GCSE
COMBINED SCIENCE: TRILOGY
8464/P/2H

Physics Paper 2H

Mark scheme

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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

No student should be disadvantaged on the basis of their gender identity and/or how they refer to the gender identity of others in their exam responses.

A consistent use of 'they/them' as a singular and pronouns beyond 'she/her' or 'he/him' will be credited in exam responses in line with existing mark scheme criteria.

Further copies of this mark scheme are available from aqa.org.uk

Information to Examiners

1. General

The mark scheme for each question shows:

- the marks available for each part of the question
- the total marks available for the question
- the typical answer or answers which are expected
- extra information to help the examiner make their judgement
- the Assessment Objectives and specification content that each question is intended to cover.

The extra information is aligned to the appropriate answer in the left-hand part of the mark scheme and should only be applied to that item in the mark scheme.

At the beginning of a part of a question a reminder may be given, for example: where consequential marking needs to be considered in a calculation; or the answer may be on the diagram or at a different place on the script.

In general the right-hand side of the mark scheme is there to provide those extra details which confuse the main part of the mark scheme yet may be helpful in ensuring that marking is straightforward and consistent (for example, a scientifically correct answer that could not reasonably be expected from a student's knowledge of the specification).

2. Emboldening and underlining

2.1 In a list of acceptable answers where more than one mark is available 'any **two** from' is used, with the number of marks emboldened. Each of the following bullet points is a potential mark.

2.2 A bold **and** is used to indicate that both parts of the answer are required to award the mark.

2.3 Alternative answers acceptable for a mark are indicated by the use of **or**.
Alternative words in the mark scheme are shown by a solidus eg allow smooth / free movement.

2.4 Any wording that is underlined is essential for the marking point to be awarded.

3. Marking points

3.1 Marking of lists

This applies to questions requiring a set number of responses, but for which students have provided extra responses. The general principle to be followed in such a situation is that 'right + wrong = wrong'.

Each error / contradiction negates each correct response. So, if the number of errors / contradictions equals or exceeds the number of marks available for the question, no marks can be awarded.

However, responses considered to be neutral (indicated as * in example 1) are not penalised.

Example 1: What is the pH of an acidic solution?

[1 mark]

Student	Response	Marks awarded
1	green, 5	0
2	red*, 5	1
3	red*, 8	0

Example 2: Name **two** magnetic materials.

[2 marks]

Student	Response	Marks awarded
1	iron, steel, tin	1
2	cobalt, nickel, nail*	2

3.2 Use of symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, or uses symbols to denote quantities in a physics equation, full credit can be given if the symbol / formula is correct and if, in the context of the question, such action is appropriate.

3.3 Marking procedure for calculations

Marks should be awarded for each stage of the calculation completed correctly, as students are instructed to show their working. At any point in a calculation students may omit steps from their working. If a subsequent step is given correctly, the relevant marks may be awarded.

Full marks should be awarded for a correct numerical answer, without any working shown.
Full marks are **not** awarded for a correct final answer from incorrect working.

3.4 Interpretation of 'it'

Answers using the word 'it' should be given credit only if it is clear that the 'it' refers to the correct subject.

3.5 Errors carried forward

An error can be carried forward from one question part to the next and is shown by the abbreviation 'ecf'.

Within an individual question part, an incorrect value in one step of a calculation does not prevent all of the subsequent marks being awarded.

3.6 Phonetic spelling

Marks should be awarded if spelling is not correct but the intention is clear, **unless** there is a possible confusion with another technical term.

3.7 Brackets

(…..) are used to indicate information which is not essential for the mark to be awarded but is included to help the examiner identify the sense of the answer required.

3.8 Allow

In the mark scheme additional information, 'allow' is used to indicate creditworthy alternative answers.

3.9 Ignore

Ignore is used when the information given is irrelevant to the question or not enough to gain the marking point. Any further correct amplification could gain the marking point.

3.10 Do <u>not</u> accept

Do **not** accept means that this is a wrong answer which, even if the correct answer is given as well, will still mean that the mark is not awarded.

3.11 Numbered answer lines

Numbered lines on the question paper are intended to support the student to give the correct number of responses. The answer should still be marked as a whole.

4. Level of response marking instructions

Extended response questions are marked on level of response mark schemes.

- Level of response mark schemes are broken down into levels, each of which has a descriptor.
- The descriptor for the level shows the average performance for the level.
- There are two marks in each level.

Before you apply the mark scheme to a student's answer, read through the answer and, if necessary, annotate it (as instructed) to show the qualities that are being looked for. You can then apply the mark scheme.

Step 1: Determine a level

Start at the lowest level of the mark scheme and use it as a ladder to see whether the answer meets the descriptor for that level.

The descriptor for the level indicates the different qualities that might be seen in the student's answer for that level. If it meets the lowest level then go to the next one and decide if it meets this level, and so on, until you have a match between the level descriptor and the answer. With practice and familiarity you will find that for better answers you will be able to quickly skip through the lower levels of the mark scheme.

When assigning a level you should look at the overall quality of the answer. Do **not** look to penalise small and specific parts of the answer where the student has not performed quite as well as the rest. If the answer covers different aspects of different levels of the mark scheme you should use a best fit approach for defining the level.

Use the variability of the response to help decide the mark within the level, ie if the response is predominantly level 2 with a small amount of level 3 material it would be placed in level 2 but be awarded a mark near the top of the level because of the level 3 content.

Step 2: Determine a mark

Once you have assigned a level you need to decide on the mark. The descriptors on how to allocate marks can help with this. The exemplar materials used during standardisation will help. There will be an answer in the standardising materials which will correspond with each level of the mark scheme. This answer will have been awarded a mark by the Lead Examiner. You can compare the student's answer with the example to determine if it is the same standard, better or worse than the example. You can then use this to allocate a mark for the answer based on the Lead Examiner's mark on the example.

You may well need to read back through the answer as you apply the mark scheme to clarify points and assure yourself that the level and the mark are appropriate.

Indicative content in the mark scheme is provided as a guide for examiners. It is not intended to be exhaustive and you must credit other valid points. Students do **not** have to cover all of the points mentioned in the indicative content to reach the highest level of the mark scheme.

You should ignore any irrelevant points made. However, full marks can be awarded only if there are no incorrect statements that contradict a correct response.

An answer which contains nothing of relevance to the question must be awarded no marks.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	distance travelled = speed × time		1	AO1 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	1 500 000 = v × 670 000 $v = \frac{1\ 500\ 000}{670\ 000}$ V = 2.2… (m/s)		1 1 1	AO2 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	F = (6 × 370) - 520 F = 1700 (N)	if no other mark awarded allow **1** mark for 370 - 520 = (-)150 (N)	1 1	AO2 6.5.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	speed	allow velocity	1	AO1 6.5.4.1.4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.5	friction + air resistance = pull of the rope on the sled		1	AO1 6.5.1.4 6.5.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.6	the force of the sled on the rope		1	AO1 6.5.4.2.3

Total Question 1	**9**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	$(0^2 -)\ 18^2 = 2 \times a \times 24$	allow $18^2 = 2 \times a \times 24$	1	AO2 6.5.4.1.5
	$a = \frac{(-)18^2}{2 \times 24}$		1	
	$a = (-)\ 6.75\ (m/s^2)$	allow $(-)\ 6.8\ (m/s^2)$	1	

Question	Answers	Mark	AO / Spec. Ref.
02.2	**Level 3:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.	5–6	AO2
	Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	3–4	AO1
	Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1–2	AO1
	No relevant content	0	6.5.4.2.2 6.5.4.3.1 6.5.4.3.3 6.5.4.3.4
	Indicative Content **Thinking distance** • condition of brakes and tyres does not affect thinking distance • speed does not affect thinking / reaction time • decreased speed decreases thinking distance **Braking distance** • condition of tyres affects friction between tyres and road • poor condition of tyres and brakes increases braking distance • decreased speed decreases braking distance **safety** • stopping distance = thinking distance + braking distance • poor condition of brakes and tyres increases stopping distance • decreased speed decreases stopping distance • decreased speed decreases the chance of the driver losing control of the vehicle • decreased speed decreases the chance of a collision • decreased speed decreases the risk of injury during a collision for **Level 3,** answers must include references to brakes / tyres, speed, thinking distance, braking distance, and safety.		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	frictional / braking force is greater (for the faster car) **or** the faster car has more kinetic energy		1	AO1
	(so) more work done (by the brakes to stop the faster car)	allow so more energy is transferred (by the brakes to stop the faster car) ignore more heating	1	AO3
	(so) the risk of the brakes overheating is greater (for the fast car)	allow (at greater speed) there is a risk of overheating MP3 dependent on MP1 or MP2	1	AO3 6.5.4.3.4

Total Question 2	**12**

Question 3

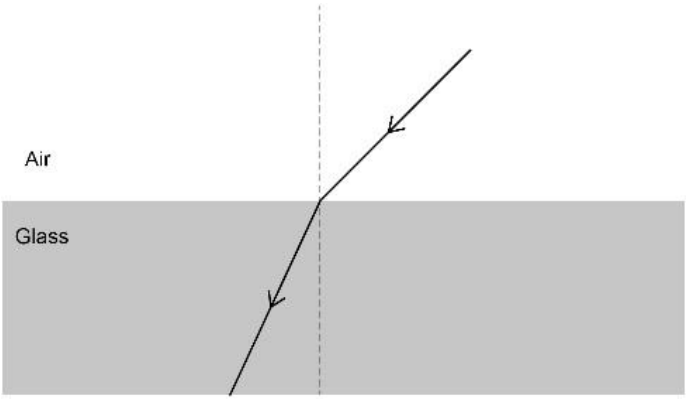
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	oscillations / vibrations are perpendicular to the direction of energy transfer	allow oscillations / vibrations are perpendicular to the direction of wave travel allow **1** mark for oscillations/ vibrations are perpendicular	2	AO1 6.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	skin cancer **or** causes skin to age (prematurely)	allow skin cell mutation ignore cancer unqualified	1	AO1 6.6.2.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	shorter		1	AO1 6.6.2.1

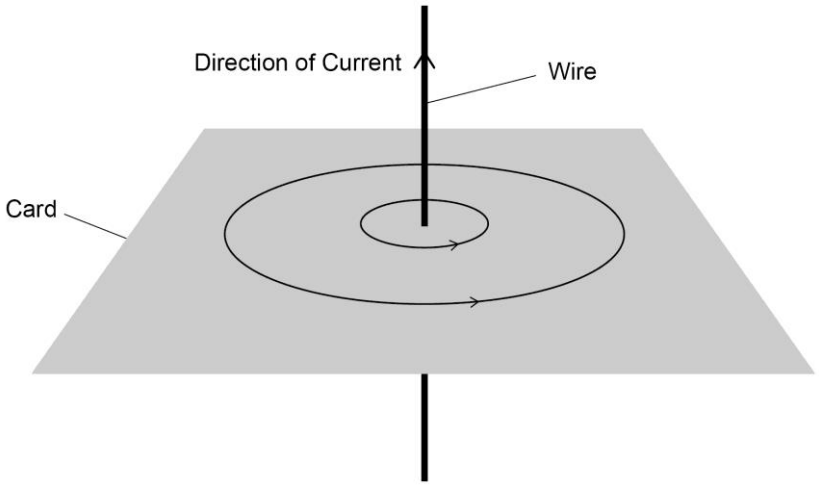
Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	$3.00 \times 10^{8} = 6.25 \times 10^{14} \times \lambda$ $\lambda = \dfrac{3.00 \times 10^{8}}{6.25 \times 10^{14}}$ $\lambda = 4.80 \times 10^{-7}$ (m) $\lambda = 480$ (nm)	 allow a correct conversion to nm of their incorrectly calculated value of λ using the numbers from the question	1 1 1 1	AO2 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	the speed of the light / waves / wavefronts decreases (when entering the lens) (so) one end of the wavefront slows before the other end	allow the speed of light / waves / wavefronts is less in the lens (than in air) ignore lens has a higher density than air ignore references to refractive index	1 1	AO1 6.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.6	normal line drawn ray drawn with an angle of refraction of 28°  ignore ray below the glass	allow a normal line that only extends from the boundary into the glass	1 1	AO2 6.6.2.2

Total Question 3	**12**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	(at least) 2 concentric rings around the point where the wire passes through the card with arrow(s) drawn in anticlockwise direction around the wire		1 1	AO1 6.7.2.1
				

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	2.1 mN = 0.0021 N	subsequent marks may be awarded if *F* is incorrectly / not converted	1	AO2
	$0.0021 = B \times 0.56 \times 0.050$		1	AO2
	$B = \dfrac{0.0021}{0.56 \times 0.050}$		1	AO2
	$B = 0.075$		1	AO2
	tesla **or** T		1	AO1 6.7.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	there is a magnetic field between the poles of the magnets		1	AO1 6.7.2.2 6.7.2.3
	a current in a loop of wire causes a magnetic field		1	
	the current is in opposite directions in side A and side B		1	
	(so) the (vertical) forces on side A and side B are in opposite directions		1	
	the force on side A is downwards **or** the force on side B is upwards	allow the forces on side A and side B cause the loop to rotate anticlockwise	1	

Total Question 4	**12**

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	random		1	AO3 6.6.2.2 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	range = 0.5 – (–0.5) **or** range = 1 **or** uncertainty = $\frac{0.5 - (-0.5)}{2}$	allow $0.5-\left(\frac{0.5+0.2-0.3+0.5+0.1}{5}\right)$ allow $\left(\frac{0.5+0.2-0.3+0.5+0.1}{5}\right)-0.5$	1	AO3 6.6.2.2 RPA 21
	uncertainty = (±) 0.5 (°C)		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	*y*-axis scale of 10 °C per cm		1	AO2
	all points plotted correctly	allow **1** mark for 3 or 4 points plotted correctly allow a tolerance of ± ½ small square'	2	AO2
	curved line of best fit ignoring anomalous point at 8 minutes		1	AO3 6.6.2.2 RPA 21

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	2 minutes = 120 seconds	subsequent marks may be awarded if time is incorrectly / not converted	1	AO2 6.6.2.2 RPA21
	rate = $\frac{63 - 18}{120}$		1	
	rate = 0.375 (°C/s)	allow 0.38 (°C/s)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5		ignore references to heat throughout		AO1 6.6.2.2 RPA21
	black surfaces are good absorbers (and emitters of infrared / radiation)		1	
	white surfaces are poor absorbers (and emitters of infrared / radiation)		1	
	as the temperature of the cubes increases the cubes emit infrared / radiation at a greater rate		1	
	at maximum / constant temperature, each cube emits infrared /radiation at the same rate that it absorbs infrared / radiation		1	

Total Question 5	**14**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	athlete's swimming speed = typical walking speed		1	AO1 6.5.4.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	time taken = 1400	subsequent marks may be awarded if time taken is determined from the graph	1	AO3 6.5.2 6.5.4.1.5
	mean speed = $\frac{7.5 + 6.2}{2}$ (= 6.85 m/s)	allow mean speed calculated using a maximum speed between 7.4 m/s and 7.6 m/s	1	
	distance (= 6.85 × 1400) = 9590 (m)	allow a distance consistent with their calculated mean speed subsequent marks may only be awarded if values of speed and time from the graph have been used to determine a distance subsequent marks may be awarded using their value of total distance	1	
	110 000 = F × 9590		1	
	$F = \frac{110\,000}{9590}$		1	
	F = 11(.470…) (N)		1	

06.2 cont.	**OR**			
	time taken = 1400 (1) area of triangle (1) = 0.5 × 1400 × (7.5 - 6.2) (= 910) **and** area of rectangle = 1400 × 6.2 (= 8680) distance (1) (= 910 + 8680) = 9590 (m) 110 000 = *F* × 9590 (1) $F = \frac{110\ 000}{9590}$ (1) *F* = 11(.470…) (N) (1)	subsequent marks may be awarded if time taken is determined from the graph allow area calculated using a maximum speed between 7.4 m/s and 7.6 m/s allow a distance consistent with their calculated areas subsequent marks may only be awarded if values of speed and time from the graph have been used to determine a distance subsequent marks may be awarded using their value of total distance		

06.2 cont.	**OR**			
	time taken = 1400 (1) acceleration= $\frac{6.2 - 7.5}{1400}$ (1) (= (-)0.00092857…) distance (1) $\left(= \frac{6.2^2 - 7.5^2}{(-)2 \times 0.00092857 \ldots}\right)$ = 9590 (m) 110 000 = *F* × 9590 (1) $F = \frac{110\ 000}{9590}$ (1) *F* = 11(.470…) (N) (1)	subsequent marks may be awarded if time taken is determined from the graph allow acceleration calculated using a maximum speed between 7.4 m/s and 7.6 m/s subsequent marks may be awarded if their calculated value for acceleration is rounded allow a distance consistent with their calculated acceleration subsequent marks may only be awarded if values of speed and time from the graph have been used to determine a distance subsequent marks may be awarded using their value of total distance		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	constant magnitude (of velocity)	allow speed was constant allow speed was 4 m/s allow (magnitude of) velocity was 4 m/s do **not** accept constant velocity	1	AO2
	direction (of velocity) kept changing		1	AO1
		if no other mark awarded allow **1** mark for the velocity is constantly changing		6.5.4.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	the gradient is equal to the deceleration / acceleration		1	AO3 6.5.4.1.5
	(and) the (magnitude of the) gradient increased		1	

Total Question 6	**11**