red shift** **Fig.7.1** shows: • Both Galaxies X and Y show red shift • Galaxy X shows more red shift that Y as spectral lines are further in the red part of the spectrum **Fig.7.2** shows: • Far away Galaxies are receding • The greater the speed galaxy moves away greater the distance from our sun • The Sun is on the origin (speed and distance 0), as it is part of our galaxy so is not receding **AO3.2b Analyse information and ideas to draw conclusions on evidence for the 'Big Bang' model of the Universe**

Question			Answer	Marks	AO element	Guidance
			No response or no response worthy of credit.			• Identify Point B with Galaxy X and Point A with Galaxy Y • Relates red shift of spectrum to speed of galaxy to distance • Explain that the further away a galaxy is, the faster it is moving away from us; this suggests that space itself is expanding. • Explanation for these observations is that the Universe began with a 'Big Bang'

Question			Answer	Marks	AO element	Guidance
8	(a)		B✓	1	1.1	
	(b)		When the coil rotates (and coil cuts magnetic field lines) potential difference <u>induced</u> ✓ When the coil is horizontal, side XY (is cutting most field lines) so maximum pd e.g. 2V or A or D on Fig.8.2 AW✓ When the coil is vertical (side XY) (is not cutting field lines) e.g. 0V or B on Fig.8.2 AW✓ When the coil is in the opposite horizontal direction, side XY (is cutting most field lines) maximum <u>negative</u> pd e.g. -2V or C on Fig.8.2 AW✓	4	1.1 2.1 x 3	**ALLOW** current <u>induced</u>
	(c)	(i)	Replace slip rings ✓ With split ring/commutator ✓	2	1.1	
		(ii)	3 positive half waves drawn at correct period✓ Amplitude unchanged and <u>all</u> positive✓	2	1.2	**IGNORE** horizontal line for DC **ALLOW** correct negative DC half waves 2 marks

Question			Answer	Marks	AO element	Guidance
9	(a)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 11.5(W) award 3 marks** Select Work Done = F x D ✓ Power = (50 x 2.3) ÷ 10 ✓ = 11.5 (W) ✓	**3**	**1.2** **2.1 x 2**	Calculated answer must be consistent to values in the table i.e.,1dp
		(ii)	All points plotted from the table✓ Curved line drawn✓	**2**	**1.2**	+/- half square tolerance on first 4 plotted points
	(b)		**Quantity** - Potential difference ✓ **Explanation** - Power depends on pd / pd x current ✓	**2**	**3.1b**	**ALLOW** voltage
	(c)		**Any one from:** Power output increases non- linearly/ at decreasing rate/gradient ✓ (So) efficiency of the electric motor decreases (with increasing current) ✓ **AND:** Between e.g., 0-0.5A, power output increase is 6.2W whereas between e.g., 0.5 and 1A, power output increase is 3.3W ✓	**2**	**3.2b**	**ALLOW** efficiency = power output/total power input

Question			Answer	Marks	AO element	Guidance
10	(a)		Gilese has greater gravitational field strength ✓ (Therefore, higher orbital velocity) needed to maintain <u>stable orbit</u> ✓	2	2.1	**ALLOW** Gilese has a greater gravity/gravitational force **IGNORE** reference to weight
	(b)		**EITHER** Orbital radius between 150 and 225 (compared to Earth's orbital radius)✓ (Orbital radius must be greater than Earth) because gravitational force is stronger (as mass of star 1.2 x Sun) ✓ (And orbital radius increases) to have smaller orbital velocity AW✓ **OR** Orbital radius greater than 225 and a higher value (compared to Kepler 452b's orbital radius) ✓ (Orbital radius must be greater than Kepler 452b) because gravitational force is the same (as mass of star is equal to Kepler 452) ✓ (And orbital radius increases) to have smaller orbital velocity AW✓	3	3.2a	**ALLOW** correct attempt at a calculation with orbital velocity/radius Explanation must be consistent with range of orbital radius given **ALLOW** correct attempt at a calculation with orbital velocity/radius Explanation must be consistent with range of orbital radius given

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