Markscheme

May 2023

Physics

On-screen examination

15 pages

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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.

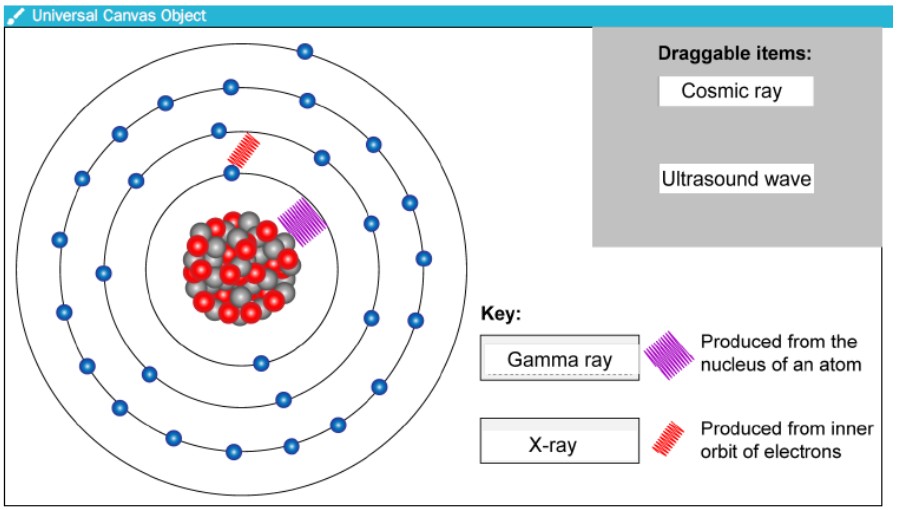
18 Marks should not be awarded where there is a contradiction in an answer. Add CON to the candidate response at the point where the contradiction is made.

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	Crit
1	a	Use of speed = distance/time 4(kmh^{-1})	*Seen or implied*	2	A
	b	◉ C. energy transformed = power × time		1	A
	c	<table><tr><td>Horse</td><td>Mass of horse/kg</td><td>Weight/N</td></tr><tr><td>A</td><td>350</td><td>**3500**</td></tr><tr><td>B</td><td>**510**</td><td>5100</td></tr></table>		2	A
	d	Chemical potential energy → **Kinetic energy** → Gravitational potential energy		1	A
	e	Calculate work done 61200 (J) Calculate power 11127 11.127 (kW)	*Award 3 marks for 11.127 expressed to 2 or more sig figs ECF*	3	A
	f	I=P/V I= 6.48695.. or 6.5 (A)	*Seen or implied* *Accept answer stated to 2 or more sig figs*	2	A

2	**a**	D. Dispersion		**1**	**A**
	b	Red light has the longest wavelength ***or*** the lowest frequency Red is <u>refracted</u> the least (of the colours) Red light is the fastest (in the prism) ***or*** Red light has the lowest refractive index ***or*** Red light is slowed down the least (by the glass)		**3**	**A**
	c	IR has longer wavelength ***or*** IR has lower frequency ***or*** IR is detectable as heat	*WTTE*	**1**	**A**
	d	$f = \frac{v}{\lambda}$ seen or implied 4(.00) x 10^{14} (Hz)		**2**	**A**

3	**a**	Atomic number= 6 Mass number=14		**2**	**A**
	b	***Accept any similarity from the list [max 1]*** • same number of protons • same charge on the nucleus ***Accept any difference from the list [max 1]*** • different number of neutrons • different number of nucleons • C-14 nucleus is unstable but C-12 nucleus is stable	*Do not accept same atomic number or both are carbon nuclei* *Do not accept different mass number*	**2**	**A**
	c	 Gamma ray in correct location X-ray in correct location		**2**	**A**
	d	$^{238}_{92}\mathrm{U} \rightarrow {}^{232}_{90}\mathrm{Th} + {}^{4}_{2}\alpha$ $^{232}_{90}\mathrm{Th} \rightarrow {}^{234}_{91}\mathrm{Pa} + {}^{0}_{-1}\beta$		**2**	**A**
	e	A <u>neutron</u> is absorbed by the <u>nucleus</u> of uranium-238	*WTTE*	**1**	**A**

4	**a**	A RQ linking mass ***or*** force ***or*** weight ***or*** pressure ***and*** volume		**1**	**B**
	b	Mass as only IV Volume of air as only DV		**2**	**B**
	c	Increase		**1**	**B**
	d	Correct use of (m x g) Increase in pressure = 1.51898 x10^5 or 151899 (Pa or Nm^{-2}) Total pressure = 2.5 x 10^5 (Pa or Nm^{-2}) or 251899 (Pa or Nm^{-2})	*Seen or implied* *Correct to at least 2 sig figs, no ECF* *Award 3 marks for correct total pressure value stated to at least 2 sig figs*	**3**	**C**
	e	As the pressure increases, the volume decreases ***Second mark, accept any further description [max 1]*** • in an inverse relationship • pressure is proportional to 1/volume • pressure is inversely proportional to volume • when pressure doubles, volume halves		**2**	**C**
	f	***Reference to the graph, for example [max 1]*** • the line is horizontal ***or*** flat ***or*** the same value (of 11000) is found for every pressure • There is a slight slope to the line • The value at 300kPa is not constant ***Justification [max 1]*** • (so) the graph supports Boyle's Law (within experimental error) • (so) the graph does not support Boyle's Law	*Reference to the graph must be made for the first marking point* *Do **not** award the second marking point without the first marking point being awarded*	**2**	**C**
	g	Answer in range 145-155 cm^3	*Award unit mark independently*	**2**	**C**

5	**a**	As temperature increases, the kinetic energy ***or*** speed increases The number of collisions between the gas particles and the wall of the balloon increases ***or*** The force of the collisions between the gas particles and the wall of the balloon increases ***or*** The kinetic energy of the particles is transferred to elastic potential energy So the balloon expands because the balloon is elastic ***or*** The balloon expands because its wall is pushed out by the pressure of the gas	*WTTE*	**3**	**B**

b

	1	2	3	4
RQ	an RQ correctly linking temperature and volume or circumference			
V (Variables)	temperature as independent variable ***or*** circumference implied as dependent variable	independent variable of temperature ***and*** dependent variable of circumference stated	independent variable of temperature ***and*** dependent variable of circumference stated ***and*** one control variable stated	
E (Equip)	equipment to measure temperature ***or*** circumference	equipment to measure temperature ***and*** circumference		
M (Method)	attempt at a method linked to circumference ***or*** temperature	method is described with measurements of circumference ***and*** temperature but not detailed enough to be followed by another student	complete method is realistic and described with measurements of circumference ***and*** temperature ***and*** could easily be followed by another student	
D (Data)	a reference to different temperatures	at least five increments of temperature	at least five increments of temperature ***and*** repeated measurements of circumference	at least five increments of temperature ***and*** repeated measurements of circumference ***and*** plans to calculate average
S (Safety)	mentions a relevant safety precaution for example: working at elevated temperature or making sure the balloon is not inflated too much at the start			

14 **B**

<table>
<tr><td rowspan="5">6</td><td>a</td><td>Acceleration is due to an unbalanced force
or
Newton’s second law says the greater the force, the greater the acceleration
or
F=ma

Expulsion of gas and thrust are paired forces
or
Forces are an action-reaction pair of forces

(this is an example of) Newton’s third law</td><td></td><td>3</td><td>C</td></tr>
<tr><td>b</td><td>An RQ correctly linking circumference or volume with distance travelled</td><td></td><td>1</td><td>B</td></tr>
<tr><td>c</td><td>38.2 and cm</td><td>Unit and value required for the point. Accept 0.382 m.</td><td>1</td><td>C</td></tr>
<tr><td>d</td><td>Table Object
<table>
<tr><th>Circumference / cm</th><th>Distance travelled / m</th></tr>
<tr><td>35.8</td><td>1.07</td></tr>
<tr><td>38.2</td><td>1.30</td></tr>
<tr><td>41.0</td><td>1.97</td></tr>
<tr><td>50.3</td><td>3.10</td></tr>
<tr><td>54.9</td><td>3.99</td></tr>
<tr><td>58.2</td><td>5.06</td></tr>
<tr><td></td><td></td></tr>
</table>
Table with circumference and distance travelled and units in headers only

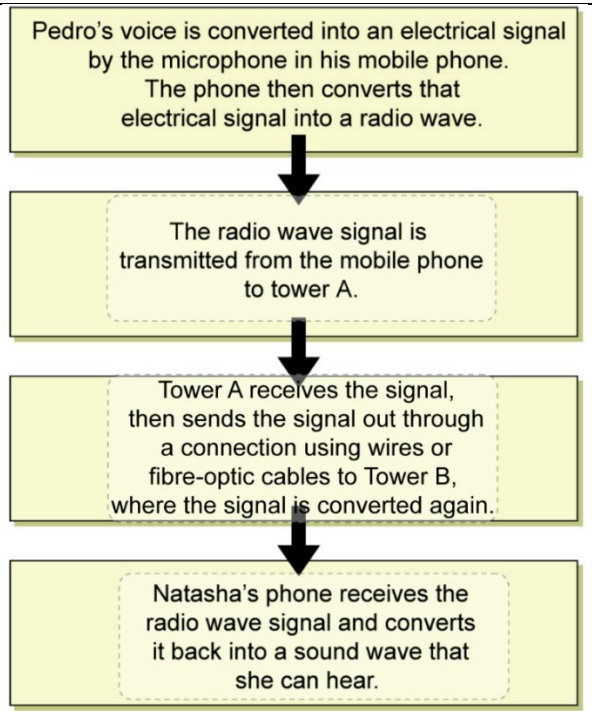
Data in ascending or descending order

Data to consistent dp

Numbers correctly converted to consistent units</td><td>Accept data arranged in either vertical columns or horizontal rows

Accept either metres or centimetres for each column</td><td>4</td><td>C</td></tr>
<tr><td>e</td><td>The graphs show that as the circumference increases, the distance travelled will increase</td><td></td><td>3</td><td>C</td></tr>
</table>

		(but) the graph shows that there is a proportional relationship between distance travelled and circumference cubed ***or*** (but) the graph shows that there is not a proportional relationship between distance travelled and circumference (so) the hypothesis is not valid ***or*** The hypothesis is only partially valid	*Only award the 3rd marking point if the first 2 points have been awarded*		
	f	***Accept any reasonable IV, for example [max 1]*** • gas inside • temperature • shape of balloon ***Accept any two reasonable CV relevant to the DV above, for example [max 2]*** • length of straw attached to balloon • angle of line • circumference or volume of gas • elasticity of balloon		**3**	**C**
	g	***Accept any reasonable hypothesis correctly linked to the IV given above and distance travelled*** If (the IV) increases then distance travelled will increase or decrease Attempt at explanation using scientific reasoning		**2**	**C**

7	**a**	Accept period in the range 1.6-1.8 Accept frequency in the range 0.56-0.63 Hz ***or*** s^{-1}	*Seen or implied* *Must be expressed as 2 sig figs* *Award the unit mark independently*	**3**	**C** **D**
	b	C		**1**	**A**
	c	 All correct		**1**	**D**

d

	1	**2**	**3**	**4**
Advantages and disadvantages (location-tracking tech)	a statement of one advantage ***or*** disadvantage for an individual	a statement of one advantage ***and*** one disadvantage for an individual ***or*** a statement of one advantage for an individual ***or*** disadvantage for an individual with support	a statement of more than one advantage for an individual ***and*** more than one disadvantage for an individual	a statement of at least two advantages for an individual with support for one ***and*** at least two disadvantages for an individual with support for one
Economic (Economic benefits)	an economic benefit for a company	more than one economic benefit for a company ***or*** one benefit with support	more than one economic benefit for a company with support for at least two	
Security (Security implications)	a positive ***or*** a negative security implication for a country	a positive ***and*** a negative security implication for a country	a positive ***and*** a negative security implication for a country with support for ***one***	a positive ***and*** a negative security implication for a country with support for ***both***
Con (Concluding appraisal)	a concluding opinion is given	a concluding appraisal linking to previous arguments		

13 **D**

<table>
<tr>
<td>8</td>
<td></td>
<td>
<table>
<tr><td></td><td>1</td><td>2</td><td>3</td></tr>
<tr><td>Benefits of controlling</td><td>a statement of a benefit</td><td>a statement of two or more benefits
or
a statement of one benefit with an explanation</td><td>a statement of two or more benefits with at least one explained</td></tr>
<tr><td>Limitations of controlling</td><td>a statement of a limitation</td><td>a statement of two or more limitations
or
a statement of one limitation with an explanation</td><td>a statement of two or more limitations with at least one explained</td></tr>
<tr><td>Con (Conclusion)</td><td>a simple conclusion</td><td>a conclusion with a detailed appraisal of the issues raised</td><td></td></tr>
</table>
</td>
<td>8</td>
<td>D</td>
</tr>
</table>