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	
8	
9	
10	
11	
12	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 2012

Physics (B):Physics in Context PHYB1

Unit 1 Harmony and Structure in the Universe

Module 1 The World of Music
Module 2 From Quarks to Quasars

Thursday 12 January 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. Use pencil only for drawing.
- 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.

Advice
- You are advised to spend about 20 minutes on **Section A** and about 55 minutes on **Section B**.

Section A

Answer **all** questions in this section.

There are 20 marks for this section.

1 (a) State **two** differences between stationary waves and progressive waves.

first difference .....

.....

.....

second difference .....

.....

.....

(2 marks)

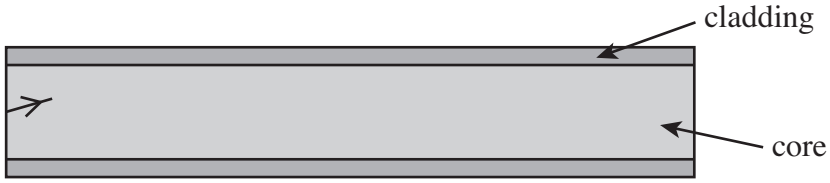
1 (b) A violin string has a length of 327 mm and produces a note of frequency 440 Hz. Calculate the frequency of the note produced when the same string is shortened or "stopped" to a length of 219 mm and the tension remains constant.

frequency ..... Hz

(2 marks)

2 **Figure 1** shows a graded-index optical fibre.

Figure 1



2 (a) Complete the path of the ray shown entering the fibre.

(1 mark)

2 (b) How does the refractive index in the fibre vary with position in the core and in the cladding of the graded-index fibre?

.....

.....

.....

.....

(2 marks)

2 (c) Explain why graded-index fibres can cope with more frequent pulses of information than ordinary fibres.

.....

.....

.....

.....

(2 marks)

Turn over for the next question

3 The table below shows the later stages in the development of the Universe.

Complete the table by filling in the missing information in the appropriate spaces.

era	time since the beginning of the Universe	processes occurring in each era
light particle era	less than 3 seconds	Hadrons formed from gluons and quarks. Isotopes of hydrogen and helium formed.
	10 000 years	Most of the Universe's energy is in the form of electromagnetic waves.
matter era	300 000 years	
galaxies formed	~10^8years	Galaxies such as Milky Way are formed.
present		Universe continues to expand and cool.

(3 marks)

4 The bombardment of protons by other particles at Stanford University in 1968 provided evidence for the existence of quarks.
Name the particles used and describe how the experiment provided the evidence.

particles .....

evidence .....

.....

.....

.....

(3 marks)

5 A Young's slits arrangement is used to view interference patterns produced by blue light and then by red light. The slit separation and the distance between the slits and the screen is the same in both cases.
In the spaces below, draw the patterns that would be observed for the blue light and red light.
The central fringe has been drawn for you in the blue light diagram.

blue light

red light

(2 marks)

6 Complete the following equation showing the β^+ decay of carbon-11.

$$^{11}_{6}\mathrm{C} \rightarrow {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{B} + {}^{\cdots\cdots}_{\cdots\cdots}\beta^+ + {}^{\cdots\cdots}_{\cdots\cdots} \cdots\cdots$$

(3 marks)

20

Turn over for the next question

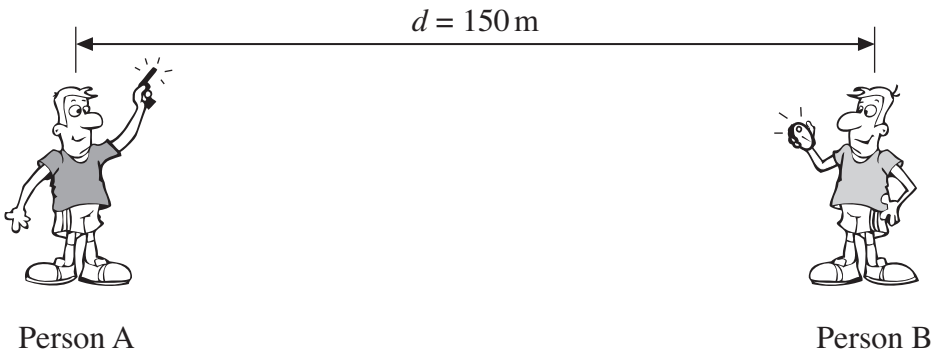
Section B

Answer **all** questions in this section.

There are 50 marks for this section.

7 The speed of sound in air may be measured by the technique illustrated in **Figure 2**.

Figure 2



7 (a) Person A fires the starting pistol. Person B starts the stopwatch when he sees the flash and stops it when he hears the sound. The distance, d, is measured with a long tape measure.

Explain why this is not a suitable method for determining an acceptable value of the speed of sound.

.....

.....

.....

.....

.....

.....

(2 marks)

7 (b) The energy released by the pistol is 500 J, of which 5.0 % is sound energy. The average power of the sound wave from a pistol is 200 W.

7 (b) (i) Calculate the duration of the explosion that produces the sound. Give your answer in ms.

duration of explosion ..... ms

(3 marks)

7 (b) (ii) Calculate the intensity of the sound heard at a distance of 150 m from the pistol. Give the appropriate SI unit for your answer.

intensity ..... unit .....

(3 marks)

8

Turn over for the next question

8 (a) (i) Describe what is meant by an analogue signal.

.....

.....

(1 mark)

8 (a) (ii) Describe what is meant by a digital signal.

.....

.....

(1 mark)

8 (b) Explain what is meant by pulse code modulation.

.....

.....

.....

.....

(2 marks)

8 (c) (i) State **one** technique for the compression of a digital signal.

.....

.....

(1 mark)

8 (c) (ii) State an advantage of using compression when storing a digital video recording.

.....

.....

(1 mark)

8 (d) State an advantage of recording music in an analogue form rather than a digital form.

.....

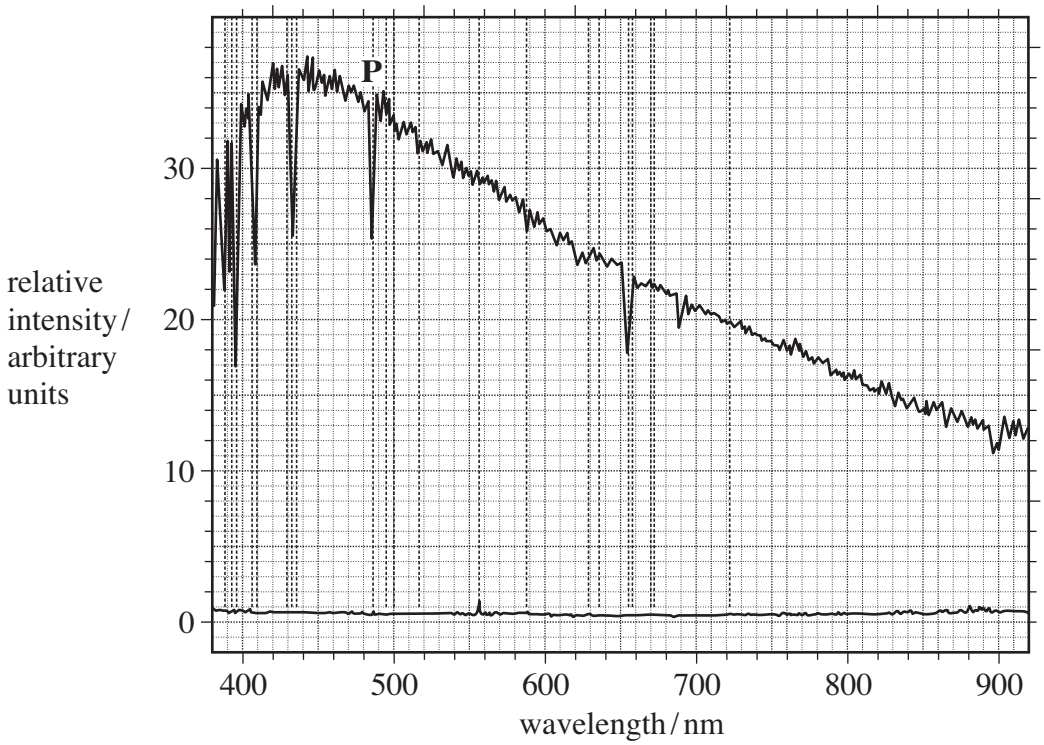
.....

(1 mark)

7

9 **Figure 3** shows the spectrum for a star as observed on Earth.

Figure 3



9 (a) (i) Determine the wavelength at which the maximum observed intensity occurs.
Give your answer in nm.

wavelength ..... nm
(1 mark)

9 (a) (ii) Calculate the surface temperature of the star.
Give the appropriate SI unit for your answer.

temperature ..... unit .....
(3 marks)

9 (b) (i) There is a sharp decrease in the intensity of the light from the star at point **P** on **Figure 3**.
Explain how this sharp decrease is caused.

.....

.....

.....

.....

.....

.....

.....

.....

(3 marks)

9 (b) (ii) Use data from the graph to calculate the energy change associated with the sharp decrease in intensity at **P**.
Give your answer in eV.

energy change ..... eV

(4 marks)

11

10 Explain what is meant by an exchange particle.
Give examples of exchange particles.
For each type of particle you name, describe the particle and state the interaction in which it is involved.

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

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6 marks)

6

Turn over for the next question

11 (a) Define a light year.

.....

(1 mark)

11 (b) A *quasar* is 2.44×10^9 light years from Earth.

11 (b) (i) State what is meant by a quasar.

.....

(1 mark)

11 (b) (ii) Show that the velocity of recession of the quasar is approximately $5 \times 10^4\,\text{km s}^{-1}$.

1 pc = 3.26 ly

H = 65 $\text{km s}^{-1}\,\text{Mpc}^{-1}$

(3 marks)

11 (c) The quasar emits light with a wavelength of 485 nm.
Calculate the wavelength of this light when it is observed on Earth.

$c = 3.00 \times 10^5\,\text{km s}^{-1}$

wavelength ..... nm

(3 marks)

11 (d) (i) What is the origin of Cosmic Microwave Background Radiation?

.....

.....

.....

(1 mark)

11 (d) (ii) Explain why Cosmic Microwave Background Radiation has a peak wavelength in the microwave region.

.....

.....

.....

.....

.....

.....

(2 marks)

11

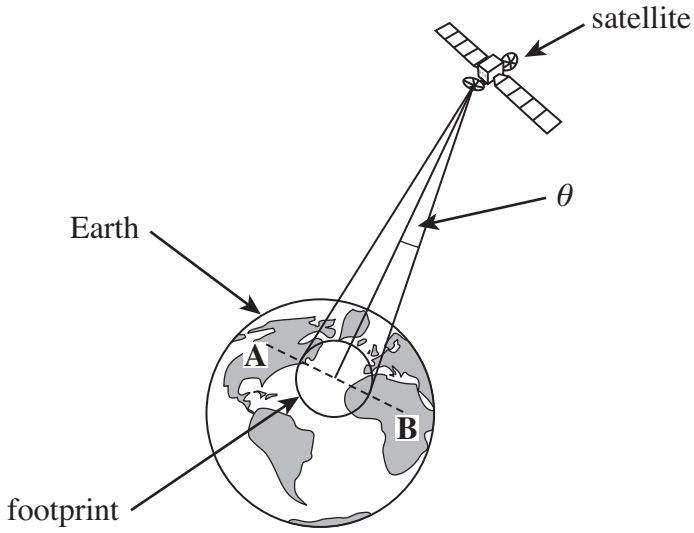
Turn over for the next question

12 (a) In the space below, draw a labelled diagram of a satellite dish.

(2 marks)

12 (b) **Figure 4** shows a communications satellite in orbit 3.6×10^7 m above the Earth's surface. It transmits waves of wavelength 2.9×10^{-2} m. The satellite's footprint has a diameter of 1200 km.

Figure 4



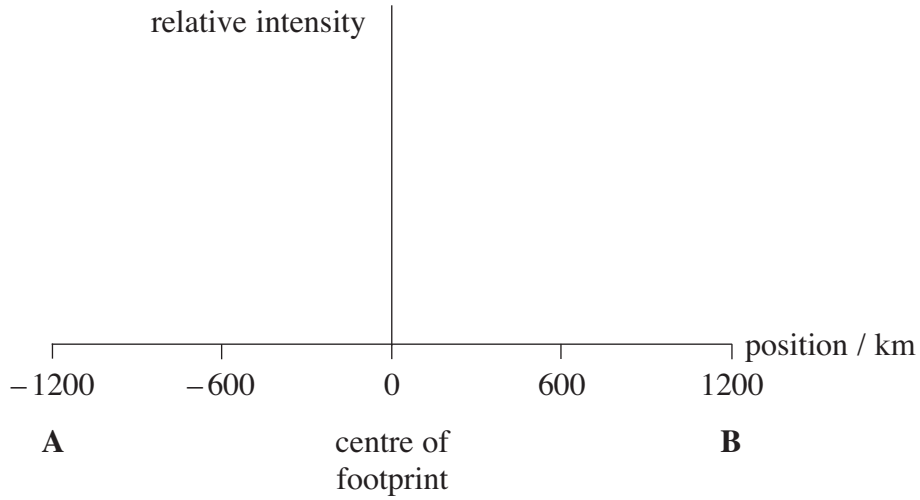
12 (b) (i) Calculate the angle, θ, shown in **Figure 4**.

(1 mark)

12 (b) (ii) Calculate the diameter of the satellite dish.

(2 marks)

12 (b) (iii) **AB** is a line across the diameter of the footprint extending 600 km beyond the footprint on either side.
On the axes below, sketch a graph showing the variation of the relative intensity of the signal received at points along the line **AB**.



(2 marks)

7

END OF QUESTIONS

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED