

Physics

UNIT: 4PH1

Science (Double Award) 4SD0

PAPER: 1P

Total Marks

Wednesday 22 May 2024 – Morning

Time: 2 hours

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

Surname										
Other names										
Centre Number										
Candidate Number										

YOU MUST HAVE

Ruler, calculator, protractor, 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.

Show all the steps in any calculations and state the units.

INFORMATION

The total mark for this paper is 110.

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

There may be spare copies of some diagrams.

Turn over

ADVICE

Read each question carefully before you start to answer it.

Write your answers neatly and in good English.

Try to answer every question.

Check your answers if you have time at the end.

Answer ALL questions.

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 motion of objects in the solar system.

**(a) (i) On the blank page for Question 1(a) in the Diagram Booklet, draw a labelled diagram showing the Moon orbiting the Earth.
(2 marks)**

**(ii) Give the name of the force that causes the Moon to orbit the Earth.
(1 mark)**

1(a) continued.

**(iii) Give the name of another object
that orbits the Earth.
(1 mark)**

**(b) A planet and a comet both orbit
a star.**

**Give a difference between the orbit
of a planet and the orbit of a comet.
(1 mark)**

(Total for Question 1 = 5 marks)

2 This question is about radioactivity.

(a) The nucleus of an atom of carbon has 6 protons and 8 neutrons.

**Which row of the table shows the nucleus of an atom that is a different isotope of carbon?
(1 mark)**

	Number of protons	Number of neutrons
<input type="checkbox"/> A	6	6
<input type="checkbox"/> B	6	8
<input type="checkbox"/> C	8	6
<input type="checkbox"/> D	8	8

(continued on the next page)

2 continued.

**(b) Which type of radiation is a high-energy electron?
(1 mark)**

- ☐ **A alpha**
- ☐ **B beta**
- ☐ **C gamma**
- ☐ **D neutron**

(continued on the next page)

2 continued.

(c) A nucleus emits radiation. This causes the mass number to decrease by one. The atomic number stays the same.

**Which type of radiation does the nucleus emit?
(1 mark)**

- ☐ **A alpha**
- ☐ **B beta**
- ☐ **C gamma**
- ☐ **D neutron**

(continued on the next page)

Turn over

2 continued.

(d) The nucleus of an isotope of uranium can be represented using this symbol.



The nucleus forms part of a positively charged ion.

**How many electrons could be in this ion?
(1 mark)**

- ☐ **A 90**
- ☐ **B 92**
- ☐ **C 146**
- ☐ **D 238**

(continued on the next page)

Turn over

2 continued.

(e) A radioactive isotope has an initial activity of 400 Bq.

The half-life of the isotope is 8 hours.

What is the activity of the isotope after 16 hours?

(1 mark)

☐ **A 25 Bq**

☐ **B 50 Bq**

☐ **C 100 Bq**

☐ **D 200 Bq**

(Total for Question 2 = 5 marks)

Turn over

3 Look at the diagram for Question 3 in the Diagram Booklet. It shows infrared heating lamps being used to harden fresh paint on a car.

**(a) Give a harmful effect of infrared waves.
(1 mark)**

(continued on the next page)

3 continued.

(b) The heating lamps produce visible light waves in addition to infrared waves.

**(i) Give two similar properties of visible light waves and infrared waves.
(2 marks)**

1 _____

2 _____

(continued on the next page)

Turn over

3(b) continued.

**(ii) Give two differences between the properties of visible light waves and infrared waves.
(2 marks)**

1 _____

2 _____

(continued on the next page)

Turn over

3 continued.

(c) The infrared heating lamps are placed 1.5 m from the car.

Calculate the time taken for infrared waves emitted from a lamp to reach the car.

(3 marks)

[for infrared waves, speed = $3.0 \times 10^8 \text{ m/s}$]

time taken = _____ s

(continued on the next page)

Turn over

3 continued.

(d) Paint takes less time to harden when it absorbs more energy from infrared radiation.

A technician observes that white paint takes more time to harden than black paint.

**Explain this observation.
(2 marks)**

Answer space continues on the next page.

Turn over

3(d) continued.

(Total for Question 3 = 10 marks)

4 This question is about the evolution of a star.

(a) A main sequence star is created in a collapsing region of a nebula.

Look at the table for Question 4(a) in the Diagram Booklet. It gives different energy stores for the gases in the collapsing nebula, from when the nebula starts to collapse to just before the main sequence star is created.

Complete the table by placing ticks (✓) to show whether each energy store increases, decreases or stays the same.

(4 marks)

(continued on the next page)

4 continued.

(b) At the end of the main sequence stage of a star's evolution, the star can become a red giant or a red supergiant.

**Give the property of a star that determines whether it becomes a red giant or a red supergiant.
(1 mark)**

(continued on the next page)

4 continued.

(c) A red giant star eventually becomes a white dwarf star.

**Discuss the differences between a red giant star and a white dwarf star.
(4 marks)**

Answer space continues on the next page.

Turn over

4(c) continued.

(Total for Question 4 = 9 marks)

5 (a) A metal spring obeys Hooke's law.

On the graph for Question 5(a) in the Diagram Booklet, sketch a graph to show that the spring obeys Hooke's law as it is stretched.

**You should label both axes with appropriate physical quantities.
(3 marks)**

(continued on the next page)

5 continued.

(b) Look at Diagram 1 for Question 5(b) in the Diagram Booklet. It shows an object suspended from a support using a metal spring.

The object is initially at rest.

(i) The object is pulled down and then released.

Look at Diagram 2 for Question 5(b)(i) in the Diagram Booklet. It shows the forces acting on the object at the instant it is released.

**Determine the magnitude and direction of the resultant force acting on the object.
(2 marks)**

(continued on the next page)

Turn over

5(b)(i) continued.

magnitude of resultant force =

_____ **N**

direction of resultant force =

(continued on the next page)

5(b) continued.

(ii) The object has a mass of 0.20 kg.

**Calculate the acceleration of the object at the instant it is released.
(3 marks)**

acceleration =
_____ m/s²

(continued on the next page)

Turn over

5(b) continued.

(iii) Explain how the magnitude of the acceleration of the object changes, from the instant the object is released until the first time the object returns to its initial resting position.

**You should refer to the forces acting on the object in your answer.
(3 marks)**

Answer space continues on the next page.

Turn over

5(b)(iii) continued.

(Total for Question 5 = 11 marks)

6 Look at Diagram 1 for Question 6 in the Diagram Booklet. It shows the magnetic field lines near the south pole of a bar magnet.

**(a) Draw two arrows on the field lines in Diagram 1 to show the direction of the magnetic field lines.
(1 mark)**

**(b) Which of these is attracted to the bar magnet if placed in the magnetic field?
(1 mark)**

☐ **A copper**

☐ **B nickel**

☐ **C plastic**

☐ **D zinc**

(continued on the next page)

6 continued.

(c) The strength of the magnetic field changes as the distance from the south pole increases.

**Explain how the magnetic field lines show this.
(2 marks)**

(continued on the next page)

Turn over

6 continued.

(d) Look at Diagram 2 for Question 6(d) in the Diagram Booklet. It shows a small piece of iron that has been placed in the magnetic field.

The piece of iron becomes magnetised when placed in the magnetic field.

(i) Explain why the piece of iron experiences a force towards the south pole of the bar magnet.

**You may add to Diagram 2 to help your answer.
(2 marks)**

Answer space continues on the next page.

Turn over

6(d)(i) continued.

(continued on the next page)

6(d) continued.

- (ii) A student suggests that the piece of iron is now a permanent magnet.**

**Explain why the student is incorrect.
(2 marks)**

(Total for Question 6 = 8 marks)

7 Look at the diagram for Question 7 in the Diagram Booklet. It shows a domestic lighting circuit.

**(a) Explain an advantage of using this circuit for domestic lighting.
(2 marks)**

(continued on the next page)

7 continued.

(b) When switch 1 is closed, the current in lamp 1 is 22 mA.

**(i) Give the name of the charged particle that moves in an electric current.
(1 mark)**

(continued on the next page)

7(b) continued.

**(ii) Show that lamp 1 has a power of about 5 W.
(3 marks)**

**(iii) Calculate the energy transferred by lamp 1 when it is on for 30 seconds.
(3 marks)**

energy transferred = _____ J

7 continued.

(c) The circuit is connected to the mains supply. Mains voltage is 230 V.

**(i) State what is meant by the term VOLTAGE.
(1 mark)**

(continued on the next page)

7(c) continued.

- (ii) Switches 1 and 3 are closed,
which turn on lamps 1 and 3.**

Switch 2 is open.

**Calculate the current in the
mains supply.
(2 marks)**

current = _____mA

(Total for Question 7 = 12 marks)

- 8 Look at the diagram for Question 8 in the Diagram Booklet. It shows two rays of light, A and B, incident on the boundary between air and water.**

The refractive index of water is 1.33

Explain the paths of the two rays of light after they strike the boundary between air and water.

Include calculations in your answer and draw on the diagram to support your answer.

(6 marks)

Answer space continues on the next page.

Turn over

8 continued.

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

(Total for Question 8 = 6 marks)

Turn over

9 This question is about air pressure.

(a) During an aeroplane flight, a passenger drinks some water from a plastic bottle.

Look at Diagram 1 for Question 9(a) in the Diagram Booklet. The passenger then replaces the top to seal the bottle, as shown.

The air pressure outside the bottle is 80 kPa.

**State the air pressure inside the bottle just after the bottle has been sealed.
(1 mark)**

air pressure = _____ kPa

(continued on the next page)

Turn over

9 continued.

(b) As the aeroplane descends, the air pressure inside the aeroplane changes.

Look at Diagram 2 for Question 9(b) in the Diagram Booklet. When the aeroplane lands, the passenger notices that the plastic bottle has collapsed, as shown.

**Explain why the bottle has collapsed.
(2 marks)**

(continued on the next page)

Turn over

9 continued.

- (c) Explain how gas molecules in the air exert a pressure on the surface of the bottle.
(3 marks)**

(Total for Question 9 = 6 marks)

Turn over

10 Look at Diagram 1 for Question 10 in the Diagram Booklet. It shows the apparatus a student uses to investigate the bending of a wooden strip.

Part of the wooden strip is clamped to a table.

A load is fixed to the free end of the wooden strip, causing it to bend.

The free end of the wooden strip is positioned a length, L , beyond the edge of the table, as shown in Diagram 1.

The weight of the load causes the end of the wooden strip to move down through a height, h .

A student investigates how the length, L , affects the height, h .

(continued on the next page)

10 continued.

(a) The load has a mass of 250 g.

**Calculate the weight of the load.
(2 marks)**

Use the formula

**weight = mass × gravitational field
strength, g**

weight = _____ N

(continued on the next page)

Turn over

10 continued.

(b) This is the student's method for the investigation.

- **clamp the wooden strip so that $L = 20 \text{ cm}$**
- **fix the load to the end of the wooden strip, as shown in Diagram 1**
- **measure the height, h**

The student repeats this method for different values of L .

(continued on the next page)

10(b) continued.

- (i) Give the independent and dependent variables in the investigation.
(2 marks)**

independent variable

dependent variable

(continued on the next page)

10(b) continued.

**(ii) Give two control variables in the investigation.
(2 marks)**

1 _____

2 _____

(continued on the next page)

10(b) continued.

**(iii) Suggest how the student could accurately measure the height, h .
(2 marks)**

(continued on the next page)

Turn over

10 continued.

(c) Look at the table for Question 10(c) in the Diagram Booklet. It shows the results of the investigation.

(i) Look at Diagram 2 for Question 10(c)(i) in the Diagram Booklet. It shows the wooden strip when $L = 80$ cm.

**Using Diagram 2, determine the height, h , in the laboratory.
(2 marks)**

[1 cm on the diagram = 10 cm in the laboratory]

height, h = _____ cm

(continued on the next page)

Turn over

10(c) continued.

**(ii) On the grid for Question 10(c)(ii) in the Diagram Booklet, plot a graph of the student's results.
(2 marks)**

**(iii) On the grid for Question 10(c)(ii) in the Diagram Booklet, draw the curve of best fit.
(1 mark)**

(continued on the next page)

10(c) continued.

(iv) The student concludes that h is directly proportional to L .

**Evaluate the student's conclusion.
(2 marks)**

(Total for Question 10 = 15 marks)

Turn over

- 11 Look at the diagram for Question 11 in the Diagram Booklet. It shows a power bank used to recharge the battery in an electronic device.**

(a) The power bank stores charge.

The charge stored can be measured in amp-hours (Ah). 1 Ah is the amount of charge transferred by a current of 1 A in a time of 1 hour.

Calculate the charge stored in coulombs when the charge stored is 1 Ah.

(2 marks)

Use the formula

charge stored = current \times time taken

charge stored = _____ C

11 continued.

- (b) An electronic device is connected to the power bank.**

Whilst recharging, the electronic device receives a constant current of 2.4A and $3.8 \times 10^3\text{C}$ of charge is transferred.

- (i) Calculate the time taken to recharge the electronic device.**

**Give your answer in minutes.
(3 marks)**

time = _____ minutes

11(b) continued.

- (ii) The electronic device is connected to the power bank using a long cable.**

**Suggest how using a long cable affects the time taken to recharge the electronic device when compared with a short cable.
(2 marks)**

Answer space continues on the next page.

Turn over

11(b)(ii) continued.

(continued on the next page)

11 continued.

(c) A student owns three electronic devices. Each electronic device stores a different amount of charge.

Look at the table for Question 11(c) in the Diagram Booklet. It gives some information about the charge stored by the electronic devices and how often they need to be recharged.

The power bank stores a maximum charge of 26·8Ah.

The student needs to take these three electronic devices on a school trip for one week.

Determine whether the maximum charge of the power bank is enough to recharge the batteries of the three electronic devices during the school trip.

(4 marks)

Answer space continues on the next page.

Turn over

[illegible]

(Total for Question 11 = 11 marks)

Turn over

- 12 A car accelerates with a constant driving force along a horizontal road and reaches its maximum speed.**

Look at the graph for Question 12 in the Diagram Booklet. It shows the velocity-time graph for the car's journey.

- (a) By drawing a tangent to the curve, determine the acceleration of the car at a time of 20 s.
(4 marks)**

acceleration = _____ m/s²

12 continued.

- (b) Determine the distance travelled by the car during the first 80 s of its journey.
(5 marks)**

distance = _____m

(continued on the next page)

Turn over

12 continued.

- (c) Explain the motion of the car
after 80 s.
(3 marks)**

Answer space continues on the next page.

Turn over

12(c) continued.

(Total for Question 12 = 12 marks)

TOTAL FOR PAPER = 110 MARKS
END OF PAPER