Please write clearly in block capitals.

Centre number _______ Candidate number _______

Surname _______

Forename(s) _______

Candidate signature _______

I declare this is my own work.

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier
Physics Paper 2H

Time allowed: 1 hour 15 minutes

Materials
For this paper you must have:
- a protractor
- a ruler
- a scientific calculator
- the Physics Equations Sheet (enclosed).

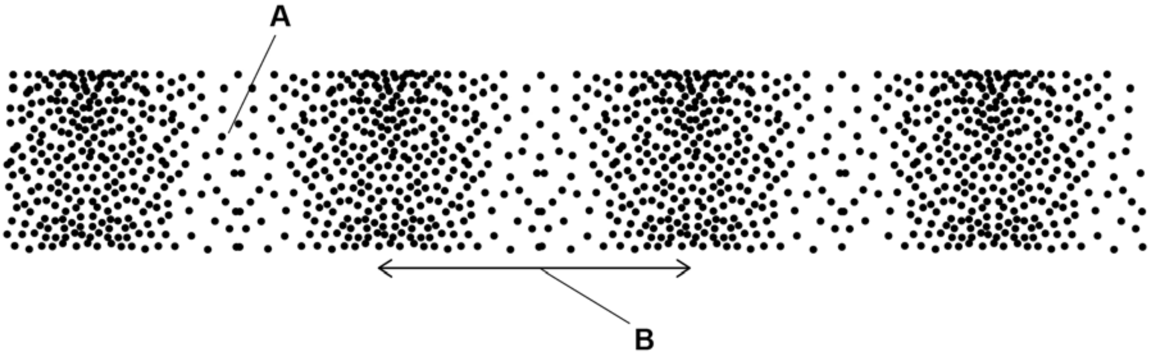
Instructions
- Use black ink or black ball-point pen.
- Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.

Information
- The maximum mark for this paper is 70.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

0 1 **Figure 1** shows a longitudinal wave.

Figure 1



0 1 . 1 What do the labels **A** and **B** on **Figure 1** represent?

Choose answers from the box.

[2 marks]

amplitude	**frequency**	**rarefaction**	**reflection**	**wavelength**

A ______________________________

B ______________________________

Do not write outside the box

0 1 . 2 The wave shown in **Figure 1** has a frequency of 4.0 kHz

Calculate the period of the wave.

Use the Physics Equations Sheet.

Give the unit.

[4 marks]

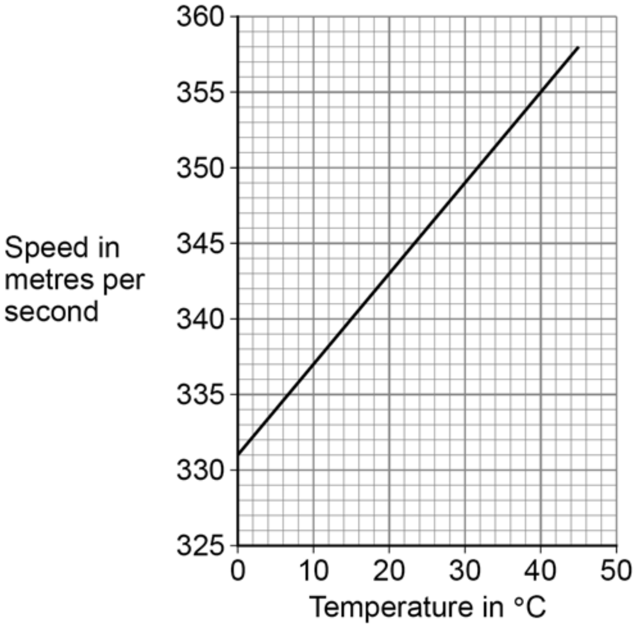
Period = ____________________ Unit ______________

Question 1 continues on the next page

Sound waves are longitudinal.

Figure 2 shows how the speed of sound varies with the temperature of the air.

Figure 2



Do not write outside the box

Use the Physics Equations Sheet to answer questions **01.3** and **01.4**.

0 1 . 3 Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

[1 mark]

____

0 1 . 4 A sound wave with a frequency of 300 Hz travels through the air.

The air has a temperature of 28.0 °C

Determine the wavelength of the sound wave.

Use **Figure 2**.

[4 marks]

____

____

____

____

____

Wavelength = ____________________ m

11

Turn over for the next question

Do not write outside the box

0 2 **Figure 3** shows competitors in the wheelchair race at the London Marathon.

The distance of the London Marathon is 42 000 m

Figure 3

Do not write outside the box

Use the Physics Equations Sheet to answer questions **02.1** and **02.2**.

0 2 . 1 Write down the equation that links distance (*s*), force (*F*) and work done (*W*).

[1 mark]

____

0 2 . 2 During the race competitors work against air resistance.

The work done against air resistance by the winner of the race was 3 360 000 J

Calculate the average air resistance acting on the winner of the race.

[3 marks]

____

____

____

____

Average air resistance = ____________________ N

Question 2 continues on the next page

Do not write outside the box

Use the Physics Equations Sheet to answer questions **02.3** and **02.4**.

0 2 . 3 Which equation links distance travelled, speed and time?

[1 mark]

Tick (✓) **one** box.

distance travelled = speed × time ☐

time = distance travelled × speed ☐

speed = distance travelled × time ☐

0 2 . 4 The distance of the London Marathon is 42 000 m

The winning time for the race was 5600 seconds.

Calculate the average speed of the winner of the race.

[3 marks]

____

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____

Average speed = ____________________ m/s

Do not write outside the box

0 2 . 5 Explain why the speed of a competitor changes during the race.

[4 marks]

12

Turn over for the next question

Do not write outside the box

0 3 **Figure 4** shows a child playing with a toy train.

The train is on a bridge.

Figure 4

When the child lets go of the train, the train rolls down the bridge.

0 3 . 1 The momentum of the train at the bottom of the bridge is 0.216 kg m/s

mass of the train = 180 g

Calculate the velocity of the train at the bottom of the bridge.

Use the Physics Equations Sheet.

[4 marks]

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Velocity = ____________________ m/s

Do not write outside the box

0 3 . 2 The train collides with a stationary carriage on the track.

Explain why the velocity of the train after the collision is less than it was before the collision.

Use ideas about momentum in your answer.

[4 marks]

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8

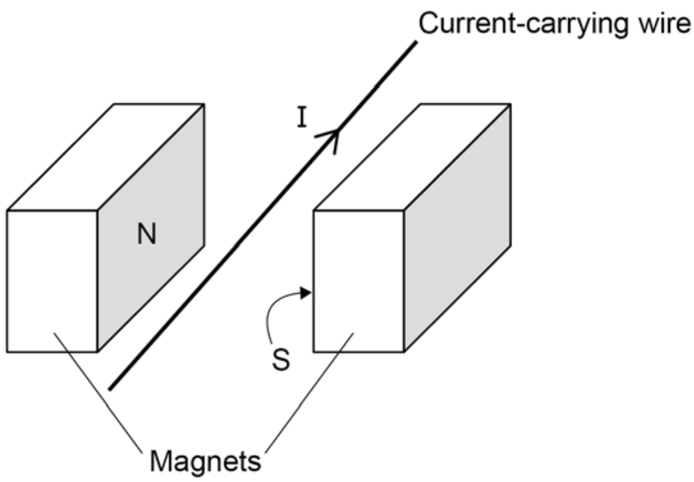
Turn over for the next question

Do not write outside the box

0 4 A teacher demonstrated the motor effect.

Figure 5 shows the equipment used.

Figure 5



0 4 . 1 Explain why there is a force on the wire when there is a current in the wire.

[2 marks]

____

____

____

____

0 4 . 2 Explain how the direction of the force on the wire can be predicted.

[3 marks]

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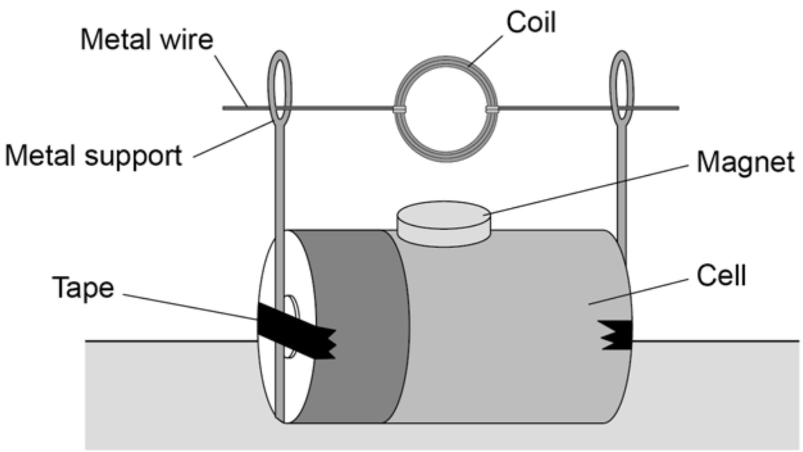
Do not write outside the box

0 4 . 3 **Figure 6** shows a simple electric motor.

Figure 6



Explain **one** way that the motor could be changed to increase the rate at which the coil rotates.

[2 marks]

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7

Turn over for the next question

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DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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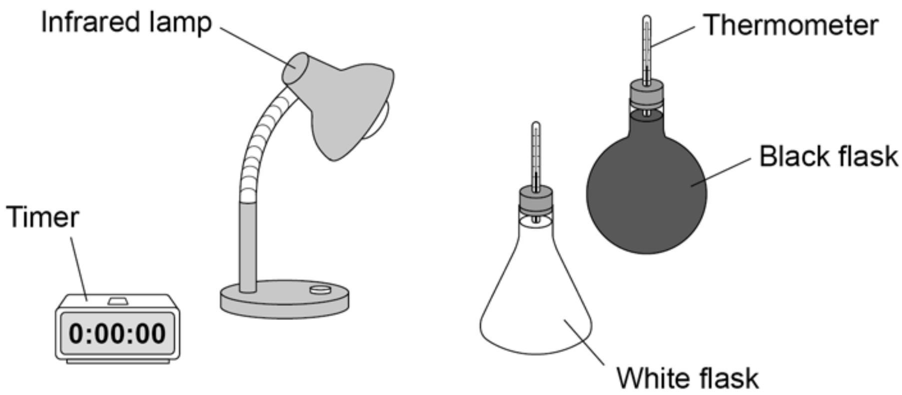
0 5 A student investigated how the colour of a surface affects the amount of infrared radiation the surface absorbs.

Figure 7 shows the equipment used.

The two flasks are painted different colours.

Figure 7



This is the method used.

1. Pour water at 20 °C into each flask.
2. Place a bung and thermometer into each flask.
3. Place each flask in front of the infrared lamp.
4. Measure the temperature of the water every 30 seconds for 10 minutes.

0 5 . 1 Explain **two** improvements to the method the student used.

[4 marks]

1 ____

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____

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2 ____

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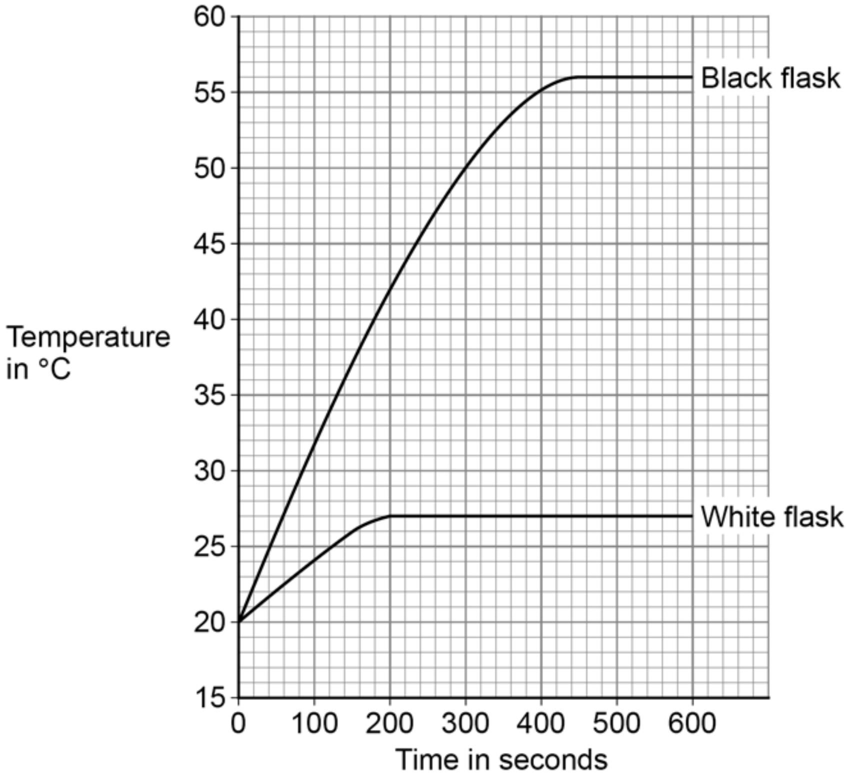
Turn over ►

Do not write outside the box

Figure 8 shows the results for each flask.

Figure 8



0 5 . 2 Complete the sentences.

[2 marks]

After 100 seconds the temperature difference between the black flask and the white flask was __________ °C

The temperature of the white flask stopped increasing. The temperature inside the black flask continued to increase for a further __________ seconds.

Do not write outside the box

0 5 . 3 The initial rate of absorption of infrared radiation by the black flask was greater than the initial rate of absorption by the white flask.

How does **Figure 8** show this?

[1 mark]

0 5 . 4 Explain why the temperature of the water in the flasks increased and then became constant.

[4 marks]

11

Turn over for the next question

Do not write outside the box

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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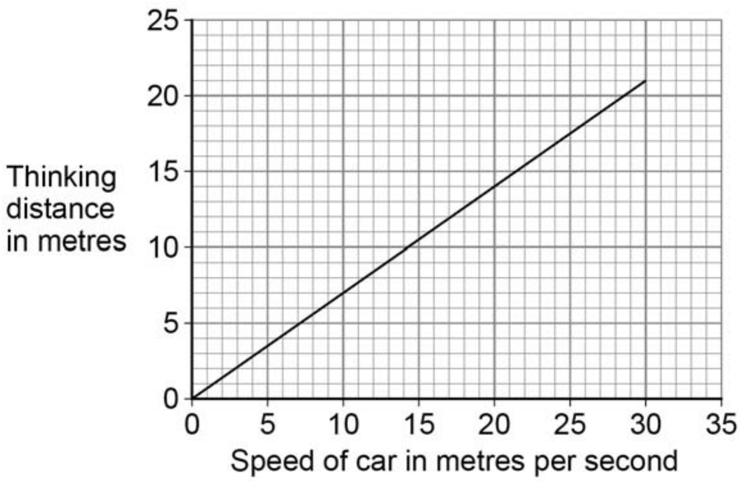
0 6 The distance a car travels during the driver's reaction time is called the thinking distance.

0 6 . 1 **Figure 9** shows how thinking distance depends on speed for a car.

Figure 9



Determine the driver's reaction time.

Use the Physics Equations Sheet.

[3 marks]

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Reaction time = ____________________ s

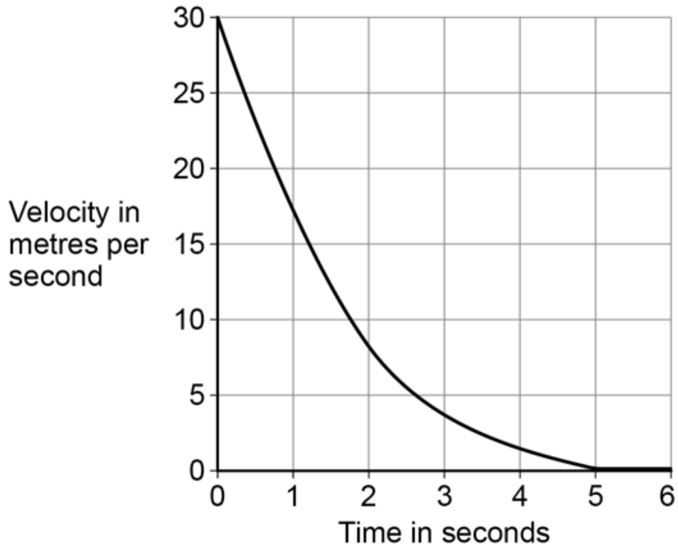
Question 6 continues on the next page

Turn over ►

Do not write outside the box

0 6 . 2 **Figure 10** shows how the velocity of a car changes during braking.

Figure 10



Determine the braking distance of the car.

[3 marks]

Braking distance = ______________________ m

Do not write outside the box

0 6 . 3 Explain how the gradient of the line on **Figure 10** shows that the resultant force on the car was **not** constant.

[3 marks]

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9

Turn over for the next question

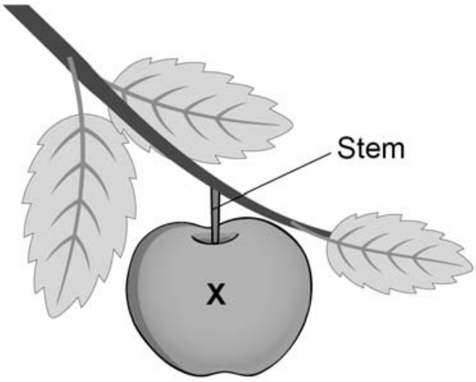
There are no questions printed on this page

**DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED**

0 7 **Figure 11** shows a stationary apple hanging from a tree.

The **X** marks the centre of mass of the apple.

Figure 11



0 7 . 1 Draw **two** arrows on **Figure 11** to show the forces acting on the apple.

[2 marks]

Question 7 continues on the next page

Do not write outside the box

0 7 . 2 It takes 0.50 s for the apple to fall to the ground.

The initial velocity of the apple is 0 m/s

acceleration due to gravity = 9.8 m/s^2

Calculate the distance fallen by the apple.

Use the Physics Equations Sheet.

[6 marks]

Distance = ____________________ m

Do not write outside the box

0 7 . 3 In Question **07.2** it was assumed that the acceleration was a constant 9.8 m/s^2

Evaluate this assumption.

[4 marks]

12

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

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Question number	**Additional page, if required. Write the question numbers in the left-hand margin.**

AQA

GCSE
COMBINED SCIENCE: TRILOGY
8464/P/2H

Physics Paper 2H

Mark scheme

June 2022

Version: 1.0 Final Mark Scheme

226G8464P2H/MS

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.

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 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	**A** = rarefaction **B** = wavelength		1 1	AO1 6.6.1.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	f = 4000 Hz		1	AO2
	$T = \frac{1}{4000}$	allow a correct substitution using an incorrectly / not converted value of f	1	AO2
	T = 0.00025	allow a correct calculation using an incorrectly / not converted value of f	1	AO2
	seconds **or** s		1	AO1 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	wave speed = frequency × wavelength **or** $v = f\lambda$		1	AO1 6.6.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	*v* = 348	allow a value in the range 347 to 348 subsequent marks may only be awarded if value for v is in the range 343 to 349	1	AO2 6.6.1.2
	348 = 300 × *λ*	allow a correct substitution using an incorrect value of *v* read from graph	1	
	$\lambda = \frac{348}{300}$	allow a correct rearrangement using an incorrect value of *v* read from graph	1	
	1.16 (m)	allow 1.2 (m) allow a correct calculation using an incorrect value of *v* read from graph allow a maximum of **2** marks for use of *v* = 330 m/s	1	

Total Question 1		**11**

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	work done = force × distance (along the line of action of the force) **or** $W = F\,s$		1	AO1 6.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.2	3 360 000 = F × 42 000 $F = \frac{3\,360\,000}{42\,000}$ F = 80 (N)		1 1 1	AO2 6.5.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	distance travelled = speed × time		1	AO1 6.5.4.1.5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	42 000 = v × 5600 $v = \frac{42\,000}{5600}$ v = 7.5 (m/s)		1 1 1	AO2 6.5.4.1.2

Question	Answers	Mark	AO / Spec. Ref.
02.5	**Level 2:** Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	3–4	AO3 6.5.4.1.2
	Level 1: Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.	1–2	
	No relevant content	0	
	Indicative content the effect on speed must be consistent with the cause of the change • competitors accelerate at the start • so speed increases • the road is not flat • so speed increases going downhill and / or speed decreases going uphill • the competitor goes round a bend • so speed decreases • competitors may tire towards the end (so the force they exert decreases) • so they slow down • competitors may sprint during the race • causing speed to increase • may get a puncture • so speed would decrease or they would stop • resistive forces on competitors may increase/decrease • so speed would decrease/increase		

Total Question 2		**12**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	$m = 0.180$		1	AO2 6.5.5.1
	$0.216 = 0.180 \times v$	allow a correct substitution using an incorrectly / not converted value of *m*	1	
	$v = \frac{0.216}{0.180}$	allow a correct rearrangement using an incorrectly / not converted value of *m*	1	
	$v = 1.2$ (m/s)	allow a correct calculation using an incorrectly / not converted value of *m*	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	(total) momentum is conserved in the collision	allow (total) momentum before collision = (total) momentum after collision	1	AO1 6.5.5.1
	during the collision the momentum of carriage increases		1	
	so the momentum of train decreases		1	
	since momentum = mass × velocity, velocity (of train) decreases	allow since mass (of train) is constant, velocity (of train) decreases	1	

Total Question 3		**8**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	there is a magnetic field due to the (permanent) magnets		1	6.7.2.1 AO1
	and the current in the wire produces a magnetic field		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	use (Fleming's) left hand rule	allow place first two fingers and thumb of left hand at right angles to each other	1	6.7.2.2 AO1
	place first finger in direction of the field lines **and** place second finger in direction of current		1	
	then thumb will show direction of the force	allow thumb points downwards allow force is downwards	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	any **one** from: • more turns of the wire on the coil • increase the current in the coil • stronger magnet	allow use a cell with a greater potential difference allow move the coil closer to the magnet ignore bigger magnet	1	6.7.2.3 AO1
	this will increase the force on the coil (due to the motor effect)		1	

Total Question 4		7

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	**any two pairs from**		4	
	• place each flask the same distance from the infrared lamp	allow use two lamps at an equal distance from each flask		AO3
	• so the intensity of infrared radiation incident on each flask is the same			AO1
	• use flasks of the same shape and size			AO3
	• so the surface area is the same			AO1 6.6.2.2
	• use equal volumes of water	allow use equal masses of water		
	• because volume of water affects the rate at which the water temperature increases			

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	7.5	allow 8	1	AO3 6.6.2.2
	240		1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	(black flask line has) a greater gradient **or** temperature (of the black flask) increased more (during the same time)		1	AO3 6.6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	the flasks absorb infrared radiation **and** transfer energy to surroundings (by heating and emission of infrared)	allow water for flasks throughout	1	AO3 6.6.2.2
	initially the rate of absorption of infrared is greater than the rate of energy transfer to the surroundings (causing the temperature to increase)		1	
	(rate of) energy transfer to surroundings increases as the temperature of the flasks increase		1	
	eventually the rate of energy transfer to surroundings = rate of energy transfer to flasks (causing the temperature to become constant)		1	

Total Question 5		**11**

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	21 = 30 × *t*	allow use of any correct pair of values from the graph	1	AO2 6.5.4.1.2
	$t = \frac{21}{30}$		1	
	t = 0.7 (s)	allow 0.70 (s)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.2	one square represents 5 (m)		1	AO2 6.5.4.1.2
	number of squares = 9	allow number of squares in the range 8.5 to 10	1	
	braking distance = 9 × 5 = 45 (m)	allow an answer in the range 42.5 (m) to 50 (m)	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.3	gradient is equal to acceleration		1	AO1
	gradient / acceleration is not constant		1	AO3
	so resultant force is not constant because resultant force is directly proportional to acceleration (for constant mass)	allow resultant force is not constant because F = ma	1	AO3 6.5.4.2.2

Total Question 6		**9**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	two vertical arrows in opposite directions away from point **X**	allow if the upwards arrow starts from the stem ignore any labels	1	AO1 6.5.4.2.1
	both arrows the same length	dependent on MP1	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.2	$9.8 = \frac{\Delta v}{0.5}$		1	AO2 6.5.4.1.5
	$\Delta v = 9.8 \times 0.5$		1	
	final velocity = Δv = 4.9 (m/s)		1	
	$4.9^2 - 0^2 = 2 \times 9.8 \times s$	allow a correct substitution of an incorrectly calculated value of final velocity	1	
	$s = \frac{4.9^2}{2 \times 9.8}$	allow a correct rearrangement of an incorrectly calculated value of final velocity	1	
	s = 1.2 m	allow 1.23 or 1.225 do **not** accept 1.22 allow a correct calculation using an incorrectly calculated value of final velocity	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.3	as the apple falls / accelerates air resistance increases	allow there is air resistance acting on the apple as it falls	1	AO1 6.5.4.1
	so resultant force decreases		1	
	so acceleration will decrease	MP3 dependent on MP1 or MP2 being awarded	1	
	acceleration will not be constant, so not a good assumption	MP4 dependent on MP1 or MP2 being awarded	1	
	OR			
	the apple only falls for a short time/distance (1)			
	air resistance is negligible (1)			
	so resultant force is constant (1)	MP3 dependent on MP1 or MP2 being awarded		
	therefore acceleration is constant, so good assumption (1)	MP4 dependent on MP1 or MP2 being awarded		

Total Question 7		**12**