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

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.

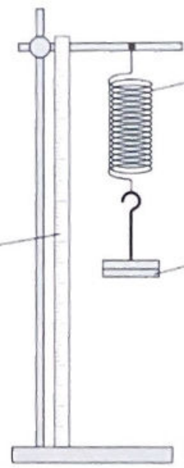
Information
- The maximum mark for this paper is 70.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

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.
- [x] The spring will return to its original length when the force is removed.

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

[2 marks]

Measure the original length of the spring and the extended length of the spring with a meter ruler.
use extension = extended length - original length

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]

extension = 0.080m

$E_e = \frac{1}{2} k x^2$ $E_e = \frac{1}{2} \times 40 \times (0.080)^2$

$E_e = 0.128$ J

Elastic potential energy = 0.128 J

Question 1 continues on the next page

Turn over ▶

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

[1 mark]

force = spring constant x extension

or F = ke

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]

300 = k x 0.40

$k = \frac{300}{0.40}$ k = 750 N/m

Spring constant = 750 N/m

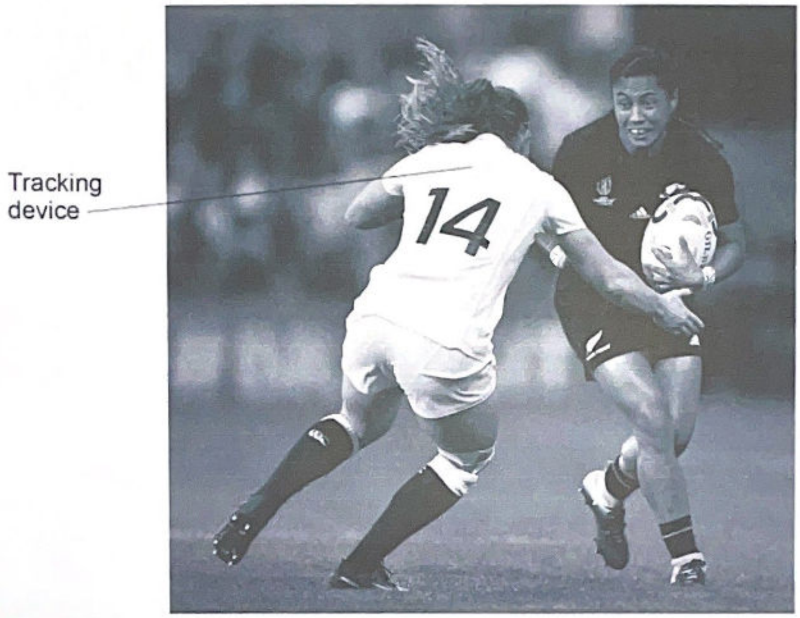
10

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.

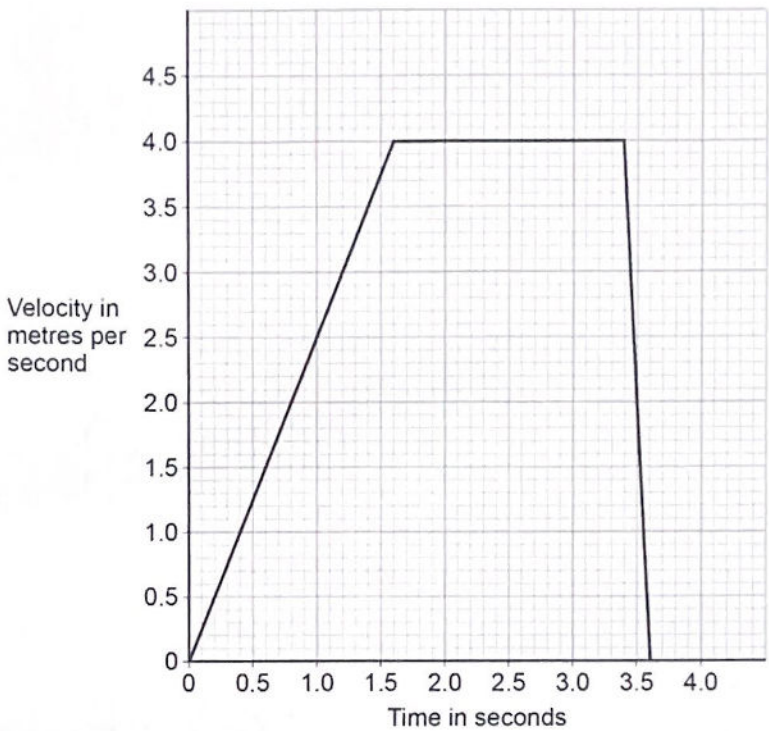
Displacement	✓
Distance	
Time	
Work done	

Question 2 continues on the next page

Turn over ▶

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]

gradient = $\frac{(4-0)}{(1.6-0)} = \frac{\Delta v}{t}$

Acceleration = 2.5 m/s²

Acceleration = 2.5 m/s^2

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

[1 mark]

Constant deceleration

Do not write outside the box

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]

resultant force = mass x acceleration

or F = ma

0 2 . 6 The player accelerates at 25 m/s² when a resultant force of 1800 N acts on her.

Calculate the mass of the player.

[3 marks]

F = ma

1800 = m x 25

$m = \frac{25}{1800}$

m = 72 kg

Mass = 72 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]

The players performance can be monitored during the game.

10

Turn over for the next question

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]

Place a meter ruler at the side of the screen perpendicular to the wave fronts and use it to measure to the length of the screen. Take photograph of the shadow on the screen, and count the number of complete waves on the screen. Calculate wavelength by dividing the length of the screen by the number of waves. For frequency, count the number of waves that pass a given point, and time how long it takes. Calculate frequency using number of waves divided by the time taken.

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

0 3 . 2 Determine the mean wave speed.

[4 marks]

Mean frequency = (9.8 + 9.4 + 9.3) ÷ 3 = 9.5 Hz

Mean wavelength = (1.7 + 2.2 + 2.1) ÷ 3 = 2cm = 0.020 m

Wave speed, v = fλ

v = 9.5 x 0.020

v = 0.19 m/s

Mean wave speed = 0.19 m/s

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

[1 mark]

It reduces the effect of random errors.

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]

Deeper water means longer wavelength because the wavespeed increases and the frequency is constant.

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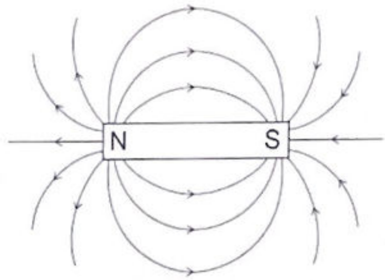
0 4 **Figure 4** shows the magnetic field pattern around a permanent magnet.

Figure 4



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

[1 mark]

At the poles.

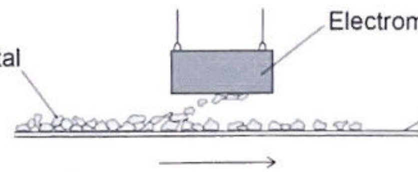
0 4 . 2 How does **Figure 4** show that the strength of the magnetic field is not the same at all places?

[1 mark]

The distance between the field lines varies.

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]

An electromagnet can be easily demagnetised, so it's easier to remove from se Seperated metal.

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 Cobalt

2 Nickel

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 Bring the electromagnet closer to the pieces of iron and steel

2 Increase the current in the coil of electromagnet

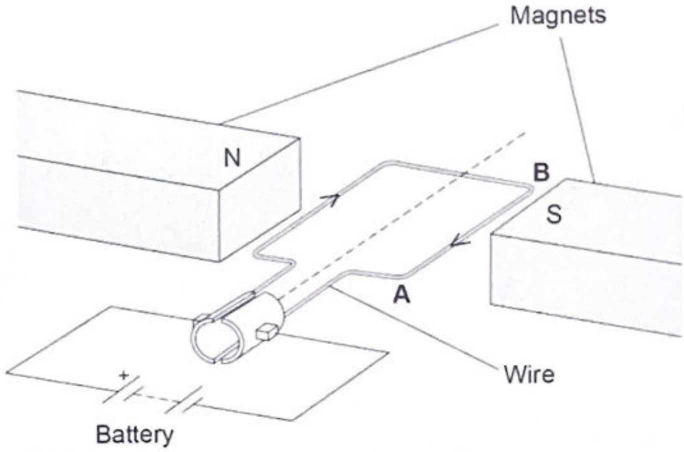
Turn over ▶

Do not write outside the box

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

Figure 6 shows a simple electric motor.

Figure 6



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]

L = 0.120 m (in meters)

Force = B x I x L

0.36 = B x 4 x 0.120m

B = 0.75 T

Magnetic flux density = 0.75 Unit T

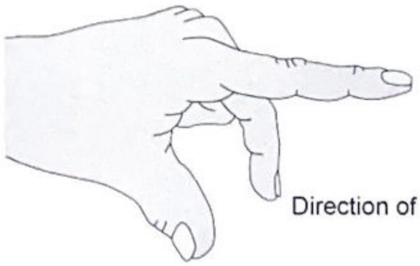
Question 4 continues on the next page

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



Direction of magnetic field

Direction of current

Direction of force

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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]

Different temperatures emit different intensities of infrared, which are represented on the camera as different shades / colours.

Question 5 continues on the next page

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]

Both methods of using X-rays and gamma rays emit ionising radiation so some risk of cancer. The whole body is irradiated by gamma rays in this method, whereas only part of the body is exposed using X-rays. Also, the exposure time for gamma rays is longer.

Question 5 continues on the next page

Do not write outside the box

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]

work done = force x distance

$1.2 \times 10^{-13} = F \times 0.015$

$F = \frac{1.2 \times 10^{-13}}{0.015}$

Force = 8.0×10^{-12} 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]

Some of the energy of the electrons causes heating. This therefore increases the temperature, and ~~it~~ allows more electrons to be collided per second than any other metal.

13

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]

At maximum power the forward force of the engines is constant. As the plane accelerates, the air resistance increases. The resultant force of the plane = force from the engines - air resistance. Therefore, the resultant force decreases.

Acceleration is directly proportional to the resultant force, so the acceleration is not constant.

Question 6 continues on the next page

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]

Change in velocity, $\Delta v = (25.5 - 5.5) \times 330$

$a = \frac{\Delta v}{t} = \frac{(25.5 - 5.5) \times 330}{300} = 22 \text{ m/s}^2$

$a = 22 \text{ m/s}^2$ $F = ma$ $m = \frac{F}{a}$

$m = \frac{630000}{22} = 28636.36 \text{ kg}$

to 2 significant figures $m = 29000$ kg

Mass (2 significant figures) = 29000 kg

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END OF QUESTIONS