

Physics
PAPER 1
Foundation Tier

Total Marks

Thursday 25 May 2023 – 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

Formulae 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 that you make are related or follow on from each other where appropriate.

(continued on the next page)

INFORMATION continued.

A list of equations is provided as a separate booklet.

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 waves in the electromagnetic (e-m) spectrum.

- (a) (i) Look at Figure 1 for Question 1(a) in the Diagram Booklet. It shows some types of radiation that form part of the e-m spectrum and some uses of e-m radiation.**

Draw ONE straight line from each type of e-m radiation to its use.

ONE line has been drawn for you.

(3 marks)

(continued on the next page)

1(a) continued.

**(ii) Which of these waves has the highest frequency?
(1 mark)**

- ☐ **A infrared**
- ☐ **B microwaves**
- ☐ **C ultraviolet**
- ☐ **D visible light**

(continued on the next page)

1 continued.

(b) X-rays are also part of the e-m spectrum.

Look at Figure 2 for Question 1(b) in the Diagram Booklet. It shows an airport security scanner using X-rays to scan passengers' bags.

- (i) Explain why X-rays are used to scan passengers' bags.
(2 marks)**

(continued on the next page)

1(b) continued.

- (ii) Explain why passengers are NOT scanned with X-rays.
(2 marks)**

(Total for Question 1 = 8 marks)

- 2 (a) Look at Figure 3 for Question 2(a) in the Diagram Booklet. It shows a ray of light striking a mirror.

The angle of incidence is 30° and the ray of light is reflected.

The angle of reflection is the angle between
(1 mark)

- ☐ A the mirror and the incident ray
- ☐ B the mirror and the normal
- ☐ C the reflected ray and the incident ray
- ☐ D the reflected ray and the normal

- (b) Look at Figure 4 for Question 2(b) in the Diagram Booklet. It shows two lenses, P and Q, arranged to form a simple telescope.

- (i) State ONE use for a telescope.
(1 mark)

2(b) continued.

**(ii) Which of these describes the lenses?
(1 mark)**

☐ **A P is converging, Q is diverging**

☐ **B P is diverging, Q is converging**

☐ **C P and Q are both converging**

☐ **D P and Q are both diverging**

(iii) The focal length of lens Q is 0.14 m.

**Calculate the power of the lens.
(2 marks)**

Use the equation

$$\text{power} = \frac{1}{\text{focal length in m}}$$

Answer space continues on the next page.

2(b)(iii) continued.

power of lens = _____ diopetre

(continued on the next page)

2 continued.

(c) A student is in a laboratory that has windows.

The student is given a converging lens, and a sheet of paper.

Describe how the student can produce an image of the window frame on the sheet of paper.

(2 marks)

(Total for Question 2 = 7 marks)

- 3 (a) Look at Figure 5 for Question 3(a) in the Diagram Booklet. The graph shows how the velocity of a car changes with time.**

The car starts from rest and travels along a level, straight road for 50 s.

- (i) Which part of the graph shows when the car has constant velocity?**
(1 mark)

☐ **A PQ**

☐ **B QR**

☐ **C RS**

☐ **D ST**

- (ii) Which part of the graph shows when the car has the greatest acceleration?**
(1 mark)

☐ **A PQ**

☐ **B QR**

☐ **C RS**

☐ **D ST**

3(a) continued.

- (iii) Calculate the acceleration of the car in the first 10 s shown on the graph.
(2 marks)**

Use the equation

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

$$\text{acceleration} = \underline{\hspace{4cm}} \text{ m/s}^2$$

(continued on the next page)

3(a) continued.

- (iv) Calculate the distance the car travels in part QR shown on the velocity/time graph in Figure 5.
(3 marks)**

distance = _____ m

(continued on the next page)

3 continued.

(b) A different car has a mass of 1200 kg.

**Calculate the force needed to give this car an
acceleration of 2.4 m/s^2
(2 marks)**

Use the equation

$$\mathbf{F = m \times a}$$

force = _____ N

(Total for Question 3 = 9 marks)

- 4 An atom has a central nucleus containing neutrons and protons.

Electrons orbit the nucleus.

- (a) (i) Which row of the table gives the relative mass and charge of a proton?
(1 mark)

	relative mass	charge
<input type="checkbox"/> A	0	+1
<input type="checkbox"/> B	0	-1
<input type="checkbox"/> C	1	+1
<input type="checkbox"/> D	1	-1

(continued on the next page)

4(a) continued.

(ii) An atom has a radius of 1.0×10^{-10} m.

A nucleus has a radius of 1.0×10^{-15} m.

Calculate the ratio of the radius of the atom to the radius of the nucleus.

(2 marks)

ratio of radius of atom to radius of nucleus =

(continued on the next page)

4(a) continued.

**(iii) Explain why an atom has no charge overall.
(2 marks)**

(continued on the next page)

4 continued.

(b) One isotope of carbon is carbon-14.



(i) State the number of protons in one atom of carbon-14.

(1 mark)

number of protons = _____

(ii) State the number of neutrons in one atom of carbon-14.

(1 mark)

number of neutrons = _____

(continued on the next page)

4(b) continued.

(iii) Look at Figure 6 for Question 4(b)(iii) in the Diagram Booklet. It shows a graph for the decay of the radioactive isotope carbon-14.

Use the graph to estimate the half-life of carbon-14.

(2 marks)

half-life = _____ years

(Total for Question 4 = 9 marks)

5 (a) Look at Figure 7 for Question 5(a) in the Diagram Booklet. It shows a wave on the surface of water.

(i) Which of the arrowed lines shows the amplitude of the wave?
(1 mark)

☐ **A**

☐ **B**

☐ **C**

☐ **D**

(ii) Explain why the wave shown in Figure 7 is a transverse wave.
(2 marks)

5 continued.

- (b) Look at Figure 8 for Question 5(b) in the Diagram Booklet. It shows the top view of the wave pattern on screen and the side view of a ripple tank.**

A screen is placed below the ripple tank.

The wave pattern produced by the ripples can be seen on the screen.

A student has a stop clock and a ruler.

- (i) Describe how the student could measure the frequency of the ripples.
(2 marks)**

(continued on the next page)

Turn over

5(b) continued.

- (ii) Describe how the student could measure the wavelength of the ripples.
(2 marks)**

(continued on the next page)

5 continued.

- (c) In a swimming pool, a wave is produced with a wavelength of 4·0 m and a velocity of 0·8 m/s.**

Calculate the frequency of the wave.

State the unit of frequency.

(3 marks)

Use the equation

$$v = f \times \lambda$$

Answer space continues on the next page.

5(c) continued.

frequency of wave _____

unit _____

(Total for Question 5 = 10 marks)

- 6 (a) Look at Figure 9 for Question 6(a) in the Diagram Booklet. It shows a metal cube filled with hot water.**

Four sides of the cube have different surfaces, as shown in Figure 9.

The four surfaces are at the same temperature.

The thermal energy radiated by each side of the box is measured using a thermal energy detector connected to a millivoltmeter.

The detector is moved to get a reading of the thermal energy emitted from each side of the box.

Look at Figure 10 for Question 6(a)(i) in the Diagram Booklet. It shows the table of results.

- (i) Suggest a possible millivoltmeter reading for the shiny black surface.
(1 mark)**

_____ mV

(continued on the next page)

6(a) continued.

- (ii) State what must be kept the same to take the measurement for each surface.
(1 mark)**

- (iii) Suggest why the cube is placed on a block of wood.
(1 mark)**

(continued on the next page)

6 continued.

- (b) A hot surface emits radiation of different wavelengths.**

Look at Figure 11 for Question 6(b) in the Diagram Booklet. The graph in Figure 11 shows how the intensity of the radiation emitted changes with the wavelength.

**Describe how intensity changes with wavelength in Figure 11.
(2 marks)**

(continued on the next page)

6 continued.

- (c) Look at Figure 12 for Question 6(c) in the Diagram Booklet. It shows two cans, a radiant heater and some other apparatus.**

The cans absorb thermal radiation from the heater.

One can has a matt black surface and the other can has a shiny silver surface.

Both cans contain water at the same temperature.

Describe how a student could use the apparatus in Figure 12 to determine which can is the better absorber of thermal radiation.

(4 marks)

Answer space continues on the next page.

Turn over

6(c) continued.

(Total for Question 6 = 9 marks)

7 This question is about radioactivity and its uses.

**(a) Which of these radiations does NOT have a charge?
(1 mark)**

- ☐ **A alpha**
- ☐ **B beta minus**
- ☐ **C beta plus**
- ☐ **D gamma**

**(b) Which of these radiations is used in smoke detectors?
(1 mark)**

- ☐ **A alpha**
- ☐ **B beta minus**
- ☐ **C beta plus**
- ☐ **D gamma**

(continued on the next page)

7 continued.

(c) Look at Figure 13 for Question 7(c) in the Diagram Booklet. The diagram shows a radioactive source used to check the thickness of paper.

**(i) Name the type of radiation used to check the thickness of the paper.
(1 mark)**

**(ii) Give the name of ONE device which could detect this type of radiation.
(1 mark)**

(continued on the next page)

7(c) continued.

When the paper is the correct thickness, the count rate is 4000 counts per minute.

(iii) The count rate increases when the paper gets thinner.

**Give ONE reason for this increase.
(1 mark)**

(continued on the next page)

7(c) continued.

- (iv) The rollers need to be adjusted if the count rate increases by 5%.**

Calculate the maximum count rate that would be allowed before the rollers need to be adjusted.

(2 marks)

maximum count rate =

_____ counts per minute

(continued on the next page)

Turn over

7 continued.

***(d) Radioactivity from radioactive sources can be used in the diagnosis and treatment of cancer.**

**Describe ONE way radioactivity can be used in the diagnosis of cancer and ONE way radioactivity can be used in the treatment of cancer.
(6 marks)**

Answer space continues on the next page.

Turn over

7(d) continued.

(Total for Question 7 = 13 marks)

8 (a) Which of these is a scalar quantity?
(1 mark)

☐ **A acceleration**

☐ **B distance**

☐ **C force**

☐ **D weight**

(b) A student has some cupcake cases.

Look at the diagrams for Question 8(b) in the Diagram Booklet. One cupcake case is shown in Figure 14.

The student drops a stack of cupcake cases with the base facing downwards, as shown in Figure 15.

The speed of the falling stack of cupcake cases depends on the number of cupcake cases in the stack.

(continued on the next page)

8(b) continued.

- (i) The student also has a stop clock and a metre rule.**

Describe an investigation to show how the speed of the falling stack of cupcake cases depends on the number of cupcake cases in the stack.

(4 marks)

Answer space continues on the next page.

8(b)(i) continued.

(continued on the next page)

8(b) continued.

- (ii) A stack of cupcake cases has a mass of 0.005 kg.

Calculate the weight, in newtons, of the stack of cupcake cases.

Gravitational field strength = 10 N/kg
(2 marks)

Use the equation

$$W = mg$$

weight = _____ N

(continued on the next page)

8(b) continued.

Look at Figure 16 for Question 8(b)(iii) in the Diagram Booklet. It shows a cupcake case that is falling at a constant velocity.

**(iii) Draw an arrow on Figure 16 to show the force due to air resistance on the cupcake case.
(1 mark)**

**(iv) State the value of the acceleration of the cupcake case when it is falling at a constant velocity.
(1 mark)**

(continued on the next page)

8 continued.

(c) A car travels along a straight road.

The car accelerates at 3 m/s^2 for a time of 7 s.

Calculate the change in velocity of the car.
(2 marks)

Use the equation

change in velocity = acceleration \times time taken

change in velocity = _____ m/s

(Total for Question 8 = 11 marks)

- 9 (a) Look at Figure 17 for Question 9(a) in the Diagram Booklet. It shows a football kicked against a wall.

The football has a mass of 0.42 kg.

- (i) The football gains 11 J of gravitational potential energy as it moves from the ground to the wall.

Calculate the height at which the ball hits the wall.

(3 marks)

Gravitational field strength = 10 N/kg

Use the equation

$$\Delta \text{GPE} = m \times g \times \Delta h$$

height = _____ m

9(a) continued.

- (ii) Calculate the kinetic energy of the football when it is moving at a velocity of 12m/s.
(2 marks)**

Use the equation

$$\text{KE} = \frac{1}{2} \times m \times v^2$$

kinetic energy = _____ J

(continued on the next page)

9(a) continued.

- (iii) Describe the energy transfers that happen when the ball hits the wall.
(2 marks)**

***(b) In the UK, electricity is generated using non-renewable and renewable energy resources.**

Look at Figure 18 for Question 9(b) in the Diagram Booklet. The graph shows how the amount of electricity generated by these resources changed from 2012 to 2020.

(continued on the next page)

9(b) continued.

Explain how and why the amount of electricity generated by renewable and non-renewable energy resources has changed from 2012 to 2020.

Your answer should include

- **the trends shown in Figure 18**
- **the change in the amount of electricity generated by at least one renewable resource**
- **the change in the amount of electricity generated by at least one non-renewable resource.**

(6 marks)

Answer space continues on the next 2 pages.

9(b) continued.

[illegible]

Turn over

9(b) continued.

(Total for Question 9 = 13 marks)

10 (a) Look at Figure 19 for Question 10(a) in the Diagram Booklet. It shows two objects, E and D.

E emits a sound.

D detects the sound.

E is moving in the direction shown by the arrow, but D is not moving.

E emits a sound of wavelength 1.86 m.

D measures the wavelength of this sound as 1.98 m.

(continued on the next page)

10(a) continued.

- (i) Calculate the difference between the wavelength that **E** emits and the wavelength that **D** detects.
(1 mark)**

difference in wavelength =

_____ m

(continued on the next page)

10(a) continued.

(ii) The velocity of sound is 330 m/s.

Calculate the velocity of E.
(2 marks)

Use the equation

velocity of E =

$$\frac{\text{velocity of sound} \times \text{difference in wavelength}}{\text{wavelength E emits}}$$

velocity of E = _____ m/s

(continued on the next page)

10 continued.

- (b) The wavelength of light emitted from distant galaxies is different when the light is detected on Earth.**

**Explain how this difference in wavelength shows that the Universe is expanding.
(2 marks)**

(continued on the next page)

10 continued.

- (c) CMB radiation provides evidence that the Universe had a definite beginning.**

Look at Figure 20 for Question 10(c) in the Diagram Booklet. Use the table in Figure 20 to give a typical value for the wavelength of CMB radiation.

(2 marks)

wavelength = _____

(continued on the next page)

10 continued.

(d) During the evolution of a star, the nebula collapses and becomes a main sequence star.

**(i) State what causes the nebula to collapse.
(1 mark)**

**(ii) Explain why the nebula stops collapsing as it becomes a main sequence star.
(3 marks)**

Answer space continues on the next page.

Turn over

10(d)(ii) continued.

(Total for Question 10 = 11 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER