

Physics
PAPER 1
Foundation Tier

Total Marks

Wednesday 22 May 2024 – Morning

Time: 1 hour 45 minutes

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

Calculator, ruler, Equation Booklet (enclosed)

YOU WILL BE GIVEN

Diagram Booklet

INSTRUCTIONS

Answer ALL questions.

Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – there may be more space than you need.

INFORMATION

The total mark for this paper is 100.

The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.

In questions marked with an ASTERISK (*), marks will be awarded for your ability to structure your answer logically, showing how the points you make are related or follow on from each other where appropriate.

There may be spare copies of some diagrams.

ADVICE

Read each question carefully before you start to answer it.

Try to answer every question.

Check your answers if you have time at the end.

Answer ALL questions. Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.

1 This question is about the electromagnetic spectrum.

(a) X-rays and microwaves are both parts of the electromagnetic spectrum.

Look at the list of words for Question 1(a) in the Diagram Booklet. Use words from the list to complete the sentences.

(3 marks)

X-rays and microwaves are both

_____ waves.

In a vacuum, x-rays and microwaves always have the same _____.

X-rays always have a higher _____ than microwaves.

(continued on the next page)

1 continued.

- (b) Look at Figure 1 for Question 1(b) in the Diagram Booklet. It shows the full electromagnetic spectrum.**

Look at Figure 2 for Question 1(b) in the Diagram Booklet. It gives information about four of the types of electromagnetic radiation shown in Figure 1.

State the name of each type of radiation next to its information.

(4 marks)

(Total for Question 1 = 7 marks)

- 2 (a) A flag has three colours in daylight.**

The flag is taken into a dark room.

Look at Figure 3 for Question 2(a) in the Diagram Booklet. It shows the flag when a torch shines white light on to the flag.

Look at Figure 4 for Question 2(a) in the Diagram Booklet. It shows the same flag when the torch is covered with a coloured filter.

State the colour of the filter that has covered the torch.

(1 mark)

(continued on the next page)

2 continued.

- (b) A student uses a converging lens to produce an image of a tree on a screen.**

Look at Figure 5 for Question 2(b) in the Diagram Booklet. The image of the tree on the screen is shown in Figure 5.

The student is asked to describe the image of the tree.

Look at the table for Question 2(b) in the Diagram Booklet. The student's descriptions are shown in the table.

The first description is correct, the image is upside down.

Complete the table by adding the correct descriptions of the image.

(2 marks)

(continued on the next page)

2 continued.

- (c) A student uses a ray box to investigate two lenses, P and Q.**

Look at Figure 6 for Question 2(c) in the Diagram Booklet. It shows the student's drawings of rays of light before and after passing through the lenses.

**Complete the following sentences.
(2 marks)**

**The focal length of lens P is _____
than the focal length of lens Q.**

**The power of lens P is _____ than
the power of lens Q.**

(continued on the next page)

2 continued.

- (d) Look at Figure 7 for Question 2(d) in the Diagram Booklet. It shows light reflecting from two mirrors in a bathroom.**

Mirror R has a dry surface.

Mirror S has lots of small drops of water on the surface.

A person looks into each mirror.

**Explain the difference between the image seen in mirror R and the image seen in mirror S.
(2 marks)**

(Total for Question 2 = 7 marks)

Turn over

- 3 Look at Figure 8 for Question 3 in the Diagram Booklet. It shows two types of force that act in the Sun.**

One type of force acts inwards, towards the centre of the Sun.

The other type of force acts outwards, away from the centre of the Sun.

- (a) Outward forces are a result of nuclear fusion in the Sun.**

**State what causes the inward forces.
(1 mark)**

(continued on the next page)

3 continued.

(b) The inward and outward forces in stars like the Sun stay balanced for 10 billion years.

(i) In the Sun, these forces have been balanced for 46% of this time.

Calculate for how many billions of years these forces have been balanced in the Sun.

(2 marks)

time = _____ billion years

(continued on the next page)

3(b) continued.

- (ii) Describe what will happen to the Sun when the inward and outward forces become unbalanced.
(2 marks)**

(continued on the next page)

3 continued.

(c) Nuclear fusion reactions take place in the Sun.

**Describe what happens in a nuclear fusion reaction.
(2 marks)**

(continued on the next page)

3 continued.

- (d) In 1989, two scientists claimed that they could produce a nuclear fusion reaction in their laboratory.**

They said their reaction could take place at room temperature in a test tube.

**Explain why other scientists did not believe them.
(2 marks)**

(Total for Question 3 = 9 marks)

- 4 (a) A car is being driven at a constant velocity.**

The driver sees an obstacle in the road ahead.

The driver uses the brakes to stop as quickly as possible.

Look at Figure 9 for Question 4(a) in the Diagram Booklet. It shows the velocity/time graph for the car from the time when the driver sees the obstacle.

- (i) Which of these is the driver's reaction time shown in Figure 9?**
(1 mark)

☐ **A 0 s**

☐ **B 1 s**

☐ **C 4 s**

☐ **D 22 s**

(continued on the next page)

4(a) continued.

- (ii) State ONE factor that might increase a driver's reaction time.
(1 mark)**

(continued on the next page)

4(a) continued.

- (iii) Calculate the distance travelled between when the driver applies the brakes and when the car comes to rest in Figure 9.
(3 marks)**

Use the equation

distance = area under the sloping line of the graph in Figure 9

distance = _____ m

(continued on the next page)

4 continued.

- (b) The stopping distance of a car is the thinking distance plus the braking distance.**

A car has a device that can detect an obstacle in the road ahead.

The device is linked to a computer that can apply the brakes.

It is claimed that, in an emergency, the computer-controlled car will have a shorter stopping distance than if the car is controlled by a human driver.

**Explain why this claim could be true.
(2 marks)**

4 continued.

(c) A different car has a device that can detect rain.

This device is linked to a computer that can change the speed of the car.

In wet weather, the computer changes the speed of the car.

- (i) State the change in speed that the computer should make when the road is wet.
(1 mark)**

- (ii) Give a reason why this change in speed is necessary when the road is wet.
(1 mark)**

(Total for Question 4 = 9 marks)

Turn over

- 5 (a) A sound wave can transfer information across a room.

Which row of the table shows what else a sound wave can transfer?

(1 mark)

	can transfer energy	can transfer air
<input type="checkbox"/> A	yes	yes
<input type="checkbox"/> B	yes	no
<input type="checkbox"/> C	no	yes
<input type="checkbox"/> D	no	no

- (b) Which of these always increases as a sound gets louder?

(1 mark)

- ☐ A amplitude
- ☐ B frequency
- ☐ C speed
- ☐ D wavelength

(continued on the next page)

Turn over

5 continued.

(c) The speed of a sound wave in air is **330 m/s**

The wavelength of this wave is **0.75 m**

Calculate the frequency of this wave.
(3 marks)

Use the equation

$$v = f \times \lambda$$

frequency = _____ Hz

(continued on the next page)

5 continued.

(d) Look at Figure 10 for Question 5(d) in the Diagram Booklet. It shows a water wave.

Which of these is the amplitude of the wave shown in Figure 10?

(1 mark)

- ☐ **A 9 cm**
- ☐ **B 18 cm**
- ☐ **C 30 cm**
- ☐ **D 60 cm**

(continued on the next page)

5 continued.

(e) Ripples travel out from the centre of a small circular pond to its edge.

(i) Describe how a student could determine the wave speed of the ripples.

(3 marks)

(continued on the next page)

5(e) continued.

- (ii) Look at Figure 11 for Question 5(e)(ii) in the Diagram Booklet. It shows a duck floating on the pond.**

The ripples cause the duck to move.

Draw arrows on Figure 11 to show how the duck moves due to the ripples.

(1 mark)

(Total for Question 5 = 10 marks)

6 Look at Figure 12 for Question 6 in the Diagram Booklet. It is a diagram representing an atom.

(a) Write the names of the particles **X**, **Y** and **Z** below.
(3 marks)

X _____

Y _____

Z _____

(continued on the next page)

6 continued.

(b) The nucleus of a different atom emits a gamma ray.

What happens to the number of particles in the nucleus?

(1 mark)

- ☐ **A it decreases by one**
- ☐ **B it decreases by two**
- ☐ **C it decreases by four**
- ☐ **D it does not change**

(continued on the next page)

6 continued.

- (c) A teacher demonstrates a radioactivity experiment to a class of students.**

The teacher places a radioactive source in front of a radiation detector.

- (i) State ONE safety precaution the teacher should take.
(1 mark)**

(continued on the next page)

6(c) continued.

- (ii) The teacher uses the detector to measure the activity of the source several times.**

Look at Figure 13 for Question 6(c)(ii) in the Diagram Booklet. It shows the results.

The teacher tells the class that radioactive decay is random.

State how the data in Figure 13 supports this statement.

(1 mark)

(continued on the next page)

6(c) continued.

- (iii) Calculate the mean of the FOUR measurements in Figure 13.
(1 mark)**

mean = _____ Bq

(continued on the next page)

6 continued.

- (d) The teacher moves the radiation detector to different distances from the radioactive source.**

The teacher determines the mean detector reading at each distance from the source.

Look at Figure 14 for Question 6(d) in the Diagram Booklet. The teacher plots the results on graph paper, as shown in Figure 14.

- (i) The source emits alpha radiation ONLY.**

Explain how the graph in Figure 14 shows that the source only emits alpha radiation.

(2 marks)

(continued on the next page)

6(d) continued.

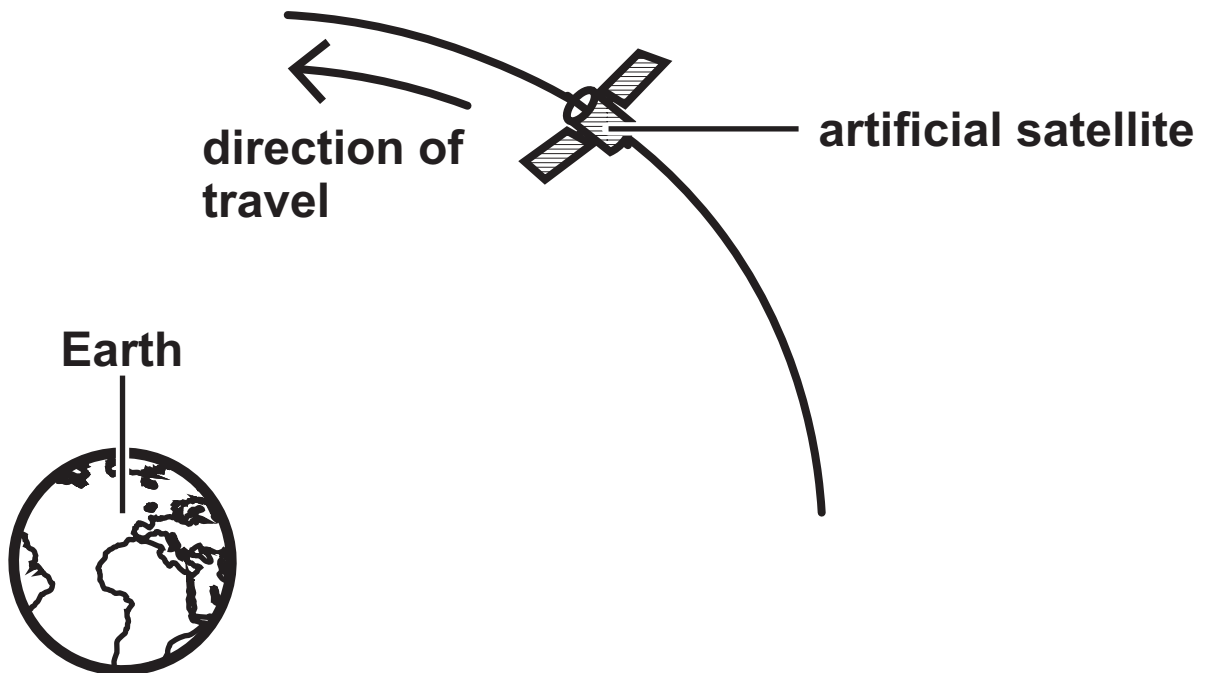
- (ii) Give a reason why the mean detector reading in Figure 14 does not fall to zero in this experiment.
(1 mark)**

(Total for Question 6 = 10 marks)

- 7 (a) Figure 15 shows an artificial satellite in orbit around the Earth.

FIGURE 15

NOT TO SCALE



- (i) Look at the diagrams for Question 7(a)(i) in the Diagram Booklet. Which of these shows the direction of the force that keeps the satellite in orbit around the Earth?

(1 mark)

- ☐ A Diagram A
- ☐ B Diagram B
- ☐ C Diagram C
- ☐ D Diagram D

7(a) continued.

- (ii) The satellite travels at a constant speed around the Earth.**

Explain why the satellite is accelerating even though it travels at a constant speed.

(2 marks)

(continued on the next page)

7 continued.

- (b) The Hubble Space Telescope is an artificial satellite in orbit about **500 km** above the Earth's surface.**

This telescope is used to observe the light from very distant objects in the Universe.

Explain why the Hubble Space Telescope must be high above the Earth's surface to make its observations.

(2 marks)

(continued on the next page)

7 continued.

- (c) There are many other artificial satellites in orbit around the Earth.**

Look at Figure 16 for Question 7(c) in the Diagram Booklet. It shows the time taken to complete one orbit for satellites at different heights above the Earth's surface.

**Describe the relationship shown in Figure 16.
(2 marks)**

(continued on the next page)

7 continued.

- *(d) Look at Figure 17 for Question 7(d) in the Diagram Booklet. A long time ago, many people thought that the objects seen in the sky were arranged as shown in Figure 17.**

Compare the arrangement shown in Figure 17 with what we now know about the Solar System.

Your answer should refer to

- the objects that are in the Solar System**
- how these objects are arranged.**

**You may draw a diagram to help your answer.
(6 marks)**

Answer space continues on the next 3 pages.

7(d) continued.

(continued on the next page)

Turn over

7(d) continued.

[illegible]

Turn over

7(d) continued.

[illegible]

(Total for Question 7 = 13 marks)

- 8 Look at Figure 18 for Question 8 in the Diagram Booklet. It shows a person on a skateboard at the top of a ramp.

At **P**, the person is not moving.

- (a) The person rides the skateboard down the ramp from **P** to **Q**.

The gravitational potential energy of the person decreases by **980 J**

The mass of the person is **35 kg**

Calculate **h**, the height of the ramp.
(2 marks)

Use **$g = 10 \text{ N/kg}$**

Use the equation

change in gravitational potential energy = **$m \times g \times h$**

Answer space continues on the next page.

8(a) continued.

change in gravitational potential energy = $m \times g \times h$

$h =$ _____ m

(continued on the next page)

8 continued.

- (b) The kinetic energy, **KE**, of the person at **Q** is **950 J**

The mass of the person is **35 kg**

Calculate the velocity of the person at **Q**.
(3 marks)

Use the equation

$$v^2 = \frac{2 \times KE}{m}$$

velocity = _____ m/s

(continued on the next page)

Turn over

8 continued.

(c) Look at Figure 19 for Question 8(c) in the Diagram Booklet. It is a diagram that represents energy changes from **P** to **Q**.

(i) State what is represented by **X**.
(1 mark)

(ii) Calculate the value of **X**.
(1 mark)

value of **X** = _____ J

(continued on the next page)

8(c) continued.

- (iii) Calculate the efficiency of the system represented in Figure 19.
(2 marks)**

efficiency = _____

(continued on the next page)

8 continued.

- (d) The person would like to start from **P** again but have a greater velocity at **Q**.**

**Suggest TWO ways that this can be achieved.
(2 marks)**

1 _____

2 _____

(Total for Question 8 = 11 marks)

- 9 (a) Two people, **L** and **M**, have a **100 m** race.

L starts running before **M**.

Look at Figure 20 for Question 9 in the Diagram Booklet. It shows a distance/time graph of the race.

- (i) State the **DISTANCE** that **L** has run when **M** overtakes.
(1 mark)

distance = _____ m

- (ii) Calculate the velocity of **L** when running the **100 m** race.
(2 marks)

velocity = _____ m/s

(continued on the next page)

Turn over

9 continued.

(b) A motorcycle is travelling at a velocity of 6.2 m/s

The motorcycle accelerates at 2.5 m/s^2 until its velocity is 10 m/s

- (i) Calculate the time taken for this acceleration.
(2 marks)

Use the equation

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

time taken = _____ s

(continued on the next page)

9(b) continued.

- (ii) The motor cycle now decelerates (slows down) from **10 m/s** to a stop.

The deceleration is at a constant rate of **4.4 m/s²**

Calculate the distance the motorcycle travels as it slows down to a stop.
(2 marks)

Use the equation

$$v^2 - u^2 = 2 \times a \times x$$

distance = _____ m

(continued on the next page)

9 continued.

- *(c) Look at Figure 21 for Question 9(c) in the Diagram Booklet. A student has a trolley and a ramp, as shown in Figure 21.**

The height, H , of one end of the ramp can be adjusted.

The student investigates how the average speed of the trolley between X and Y depends on the height, H , of the ramp.

Describe

- the additional equipment that the student needs**
- how that equipment is used to obtain the measurements needed.**

(6 marks)

Answer space continues on the next 3 pages.

Turn over

9(c) continued.

[illegible]

Turn over

9(c) continued.

[illegible]

Turn over

9(c) continued.

(Total for Question 9 = 13 marks)

10 (a) Radiation is used to treat tumours (cancer).

The source of the radiation can be inside or outside the human body.

**Which of these has a radiation source that can be positioned inside the body to treat tumours?
(1 mark)**

- ☐ **A gamma rays**
- ☐ **B x-rays**
- ☐ **C radio waves**
- ☐ **D microwaves**

(continued on the next page)

10 continued.

- (b) Look at Figure 22 for Question 10(b) in the Diagram Booklet. It shows a **PET** scanner used to detect cancerous tumours.**

A radioactive isotope is injected into a patient.

The isotope is absorbed by the tumour.

The isotope emits positrons from the location of the tumour.

The ring of radiation detectors rotates around the person.

- (i) Explain how the scan can give the location of the tumour.
(3 marks)**

Answer space continues on the next page.

Turn over

10(b)(i) continued.

(continued on the next page)

10(b) continued.

- (ii) Explain why the radioactive isotope injected into the patient must be produced near to the place where it is to be used.
(2 marks)**

(continued on the next page)

10 continued.

(c) Radiotherapy can involve irradiation of patients.

Radioactive tracers can involve contamination of patients.

State TWO differences between irradiation and radioactive contamination.
(2 marks)

1 _____

2 _____

(continued on the next page)

10 continued.

(d) Look at Figure 23 for Question 10(d) in the Diagram Booklet. It shows the decay curves of two different isotopes, **Q and **P**.**

- (i) Use the graph in Figure 23 to determine the half-life of isotope **P**.
(2 marks)**

half-life of isotope **P = _____ hours**

- (ii) Suggest a reason why the sample of isotope **Q** could be more dangerous to humans than the sample of isotope **P**.
(1 mark)**

(Total for Question 10 = 11 marks)

**TOTAL FOR PAPER = 100 MARKS
END OF PAPER**