

OCR • GCSE PHYSICS J249

Higher Tier — Paper 4

June 2025 exam series

MARK SCHEME

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Higher

GCSE

Physics A Gateway

J249/04: Paper 4 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2025

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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 40% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.
4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, 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 a similar basis – that is downwards (as it is unlikely in this situation that a candidate will provide more than one response in each section of the response space).

Longer Answer Questions (requiring a developed response)

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

6. Always check the pages (and additional 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 seen and mark any responses using the annotations in section 11.
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 is not 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.**
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 **21b**

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	A	1	1.1	
2	D	1	2.1	A: $80 \div 4$ B: $80 \div 2$ C: 80×2 D: 80×4
3	B	1	1.1	
4	D	1	1.1	
5	A	1	1.1	
6	A	1	1.1	
7	B	1	1.1	
8	C	1	1.1	
9	C	1	1.1	
10	C	1	1.2	
11	B	1	1.1	
12	B	1	1.1	
13	C	1	1.1	

14	C	1	2.1	A: $2 \times \text{energy}$ B: $3 \times \text{energy}$ C: $(1 + 3) \times \text{energy}$ D: $3 \times 3 \times \text{energy}$
15	D	1	2.1	

Question			Answer	Marks	AO element	Guidance
16	(a)			4	4 × 1.1	ALLOW in same direction for parallel ALLOW at right angles/90° for perpendicular IGNORE left to right / side to side / up and down / vertical If no other marks awarded: ALLOW 1 mark for identifying transverse as having perpendicular vibrations if linked to sound and/or ALLOW 1 mark for identifying longitudinal as having parallel vibrations if linked to water ripples
	(b)	(i)	Any two from: Rock has more energy in its gravitational store ✓ Rock has more energy in its kinetic store (when it hits the water) ✓ Rock transfers more energy (to the water) ✓	2	2 × 2.1	ALLOW rock has more gravitational/potential energy / (G)PE ALLOW rock has more kinetic energy / KE / moving faster / accelerating for a longer time If no other marks awarded: ALLOW rock hits the water harder/with more force OR ALLOW rock has more energy

Question			Answer	Marks	AO element	Guidance
16	(b)	(ii)	(Idea of use of metre ruler) to measure a (set) distance the ripple travels ✓ (Idea of use of stop clock) to measure the time for a ripple to travel the (set) distance ✓ (speed =) distance (travelled) ÷ time (taken) ✓ OR (Idea of use of metre ruler) to measure distance between (many) ripples/crests/troughs ✓ (Idea of use of stop clock) to obtain frequency using sensible method ✓ (speed =) wavelength x frequency ✓	3	3 × 3.3a	ALLOW either method but if methods are mixed only award the marks scored from the highest scoring method IGNORE measuring drop height / distance travelled by falling rock IGNORE time travelled by falling rock ALLOW measure the distance travelled by a ripple in a (set) time for 2 marks ALLOW measure the time it take for a ripple to travel a (set) distance for 2 marks ALLOW words or symbols ALLOW e.g. measure distance between 10 crests and divide by 9 / measure length of 10 waves and divide by 10 ALLOW e.g. 1 ÷ time for 1 wave / count number of waves in 10 s and divide by 10 ALLOW words or symbols

Question			Answer	Marks	AO element	Guidance
17	(a)		friction / air resistance / drag ✓ (friction) does work on pendulum / energy transferred to thermal (store of surroundings) ✓	2	2 × 2.2	ALLOW force of air ALLOW energy lost to surroundings / energy dissipated (to surroundings/thermal store) IGNORE pendulum loses energy IGNORE KE decreases
	(b)	(i)	Any two from: difficult to read the ruler at the right time / while bob is moving/swinging ✓ ruler might not be vertical ✓ reading might not be taken perpendicularly/at eye level to the ruler/scale ✓	2	2 × 3.1b	IGNORE human error unqualified ALLOW difficult to see where the bottom of the bob is / bob is moving too fast / hard to tell exactly when bob is at its highest point ALLOW ruler held at an angle ALLOW there is parallax error when reading scale ALLOW if the ruler is behind the pendulum it is hard to see the values
		(ii)	Any two from: Record the motion on a video and playback in slow motion ✓ (Idea of) mark a point (on piece of card) behind the bob (at end of swing) or use a grid/graph paper behind bob ✓ Clamp the metre ruler/card/graph paper in place ✓ (Idea of) Use a set square/plumb line/spirit level to ensure metre ruler is vertical ✓	2	2 × 3.3b	IGNORE repeat and average ALLOW record/video it (and playback) / take photo(s) at end of swing

Question			Answer	Marks	AO element	Guidance
17	(c)		First check the answer on the answer line If answer = 21 (%) award 3 marks Read value from graph for 6 swings= 4 (cm) ✓ $4 \div 19 (\times 100)$ ✓ (percentage of initial release height =) 21 (%) ✓	3	3×1.2	ALLOW tolerance ± 0.25 (cm) ALLOW ECF for last two marks for incorrect value read from graph

Question			Answer	Marks	AO element	Guidance
18	(a)	(i)	gravitational (force/pull) ✓	1	1.1	ALLOW gravity/weight IGNORE centripetal / gravitational potential
		(ii)	(Straight) arrow pointing from telescope to Sun ✓	1	2.1	
	(b)		Telescope constantly changes direction ✓ (so) velocity changes ✓	2	2.1 1.1	ALLOW acceleration/velocity is a vector / acceleration/velocity has magnitude and direction IGNORE velocity increases/decreases
	(c)		Any one from: (Idea of) remaining in contact with the (scientists on) Earth at all times (because signal is strong enough) ✓ (Idea of) short communication time between satellite and the Earth ✓ (Idea of) accessibility for maintenance of the satellite ✓	1	2.1	ALLOW (idea of) signal doesn't become (too) weak
	(d)		Radiation received by the satellite does not need to pass through the Earth's atmosphere / ORA ✓	1	1.1	ALLOW avoids interference from the Earth's atmosphere/other sources (of EM radiation) on the Earth ALLOW clearer signal ALLOW some wavelengths cannot pass through atmosphere / some wavelengths are absorbed by the atmosphere
	(e)		X has a faster speed / ORA ✓ Force (of gravity from Sun) stronger on X / ORA ✓	2	2 × 2.1	IGNORE reference to smaller radius/ circumference.

Question			Answer	Marks	AO element	Guidance
19	(a)		Increases height/going further away from the Earth ✓	1	1.1	ALLOW it is going (higher) up DO NOT ALLOW gravitational force increases
	(b)		Increases temperature ✓	1	1.1	ALLOW gets hotter/heats up
	(c)	(i)	Energy is (always) conserved OR <u>total</u> energy in is equal to <u>total</u> energy out ✓	1	1.1	ALLOW energy cannot be created or destroyed / total energy cannot change / law of conservation of energy IGNORE ideas about conservation of mass
		(ii)	First check the answer on the answer line If answer = 0.37 award 3 marks (useful energy =) 190 (MJ) ✓ substitution: (efficiency =) $190(\text{MJ}) \div 510(\text{MJ})$ ✓ evaluation: (efficiency =) 0.37 ✓	3	3 × 2.1	ALLOW 37 % for 3 marks ALLOW 0.372549 or 37.2549 % to at least 2 significant figures correctly rounded or truncated ALLOW 190 seen anywhere for this mark ALLOW ECF for substitution of incorrectly calculated useful energy for 1 mark ALLOW ECF for correct evaluation of incorrectly calculated useful energy for 2 marks ALLOW 0.37 to any other power of ten for 2 marks

Question			Answer	Marks	AO element	Guidance
19	(d)	(i)	First check the answer on the answer line If answer = 184 award 4 marks (total KE gained =) $1.2 \times 10^8 \times 12$ OR 1.44×10^9 (J) ✓ substitution : $1.44 \times 10^9 = 0.5 \times 8.5 \times 10^4 \times v^2$ ✓ rearrangement: (speed =) $\sqrt{\frac{2 \times 1.44 \times 10^9}{8.5 \times 10^4}}$ ✓ Evaluation: (speed =) 184 m/s ✓	4	4 × 2.1	ALLOW 184.071597 to at least 2 significant figures correctly rounded or truncated for 4 marks ALLOW 53.13689 to at least 2 significant figures correctly rounded or truncated for 3 marks (did not multiply KE by 12) ALLOW 33882.3529 to at least 5 significant figures correctly rounded or truncated for 3 marks (did not take square root) ALLOW the substitution mark for substitution of candidate's incorrect KE ALLOW rearrangement mark with use of incorrect KE ALLOW rearrangement mark in symbols or words ALLOW substitution and rearrangement in either order
		(ii)	Rocket mass/weight decreases (as fuel burns) ✓ (Idea that) for <u>same KE</u> (gained), speed will increase more (if mass is less) ✓	2	2 × 2.2	DO NOT ALLOW weight will be lower due to lower gravitational force IGNORE less air resistance due to thinner atmosphere ALLOW for the same accelerating force, there will be a greater acceleration, so a greater speed

Question			Answer	Marks	AO element	Guidance
20	(a)	(i)	Use a (radiation) detector (and counter) / GM tube (close to the metal) ✓ (Idea of) measure number of counts over a certain time and divide number of counts by the time used ✓ Repeat the measurement multiple times and calculate an average count (rate) ✓	3	1.2 3.3a 3.3a	IGNORE ideas about background radiation ALLOW shown on a diagram ALLOW measure the number of counts in a minute IGNORE measure number of counts in 1 second
	(a)	(ii)	Place material that absorbs both alpha and beta, but not gamma, between source and detector (e.g. thin aluminium sheet) ✓ (Idea that) alpha and beta radiation cannot penetrate aluminium (but gamma radiation can) / only gamma can penetrate aluminium ✓ (Idea that) reading on detector is the same with the aluminium and without aluminium ✓	3	1 × 1.2 2 × 2.2	IGNORE references to paper ALLOW use of aluminium (sheet) If no other marks awarded: ALLOW 1 mark for only gamma radiation can pass through thin lead/concrete OR ALLOW 1 mark for idea that the reading on detector does not change over a long distance if only gamma radiation is emitted

Question			Answer	Marks	AO element	Guidance
20	(b)	(i)	(Metal) A (is most hazardous) ✓ (Shorter half-life means) higher activity / ORA ✓	2	1.1 3.1a	No mark for question if A not chosen ALLOW idea that (short half-life means) more radiation emitted per second/unit time/during time of experiment / higher count rate / ORA
		(ii)	First check the answer on the answer line If answer = 140 award 3 marks (1/32 =) 5 half-lives ✓ (time required =) 28 x 5 ✓ (time required =) 140 ✓	3	3 × 2.2	ALLOW evidence of halving something 5 times e.g. $1 \rightarrow \frac{1}{2} \rightarrow \frac{1}{4} \rightarrow \frac{1}{8} \rightarrow \frac{1}{16} \rightarrow \frac{1}{32}$

Question			Answer	Marks	AO element	Guidance
21	(a)		First check the answer on the answer line If answer = 4.6×10^{20} award 2 marks (number =) $1.3 \times 10^9 \div 2.8 \times 10^{-12}$ ✓ evaluation: (number =) 4.6×10^{20} ✓	2	2 × 2.2	ALLOW $4.642857143 \times 10^{20}$ to at least 2 significant figures correctly rounded or truncated Alternative method: time/t (for 1 reaction) = $2.8 \times 10^{-12} \div 1.3 \times 10^9$ (= 2.15×10^{-21}) evaluation: (number = $1 \div$ time =) 4.6×10^{20}
	(b)*		Please refer to the marking instructions on page 5 of this mark scheme for guidance on how to mark this question. Level 3 (5–6 marks) Detailed description of differences between fission and fusion reactions AND Detailed comparison of the benefits and difficulties of using fusion <i>There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.</i> Level 2 (3–4 marks) Clear description of differences between fission and fusion reactions AND Clear comparison of the benefits and difficulties of using fusion OR	6	3 × 1.1 1 × 3.1a 2 × 3.2b	AO1.1– Demonstrate knowledge and understanding of differences between fission and fusion reactions - fission is splitting (of nucleus) / produces lighter nuclei - fusion is combining (nuclei) / produces heavier/helium nuclei - fission is splitting heavy/uranium nucleus into lighter nuclei (and neutrons) - fusion is combining lighter/hydrogen nuclei into heavier/helium nuclei (description of) chain reactions occur in fission (and have to be controlled) - fusion requires high temperature and pressure AO3.1a– Analyse information from the table to suggest benefits of nuclear fusion - Nuclear fusion power station will (likely) output (1.3 times) more power / ORA

Question			Answer	Marks	AO element	Guidance
			Detailed description of differences between fission and fusion reactions AND Basic comparison of the benefits and difficulties of using fusion OR Basic description of differences between fission and fusion reactions AND Detailed comparison of the benefits and difficulties of using fusion <i>There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.</i> Level 1 (1–2 marks) Basic description of a difference between fission and fusion reactions OR Basic comparison of the benefits and difficulties of using fusion from the table. <i>There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.</i> 0 marks <i>No response or no response worthy of credit.</i>			- Fission waste products are more radioactive / ORA - Fission waste products have a longer half-life / ORA AO3.2b– Analyse information from the table and from knowledge to draw conclusions about the benefits and difficulties of using fission and fusion (Fusion power station will (likely) output more power) so fewer needed / can be smaller / don't need to use other resources / ORA (Fission waste products have a longer half-life) so they stay dangerous for longer / have to be stored / ORA - Fission reactors pose a safety risk so reactions have to be controlled - Fusion needs high temperature and pressure (to maintain reactions), which is difficult to produce on the Earth - Uranium is non-renewable and hydrogen is renewable/more easily obtained

Question			Answer	Marks	AO element	Guidance
22	(a)		First check the answer on the answer line If answer = 2.1×10^{-4} (m) award 3 marks select equation: (distance =) speed x time ✓ substitution: (distance =) $1500 \times (2.8 \times 10^{-7} \div 2)$ ✓ evaluation: (distance =) 2.1×10^{-4} (m) ✓	3	1.1 2 × 2.2	ALLOW 4.2×10^{-4} (m) for 2 marks (did not divide by 2) ALLOW equation in any form ALLOW (distance =) $1500 \times 2.8 \times 10^{-7}$ for 1 mark
	(b)		First check the answer on the answer line If answer = $3.48837 \dots \times 10^6$ (Hz) award 3 marks If answer = 3.5×10^6 (Hz) award 4 marks substitution: $1500 = \text{frequency} \times 4.3 \times 10^{-4}$ ✓ rearrangement: (frequency =) $1500 \div 4.3 \times 10^{-4}$ ✓ evaluation: (frequency =) $3.48837 \dots \times 10^6$ (Hz) ✓ evaluation to 2sf : (frequency =) 3.5×10^6 (Hz) ✓	4	1.2 3 × 2.2	ALLOW substitution and rearrangement in either order. ALLOW rearrangement in words or symbols ALLOW incorrect answer correctly rounded to 2sf for this mark if calculation attempted
	(c)		Sound wave travels faster in muscle/denser materials ✓ Frequency remains constant therefore wavelength increases ✓	2	2 × 1.1	

Question			Answer	Marks	AO element	Guidance
23	(a)		Use an a.c. supply / alternating current/ potential difference. ✓ Transformers require (a.c. to create) an alternating/changing magnetic field ✓	2	3.1b 3.3b	
	(b)	(i)	As the number of turns increases the potential difference increases/ ORA ✓ BUT Number of turns is directly proportional to potential difference ✓✓	2	2 × 3.2a	ALLOW linear relationship ALLOW as number of turns doubles/halves, potential difference doubles/halves / they are (directly) proportional / number of turns is 25 times the potential difference / constant of proportionality is 25 or 0.04 / ratio of number of turns to potential difference is always 25 for 2 marks
		(ii)	First check the answer on the answer line If answer = 0.63 award 3 marks select and substitute: $3.2 \times 0.94 = 4.8 \times \text{current}$ ✓ rearrangement: $(\text{current} =) 3.2 \times 0.94 \div 4.8$ ✓ evaluation: $(\text{current} =) 0.63 \text{ (A)}$ ✓	3	3 × 2.2	ALLOW 0.627 or 0.626(66...) ALLOW use of top row of table instead $6.4 \times 0.47 = 4.8 \times \text{current}$ ALLOW substitution and rearrangement in either order. ALLOW rearrangement in words or symbols ALLOW $(\text{current} =) 6.4 \times 0.47 \div 4.8$

Question			Answer	Marks	AO element	Guidance
23		(iii)	This is a step-down transformer / transformer between power station and transmission lines is step-up ✓ (Transformers between power station and power lines) need to transfer power to power lines at (very) high voltage / low current ✓	2	1.1 3.2b	ALLOW (transformers between power station and power lines) need to reduce (thermal) energy lost to surroundings / reduce (thermal) energy dissipation / reduce energy lost as heat / reduce power loss (in transmission wires) IGNORE voltage increases

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