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.

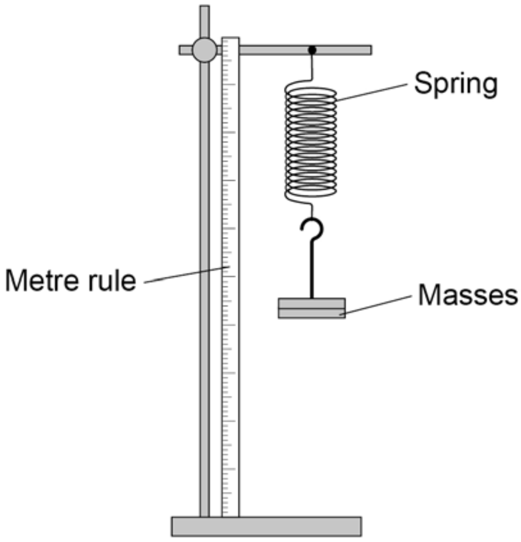
Information
- The maximum mark for this paper is 70.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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

0 1 **Figure 1** shows a stretched spring.

The spring is elastically deformed.

Figure 1



0 1 . 1 What is meant by 'elastically deformed'?

[1 mark]

Tick (✓) **one** box.

As the force on the spring increases the length of the spring increases. ☐

Only a very small force is needed to stretch the spring. ☐

The force on the spring causes it to change shape. ☐

The spring will return to its original length when the force is removed. ☐

Do not write outside the box

0 1 . 2 Describe a method to determine the extension of the spring.

[2 marks]

____

____

____

____

0 1 . 3 The extension of the spring is 80 mm.

spring constant = 40 N/m

Calculate the elastic potential energy of the spring.

Use the Physics Equations Sheet.

[3 marks]

____

____

____

____

____

Elastic potential energy = ______________________ J

Question 1 continues on the next page

Do not write outside the box

0 1 . 4 Write down the equation which links extension (e), force (F) and spring constant (k).

[1 mark]

---

0 1 . 5 A force of 300 N acts on a different spring.

The force causes the spring to extend by 0.40 m.

Calculate the spring constant of the spring.

[3 marks]

Spring constant = ____________________ N/m

10

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 2 Professional rugby players wear a tracking device that measures their velocity and acceleration.

Figure 2 shows a player wearing a tracking device.

The player is tackling another player who is running with the ball.

Figure 2

0 2 . 1 Velocity and acceleration are both vector quantities.

What is a vector quantity?

[1 mark]

Tick (✓) **one** box.

A quantity with both magnitude and direction ☐

A quantity with direction only ☐

A quantity with magnitude only ☐

0 2 . 2 Which of the following is a vector quantity?

[1 mark]

Tick (✓) **one** box.

Displacement ☐

Distance ☐

Time ☐

Work done ☐

Question 2 continues on the next page

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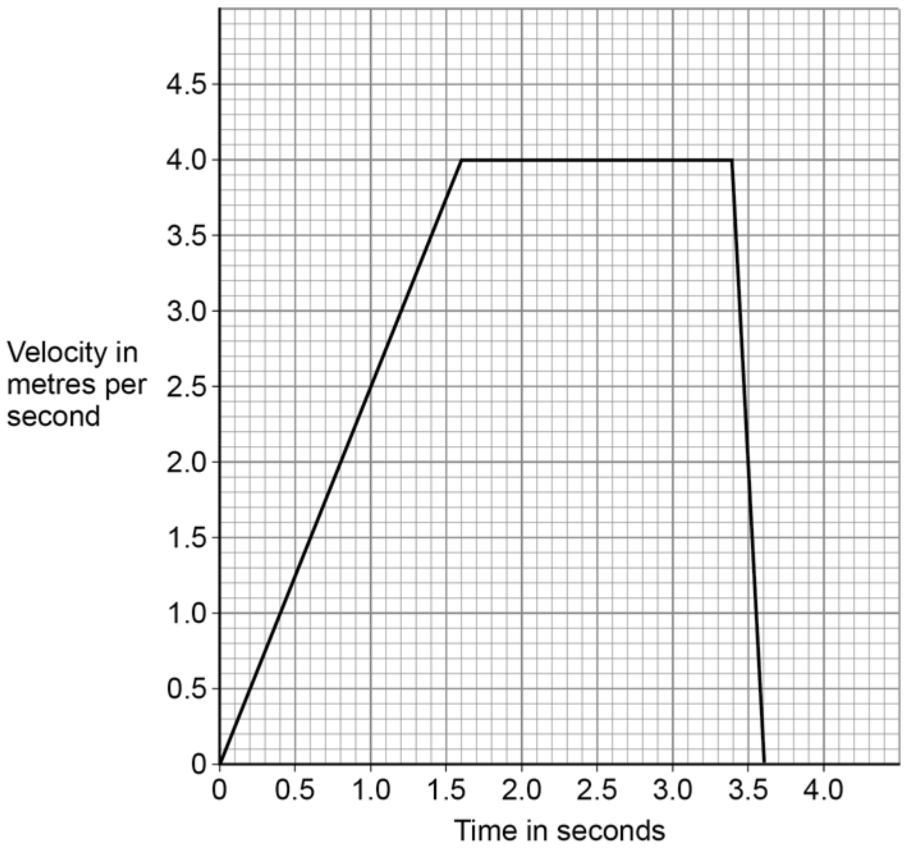
Figure 3 shows a velocity–time graph for the player running with the ball.

Figure 3



0 2 . 3 Determine the acceleration of the player between 0 and 1.6 s.

[2 marks]

Acceleration = ____________________ m/s^2

0 2 . 4 Describe the motion of the player between 3.4 s and 3.6 s.

[1 mark]

The force exerted on the player when she is tackled causes her to accelerate.

0 2 . 5 Write down the equation which links acceleration (*a*), mass (*m*) and resultant force (*F*).

[1 mark]

____

0 2 . 6 The player accelerates at 25 m/s^2 when a resultant force of 1800 N acts on her.

Calculate the mass of the player.

[3 marks]

____

____

____

____

____

Mass = ____________________ kg

0 2 . 7 The tracking device sends data to a computer during the game.

Suggest **one** advantage of the data being sent during the game.

[1 mark]

____

____

10

Turn over for the next question

Do not write outside the box

0 3 A student made water waves in a ripple tank.

0 3 . 1 Describe how the frequency and wavelength of the water waves in the ripple tank can be measured accurately.

[4 marks]

The student recorded values for the frequency and the wavelength of waves in the ripple tank.

Table 1 and **Table 2** show the results.

Table 1

Reading	**1**	**2**	**3**
Frequency in hertz	9.8	9.4	9.3

Table 2

Reading	**1**	**2**	**3**
Wavelength in cm	1.7	2.2	2.1

Do not write outside the box

0 3 . 2 Determine the mean wave speed.

[4 marks]

Mean wave speed = ____________________ m/s

0 3 . 3 What is the advantage of taking repeat readings and then calculating a mean?

[1 mark]

0 3 . 4 The speed of the wave is affected by the depth of the water in the ripple tank.

The deeper the water the faster the wave.

Explain how the depth of the water affects the wavelength of the wave if the frequency is constant.

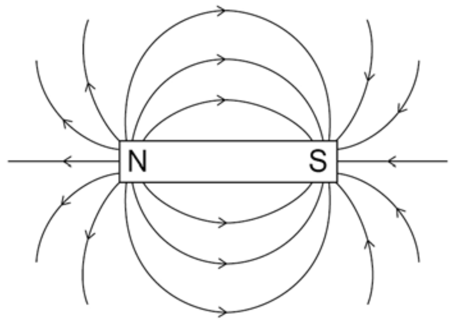
[2 marks]

11

Do not write outside the box

0 4 **Figure 4** shows the magnetic field pattern around a permanent magnet.

Figure 4



0 4 . 1 Where is the magnetic field of the magnet the strongest?

[1 mark]

____

____

0 4 . 2 How does **Figure 4** show that the strength of the magnetic field is not the same at all places?

[1 mark]

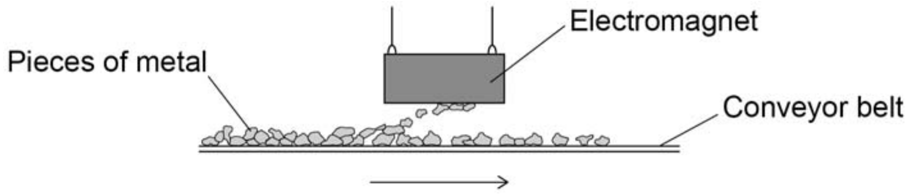
____

____

Do not write outside the box

Figure 5 shows an electromagnet being used to separate iron and steel from non-magnetic metals.

Figure 5



0 4 . 3 Explain **one** reason why an electromagnet is used instead of a permanent magnet.

[2 marks]

____

____

____

____

0 4 . 4 Pieces of iron and steel are attracted to the electromagnet.

Name **two** other metals that would be attracted to the electromagnet.

[2 marks]

1 ______________________

2 ______________________

0 4 . 5 The design of the electromagnet **cannot** be changed.

Give **two** ways the force exerted by the electromagnet on a piece of iron or steel could be increased.

[2 marks]

1 ____

____

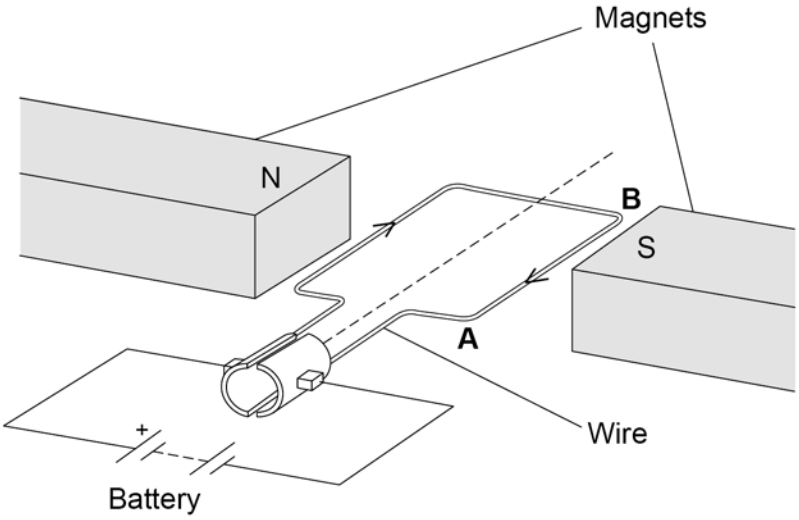
2 ____

____

The conveyor belt that moves the pieces of metal is driven by an electric motor.

Figure 6 shows a simple electric motor.

Figure 6



Do not write outside the box

0 4 . 6 The length of the wire **AB** in the magnetic field is 120 mm.

There is a current of 4.0 A in the wire. The length of wire **AB** experiences a force of 0.36 N.

Calculate the magnetic flux density between the magnets.

Give the unit.

[5 marks]

Magnetic flux density = ________________ Unit ________

Question 4 continues on the next page

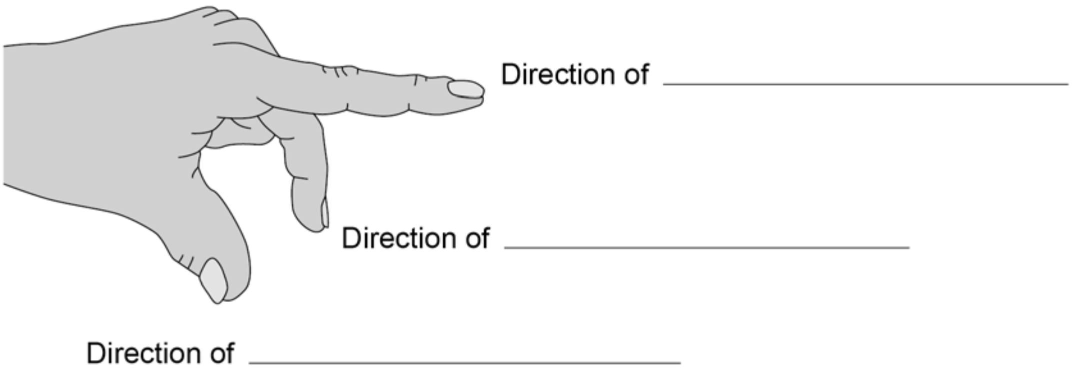
Do not write outside the box

0 4 . 7 Fleming's left-hand rule can be used to determine the direction of the force on wire **AB**.

Complete the labels on **Figure 7** to show Fleming's left-hand rule.

[2 marks]

Figure 7



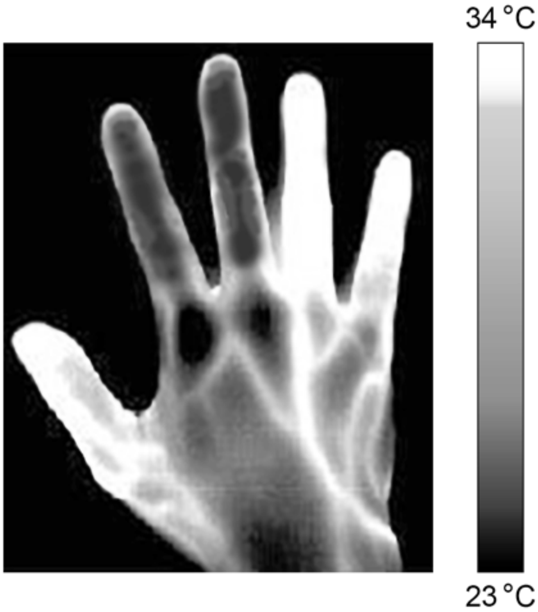
15

Do not write outside the box

0 5 Different parts of the electromagnetic spectrum are used in medical imaging.

Figure 8 shows an image of a person's hand taken with an infrared camera.

Figure 8



0 5 . 1 Explain why the infrared camera is able to show that parts of the hand are at different temperatures.

[2 marks]

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Question 5 continues on the next page

Do not write outside the box

0 5 . 2 Infrared has a range of wavelengths from 700 nm to 1 mm.

Which part of the electromagnetic spectrum would have waves with a wavelength of 6.5×10^{-7} m?

[1 mark]

Tick (✓) **one** box.

Infrared ☐

Microwaves ☐

Radio waves ☐

Visible light ☐

Do not write outside the box

0 5 . 3 **Figure 9** shows X-rays and gamma rays being used for medical imaging.

Figure 9

X-rays | **Gamma rays**

To use X-rays for medical imaging, a machine produces a very brief burst of X-rays.

To use gamma rays for medical imaging, a radioactive isotope is injected into the patient's blood. The isotope is circulated around the body in the blood. The isotope emits gamma rays.

Compare the potential risks to a patient of using X-rays and gamma rays for medical imaging.

[4 marks]

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Question 5 continues on the next page

X-rays are produced by colliding high-energy electrons into a metal target.

The electrons have high energy because they are accelerated to high speeds.

Only a small proportion of the kinetic energy of an electron is converted into an X-ray when it collides with the metal target.

0 5 . 4 An electron is accelerated through a distance of 15 mm.

The work done on the electron is 1.2×10^{-13} J.

Calculate the force on the electron.

[3 marks]

Force = ____________________ N

0 5 . 5 The metal target is made from tungsten.

Tungsten has the highest melting point of any metal.

Explain why using tungsten as the metal target enables the X-ray machine to be more powerful.

[3 marks]

13

Do not write outside the box

0 6 Scientists are developing a hypersonic aeroplane that will travel much faster than normal aeroplanes.

0 6 . 1 An aeroplane accelerates from a low speed to a high speed with the engines at maximum power.

Explain why the acceleration is **not** constant.

[5 marks]

Question 6 continues on the next page

Do not write outside the box

0 6 . 2 The hypersonic aeroplane will have jet engines and a rocket engine.

The speed of aeroplanes can be measured on a uniform scale called the Mach scale.

Mach 1 = 330 m/s

The jet engines will accelerate the aeroplane to Mach 5.5.

The rocket engine will accelerate the aeroplane from Mach 5.5 to Mach 25.5 in 300 s.

The average resultant force on the aeroplane when the rocket engine is used will be 630 000 N.

Calculate the mass of the hypersonic aeroplane.

Give your answer to 2 significant figures.

[6 marks]

Mass (2 significant figures) = ____________________ kg

11

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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

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GCSE
COMBINED SCIENCE: TRILOGY
8464/P/2H

Physics Paper 2H

Mark scheme

June 2021

Version: 1.0 Final Mark Scheme

216G8464P2H/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 his or her judgement
- the Assessment Objectives, level of demand 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.

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**. Different terms in the mark scheme are shown by a / ; 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 error / 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 planets in the solar system.

[2 marks]

Student	Response	Marks awarded
1	Neptune, Mars, Moon	1
2	Neptune, Sun, Mars, Moon	0

3.2 Use of chemical symbols / formulae

If a student writes a chemical symbol / formula instead of a required chemical name, 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. Full marks can, however, be given for a correct numerical answer, without any working shown.

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

Any error in the answers to a structured question should be penalised once only.

Papers should be constructed in such a way that the number of times errors can be carried forward is kept to a minimum. Allowances for errors carried forward are most likely to be restricted to calculation questions and should be shown by the abbreviation ecf in the marking scheme.

3.6 Phonetic spelling

The phonetic spelling of correct scientific terminology should be credited **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.

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 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.

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.

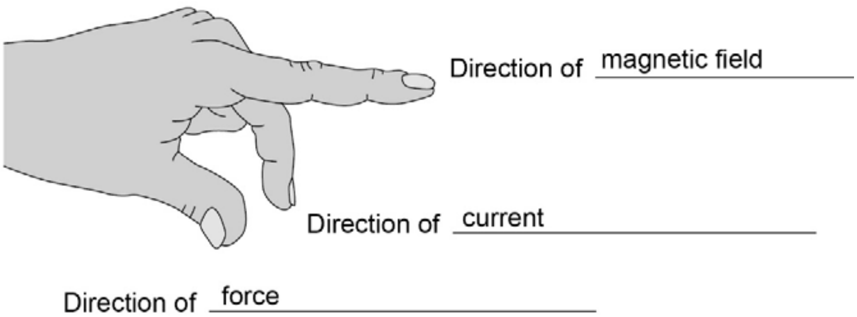
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	the spring will return to its original length when the force is removed		1	6.5.3 AO1
01.2	measure the original length of the spring **and** the extended length of the spring (with the metre rule) extension = extended length – original length		1 1	6.5.3 AO1
01.3	$e = 0.080$ m $E_e = 0.5 \times 40 \times (0.080)^2$ $E_e = 0.128$ (J)	 allow a correct substitution using an incorrectly / not converted value of e allow a correct calculation using an incorrectly / not converted value of e	1 1 1	6.5.3 AO2
01.4	force = spring constant × extension **or** $F = k\,e$		1	6.5.3 AO1
01.5	$300 = k \times 0.40$ $k = \frac{300}{0.40}$ $k = 750$ (N/m)		1 1 1	6.5.3 AO2
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	a quantity with both magnitude and direction		1	AO1 6.5.1.1
02.2	displacement		1	AO1 6.5.4.1.1
02.3	gradient = $\frac{(4 - 0)}{(1.6 - 0)}$ acceleration = 2.5 m/s^2	 allow use of a = Δv / t	1 1	AO2 6.5.4.1.5
02.4	constant deceleration	allow large deceleration allow decelerates to a stop	1	AO2 6.5.4.1.5
02.5	resultant force = mass × acceleration **or** F = ma	allow force = mass × acceleration	1	AO1 6.5.4.2.2
02.6	1800 = m × 25 m = $\frac{1800}{25}$ m = 72 (kg)		1 1 1	AO2 6.5.4.2.2
02.7	performance can be monitored during the game	allow do not have to wait until the end of the game to download data	1	AO3 6.6.2.4
Total			**10**	

Question	Answers	Mark	AO / Spec. Ref.
03.1	**Level 2:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO1 6.6.1.2
	Level 1: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	1–2	
	No relevant content	0	
	Indicative content **Wavelength** • place a metre rule at the side of the screen perpendicular to the wave fronts • use the metre rule to measure the length of the screen • take a photograph of the shadow on the screen • count the number of complete waves on the screen • determine the wavelength by dividing the length of the by the number of complete waves **or** • place a metre rule at the side of the screen perpendicular to the wave fronts • take a photograph of the shadow on the screen • use the metre rule to measure the distance between two wave front **Frequency** • count the number of waves that pass a given point • time how long it takes for the waves to pass that point using a stop clock • frequency is number of waves divided by time taken **or** • put a stop clock on the screen • use a digital video camera to record the waves passing a point • replay in slow motion and count the number of waves passing a point in 1 second There must be a description of both frequency and wavelength measurement to access level 2		

03.2	mean f = 9.5 Hz mean λ = 0.020 m v = 9.5 × 0.020 v = 0.19 (m/s) **or** v = 9.8 × 0.017 **and** v = 9.4 × 0.022 **and** v = 9.3 × 0.021 (2) $v = \frac{(1.67 + 2.07 + 1.95)}{3}$ (1) v = 0.19 (m/s) (1)	 allow a correct substitution of an incorrect value of mean frequency and/or wavelength allow a correct calculation using an incorrect value of mean frequency and/or wavelength allow a maximum of **2** marks if a single pair of values is used	1 1 1 1	AO2 6.6.1.2
03.3	reduces the effect of random errors	allow anomalous readings can be discarded before calculating a mean	1	AO1 6.6.1.2
03.4	deeper water means longer wavelength because v increases and f is constant	 allow for a fixed frequency period is constant	1 1	AO3 6.6.1.2
Total			**11**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	at the poles		1	AO1 6.7.1.2
04.2	the distance between the field lines varies		1	AO1 6.7.1.2
04.3	electromagnet is easy to demagnetise so easy to remove separated metal	allow electromagnet can be switched off allow electromagnet is (generally) stronger than a permanent magnet for **1** mark if no other marks are awarded	1 1	AO1 6.7.2.1
04.4	cobalt nickel		1 1	AO1 6.7.1.2
04.5	increases the current in the coil of the electromagnet bring the electromagnet closer to the pieces of iron and steel	allow increase potential difference across the coil	1 1	AO1 AO3 6.7.2.1

04.6	L = 0.120 m		1	AO2 6.7.2.2
	0.36 = B × 4.0 × 0.120	allow a correct substitution of an incorrectly / not converted value of L	1	
	$B = \frac{0.36}{(4.0 \times 0.120)}$	allow a correct rearrangement using an incorrectly / not converted value of L	1	
	B = 0.75	allow a correct calculation using an incorrectly / not converted value of L	1	
	T		1	
04.7	 allow **1** mark for 1 or 2 correct		2	AO1 6.7.2.2
Total			**15**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	different temperatures emit different intensities of infrared		1	AO1
	which are represented (on the infrared camera) as different shades / colours		1	AO3 6.6.2.4
		allow wavelength / frequency / amount for intensity throughout		
05.2	visible light		1	AO3 6.6.2.1
05.3	both ionising radiation so some risk of cancer		1	AO1
	the whole body is irradiated by gamma rays		1	AO3
	when an X-ray is taken only part of the body is exposed		1	AO3
	exposure time for gamma rays is longer		1	AO3 6.6.2.3
05.4	$1.2 \times 10^{-13} = F \times 0.015$		1	AO2 6.5.2
	$F = \frac{1.2 \times 10^{-13}}{0.015}$	allow a correct rearrangement using an incorrectly / not converted value of s	1	
	$F = 8.0 \times 10^{-12}$ N	allow 8×10^{-12} allow a correct calculation using an incorrectly / not converted value of s	1	

05.5	some of the energy of the electrons causes heating		1	AO1
	(therefore) increasing the temperature		1	AO3
	(so using tungsten) allows more electrons to be collided per second than using any other metal	allow (so using tungsten) enables more energy per second to be transferred than using any other metal	1	AO3 6.5.2

Total			**13**

Question	Answers	Extra information	Mark	AO / Spec.
06.1	at maximum power the forward force of the engines is constant		1	AO3
	as it accelerates the air resistance increases		1	AO1
	resultant force = force from engines – air resistance		1	AO1
	therefore resultant force decreases		1	AO3
	acceleration is directly proportional to resultant force		1	AO1 6.5.1.4 6.5.4.2.2 6.5.4.1.5

06.2	$\Delta v = (25.5 – 5.5) \times 330$	allow 6600 m/s	1	AO2 6.5.4.1.5 6.5.5.1
	$a = \frac{((25.5 \times 330) - (5.5 \times 330))}{300}$	allow a correct substitution using incorrectly / not converted values of u and v	1	
	$a = 22\ m/s^2$	allow a correct calculation using incorrectly / not converted values of u and v a = Δv / t must have been used to score subsequent marks	1	
	m = 630 000 / 22	allow a correct substitution using an incorrectly calculated value of a	1	
	m = 28636.36 (kg)	allow a correct calculation using an incorrectly calculated value of a	1	
	m = 29000 (kg)	this mark can only be awarded for a calculation using the correct equations	1	
Total			**11**	