physmMOEENGTZ0XXXX

Markscheme

May 2025

Physics

On-screen examination

18 pages

The following are the annotations available to use when marking responses.

Annotation	Explanation
	Correct point, place at the point in the response where it is clear that the candidate deserves the mark. For use in analytically marked questions only.
	Omission, incomplete
CON	Contradiction
	Valid part (to be used when more than one element is required to gain the mark)
	Error carried forward
	Dynamic annotation, it can be expanded to surround work
	Underline tool that can be expanded
	Highlight tool that can be expanded to mark an area of a response

Annotation	Explanation
	Not good enough
	The candidate has given a response but it is not worthy of any marks
	Text box used for additional marking comments
	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

Markscheme instructions

1 Mark positively. Give candidates credit for what they have achieved and what is correct. Do not deduct marks for incorrect responses. Do not deduct marks for spelling errors.

2 Follow the markscheme provided and award only whole marks.

3 Each marking point appears on a separate line.

4 The maximum mark for each subpart is indicated in the "Total" column.

5 Where a mark is awarded a tick should be placed in the text at the precise point where it is clear the candidate deserves the mark.

6 Each marking point in a question part should be awarded separately unless there is an instruction to the contrary in the Notes column.

7 A question subpart may have more marking points than the total allows. This will be indicated by the word "***max***" in the Answer column. Further guidance may be given in the Notes column.

8 Additional instructions on how to interpret the markscheme are in bold italic text in the Answer column.

9 Alternative wording may be indicated in the Answer column by a slash (/). Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.

10 Alternative answers are indicated in the Answer column by "***or***". Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.

11 If two related points are required to award a mark, this is indicated by "***and***" in the answer column.

12 Words in brackets ( ) in the Answer column are not necessary to gain the mark.

13 Words that are underlined are essential for the mark.

14 In some questions a reverse argument is also acceptable. This is indicated by the abbreviation *ORA (or reverse argument)* in the Notes column. Candidates should not be rewarded for reverse arguments unless *ORA* is given in the Notes column.

15 If the candidate's response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation *WTTE (or words to that effect)* in the Notes column.

16 When incorrect answers are used correctly in subsequent question parts the follow through rule applies. Award the mark and add ECF (error carried forward) to the candidate response.

17 The order of marking points does not have to be the same as in the Answer column unless stated otherwise.

18 Marks should not be awarded where there is a contradiction in an answer. Add CON to the candidate response at the point where the contradiction is made.

19 Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.

20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. A candidate's work should be reviewed to determine holistically the mark for each row of the holistic grid and a mark awarded for each row.

Question		Answers	Notes	Total	
1	a	Electrons		1	A
	b	Conversion of 30 milliseconds to 0.03s Use of E = VIt to find current (150 = 300 x I x 0.03) ***or*** Use of P=W/t to find Power (P=150/0.03 = 5000W) ***or*** Use of Q=E/V to find charge (Q = 150/300 = 0.5C) I=16.6666....(A) correctly rounded to 2 or more sig figs	*Seen or implied* *Seen or implied* *Award 3 marks for a correctly rounded value to 2 or more sig figs* *Do not accept 16, 16.6, 16.66 etc for mp3*	3	A
	c	***Accept any reasonable suggestion, for example [max 1]*** • reduces resistance therefore increasing the current • improves conduction or contact with the skin • minimizes damage to the skin • protects skin from burns	*Do not accept vague references to helping the current flow*	**1**	A
	d	***Adhesive pads: Accept any reasonable answer, for example [max 1]*** • person applying treatment is not in contact so safer • they will not move out of position during the treatment • keeps the doctor's hands free to do other things • makes the device small and portable ***Insulating handles: Accept any reasonable answer, for example [max 1]*** • can apply pressure to the body • insulation protects the person applying the treatment • can relocate the plates quickly to another patient or a different part of the body • can be removed quickly	*Do not accept references to gel as this is used in both types of device*	**2**	D

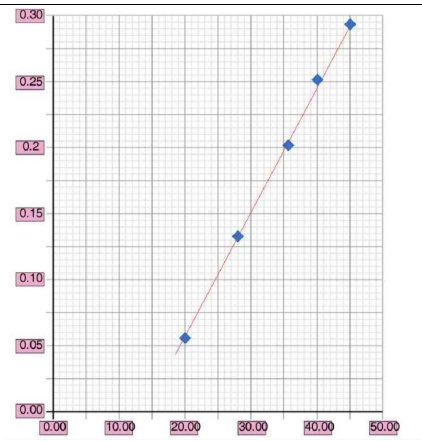
2	**a**	Use of F = v/λ 5.454545x10^{14} (Hz or s^{-1}) 5.5 x10^{14} (Hz or s^{-1})	*Seen or implied* *No ECF from mp2.* *Award 3 marks for a correct answer*	**3**	A
	b	Red ***or*** orange		**1**	A
	c	Frequency		**1**	A
	d	Light travels from the fish to the person ***or*** person's eye ***or*** Light travels from water to air Light refracts ***or*** bends away from the normal Eyes ***or*** brain ***or*** person expects light to travel in straight line (so seeing the fish in a different position to reality)		**3**	A
	e	Refracts light rays outwards ***or*** away from the normal ***or*** Spreads the light rays ***or*** Changes the focal point of the light rays (so that the) rays meet on the retina		**2**	A

3	**a**	***Accept any reasonable suggestion, for example [max 1]*** • climate change/Greenhouse effect/CO_2 emission • air pollution • habitat destruction from extraction • non-renewable • acid rain		**1**	D
	b	Different numbers of <u>neutrons</u> ***or*** U-236 has one more <u>neutron</u>	*Do **not** accept different mass numbers or that they are isotopes*	**1**	A
	c	3		**1**	A
	d	3.111111×10^{-28} kg	*Value to 2 or more significant figures*	**2**	A
	e	Conversion of GJ to J (9.7×10^9) $3.46428571 \times 10^{20}$ (fissions)	*Seen or implied* *Award 2 marks for a correct value to 2 or more sig figs*	**2**	A
	f	Use of 35/100 or 0.35 in calculation 4.3×10^9 (W) ***or*** 4.2857...x 10^9(W)	*Seen or implied* *Award 2 marks for a correct answer.* *Accept values in the range 4.2-4.3 x 10^9* *Accept equivalent correct answers only if correct unit is given eg 4.3 GW*	**2**	A

4	**a**	10 Hz ***or*** s^{-1}	 *Accept hz, hertz, per second or dots per second*	2	C
	b	5.4		**1**	C
	c	105±5 cms^{-2} Acceleration	 *Accept cm/s^2 or centimetres per second squared*	**3**	C
	d	Gradient would increase ***or*** the line would be steeper The (elastic) force ***or*** tension would be greater	*WTTE*	**2**	C
	e	***Accept any two reasonable examples, for example [max 2]*** • reaction time errors when using the stopwatch • locating position using the ruler would lead to errors due to the movement of the model car • measurements of time ***or*** velocity ***or*** acceleration throughout the movement would not be possible	 *Accept reference to parallax errors*	**2**	C

5	a					16	B
	1 mark	**2 marks**	**3 marks**	**4 marks**	***Notes***		
V	Explicitly states appropriate: number of turns as IV ***or*** time as DV	Explicitly states appropriate: number of turns as IV ***and*** time as DV	Explicitly states appropriate: number of turns ***and*** time ***and*** one CV		*Only requirement is to state using the terminology of IV, DV and CV. No need to explain further.* *Do not accept "keeping equipment the same" as a CV. Acceptable CVs: mass, (fixed) distance, type of rubber band, material of track surface* *Do not accept calculated values as DV unless explicitly shown how calculated from measured values.*		
H	Hypothesis links to either turns ***or*** time	Testable hypothesis links turns ***and*** time	Testable hypothesis links turns ***and*** time ***and*** explains using relevant scientific knowledge		*A testable hypothesis will link increase or decrease or constant time to number of turns*		
E	Stopwatch ***or*** ruler to measure fixed distance	Stopwatch ***and*** ruler to measure fixed distance			*Accept measuring tape or metre rule for measuring distance. Credit video analysis software as a substitute for the stopwatch for timing.*		
M	Method is linked to turns ***or*** time	Method is linked to turns ***and*** time but is incomplete	Method linked to turns ***and*** time to travel fixed distance ***and*** can be followed	Method linked to turns ***and*** time to travel stated fixed distance ***and*** can be followed ***and*** includes details on how to control main CVs	*A method that does not include how to vary the IV is incomplete.* *Limited information about CVs mean that data is unlikely to be relevant*		
D	Any reference made to different number of turns	At least five different numbers of turns ***or*** at least three trials	At least five stated numbers of turns ***and*** at least three trials	At least five stated numbers of turns ***and*** at least three trials ***and*** takes an average	*The values of the five or more variations should be explicitly stated for 3 or 4 marks*		

5	**b**	***Accept any reasonable RQ linking IV with DV with at least one new variable, for example [max 1]*** • does a different elastic band affect the time taken to travel 50 cm? • does a different surface affect the distance travelled for 10 s?	*Examples of other variables could be: Inclination of slope, properties of cotton reel (diameter, mass, material)*	**1**	C

6	**a**	What is the relationship between <u>temperature difference</u> and <u>voltage</u>? ***or*** How does <u>temperature difference</u> affect <u>voltage</u> produced?	*Accept reverse order* *Do not accept 'How does voltage affect temperature difference?'*	**1**	B
	b	Thermometer ***or*** temperature probe Voltmeter		**2**	B
	c	20.0	*Do not accept 20*	**1**	C
	d	 X and y axis labels complete – temperature difference (°C) and voltage (V) Axes numbered with even increments All data points plotted correctly Appropriate LoBF	*Accept the labels on either axis, degree must be included as symbol or word* *Axes do not have to start from 0* *Plotted ±1 grid line* *Data points above and below the line should be equal. Judge by eye*	**4**	C

	e	Graph – LoBF does not pass through the origin ***or*** Data – if you double the temperature difference the voltage does not double ***or*** Calculation showing that V/ΔT is not the same using a pair of data points (so) the claim is not valid	 *Only award the second mark if the first is awarded*	**2**	C
	f	Calculate the gradient of the LoBF on the graph of voltage against temperature difference ***or*** Calculate1/gradient of the LoBF on the graph of temperature difference against voltage Multiply by –1	*Refer to the answer in part d* *Ignore incorrect values in gradient calculation if method is correct*	**2**	C
	g	0.04367 W	*Accept a correctly rounded value to 2 or more sig figs* *Accept watts* *Award 2 marks to a correctly stated value in mW*	**2**	A
	h	***Accept any reasonable suggestion, for example [max 1]*** • bigger temperature difference • reduce the mass of the car • reduce drag forces ***Correctly linked justification*** • bigger voltage generated means more power output • same force on lower mass means greater acceleration (Newton's second law) • less drag force means that the resultant force would be greater		**2**	C
	i	Heat → Electrical → Kinetic		**1**	A

	j	***Accept any reasonable IV, for example [max 1]*** • length of propellers • mass of car (system) or volume of water • (initial) temperature difference • angle of slope ***Accept any reasonable DV, for example [max 1]*** • time (taken to travel a certain distance) • distance (travelled in a fixed period of time) ***Accept any two reasonable CV, for example [max 2]*** • (time taken to travel a certain) distance • (distance travelled in a fixed period of) time • mass of car (system) or volume of water • type of propeller • horizontal or angle of surface	*Award each mp independently* *Do not accept voltage, current or power of the motor as variables* *Check that CVs are consistent with IV or DV*	**4**	B
	k	Accept any reasonable hypothesis correctly linking their IV and DV from previous question part Explanation linked to scientific reasoning and their IV and DV	*ECF from part j for mp1*	**2**	B

7	**a**	**A.** 4700 m s^{-1} **B.** 7800 m s^{-1} **C.** 0 m s^{-1} **D.** 14 200 m s^{-1} All correct		1	A
	b	A. ○ B. ◉ C. ○ D. ○		1	A

7	**c**		**14**	D

The scientific and technological challenges of putting a satellite into orbit		
Mark	**Descriptor**	**Examples**
1	A statement	***Statement*** • Challenges to launch the satellite • Allocation of space in the geostationary orbit • Many satellites are already in orbit ***Support*** • Need high thrust to overcome gravitational force • Need to navigate path through all existing satellites/space debris • Need to have accurate calculations of the weight of satellite for launch • Multiple satellites launched on one rocket will have many different trajectories • Would take detailed planning to reach correct geostationary orbit
2	A statement with further support ***or*** Two statements	
3	Two statements with further support for one	
4	Two statements with further support for both	

The economic implications of private companies controlling access to the limited space in the Clarke belt		
Mark	**Descriptor**	**Examples**
1	A positive ***or*** a negative implication	***Statements*** • Can lead to the development of a monopoly • Job creation/loss • Company could increase the efficiency of their process • Over reliance of one company • Gives access to satellites for smaller companies with fewer resources ***Support*** • Company might not be independent/interested in the greater good • Company might just be profit focused • (Over reliance on one company) can lead to lack of competition • (Over reliance on one company) can lead to over dependence or lack of resilience • Lack of competition stifling innovation or research
2	A positive ***and*** a negative implication	
3	A positive ***and*** a negative implication with support for ***one***	
4	A positive ***and*** a negative implication with support for ***both***	

The political implications for governments of the global communication system		
Mark	**Descriptor**	**Examples**
1	An implication	***Statement*** • National security concerns • Government space programs might be limited • Countries without this technology can now have access to satellites ***Support*** • Company might not have a country's best interests in mind • Defence and intelligence operations may be compromised • Countries may no longer have access to satellites • Countries can secure themselves against threats or increased security
2	An implication with further support ***or*** Two implications	
3	Two implications with further support for one	
4	Two implications with further support for both	

Concluding appraisal		
Mark	**Descriptor**	**Examples**
1	A concluding opinion	Justification should be linked to points made earlier
2	A concluding appraisal with justification	

8			**8**	D

Benefits

Mark	Descriptor	Examples
1	A statement	***Statements*** • Increased access to space • Use of electricity rather than rocket fuel – more sustainable route to space • Opportunity for a country to be a world leader in scientific development ***Support*** • Construction and maintenance of space stations or satellites would be much easier. • Solar panels can be transported to space to power the elevator • Can showcase the science and technology of the country and be a leader in a new space race
2	A statement with further support ***or*** Two statements	
3	Two statements with further support for one	

Limitations

Mark	Descriptor	Examples
1	A statement	***Statements*** • Suitable materials to withstand stresses are not available • Could be damaged by space debris • Costs would be extreme ***Support*** • Tensile forces are extreme and whether materials can ever be developed to withstand the forces involved is unclear • Could be impacted by collisions with space junk or other objects in space • Governments should consider the costs involved and the risk of failure
2	A statement with further support ***or*** Two statements	
3	Two statements with further support for one	

Conclusion

Mark	Descriptor	Examples
1	A conclusion	***Conclusion*** • An opinion is stated • The government should spend money building a space elevator • The government should not spend money on building a space elevator
2	A conclusion with justification	***Justification*** • A statement balancing up both sides of the argument