2024

Name_____

Combined Science

Foundation

Physics: Paper 2

Physics Equations Sheet

GCSE Combined Science: Trilogy (8464) and GCSE Combined Science: Synergy (8465)

FOR USE IN JUNE 2024 ONLY

HT = Higher Tier only equations

kinetic energy = 0.5 × mass × (speed)^2	$E_k = \frac{1}{2} m v^2$
elastic potential energy = 0.5 × spring constant × (extension)^2	$E_e = \frac{1}{2} k e^2$
gravitational potential energy = mass × gravitational field strength × height	$E_p = m g h$
change in thermal energy = mass × specific heat capacity × temperature change	$\Delta E = m c \Delta\theta$
power = $\frac{\text{energy transferred}}{\text{time}}$	$P = \frac{E}{t}$
power = $\frac{\text{work done}}{\text{time}}$	$P = \frac{W}{t}$
efficiency = $\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$	
efficiency = $\frac{\text{useful power output}}{\text{total power input}}$	
charge flow = current × time	$Q = I t$
potential difference = current × resistance	$V = I R$
power = potential difference × current	$P = V I$
power = (current)^2 × resistance	$P = I^2 R$
energy transferred = power × time	$E = P t$

	energy transferred = charge flow × potential difference	$E = Q\ V$
HT	**potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil**	$\boldsymbol{V_p\ I_p = V_s\ I_s}$
	density = $\frac{\text{mass}}{\text{volume}}$	$\rho = \frac{m}{V}$
	thermal energy for a change of state = mass × specific latent heat	$E = m\ L$
	weight = mass × gravitational field strength	$W = m\ g$
	work done = force × distance (along the line of action of the force)	$W = F\ s$
	force = spring constant × extension	$F = k\ e$
	distance travelled = speed × time	$s = v\ t$
	acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$	$a = \frac{\Delta v}{t}$
	(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance	$v^2 - u^2 = 2\ a\ s$
	resultant force = mass × acceleration	$F = m\ a$
HT	**momentum = mass × velocity**	$\boldsymbol{p = m\ v}$
	period = $\frac{1}{\text{frequency}}$	$T = \frac{1}{f}$
	wave speed = frequency × wavelength	$v = f\ \lambda$
HT	**force on a conductor (at right angles to a magnetic field) carrying a current = magnetic flux density × current × length**	$\boldsymbol{F = B\ I\ l}$

AQA

Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____

GCSE
COMBINED SCIENCE: TRILOGY

F

Foundation Tier
Physics Paper 2F

Friday 14 June 2019 Morning 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.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- 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.

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

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.

Do not write outside the box

0 1 Magnetic force is a non-contact force.

0 1 . 1 Which **two** of these are also non-contact forces?

[2 marks]

Tick (✓) **two** boxes.

- Air resistance ☐
- Electrostatic ☐
- Friction ☐
- Gravitational ☐
- Tension ☐

0 1 . 2 **Figure 1** shows a bar magnet.

Figure 1

Which letter shows the position where the magnetic field around the bar magnet is strongest?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Do not write outside the box

0 1 . 3 When two magnets are brought close to each other they exert a force on each other.

Describe how two bar magnets can be used to demonstrate a force of attraction and a force of repulsion.

[2 marks]

Force of attraction _____

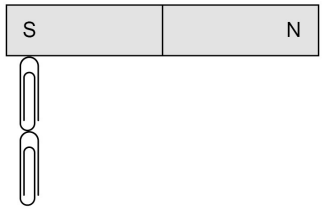
_____

Force of repulsion _____

_____

Figure 2 shows some paper clips that are attracted to a permanent magnet.

Figure 2



0 1 . 4 The paperclips become magnetised when they are close to the permanent magnet.

What is the name of this type of magnetism?

[1 mark]

Tick (✓) **one** box.

Forced magnetism ☐

Induced magnetism ☐

Strong magnetism ☐

0 1 . 5 Label the north and south poles of the two magnetised paper clips in **Figure 2**.

[2 marks]

8

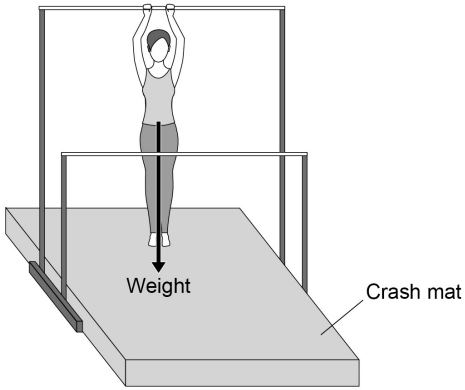
Turn over ►

Do not write outside the box

0 2 **Figure 3** shows a gymnast on a piece of gymnastic equipment.

The equipment consists of two bars at different heights.

Figure 3



0 2 . 1 The gymnast exerts a downward force on the bar.

What is the size of the upward force acting on the gymnast from the bar?

[1 mark]

Tick (✓) **one** box.

It is greater than the downward force. ☐

It is less than the downward force. ☐

It is the same size as the downward force. ☐

Do not write outside the box

0 2 . 2 Why is the weight of the gymnast represented by an arrow?

[1 mark]

Tick (✓) **one** box.

Weight is a constant. ☐

Weight is a scalar. ☐

Weight is a unit. ☐

Weight is a vector. ☐

0 2 . 3 **Figure 3** shows the weight of the gymnast acting from a point.

What name is given to this point?

[1 mark]

Tick (✓) **one** box.

Centre of force ☐

Centre of mass ☐

Centre of tension ☐

Centre of weight ☐

Question 2 continues on the next page

Do not write outside the box

0 2 . 4 The gymnast has a mass of 45 kg

gravitational field strength = 9.8 N/kg

Calculate the weight of the gymnast.

Use the equation:

weight = mass × gravitational field strength

[2 marks]

Weight = _____ N

0 2 . 5 The gymnast swings from one bar to the other bar several times.

Describe how the gravitational potential energy store and the kinetic energy store of the gymnast change as she moves between the bars.

[4 marks]

Do not write outside the box

0 2 . 6 Falling on the crash mat reduces the average deceleration of the gymnast compared with falling on a hard surface.

Explain why reducing the deceleration is important to the gymnast.

[2 marks]

11

Turn over for the next question

Do not write outside the box

0 3 **Figure 4** shows two children playing table tennis.

The boy hits the ball from one end of the table.

Figure 4

0 3 . 1 Why does the velocity of the ball change when the boy hits it?

[1 mark]

Tick (✓) **one** box.

- The direction of the ball does not change. ☐
- There is a resultant force on the ball. ☐
- The mass of the ball increases. ☐
- The speed of the ball is constant. ☐

Do not write outside the box

0 3 . 2 The ball has an average speed of 11 m/s

The ball takes 0.25 s to travel the same distance as the length of the table.

Calculate the length of the table.

Use the equation:

distance travelled = speed × time

[2 marks]

Length of table = _____ m

Question 3 continues on the next page

Do not write outside the box

0 3 . 3 A table tennis ball should only be used if it bounces to at least 75% of the height it was dropped from.

A manufacturer tested a table tennis ball.

Table 1 shows the results.

Table 1

Height ball was dropped from in cm	Height of bounce in cm
30.0	25.1

Determine whether the ball can be used.

Use the data from **Table 1**.

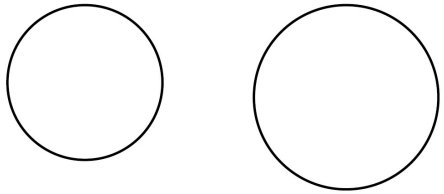
[3 marks]

Do not write outside the box

0 3 . 4 **Figure 5** shows two table tennis balls.

The balls are different sizes but have the same mass.

Figure 5



Both balls were dropped onto the table from the same height.

After they were dropped, the resultant force on the smaller ball was greater than the resultant force on the larger ball.

Explain why.

[2 marks]

8

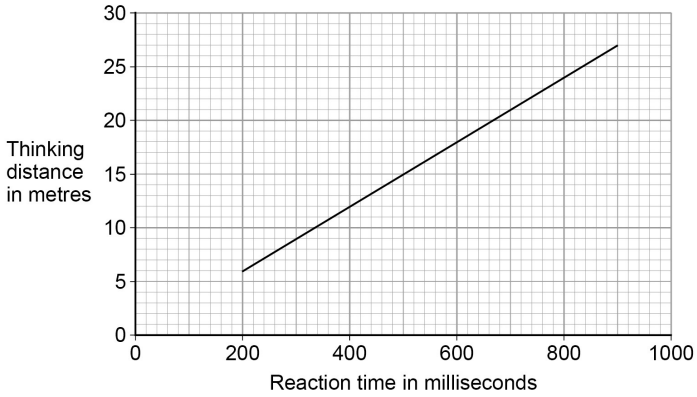
Turn over for the next question

Do not write outside the box

0 4 The thinking distance of a car depends on the reaction time of the driver.

Figure 6 shows how thinking distance varies with reaction time for a car travelling at 30 m/s

Figure 6



0 4 . 1 The reaction time of a driver can double if the driver is distracted.

Explain the effect doubling the reaction time has on the thinking distance.

Use data from **Figure 6**.

[2 marks]

0 4 . 2 Give the reason why there are no values of thinking distance for reaction times less than 200 milliseconds.

[1 mark]

Do not write outside the box

A driver measured her reaction time using an online test. She did the test five times.

Table 2 shows the results.

Table 2

Reaction time in milliseconds				
258	265	302	248	327

0 4 . 3 How does the data in **Table 2** show that it was important that the driver did the test five times?

[1 mark]

0 4 . 4 Calculate the mean reaction time of the driver.

[2 marks]

Mean reaction time = _____ ms

0 4 . 5 The driver is driving her car at 30 m/s

Determine the thinking distance.

Use **Figure 6** and your answer from Question **04.4**

[1 mark]

Thinking distance = _____ m

Turn over ►

Do not write outside the box

0 4 . 6 The driver applies the brakes and the car comes to a stop.

The force exerted by the brakes affects the braking distance.

Give **two** other factors that affect the braking distance.

[2 marks]

1 _____

2 _____

0 4 . 7 Write down the equation that links distance, force and work done.

[1 mark]

_____

0 4 . 8 When the driver applies the brakes, there is a constant resultant force of 6.0 kN on the car.

The car travels a distance of 75 m before stopping.

Calculate the work done in stopping the car.

[3 marks]

Work done = _____ J

13

0 5 The Sun emits all types of electromagnetic waves.

Figure 7 shows the electromagnetic spectrum.

Figure 7

Radio waves	Microwaves	Infrared	Visible light	Ultraviolet	X-rays	Gamma rays

0 5 . 1 Complete the sentences.

Choose answers from the box.

[3 marks]

frequency	**mass**	**power**
velocity		**wavelength**

In a vacuum, all electromagnetic waves travel at the same _____ .

Gamma waves have the greatest _____ .

Radio waves have the greatest _____ .

0 5 . 2 Explain why it is important that the Earth's atmosphere absorbs gamma rays emitted by the Sun.

[2 marks]

0 5 . 3 Some microwaves are **not** absorbed by the Earth's atmosphere.

Why is this useful?

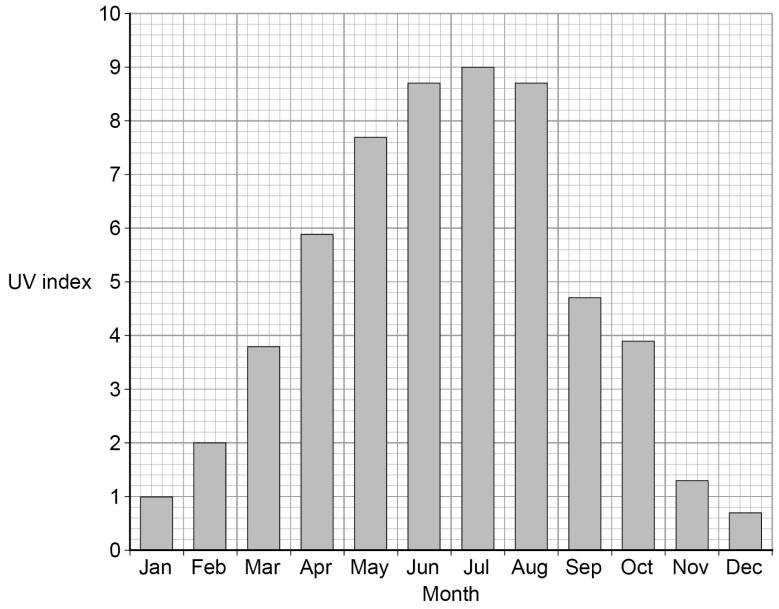
[1 mark]

Some ultraviolet (UV) radiation from the Sun passes through the atmosphere and reaches the surface of the Earth.

The amount of UV radiation that reaches the surface of the Earth can be measured on a scale called the UV index.

Figure 8 shows the average midday UV index in the UK for 1 year.

Figure 8



0 5 . 4 Why is exposure to UV radiation harmful to humans?

[1 mark]

Do not write outside the box

0 5 . 5 Compare the risk from UV radiation at different times of year in the UK.

Use data from **Figure 8**.

[2 marks]

9

Turn over for the next question

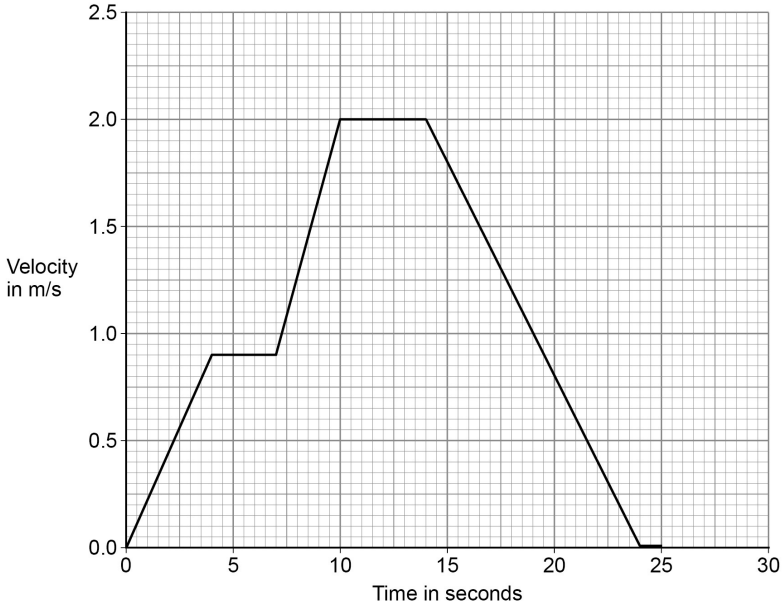
Do not write outside the box

0 6 **Figure 9** shows a runner using a smart watch and a mobile phone to monitor her run.

Figure 9

Figure 10 is a velocity–time graph for part of the runner's warm-up.

Figure 10



Do not write outside the box

0 6 . 1 Determine the total time for which the velocity of the runner was increasing.

[2 marks]

Time = _____ s

0 6 . 2 Determine the deceleration of the runner.

[2 marks]

Deceleration = _____ m/s^2

Question 6 continues on the next page

Do not write outside the box

The smart watch and mobile phone are connected to each other by a system called Bluetooth.

Bluetooth is wireless and uses electromagnetic waves for communication.

0 6 . 3 Suggest why the phone and watch being connected by a wireless system is an advantage when running.

[1 mark]

0 6 . 4 Write down the equation that links frequency, wave speed and wavelength.

[1 mark]

0 6 . 5 The electromagnetic waves have a frequency of 2 400 000 000 Hz

The speed of electromagnetic waves is 300 000 000 m/s

Calculate the wavelength of the electromagnetic waves.

[3 marks]

Wavelength = _____ m

Do not write outside the box

0 6 . 6 **Table 3** shows some information about four types of Bluetooth.

Table 3

Type	Power in milliwatts	Range in metres
1	100	100
2	2.50	10.0
3	1.00	1.00
4	0.50	0.50

Mobile phones use type **2** Bluetooth to communicate with other devices.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

2 _____

_____

11

Turn over for the next question

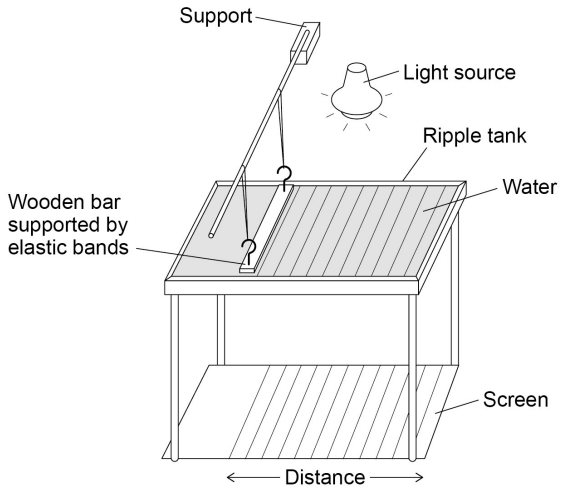
Do not write outside the box

0 7 **Figure 11** shows the equipment a teacher used to determine the speed of a water wave.

The equipment includes:

- a ripple tank filled with water
- a wooden bar that creates ripples on the surface of the water
- a light source which causes a shadow of the ripples on the screen.

Figure 11



0 7 . 1 Describe how equipment in **Figure 11** can be used to measure the wavelength, frequency and speed of a water wave.

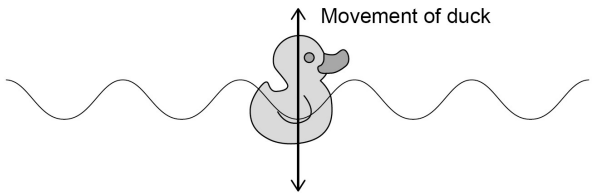
[6 marks]

Do not write outside the box

The teacher put a plastic duck in the ripple tank as shown in **Figure 12.**

The plastic duck moved up and down as the waves in the water passed.

Figure 12



0 7 . 2 How does the movement of the plastic duck in **Figure 12** demonstrate that water waves are transverse?

[1 mark]

Question 7 continues on the next page

Do not write outside the box

0 7 . 3 The teacher measured the maximum height and the minimum height of the plastic duck above the screen as the wave passed.

The teacher repeated his measurements.

Table 4 shows the teacher's measurements.

Table 4

Maximum height in mm	509	513	511
Minimum height in mm	503	498	499

Calculate the mean amplitude of the water wave.

[3 marks]

Mean amplitude = _____ mm

10

END OF QUESTIONS

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
01.1	electrostatic gravitational		1 1	AO1 6.5.1.2	A
01.2	D		1	AO2 6.7.1.1	A
01.3	bring two unlike poles close together bring two like poles close together	allow north and south poles allow opposite poles allow two north / south poles allow N for north and S for south	1 1	AO1 6.7.1.1	E
01.4	induced magnetism		1	AO1 6.7.1.1	A
01.5	all 4 poles correctly labelled north and south	allow N for north and S for south allow 1 mark for 2 or 3 correctly labelled poles	2	AO3 6.7.1.1	E
Total			**8**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
02.1	it is the same size as the downward force		1	AO2 6.5.4.3.2	A
02.2	weight is a vector		1	AO1 6.5.1.1	A
02.3	centre of mass		1	AO2 6.5.1.3	A
02.4	W = 45 × 9.8 W = 441 (N)	an answer of 441 (N) scores **2** marks allow 440 (N)	1 1	AO2 6.5.1.3	E
02.5	**Level 2:** Scientifically relevant facts, events or processes are identified and given in detail to form an accurate account.		3–4	AO1 6.1.1.1	E
	Level 1: Facts, events or processes are identified and simply stated but their relevance is not clear.		1–2		
	No relevant content.		0		
	Indicative content • as height changes gravitational potential energy changes • gravitational potential energy decreases when moving to the lower bar • as speed changes kinetic energy changes • kinetic energy increases when moving to the lower bar • transfer from gravitational potential energy to kinetic energy as height decreases • the sum of the kinetic energy and gravitational potential energy is constant				
02.6	reduces the force exerted the risk of injury to gymnast is reduced	ignore impact allow so the gymnast does not get injured	1 1	AO3 6.5.4.2.2	E
Total			**11**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
03.1	there is a resultant force on the ball		1	AO1 6.5.4.2.1	A
03.2	s = 11 × 0.25 s = 2.75 (m)	an answer of 2.75 scores **2** marks allow 2.8 (m)	1 1	AO2 6.5.4.1.2	E
03.3	$\frac{75}{100}$ × 30.0 22.5 (cm) (25.1 > 22.5) therefore the ball can be used OR $\frac{25.1}{30.0}$ ×100 (1) 84 % (1) (84% > 75%) therefore the ball can be used (1)	allow any correct method of determining 75% of 30 this mark can only be awarded if a supporting calculation has been done allow any correct supported conclusion allow a conclusion consistent with an incorrect percentage calculation this mark can only be awarded if a supporting calculation has been done allow any correct supported conclusion allow a conclusion consistent with an incorrect percentage calculation	1 1 1	AO3 6.5.4.1.2	E
03.4	the smaller ball has a smaller area (so) air resistance is less (on the smaller ball)		1 1	AO2 6.5.4.2.1	E
Total			**8**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
04.1	(thinking distance) will double any correct pair of points from graph eg (200,6) and (400,12)	allow graph shows direct proportionality (after 200 ms) allow **1** mark for thinking distance increases with supporting data.	1 1	AO3 6.5.4.3.2	E
04.2	(most) people cannot react any quicker than 200 ms		1	AO1 6.5.4.3.2	E
04.3	there is variation in the measurements	allow the data is not very precise allow lots of random error ignore references to accuracy / reliability / average	1	AO3 6.5.4.3.2	E
04.4	(258+265+302+248+327) / 5 280 (ms)	an answer of 280 gains **2** marks	1 1	AO2 6.5.4.3.2	E
04.5	8.4 (m)	allow 7.9 (m) to 8.9 (m) allow ecf from **04.4**	1	AO2 6.5.4.3.2	E
04.6	any **two** from: • (material of) road surface • condition of the tyres • speed of the car • wet / icy road surface • gradient of road • mass / weight of the car	Ignore any reference to brakes	2	AO1 6.5.4.3.3	
04.7	work done = force × distance (along the line of action of the force)	allow W = F s allow any correct re-arrangement	1	AO1 6.5.2	

04.8	F = 6000 N W = 6000 × 75 W = 450 000 (J)	an answer of 450 000 scores 3 marks allow a correct substitution using an incorrectly / not converted value of F allow a correct calculation using an incorrectly / not converted value of F	1 1 1	AO2 6.5.2	
Total			**13**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
05.1	velocity frequency wavelength		1 1 1	AO1 6.6.2.3	G
05.2	so people are not exposed to (as much) gamma radiation because gamma radiation can damage human tissue	allow less gamma radiation reaches the Earth's surface allow increases the risk of cancer or (cell) mutation allow gamma rays are ionising ignore any reference to temperature / heating of the atmosphere	1 1	AO1 6.6.2.3	E
05.3	(microwaves) are used in (satellite) communications	ignore any reference to temperature / heating of the atmosphere	1	AO2 6.6.2.4	E
05.4	can cause skin cancer / premature ageing	allow sunburn allow eye / skin damage cancer on its own is insufficient	1	AO1 6.6.2.3	E
05.5	risk from UV radiation is highest in July / summer two correct readings from the bar chart which support their comparison	allow any sensible comparison of named months / seasons if no other mark scored, two correct readings from the graph scores **1** mark	1 1	AO3 6.6.2.3	E
Total			**9**		

Question	Answers	Extra information	Mark	AO / Spec. Ref.	ID
06.1	(4 - 0) + (10 - 7) **or** 4 + 3 **or** 10 - 3 7 (s)	an answer of 7 (s) gains **2** marks	 1 1	AO2 6.5.4.1.5	E
06.2	gradient = $\frac{0-2}{24-14}$ (-) 0.2 (m/s^2)	an answer of 0.2 (m/s^2) gains **2** marks allow readings from any two points correctly substituted allow correct use of $a = \frac{\Delta v}{t}$	 1 1	AO2 6.5.4.1.5	E
06.3	(there are no wires) to get tangled / disconnected	allow easier to move arms allow wires are inconvenient allow easier to transfer data	1	AO3 6.6.2.4	E
06.4	wave speed = frequency × wavelength	allow v = f λ allow any correct re-arrangement	1	AO1 6.6.1.2	E
06.5	300 000 000 = 2 400 000 000 × λ $\lambda = \frac{300\,000\,000}{2\,400\,000\,000}$ λ = 0.125 (m)	an answer of 0.125 (m) or 0.13 (m) scores **3** marks allow λ = 0.13 (m)	 1 1 1	AO2 6.6.1.2	E
06.6	range is far enough (for most uses) power is not too great so the battery will not drain quickly	 allow power not too great so the phone will not overheat allow the range per milliwatt is greatest or 4 metres	1 1	AO3 6.6.2.4	E

Total			**11**		

Question	Answers	Mark	AO / Spec. Ref.	ID
07.1	**Level 3:** The design/plan would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6	AO1 6.6.1.2	E
	Level 2: The design/plan would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.	3–4		
	Level 1: The design/plan would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2		
	No relevant content.	0		
	Indicative content • if two quantities have been determined, v = f λ can be used to find the third. **Frequency** • use a stopclock • count the number of waves passing a point in a fixed time period • divide the time by the number of waves to determine the time for one wave, T • f = 1/T • read the frequency off the oscillator **Wavelength** • use a camera to freeze the image • use a metre rule to measure the distance between two wavefronts • count the number of waves between the wavefronts • divide distance by the number of waves to determine λ **Velocity** • determine a mean value of frequency • determine a mean value of wavelength • measure the time it takes one wavefront to travel the length of the screen • measure the length of the screen • speed = distance / time To access Level 3 there must be a description of how frequency, wavelength and velocity can be determined			

07.2	(the duck) moves perpendicular to the direction of wave travel	duck moves up and down is insufficient	1	AO2 6.6.1.1	E
07.3	mean maximum height = 511 **and** mean minimum height = 500 511 – 500 = 11 11 / 2 = 5.5 (mm)	an answer of 5.5 (mm) gains **3** marks allow a calculated difference from incorrect means allow their difference divided by 2 any correct method of determining the mean amplitude can score 3 marks	1 1 1	AO2 6.6.1.2	E
Total			**10**		

AQA

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

F

Foundation Tier
Physics Paper 2F

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.

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

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.

Do not write outside the box

0 1 Forces are either contact forces or non-contact forces.

0 1 . 1 Which of the following is a non-contact force?

[1 mark]

Tick (✓) **one** box.

Electrostatic force ☐

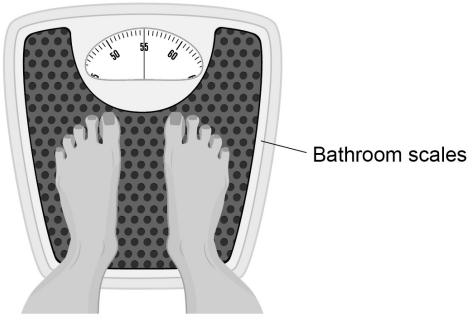
Friction force ☐

Tension force ☐

Do not write outside the box

Figure 1 shows a person standing on some bathroom scales.

Figure 1



The person exerts a downward force on the scales and the scales exert an upward force on the person.

0 1 . 2 Which sentence about the forces is true?

[1 mark]

Tick (✓) **one** box.

The downward force is less than the upward force. ☐

The downward force is the same size as the upward force. ☐

The downward force is greater than the upward force. ☐

0 1 . 3 What is the name of the upward force on the person?

[1 mark]

Tick (✓) **one** box.

Air resistance ☐

Normal contact force ☐

Weight ☐

Turn over ►

Do not write outside the box

0 1 . 4 The person on the scales has a mass of 55 kg.

gravitational field strength = 9.8 N/kg

Calculate the weight of the person.

Use the equation:

weight = mass × gravitational field strength

[2 marks]

Weight = _____ N

0 1 . 5 The gravitational field strength is **not** the same at all points on the surface of the Earth.

The gravitational field strength is weakest at the equator.

A person travelled from the UK to the equator.

What happened to the weight of the person?

[1 mark]

Tick (✓) **one** box.

The weight decreased. ☐

The weight remained the same. ☐

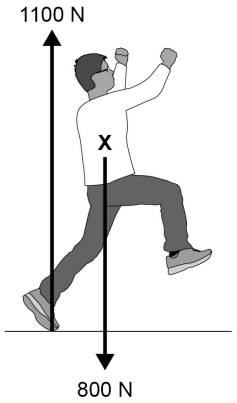
The weight increased. ☐

Do not write outside the box

Figure 2 shows the forces acting on a person.

The person is about to jump.

Figure 2



0 1 . 6 The arrow representing the weight of the person is drawn from point **X.**

What is the name given to point **X**?

[1 mark]

Tick (✓) **one** box.

Centre of force ☐

Centre of mass ☐

Centre of weight ☐

0 1 . 7 Determine the size of the resultant force on the person in **Figure 2.**

[1 mark]

_____

_____

Resultant force = _____ N

8

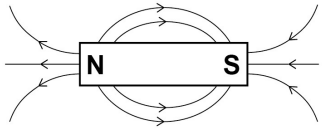
Do not write outside the box

0 2 Magnets attract some metals.

0 2 . 1 Which diagram shows the correct magnetic field pattern for a bar magnet?

[1 mark]

Tick (✓) **one** box.



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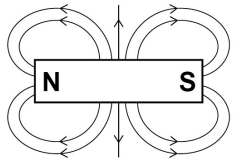
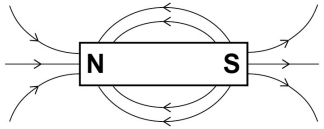
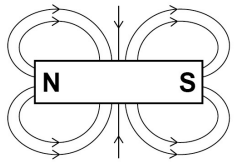


☐



☐

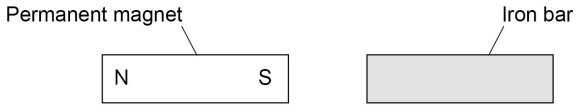


☐

Do not write outside the box

Figure 3 shows an iron bar near a permanent magnet.

Figure 3



The iron bar becomes an induced magnet.

0 2 . 2 Label the poles on the iron bar.

[1 mark]

0 2 . 3 The magnet is turned around so that the north pole is closest to the iron bar.

Which statement about the iron bar is true?

[1 mark]

Tick (✓) **one** box.

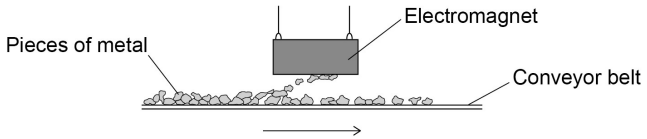
- The iron bar does not experience a magnetic force. ☐
- The iron bar experiences a magnetic force of attraction. ☐
- The iron bar experiences a magnetic force of repulsion. ☐

Question 2 continues on the next page

Do not write outside the box

Figure 4 shows an electromagnet being used to separate pieces of different types of metal on a conveyor belt.

Figure 4



0 2 . 4 Which **two** of the following types of metal would be attracted to the electromagnet?

[2 marks]

Tick (✓) **two** boxes.

- Aluminium ☐
- Copper ☐
- Magnesium ☐
- Nickel ☐
- Steel ☐

0 2 . 5 What is an advantage of using an electromagnet instead of a permanent magnet to separate the types of metal?

[1 mark]

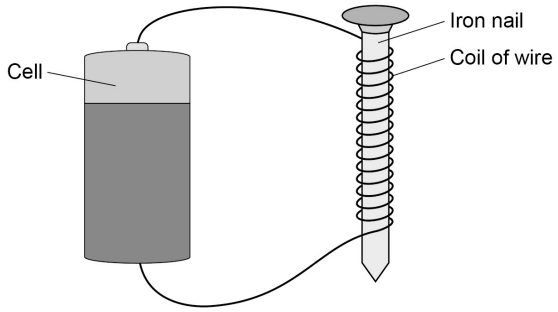
Tick (✓) **one** box.

- An electromagnet attracts more types of metal than a permanent magnet. ☐
- An electromagnet can be switched on and off. ☐
- An electromagnet transfers less energy than a permanent magnet. ☐

Do not write outside the box

Figure 5 shows a simple electromagnet.

Figure 5



0 2 . 6 What is the purpose of the iron nail inside the coil of wire?

[1 mark]

Tick (✓) **one** box.

The iron nail makes the magnetic field stronger. ☐

The iron nail reduces the magnetic field to zero. ☐

The iron nail reverses the magnetic field. ☐

0 2 . 7 Which of the following would increase the strength of the electromagnet?

[1 mark]

Tick (✓) **one** box.

Use a greater current. ☐

Use a shorter nail. ☐

Use a thinner wire. ☐

8

Turn over ►

Do not write outside the box

0 3 The stopping distance of a car is the sum of the thinking distance and the braking distance.

0 3 . 1 The thinking distance is affected by the reaction time of the driver.

Which **two** of the following can affect the reaction time of the driver?

[2 marks]

Tick (✓) **two** boxes.

Damaged brakes ☐

Taking drugs ☐

Tiredness ☐

Wet roads ☐

Worn tyres ☐

Scientists measured the reaction time for drivers of different ages.

Figure 6 shows the results.

Figure 6

0 3 . 2 At what age did the drivers have the lowest mean reaction time?

[1 mark]

Age = _____ years

0 3 . 3 What was the lowest mean reaction time?

[1 mark]

Time = _____ seconds

Question 3 continues on the next page

The braking distance of a car is the distance travelled between the driver applying the brakes and the car stopping.

0 3 . 4 Complete the sentences.

Choose answers from the box.

Each answer may be used once, more than once or not at all.

[2 marks]

decreases	**stays the same**	**increases**

When the brakes are applied, the kinetic energy of the

car _____ .

The temperature of the brakes _____ .

0 3 . 5 A car is travelling at a speed of 12 m/s.

The driver applies the brakes and the car decelerates at a constant 3.0 m/s^2.

Calculate the braking distance of the car.

Use the equation:

$$\text{braking distance} = \frac{(\text{speed})^2}{2 \times \text{deceleration}}$$

Choose the unit from the box.

[3 marks]

m	kg	s

Braking distance = _____ Unit _____

0 3 . 6 To pass the UK driving test, people must know the typical stopping distance of a car at certain speeds.

Suggest **one** reason why.

[1 mark]

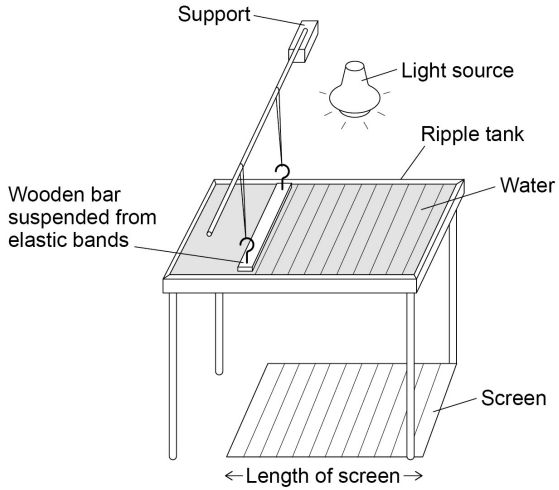
10

0 4 **Figure 7** shows a ripple tank.

The wooden bar vibrates up and down producing waves on the water.

The light source produces shadows of the water waves on the screen.

Figure 7



0 4 . 1 Describe how the student can measure the frequency and wavelength of the waves.

You should refer to any equipment the student needs in your answer.

[4 marks]

Do not write outside the box

A student measured the frequency and wavelength of the waves produced.

Table 1 shows some of the results.

Table 1

Reading	**1**	**2**	**3**	**Mean**
Frequency in hertz	12.8	12.4	12.3	**X**

0 4 . 2 Calculate value **X** in **Table 1**.

[1 mark]

X = _____ Hz

0 4 . 3 Why is it a good idea to take repeat readings and then calculate a mean?

[1 mark]

Tick (✓) **one** box.

To reduce the effect of random errors. ☐

To reduce the effect of systematic errors. ☐

To reduce the effect of zero errors. ☐

Question 4 continues on the next page

Do not write outside the box

0 4 . 4 The student changed the frequency of the waves in the ripple tank to 20 Hz.

Calculate the period of the waves.

Use the equation:

$$\text{period} = \frac{1}{\text{frequency}}$$

[2 marks]

Period = _____ s

0 4 . 5 At a frequency of 20 Hz the wavelength of the waves was 0.012 m.

Calculate the wave speed.

Use the equation:

wave speed = frequency × wavelength

[2 marks]

Wave speed = _____ m/s

10

Do not write outside the box

0 5 Scientists are developing a rocket aeroplane designed to travel much faster than jet aeroplanes.

0 5 . 1 The rocket aeroplane must accelerate along a runway to take off.

What would happen to the air resistance acting on the rocket aeroplane as it accelerates?

[1 mark]

0 5 . 2 An upward force called lift will act on the wings of the rocket aeroplane when it moves.

Complete the sentence.

Choose the answer from the box.

[1 mark]

less than	**the same as**	**greater than**

As the rocket aeroplane starts to accelerate along the runway, the lift force on the wings will be _____ the weight of the rocket aeroplane.

Question 5 continues on the next page

Turn over ►

Do not write outside the box

0 5 . 3 During the first 14 seconds the average speed of the rocket aeroplane on the runway will be 35 m/s.

Calculate the distance that the rocket aeroplane will travel during the first 14 seconds.

Use the equation:

distance travelled = average speed × time

[2 marks]

Distance travelled = _____ m

0 5 . 4 Write down the equation which links distance (*s*), force (*F*) and work done (*W*).

[1 mark]

0 5 . 5 When the rocket aeroplane travels a distance of 270 m on the runway the engines will do 54 000 000 J of work.

Calculate the average force exerted by the engines.

[3 marks]

Average force = _____ N

Do not write outside the box

0 5 . 6 The rocket aeroplane will fly at a greater height than a jet aeroplane.

The height that an aeroplane flies at affects the radiation dose a passenger will receive each hour.

Table 2 shows the speed of each aeroplane and the radiation dose a passenger will receive each hour.

Table 2

Aeroplane	Speed in metres per second	Radiation dose each hour in millisieverts
Rocket aeroplane	8000	0.006
Jet aeroplane	250	0.003

Exposure to ionising radiation has risks and possible consequences.

Evaluate the risks and possible consequences of flying in a rocket aeroplane and in a jet aeroplane.

Assume the same journey is made in each aeroplane.

Use values from **Table 2.**

[6 marks]

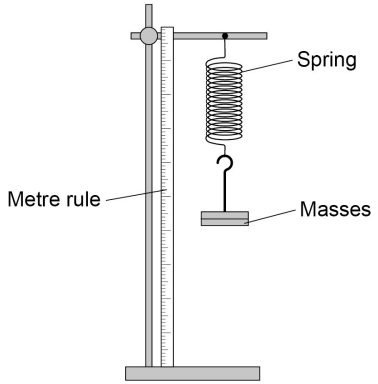
14

Do not write outside the box

0 6 **Figure 8** shows a stretched spring.

The spring is elastically deformed.

Figure 8



0 6 . 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 6 . 2 Describe a method to determine the extension of the spring.

[2 marks]

0 6 . 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 6 continues on the next page

Do not write outside the box

0 6 . 4 Write down the equation which links extension (*e*), force (*F*) and spring constant (*k*).

[1 mark]

0 6 . 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

Do not write outside the box

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

Do not write outside the box

0 7 Professional rugby players wear a tracking device that measures their velocity and acceleration.

Figure 9 shows a player wearing a tracking device.

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

Figure 9

0 7 . 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 ☐

Do not write outside the box

0 7 . 2 Which of the following is a vector quantity?

[1 mark]

Tick (✓) **one** box.

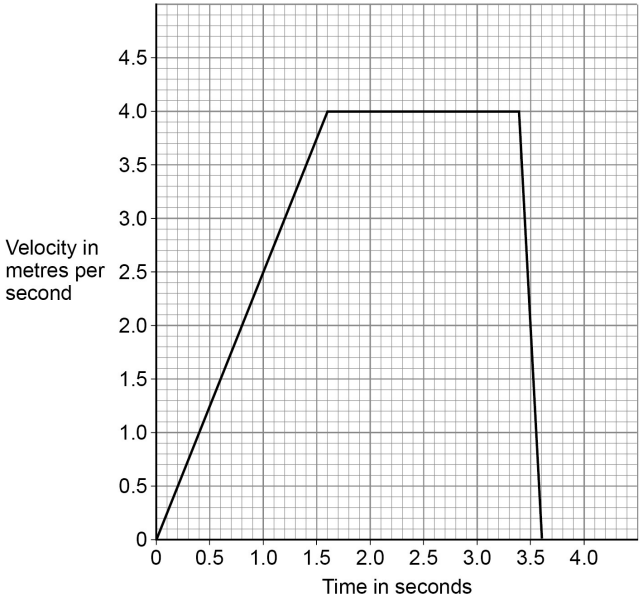
- Displacement ☐
- Distance ☐
- Time ☐
- Work done ☐

Question 7 continues on the next page

Do not write outside the box

Figure 10 shows a velocity–time graph for the player running with the ball.

Figure 10



0 7 . 3 Determine the acceleration of the player between 0 and 1.6 s.

[2 marks]

Acceleration = _____ m/s^2

0 7 . 4 Describe the motion of the player between 3.4 s and 3.6 s.

[1 mark]

Do not write outside the box

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

0 7 . 5 Write down the equation which links acceleration (a), mass (m) and resultant force (F).

[1 mark]

0 7 . 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 7 . 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

END OF QUESTIONS

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ANSWER IN THE SPACES PROVIDED

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.

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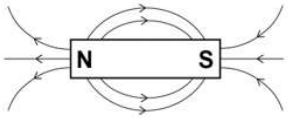
Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	electrostatic force		1	AO1 6.5.1.2
01.2	the downward force is the same size as the upward force		1	AO2 6.5.1.2
01.3	normal contact force		1	AO1 6.5.1.2
01.4	W = 55 × 9.8 539 (N)	 allow 540 (N)	1 1	AO2 6.5.1.3
01.5	the weight decreased		1	AO3 6.5.1.3
01.6	centre of mass		1	AO3 6.5.1.3
01.7	300 (N)		1	AO2 6.5.1.4
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	first box ticked  		1	AO1 6.7.1.2
02.2	 		1	AO3 6.7.1.1
02.3	the iron bar experiences a magnetic force of attraction		1	AO1 6.7.1.1
02.4	nickel steel		1 1	AO1 6.7.1.2
02.5	an electromagnet can be switched on and off		1	AO3 6.7.2.1
02.6	the iron nail makes the magnetic field stronger		1	AO1 6.7.2.1
02.7	use a greater current		1	AO1 6.7.2.1
Total			**8**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	taking drugs tiredness		1 1	AO1 6.5.4.3.2
03.2	24 (years)		1	AO3 6.5.4.3.2
03.3	0.55 (s)	allow answer in range 0.54 to 0.56	1	AO3 6.5.4.3.2
03.4	decreases increases	this order only	1 1	AO1 6.5.4.3.4
03.5	braking distance = $\frac{(12)^2}{(2 \times 3)}$ braking distance = 24 unit = m		1 1 1	AO1 AO2 AO2 6.5.4.1.5
03.6	so they know how far behind another car they should drive **or** so they can stop safely if the car in front stops		1	AO3 6.5.4.3.3
Total			**10**	

Question	Answers	Mark	AO / Spec. Ref.
04.1	**Level 2:** The design 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 would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	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		

04.2	12.5 (Hz)		1	AO2 6.6.1.2
04.3	to reduce the effect of random errors		1	AO1 6.6.1.2
04.4	period = $\frac{1}{20}$ period = 0.05 (s)	allow 0.050 (s)	1 1	AO2 6.6.1.2
04.5	v = 20 × 0.012 v = 0.24 (m/s)		1 1	AO2 6.6.1.2
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	(air resistance) increases		1	AO1 6.5.4.1.5
05.2	less than		1	AO3 6.5.4.1.5
05.3	s = 35 × 14 s = 490 (m)		1 1	AO2 6.5.4.1.2
05.4	work done = force × distance **or** W = Fs		1	AO1 6.5.2
05.5	54 000 000 = F × 270 F = $\frac{54\,000\,000}{270}$ F = 200 000 (N)		1 1 1	AO2 6.5.2

Question	Answers	Mark	AO / Spec. Ref.
05.6	**Level 2:** Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	4–6	AO3 6.5.4.1.2
	Level 1: Relevant features are identified and differences noted.	1–3	
	No relevant content	0	
	Indicative content • distance travelled is the same for each aeroplane • time in the air is much greater for jet aeroplane • speed of rocket plane is much greater • speed of rocket plane is 32 times greater • radiation dose each hour greater for rocket aeroplane • radiation dose each hour is 2 times greater for rocket aeroplane • overall radiation dose is less for rocket plane • dose in jet aeroplane is 16 times greater overall • much higher risk in jet aeroplane • increased risk of skin cancer • increased risk of gene mutation and cancer To access level 2, there must be a relevant calculation.		
Total			**14**

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	the spring will return to its original length when the force is removed		1	6.5.3 AO1
06.2	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
06.3	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
06.4	force = spring constant × extension **or** F = k e		1	6.5.3 AO1
06.5	$300 = k \times 0.40$ $k = \frac{300}{0.40}$ k = 750 (N/m)		1 1 1	6.5.3 AO2
Total			**10**	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	a quantity with both magnitude and direction		1	AO1 6.5.1.1
07.2	displacement		1	AO1 6.5.4.1.1
07.3	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
07.4	constant deceleration	allow large deceleration allow decelerates to a stop	1	AO2 6.5.4.1.5
07.5	resultant force = mass × acceleration **or** F = ma	allow force = mass × acceleration	1	AO1 6.5.4.2.2
07.6	1800 = m × 25 m = $\frac{1800}{25}$ m = 72 (kg)		1 1 1	AO2 6.5.4.2.2
07.7	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**	

AQA

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

F

Foundation Tier
Physics Paper 2F

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.

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

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.

Do not write outside the box

0 1 There are different types of electromagnetic waves.

0 1 . 1 What do all electromagnetic waves transfer?

[1 mark]

Tick (✓) **one** box.

Charge ☐

Energy ☐

Matter ☐

Sound ☐

0 1 . 2 Complete the sentence.

Choose answers from the box.

[2 marks]

charge	**frequency**	**speed**	**wavelength**

Different types of electromagnetic waves have a different _____

and a different _____ .

0 1 . 3 **Figure 1** shows the electromagnetic spectrum.

Figure 1

Radio waves	Microwaves	Infrared	**A**	Ultraviolet	X-rays	**B**

Give the names of parts **A** and **B** of the electromagnetic spectrum.

[2 marks]

A _____

B _____

Do not write outside the box

0 1 . 4 Different types of electromagnetic waves have different uses.

Draw **one** line from each type of electromagnetic wave to its use.

[3 marks]

Type of electromagnetic wave	Use
Microwaves	Electrical heaters
Ultraviolet	Energy efficient lamps
X-rays	Imaging bones
	Satellite communications

8

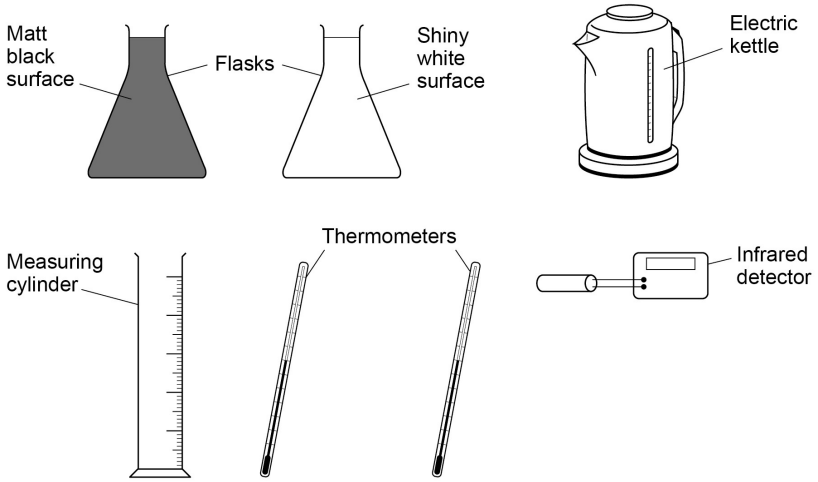
Turn over for the next question

Do not write outside the box

0 2 A student investigated how the colour of a surface affects the power of the infrared radiation emitted by the surface.

Figure 2 shows the equipment used.

Figure 2



Do not write outside the box

The infrared detector measures the power of the infrared radiation emitted by the flasks.

0 2 . 1 The student poured hot water into each flask.

What should the student do to reduce the risk of burning herself with the hot water?

[1 mark]

0 2 . 2 Describe how the student should use the equipment in **Figure 2** to compare the power of the infrared radiation emitted by each surface.

[4 marks]

Question 2 continues on the next page

Do not write outside the box

A student investigated how the power of the infrared radiation emitted from a flask changed with time.

Table 1 shows the results.

Table 1

Time in seconds	Power in watts
0	8.0
60	7.2
120	6.5
180	5.9
240	5.4
300	5.0
360	4.7
420	4.5

0 2 . 3 Describe the pattern shown by the data in **Table 1**.

[2 marks]

0 2 . 4 What is the most likely value for the power of the infrared radiation emitted after 480 seconds?

Use **Table 1**.

[1 mark]

Tick (✓) **one** box.

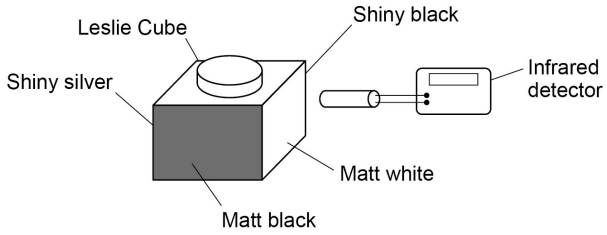
4.0 W ☐ 4.2 W ☐ 4.4 W ☐ 4.6 W ☐

Do not write outside the box

A Leslie Cube is used to demonstrate that different surfaces emit different amounts of infrared radiation.

Figure 3 shows an infrared detector and a Leslie Cube filled with hot water.

Figure 3



0 2 . 5 Give **one** advantage of using a Leslie Cube rather than the equipment in **Figure 2** on page 4.

[1 mark]

0 2 . 6 The teacher improved the demonstration by using four infrared detectors connected to a data logger and computer. Each detector was pointed at a different surface of the Leslie Cube.

The distance between the surface and the detector was the same in each case.

Give **two** reasons why this improved the demonstration.

[2 marks]

1

2

11

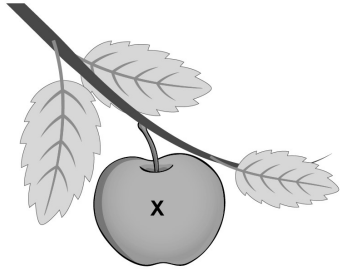
Turn over ►

Do not write outside the box

0 3 **Figure 4** shows an apple hanging from a tree.

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

Figure 4



0 3 . 1 Draw an arrow on **Figure 4** to represent the weight of the apple.

[1 mark]

0 3 . 2 The apple has a mass of 0.150 kg

gravitational field strength = 9.8 N/kg

Calculate the weight of the apple.

Use the equation:

weight = mass × gravitational field strength

[2 marks]

Weight = _____ N

Do not write outside the box

0 3 . 3 The apple in **Figure 4** is stationary.

Why is the apple stationary?

[1 mark]

Tick (✓) **one** box.

The resultant force on the apple is downwards. ☐

The resultant force on the apple is upwards. ☐

The resultant force on the apple is zero. ☐

Question 3 continues on the next page

Do not write outside the box

When the apple is ripe it falls from the tree and accelerates towards the ground.

0 3 . 4 Why does the apple accelerate?

[1 mark]

Tick (✓) **one** box.

The resultant force on the apple is downwards. ☐

The resultant force on the apple is upwards. ☐

The resultant force on the apple is zero. ☐

0 3 . 5 The acceleration of the apple is 9.8 m/s^2

The velocity of the apple changes from 0 to 4.9 m/s

Calculate the time taken for the apple to fall to the ground.

Use the equation:

$$\text{time taken} = \frac{\text{change in velocity}}{\text{acceleration}}$$

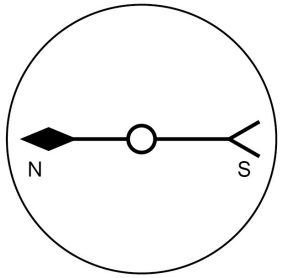
[2 marks]

Time taken = _____ s

7

0 4 **Figure 5** shows a compass.

Figure 5



0 4 . 1 Why does the compass always point in the same direction when it is **not** near a magnet?

[1 mark]

Tick (✓) **one** box.

The compass is not magnetic. ☐

The Earth has a magnetic field. ☐

There is no force acting on the compass. ☐

0 4 . 2 What material could the needle of the compass be made from?

[1 mark]

Tick (✓) **one** box.

Aluminium ☐

Copper ☐

Plastic ☐

Steel ☐

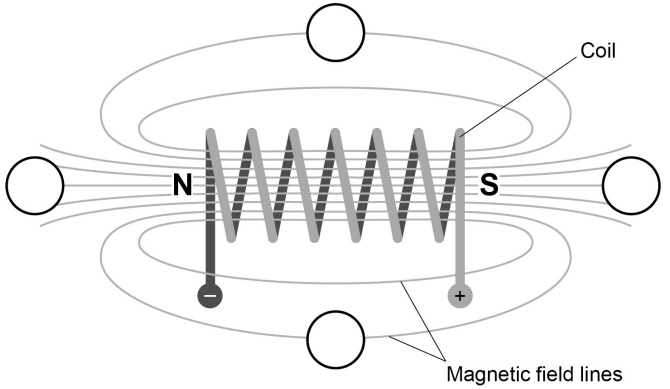
Turn over ►

Figure 6 shows a coil of wire.

There is a current in the coil.

The circles show the position of four compasses.

Figure 6



0 4 . 3 Which statement describes the magnetic field around the coil?

[1 mark]

Tick (✓) **one** box.

The field has the same strength at all points. ☐

The field is stronger further away from the coil. ☐

The field is strongest at the ends of the coil. ☐

0 4 . 4 Draw **one** arrow in **each** circle on **Figure 6** to show the direction of the magnetic field at that point.

[2 marks]

Do not write outside the box

0 4 . 5 Give **two** ways the magnetic field around the coil could be made stronger.

[2 marks]

1 _____

_____

2 _____

_____

7

Turn over for the next question

Do not write outside the box

0 5 The stopping distance of a car is the sum of the thinking distance and the braking distance.

0 5 . 1 Which factors affect the thinking distance?

[2 marks]

Tick (✓) **two** boxes.

- Condition of the tyres ☐
- Driving on wet roads ☐
- Mass of the car ☐
- Tiredness of the driver ☐
- Using a mobile phone ☐

0 5 . 2 Explain why a person should **not** drink alcohol and then drive.

[3 marks]

_____

_____

_____

_____

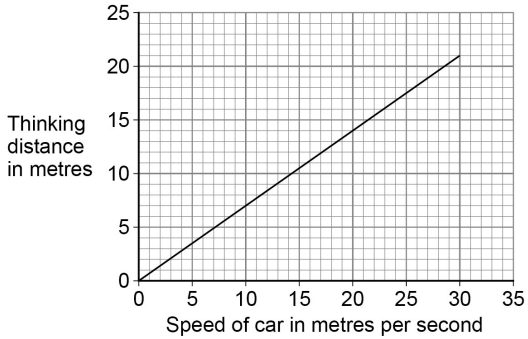
_____

_____

The Highway Code gives information on how thinking distance depends on the speed of a car.

Figure 7 shows the information as a graph.

Figure 7



0 5 . 3 What is the speed of a car if the thinking distance is 16 m?

[1 mark]

Speed of car = _____ m/s

0 5 . 4 Describe the relationship between speed and thinking distance.

[2 marks]

_____

_____

_____

_____

0 5 . 5 The Highway Code assumes the driver's reaction time is 0.70 seconds.

Draw a line on **Figure 7** to show the relationship for a driver with a reaction time of 1.4 seconds.

[2 marks]

Turn over ►

0 5 . 6 A car accelerates at 5.0 m/s^2 over a distance of 45 m

initial velocity of the car = 0 m/s

Calculate the final velocity of the car.

Use the Physics Equations Sheet.

Give your answer to 2 significant figures.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

_____

Final velocity (2 significant figures) = _____ m/s

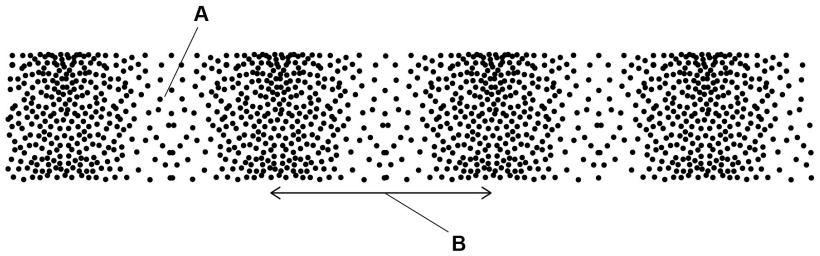
14

Turn over for the next question

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

0 6 **Figure 8** shows a longitudinal wave.

Figure 8



0 6 . 1 What do the labels **A** and **B** on **Figure 8** represent?

Choose answers from the box.

[2 marks]

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

A _____

B _____

Do not write outside the box

0 6 . 2 The wave shown in **Figure 8** 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 _____

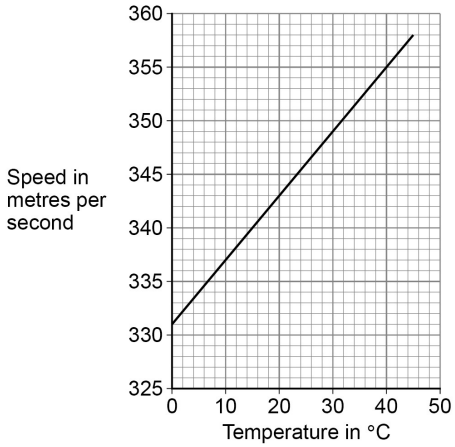
Question 6 continues on the next page

Do not write outside the box

Sound waves are longitudinal.

Figure 9 shows how the speed of sound varies with the temperature of the air.

Figure 9



Do not write outside the box

Use the Physics Equations Sheet to answer questions **06.3** and **06.4**.

0 6 . 3 Write down the equation that links frequency (f), wavelength (λ) and wave speed (v).

[1 mark]

0 6 . 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 9**.

[4 marks]

Wavelength = _____ m

11

Turn over for the next question

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0 7 **Figure 10** shows competitors in the wheelchair race at the London Marathon.

The distance of the London Marathon is 42 000 m

Figure 10

Do not write outside the box

Use the Physics Equations Sheet to answer questions **07.1** and **07.2.**

0 7 . 1 Write down the equation that links distance (*s*), force (*F*) and work done (*W*).

[1 mark]

0 7 . 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 7 continues on the next page

Do not write outside the box

Use the Physics Equations Sheet to answer questions **07.3** and **07.4.**

0 7 . 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 7 . 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]

Average speed = _____ m/s

Do not write outside the box

0 7 . 5 Explain why the speed of a competitor changes during the race.

[4 marks]

12

END OF QUESTIONS

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There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

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

Do not write outside the box

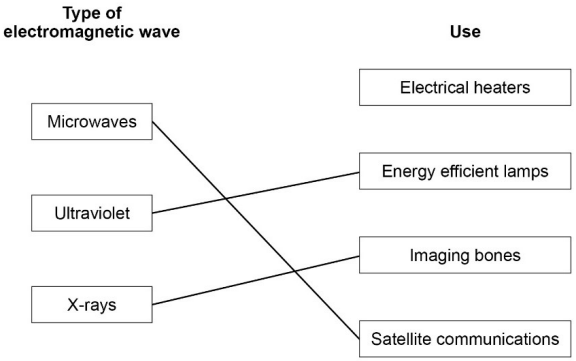
Question number	Additional page, if required. Write the question numbers in the left-hand margin.

Question 1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.1	energy		1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.2	frequency wavelength	either order	1 1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.3	**A** = visible light **B** = gamma (rays / waves / radiation)	allow visible allow light	1 1	AO1 6.6.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
01.4	 additional line from a box on the left negates the mark for that box		1 1 1	AO1 6.6.2.4

Total Question 1		8

Question 2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.1	any **one** from: • stand up • use a funnel • pour water slowly • pour at arms-length • wear heat-proof gloves	gloves on its own is insufficient allow do not touch hot objects (with bare hands)	1	AO3 6.6.2

Question	Answers	Mark	AO / Spec. Ref.
02.2	**Level 2:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	3–4	AO1 6.6.2.2
	Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2	
	No relevant content	0	
	Indicative content • use the kettle to heat the water • use measuring cylinder to measure volume of water • same volume of water in each flask • use the thermometer to measure temperature of the water • ensure temperature is the same in each flask • infrared detector the same distance from each flask • use the infrared detector to measure the power of infrared radiation from each flask and compare results		

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.3	as time increases the power decreases		1	AO3 6.2.2
	the change (in power) each 60s decreases as the time increases	allow rate of decrease of power decreases	1	

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.4	4.4 W		1	AO3 6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.5	any **one** from: • all surfaces will be at the same temperature • temperature of the water does not need to be measured • more surfaces can be tested • the procedure only needs to be done once • volume of water does not need to be measured	allow different surfaces can be tested at the same time	1	AO3 6.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
02.6	measurements can be taken at the same time results will be more accurate	allow no need to move the detectors / cube	1 1	AO3 6.2.2

Total Question 2		**11**

Question 3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.1	vertical arrow from **X** pointing downwards	ignore any labels	1	AO2 6.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.2	$W = 0.150 \times 9.8$ $W = 1.47$ (N)	 allow 1.5 (N)	1 1	AO2 6.5.1.3

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.3	the resultant force on the apple is zero		1	AO1 6.5.4.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.4	the resultant force on the apple is downwards		1	AO1 6.5.4.2.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
03.5	$t = \frac{4.9}{9.8}$ t = 0.5 (s)	 allow 0.50 (s)	1 1	AO2 6.5.4.1.2

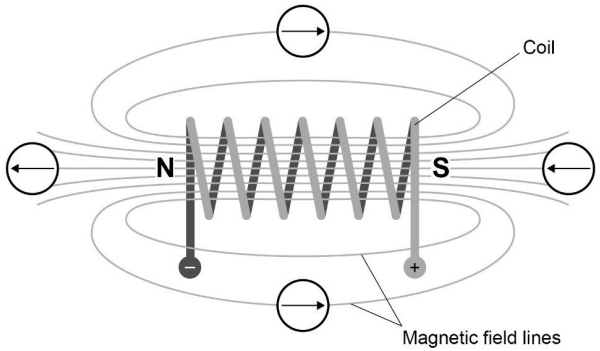
Total Question 3		**7**

Question 4

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.1	the Earth has a magnetic field		1	AO2 6.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.2	steel		1	AO1 6.7.1.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.3	the field is strongest at the ends of the coil		1	AO1 6.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.4	all arrows in the correct direction  allow **1** mark for 2 or 3 arrows in the correct direction		2	AO2 6.7.2.1

Question	Answers	Extra information	Mark	AO / Spec. Ref.
04.5	any **two** from: • increase the current • insert an iron core • increase the number of turns	allow increase potential difference allow turns closer together	2	AO1 6.7.2.1

Total Question 4		7

Question 5

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.1	tiredness of the driver using a mobile phone		1 1	AO1 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.2	increases reaction time so increases the thinking distance so more likely to have a collision	 allow travels a greater distance before stopping (in an emergency)	1 1 1	AO1 AO1 AO3 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.3	23 m/s		1	AO2 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.4	directly proportional allow **1** mark for as speed increases thinking distance increases		2	AO3 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.5	straight line from the origin with a greater gradient through (15,21)	 allow a line that passes within half a small square of (15,21) dependent on MP1	1 1	AO2 6.5.4.3.2

Question	Answers	Extra information	Mark	AO / Spec. Ref.
05.6	$v^2 - 0^2 = 2 \times 5.0 \times 45$ $v^2 = 450$ **or** $v = \sqrt{450}$ v = 21.21320343 v = 21 (m/s)	 allow a correctly rounded value of v calculated using the correct equation	1 1 1 1	AO2 6.5.4.1.5

Total Question 5		14

Question 6

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.1	**A** = rarefaction **B** = wavelength		1 1	AO1 6.6.1.1

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

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
06.4	$v = 348$	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
	$348 = 300 \times \lambda$	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 6		**11**

Question 7

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.1	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.
07.2	$3\,360\,000 = F \times 42\,000$ $F = \frac{3\,360\,000}{42\,000}$ $F = 80$ (N)		1 1 1	AO2 6.5.2

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

Question	Answers	Extra information	Mark	AO / Spec. Ref.
07.4	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.
07.5	**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 7		12