Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

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

General Certificate of Education
Advanced Subsidiary Examination
June 2012

Physics A PHYA2

Unit 2 Mechanics, Materials and Waves

Friday 25 May 2012 1.30 pm to 2.45 pm

For this paper you must have:
- a pencil and a ruler
- a calculator
- a Data and Formulae Booklet (enclosed).

Time allowed
- 1 hour 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show all your working.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

Answer **all** questions in the spaces provided.

1 (a) (i) State **two** vector quantities.

vector quantity 1 ....

vector quantity 2 ....

1 (a) (ii) State **two** scalar quantities.

scalar quantity 1 ....

scalar quantity 2 ....

(2 marks)

1 (b) The helicopter shown in **Figure 1a** is moving horizontally through still air. The lift force from the helicopter's blades is labelled **A**.

Figure 1a

not to scale

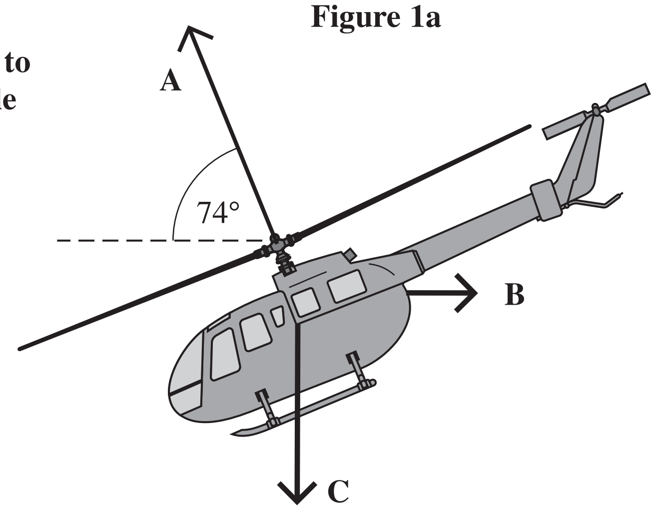
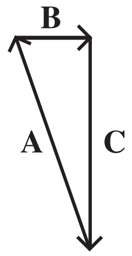


Figure 1b



1 (b) (i) Name the two forces **B** and **C** that also act on the helicopter.

B ....

C ....

(2 marks)

1 (b) (ii) The force vectors are also shown arranged as a triangle in **Figure 1b**.

State and explain how **Figure 1b** shows that the helicopter is moving at a constant velocity.

....

....

....

....

....

(2 marks)

1 (c) The lift force, **A**, is 9.5 kN and acts at an angle of 74° to the horizontal.

Calculate the weight of the helicopter. Give your answer to an appropriate number of significant figures.

answer = ... N

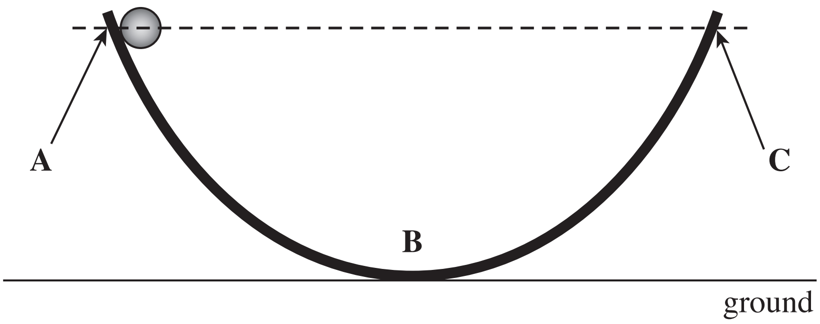
(3 marks)

9

Turn over for the next question

2 In the 17th century, when thinking about forces, Galileo imagined a ball moving in the absence of air resistance on a frictionless track as shown in **Figure 2**.

Figure 2



2 (a) Galileo thought that, under these circumstances, the ball would reach position **C** if released from rest at position **A**. Position **C** is the same height above the ground as **A**.

Using ideas about energy, explain why Galileo was correct.

....

....

....

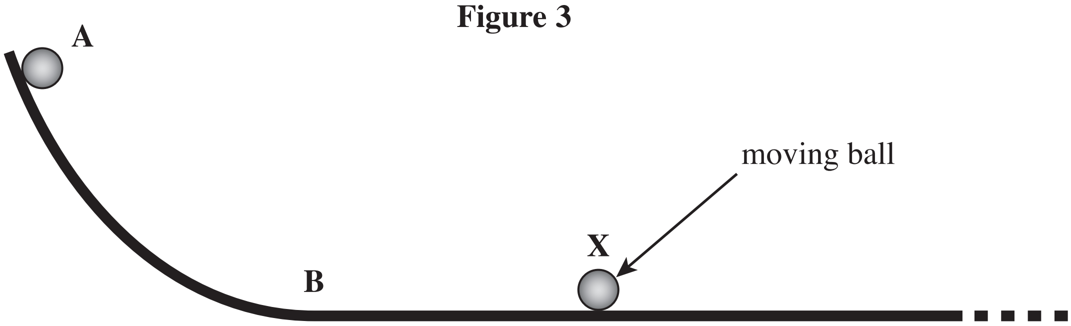
....

....

(3 marks)

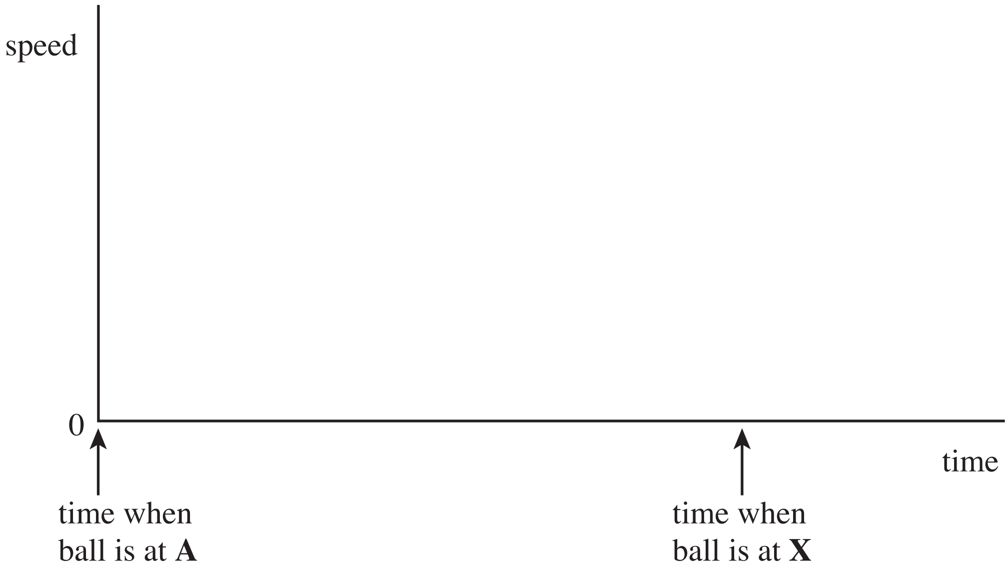
2 (b) Galileo then imagined that the track was changed, as shown in **Figure 3**.

Figure 3



The slope beyond **B** was now horizontal.

On the axes below, sketch a speed – time graph for the ball from its release at **A** until it reaches the position **X** shown in **Figure 3**. Indicate on your graph the time when the ball is at **B**.



(3 marks)

2 (c) Newton later published his three laws of motion.

Explain how Newton's first law of motion is illustrated by the motion of the ball between **B** and **X**.

....

....

....

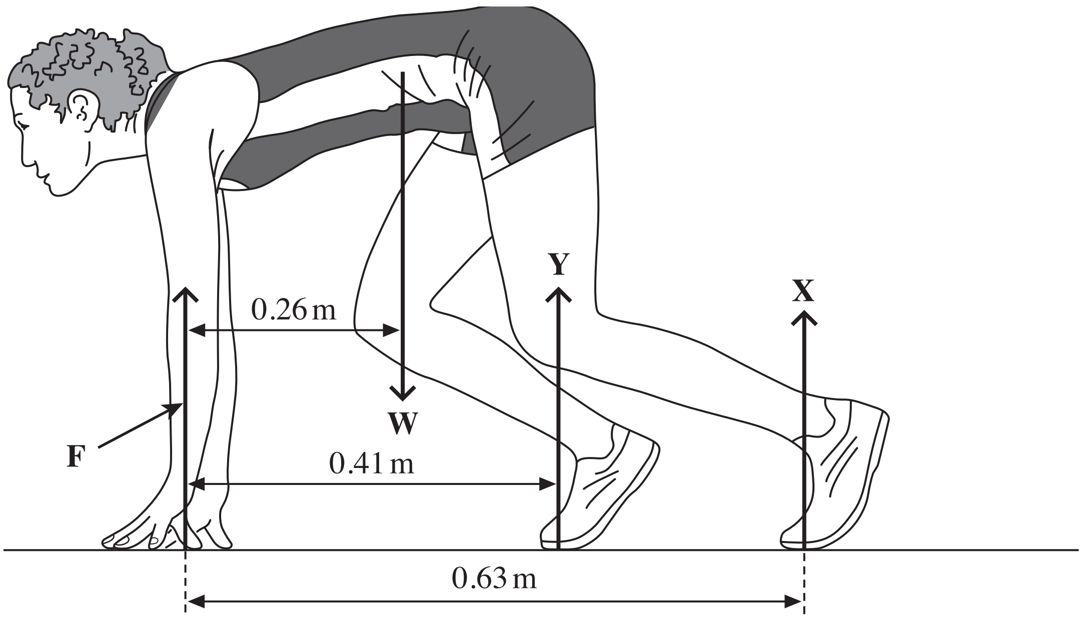
....

(2 marks)

8

3 A sprinter is shown before a race, stationary in the 'set' position, as shown in **Figure 4**. Force **F** is the resultant force on the sprinter's finger tips. The reaction force, **Y**, on her forward foot is 180 N and her weight, **W**, is 520 N. **X** is the vertical reaction force on her back foot.

Figure 4



3 (a) (i) Calculate the moment of the sprinter's weight, **W**, about her finger tips.
Give an appropriate unit.

answer = ... unit ....
(2 marks)

3 (a) (ii) By taking moments about her finger tips, calculate the force on her back foot, marked **X**.

answer = ...N
(3 marks)

Do not write outside the box

3 (a) (iii) Calculate the force **F**.

answer = ...N
(1 mark)

3 (b) The sprinter starts running and reaches a horizontal velocity of 9.3 m s^{-1} in a distance of 35 m.

3 (b) (i) Calculate her average acceleration over this distance.

answer = ...m s^{-2}
(2 marks)

3 (b) (ii) Calculate the resultant force necessary to produce this acceleration.

answer = ...N
(2 marks)

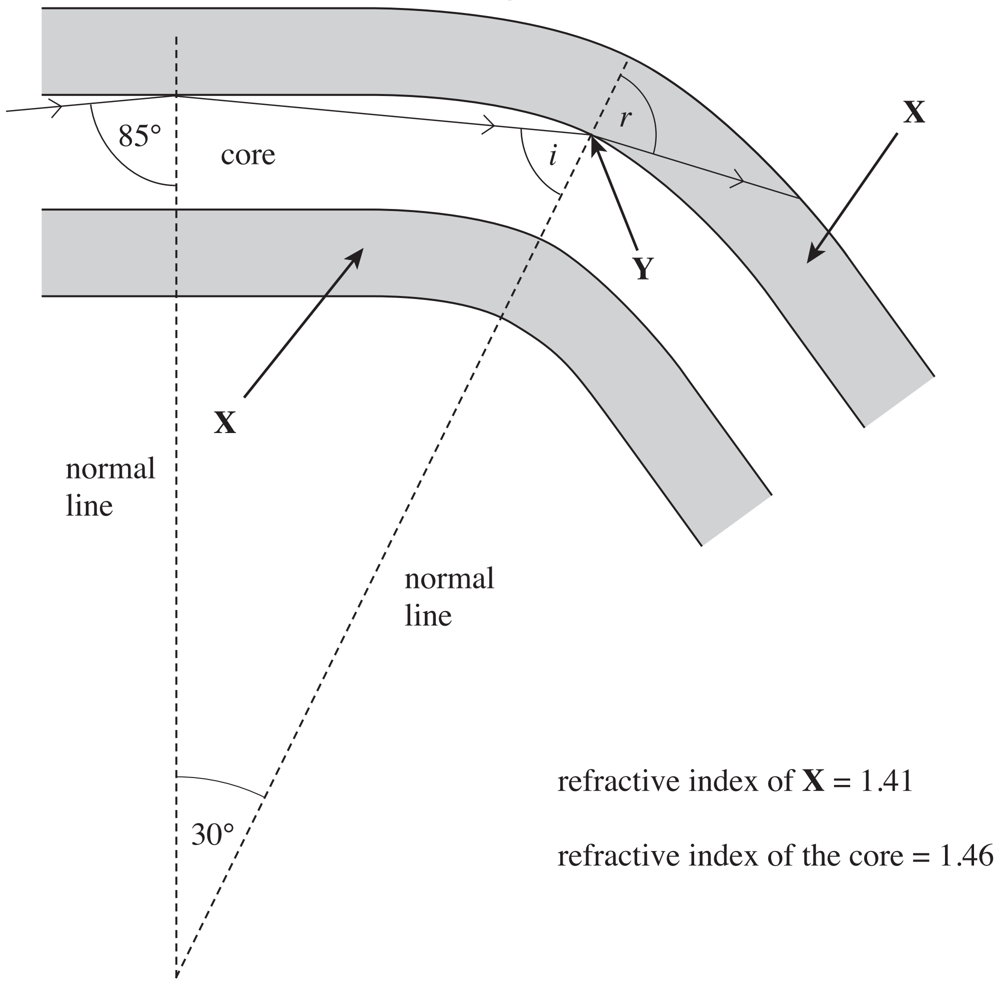
10

Turn over ▶

Do not write outside the box

4 **Figure 5** shows a cross-section through an optical fibre used for communications.

Figure 5



4 (a) (i) Name the part of the fibre labelled **X**.

....

(1 mark)

4 (a) (ii) Calculate the critical angle for the boundary between the core and **X**.

answer = ...degrees

(2 marks)

4 (b) (i) The ray leaves the core at **Y**. At this point the fibre has been bent through an angle of 30° as shown in **Figure 5**.

Calculate the value of the angle i.

answer = ...degrees
(1 mark)

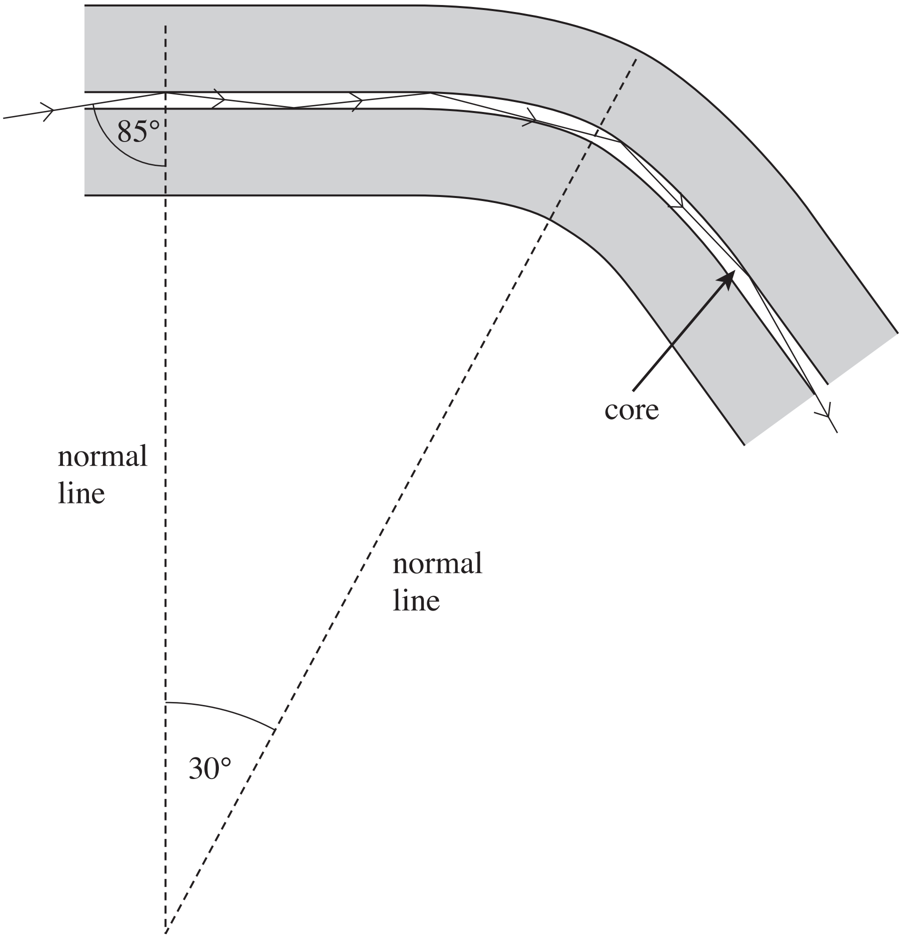
4 (b) (ii) Calculate the angle r.

answer = ...degrees
(2 marks)

Question 4 continues on the next page

4 (c) The core of another fibre is made with a smaller diameter than the first, as shown in **Figure 6**. The curvature is the same and the path of a ray of light is shown.

Figure 6



4 (c) State and explain **one** advantage associated with a smaller diameter core.

....

....

....

....

....

(2 marks)

8

5 (a) Describe an experiment to accurately determine the spring constant *k* of a spring that is thought to reach its limit of proportionality when the load is about 20 N.

Include details of the necessary measurements and calculations and describe how you would reduce uncertainty in your measurements. A space is provided for a labelled diagram should you wish to include one.

The quality of your written communication will be assessed in this question.

....

....

....

....

....

....

....

....

....

....

....

....

....

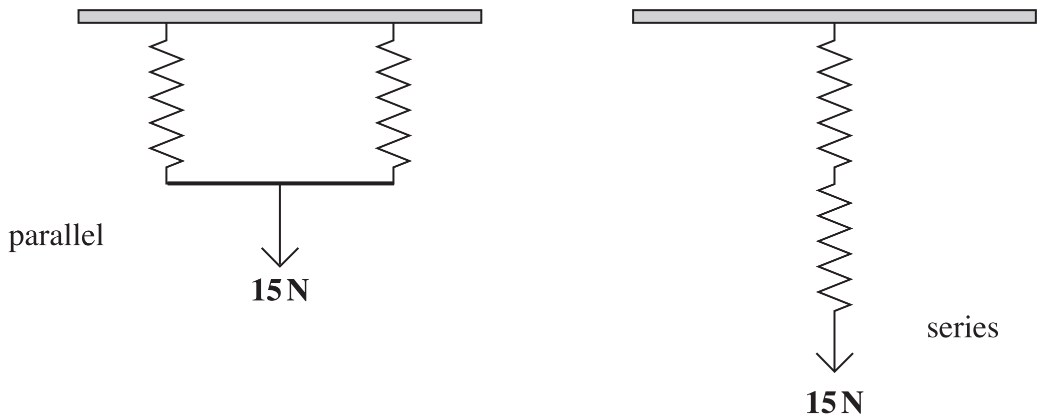
....

(6 marks)

Do not write outside the box

5 (b) Two identical springs, each having a spring constant of $85\,\mathrm{N\,m^{-1}}$, are shown arranged in parallel and series in **Figure 7**.

Figure 7



A load of 15 N is attached to each arrangement.

5 (b) (i) Calculate the extension for the parallel arrangement when the load is midway between the lower ends of the springs.

answer = ... m

(2 marks)

5 (b) (ii) Calculate the extension for the series arrangement.

answer = ... m

(2 marks)

5 (b) (iii) Calculate the energy stored in the parallel arrangement.

answer = ... J

(2 marks)

Do not write outside the box

5 (b) (iv) Without further calculation, discuss whether the energy stored in the series arrangement is less, or greater, or the same as in the parallel arrangement.

....

....

....

....

....

....

(3 marks)

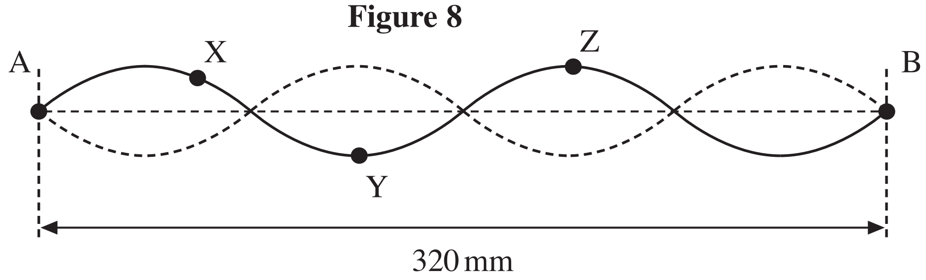
15

Turn over for the next question

6 When a note is played on a violin, the sound it produces consists of the fundamental and many overtones.

Figure 8 shows the shape of the string for a stationary wave that corresponds to one of these overtones. The positions of maximum and zero displacement for one overtone are shown. Points **A** and **B** are fixed. Points **X**, **Y** and **Z** are points on the string.

Figure 8



6 (a) (i) Describe the motion of point **X**.

....

....

....

....

(2 marks)

6 (a) (ii) State the phase relationship between

X and **Y** ....

X and **Z** ....

(2 marks)

6 (b) The frequency of this overtone is 780 Hz.

6 (b) (i) Show that the speed of a progressive wave on this string is about $125\,\mathrm{m\,s^{-1}}$

(2 marks)

Do not write outside the box

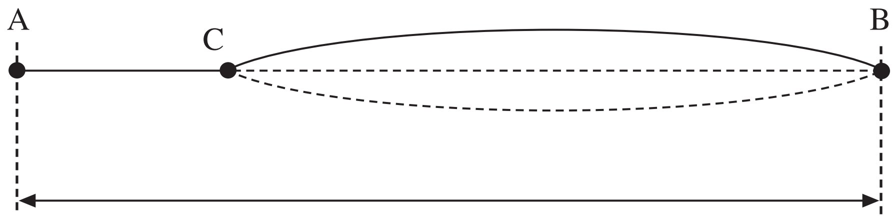
6 (b) (ii) Calculate the time taken for the string at point **Z** to move from maximum displacement back to zero displacement.

answer = ... s

(3 marks)

6 (c) The violinist presses on the string at **C** to shorten the part of the string that vibrates. **Figure 9** shows the string between **C** and **B** vibrating in its fundamental mode. The length of the whole string is 320 mm and the distance between **C** and **B** is 240 mm.

Figure 9



6 (c) (i) State the name given to the point on the wave midway between **C** and **B**.

....

(1 mark)

6 (c) (ii) Calculate the wavelength of this stationary wave.

answer = ...m

(2 marks)

Do not write outside the box

6 (c) (iii) Calculate the frequency of this fundamental mode. The speed of the progressive wave remains at $125\,m\,s^{-1}$.

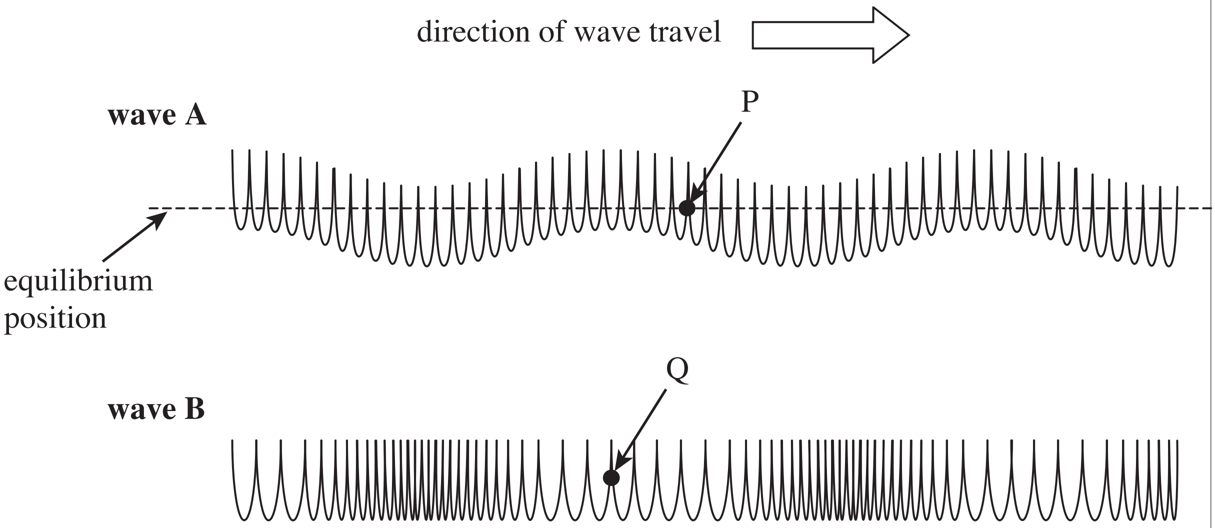
answer = ...Hz

(1 mark)

13

7 **Figure 10** shows two ways in which a wave can travel along a slinky spring.

Figure 10



7 (a) State and explain which wave is longitudinal.

....

....

(2 marks)

7 (b) On **Figure 10**,

7 (b) (i) clearly indicate and label the wavelength of **wave B**

(1 mark)

7 (b) (ii) use arrows to show the direction in which the points **P** and **Q** are about to move as each wave moves to the right.

(2 marks)

7 (c) Electromagnetic waves are similar in nature to **wave A**.

Explain why it is important to correctly align the aerial of a TV in order to receive the strongest signal.

....

....

....

....

(2 marks)

END OF QUESTIONS

7

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED