OCR
Oxford Cambridge and RSA

Higher

GCSE

Physics A Gateway

J249/04: Paper 4 (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.

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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 a tick 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 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 question on this paper is **19.**

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 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	2.2	
2			A ✓	1	1.1	
3			B ✓	1	1.2	
4			B ✓	1	2.1	
5			A ✓	1	1.2	
6			A ✓	1	2.1	
7			D ✓	1	1.1	
8			C ✓	1	2.1	
9			C ✓	1	2.1	
10			A ✓	1	2.2	
11			B ✓	1	1.2	
12			D ✓	1	2.2	
13			C ✓	1	2.1	
14			C ✓	1	2.1	
15			A ✓	1	2.2	

Question			Answer	Marks	AO element	Guidance
16	(a)		**Any three from:** Use a force meter/newton meter to measure (pulling) force ✓ Measure distance (moved) using a ruler/metre rule/ measuring tape ✓ Repeat experiment with different masses (on the wooden block) ✓ Use work done = force × distance ✓	**3**	**3 × 3.3a**	**ALLOW** metre stick / metre tape **ALLOW** different weights (on the wooden block) **ALLOW** balance/scales to measure mass (on the wooden block) **IGNORE** ideas about masses on pulleys **IGNORE** idea of repeating the same experiment (with same mass)
	(b)	**(i)**	4 points correctly plotted to within ½ small square ✓✓ Thin, straight line of best fit drawn ✓	**3**	**3 × 2.2**	**ALLOW** 1 mark for 2 points correctly plotted. **DO NOT ALLOW** points more than half a square in diameter **DO NOT ALLOW** all points above or below the line **IGNORE** line before first plot **DO NOT ALLOW** first plot joined to last plot **ALLOW ECF** for lobf drawn for candidate's points
		(ii)	Work done increases as mass increases / **ORA** ✓	**1**	**3.1a**	**ALLOW** linear relationship **IGNORE** it is proportional **IGNORE** positive correlation

Question			Answer	Marks	AO element	Guidance
16	(c)	(i)	Line with positive gradient drawn below the first line of best fit (for all points) ✓	1	3.2b	**IGNORE** horizontal line / line starting at origin **ALLOW** curve / missing label L **DO NOT ALLOW** if the line cuts the x axis from 0.1 kg or more
		(ii)	**Any one from:** (The lubricant) reduces friction ✓ reduces transfer to thermal energy (store) ✓	1	2.1	**ALLOW** less friction / prevents friction / less resistance (to motion) **ALLOW** heat for thermal energy **ALLOW** less energy transferred to other stores / less energy dissipated / more efficient **IGNORE** less work done / less energy (needed) / less force

Question			Answer	Marks	AO element	Guidance
17	(a)	(i)	$^{32}_{15}P$ ✓	1	2.1	Both numbers in the correct order needed for the mark.
		(ii)	Relative charge: (+) 16 ✓ Relative mass: (+) 32 ✓	2	2 × 2.1	**ALLOW** increases by 1 **ALLOW** stays the same
	(b)		(the) same (as B) ✓ less (than B) ✓	2	2 × 2.1	
	(c)	(i)	Gamma / beta ✓ As it is the <u>most/more</u> penetrating / can be detected outside the body / **ORA** for alpha ✓	2	2 × 1.2	Mark independently **ALLOW** this mark if alpha is chosen **ALLOW (**gamma/beta) passes/travels through the body/skin (easily) **ALLOW** very/highly penetrating **ALLOW** least/less ionising **ALLOW** alpha and/or beta would be (mostly) absorbed by the body / gamma can leave body **IGNORE** ideas about effects on the body
		(ii)	(Idea that half-life is) long enough to allow the isotope to circulate around the body / **ORA** for ideas about half-life of 4 minutes ✓ (Idea that half-life is) short enough for less damage/harm (to patient's cells/body) / patient will not be contaminated/radioactive for a long time / **ORA** for ideas about half-life of 18 days ✓	2	2 × 3.2a	**ALLOW** long enough to get results/information / take observations / explore organs / get to the patient from the lab **ALLOW (**idea that) four minutes is not long enough to take observations / look at patients / do experiments with / for it to work / to be detected **IGNORE** it can be used for a long time **ALLOW** (idea that) 18 days is too harmful / too long for patient to be contaminated/radioactive **IGNORE** it won't emit too much radiation / it is dangerous

Question			Answer	Marks	AO element	Guidance
18	(a)	(i)	The sound reflects/echoes (from the cliff) ✓ The amplitude of the sound decreases with distance / some of the energy/wave/sound is absorbed (by the cliff/air) ✓	2	2 × 1.1	**IGNORE** bounces **ALLOW** energy lost as travelling through air / energy dissipated into surroundings/cliff **ALLOW** sound/waves/energy spreads out **ALLOW** some sound/waves/energy reflect/travel in different directions **IGNORE** just energy lost
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 231 (m) award 4 marks** (distance =) speed × time ✓ (distance travelled by wave =) 330 ×1.40 ✓ (distance travelled by wave =) 462 (m) ✓ (distance to cliff =) ½ × 462 = 231 (m) ✓	4	1.2 3 × 2.1	**ALLOW** symbol equation / equation in any form **ALLOW** 0.7 seen for 1 mark **ALLOW** 330 x 0.7 for 3 marks **ALLOW** 3 marks for answer of 462(m)
		(iii)	**Any two from:** Due to reaction time ✓ Sound may not be heard (clearly) ✓ The student might start the stopwatch too early / stop the stopwatch too late / be distracted ✓ Wind/temperature/humidity/rain affects the speed ✓	2	2 × 3.2a	**IGNORE** human error **ALLOW** cliff surface is not flat so waves take different times to return **ALLOW** starts/stops stopwatch at the wrong time / can't clap and press button at the same time **IGNORE** weather conditions

Question			Answer	Marks	AO element	Guidance
18	(a)	(iv)	**Any one from:** Repeat the measurements and take a mean ✓ (Idea of) recording sound (and playback) to find accurate time ✓ Use another person (next to first student) to measure the time between clap and echo ✓	1	3.3b	**ALLOW** (idea of) clap-echo method / measuring time for multiple claps **ALLOW** (idea of) a method using microphone(s) linked to computer/oscilloscope/electronic timers
	(b)	(i)	**Any two from**: (Sound travels as) a longitudinal wave ✓ (Sound travels as) compressions and rarefactions ✓ Air particles vibrate ✓ Vibrations are <u>parallel</u> to the direction of energy transfer/ wave travel ✓	2	2 × 1.1	
		(ii)	**Any two from:** Outer ear/pinna/auditory canal (transfers sound to ear drum) ✓ Ear drum (vibrates) ✓ (passed to/vibrates) ossicles/small bones/anvil/hammer/ stirrup ✓ (Liquid in) cochlea (transmits movement to small hairs) ✓ Hairs/cilia (vibrate) ✓	2	2 × 1.1	If vibrations not mentioned, maximum of 1 mark **ALLOW** vibrates/oscillations/oscillates/moves in and out for idea of vibrations **ALLOW** ossicles/small bones/anvil/hammer/ stirrup amplify vibration

Question			Answer	Marks	AO element	Guidance
18	(c)		Wavelength of **A** is longer (than **B)** / double (**B**) / **ORA** ✓ And any **one** from: Wavelength is inversely proportional to frequency ✓ Wavelength = wave speed ÷ frequency <u>and</u> speed (of sound) is constant ✓ As frequency decreases, wavelength increases ✓ As frequency halves, wavelength doubles ✓	**2**	**2 × 2.1**	**ALLOW** 2 marks for calculations to show this e.g. λ_A = 0.55(m) **and** λ_B = 0.275(m) **ALLOW** a lower frequency/less waves per second means a longer wavelength / **ORA** Maximum of 1 mark if speed changes

Question			Answer	Marks	AO element	Guidance
19*			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 explanation of why car **A** is safer than car **B** **AND** good estimation of deceleration of car **A** / quantitative comparison of decelerations *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 explanation of why car **A** is safer than car **B** **AND** an attempt at estimation/comparison of decelerations **OR** Good estimation of deceleration of car **A** / quantitative comparison of decelerations **AND** a basic explanation of why car **A** is safer than car **B** *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)** Basic explanation of why car **A** is safer than car **B** **OR** An attempt at estimation/comparison of decelerations	**6**	**3 × 2.1** **3 × 1.1**	**AO2.1 Applies knowledge and understanding of scientific ideas to estimate acceleration** Estimation of acceleration using distance or time • car **B** has a higher/double acceleration • Use of $a = (v^2 - u^2)/2s$ • $a = (-)14^2 / 2 \times$ (their value of distance) • Use of $a = (v - u) / t$ • $a = 14/$ (their value of time) **AO1.1 – Demonstrates knowledge and understanding why car A is safer than car B** • (Smaller force) reduces risk of (serious) injury to driver/passengers Explanation • Increased stopping distance/time for car **A** means deceleration of car **A** is half/less than car **B** / **ORA** • Car **A** slows down over a longer distance/time • Smaller acceleration / smaller rate of change of momentum for car **A** / **ORA** • So force acting on car **A** is half/less than car **B** / **ORA** • Since F = ma / F= rate of change of momentum • Greater distance/time for (kinetic) energy to be dissipated • Since W = Fd / same KE transferred / same KE dissipated over a longer distance/time

			*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*			

Question			Answer	Marks	AO element	Guidance
20	(a)		Power supply attached to electric heater **AND** correct symbol for ammeter in series with heater ✓ Correct symbol for voltmeter in parallel with heater or power supply ✓	**2**	**2 × 1.2**	Maximum of 1 mark if a line drawn through the ammeter and/or voltmeter **IGNORE** extra ammeters/other components in series **ALLOW** 1 mark for incorrect symbols for ammeter and voltmeter in the correct places
	(b)	**(i)**	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 480 (J / kg °C) award 4 marks** 24 kJ = 24 000 J ✓ Rearrangement: Specific heat capacity = change in thermal energy ÷ (mass × change in temperature) ✓ (Specific heat capacity =) 24 000 ÷ (2 × 25) ✓ (Specific heat capacity =) 480 (J / kg °C) ✓	**4**	**2 × 1.2** **2 × 2.1**	**ALLOW** 2 marks for 24 ÷ (2 × 25) or 2.4 x 10^n ÷ (2 × 25) **ALLOW** 3 marks for answer of 0.48 or 4.8 x 10^n (J/kg°C)
		(ii)	(Idea that) thermal energy is lost/wasted to the surroundings / not all energy supplied to the heater is transferred into the metal block ✓	**1**	**3.2a**	**ALLOW** heat for thermal energy **ALLOW** thermal energy is dissipated (to the surroundings)
		(iii)	**Any one from:** Insulate the metal block ✓ Put the heater further into the metal block / use a smaller heater ✓ Use oil/lubricant to improve contact between heater and block ✓ Repeat and calculate the mean ✓	**1**	**3.3b**	**ALLOW** add lid

Question			Answer	Marks	AO element	Guidance
20	(c)		Block C (has the highest specific heat capacity) ✓ It has the smallest change in temperature (for the same rate of input in energy) ✓	2	3.2b 3.1b	No mark if block A or B chosen **ALLOW** it has the lowest gradient/slope **ALLOW** it has the slowest change in temperature **IGNORE** (idea that) it needs more energy to raise temperature by 1°C

Question			Answer	Marks	AO element	Guidance
21	(a)	(i)	**1** Not enough wind/force/energy/speed to turn the turbine ✓ **2** (Speed too high so) could damage the turbine / turbine is shut down to stop damage/for safety reasons ✓	**2**	**2 x 3.2a**	**ALLOW** turbine does not turn **ALLOW** idea of (the turbine/it) being damaged/broken
		(ii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 4.3 (MJ) award 5 marks** (Useful output energy transfer per second =) 1.5 (MJ) ✓ Efficiency = Useful output energy transfer ÷ Input energy transfer ✓ (Input energy transfer =) 1.5 ÷ 0.35 ✓ (Input energy transfer =) 4.2857… ✓ (Input energy transfer =) 4.3 (MJ) ✓	**5**	**2.2** **1.2** **2 × 2.1** **1.2**	**ALLOW** equation in any form **ALLOW** 4.2857... x 10^6 or 4.3 x 10^6 for 4 marks **ALLOW** an incorrect answer rounded to 2 sig. fig. for this mark
	(b)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 7.7 × 10^{17} (J) award 2 marks** 215 (TWh) from graph ✓ (215 × 3.6 × 10^{15} =) 7.7 × 10^{17}(J) ✓	**2**	**2 × 1.2**	**ALLOW** 210 – 220 (TWh) from graph **ALLOW** 1 mark for any correct conversion into J e.g. 210 × 3.6 × 10^{15} = 7.6 × 10^{17}(J) 220 × 3.6 × 10^{15} = 7.9 × 10^{17}(J) **IGNORE** answer not in standard form

Question			Answer	Marks	AO element	Guidance
21	(b)	(ii)	**Any two from:** More wind turbines have been built ✓ Modern turbines have a better design / are more efficient ✓ (wind turbines) do not produce air pollution/harmful gases/ carbon dioxide/greenhouse gases / do not contribute to global warming/greenhouse effect/climate change ✓ (idea that wind turbines) conserve/reduce use of fossil fuels ✓ (Idea of) renewable energy✓ (wind turbines) have low fuel/running costs once set up ✓	2	2 × 1.1	**IGNORE** increased demand **ALLOW** better technology **IGNORE** no pollution **/** better for the environment unless qualified **IGNORE** sustainable **ALLOW** reduce use of finite resources / fossil fuels are running out **ALLOW** high cost of fossil fuels
	(c)	(i)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 70 (A) award 2 marks** Rearrangement: Current in secondary coil = current in primary coil × potential difference across primary coil ÷ potential difference across secondary coil **OR** 2800 × 900 ÷ 36000 ✓ (Current in secondary coil =) 70 (A) ✓	2	2 × 2.1	**ALLOW** rearranged equation in symbols or numbers

Question			Answer	Marks	AO element	Guidance
21	(c)	(ii)	**Any three from:** It is a step-up transformer / to increase p.d. ✓ Decrease current (in power lines) ✓ less energy wasted/lost / less heat in power lines / less thermal transfer ✓ (idea that) power loss depends on current^2 ✓	3	3 × 1.1	**ALLOW** voltage **ALLOW ORA** for high current **IGNORE** just ideas about efficiency **DO NOT ALLOW** so no power wasted / no energy wasted (as heat in power lines) / no thermal transfer **IGNORE** less power loss
		(iii)	**FIRST CHECK THE ANSWER ON ANSWER LINE** **If answer = 0.25 (Ω) award 3 marks** Rearrangement: resistance = power ÷ (current)^2 ✓ (Resistance =) 864 900 ÷ 1860^2 or 864 900 ÷ 3 459 600 ✓ (Resistance =) 0.25 (Ω) ✓	3	**1 × 1.2** **2 × 2.1**	**Allow** ¼ (Ω)

Question			Answer	Marks	AO element	Guidance
22	(a)		**Any three from:** (Speed is constant because) (resultant) force is perpendicular to direction of motion / (resultant) force is a centripetal force / there is no displacement in direction of force ✓ No work is done on the planet ✓ (Velocity is changing because) the direction is changing ✓ (Resultant force) provided by gravitational pull of the sun (causes the direction of motion to change) ✓ (So) planet is accelerating ✓	**3**	**3 × 1.1**	**ALLOW** (resultant) force is always towards the Sun/centre of circle **ALLOW** velocity is a vector and speed is a scalar **ALLOW** force provided by the gravity of the Sun
	(b)	**(i)**	Smaller radius or closer to the Sun means larger (gravitational/centripetal) force/pull ✓ (smaller radius or closer to Sun or larger gravitational/centripetal force means) larger acceleration/speed ✓ **OR** Closer orbits have a lower GPE ✓ (closer orbits have) higher KE ✓	**2**	**2 × 1.1**	**ALLOW ORA** in each case **ALLOW** smaller radius means more gravity

Question			Answer	Marks	AO element	Guidance
22	(b)	(ii)	**Any two from:** (A statement explaining that if proportional, you would expect:) e.g. $T = kr$ **OR** $T \div r = k$ **OR** $T_A \div r_A = T_A \div r_A$ **OR** $r_A \div T_A = r_B \div T_B$ **OR** $T_A \div T_B = r_A \div r_B$ **OR** $T_B \div T_A = r_B \div r_A$ / **ORA** ✓ Correct calculation of k or ratio of variables ✓ (Idea that) planet A is (approximately) double the radius of B but (approximately) triple the time (to orbit the Sun)✓ **BUT** Statement (comparing two correctly calculated values) showing values are not equal or k is not constant ✓✓ Correct calculation of k from planet A (or B) and used to show that this k does not give correct value for the other planet ✓✓	**2**	**2 × 3.1b**	**ALLOW** <u>all</u> numbers substituted correctly in any version for 2 marks. e.g. $k = T_A \div r_A = 1.88 \div 2.28 \times 10^{11} = 8.25 \times 10^{-12}$ $k = T_B \div r_B = 0.62 \div 1.08 \times 10^{11} = 5.74 \times 10^{-12}$ e.g. $T_A \div r_A = 8.25 \times 10^{-12} \neq T_B \div r_B = 5.74 \times 10^{-12}$ $r_A \div T_A = 1.21 \times 10^{11} \neq T_B \div r_B = 1.74 \times 10^{11}$ $T_A \div T_B = 3.03 \neq r_A \div r_B = 2.11$ $T_B \div T_A = 0.330 \neq r_B \div r_A = 0.474$

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