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	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2010

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 27 May 2010 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.

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) (i) A listener is disturbed by a noise which has an intensity level of 75 dB. State the full name of the unit dB.

.....

(1 mark)

1 (a) (ii) State how the loudness experienced by the listener would change if the noise's intensity level were to be reduced to

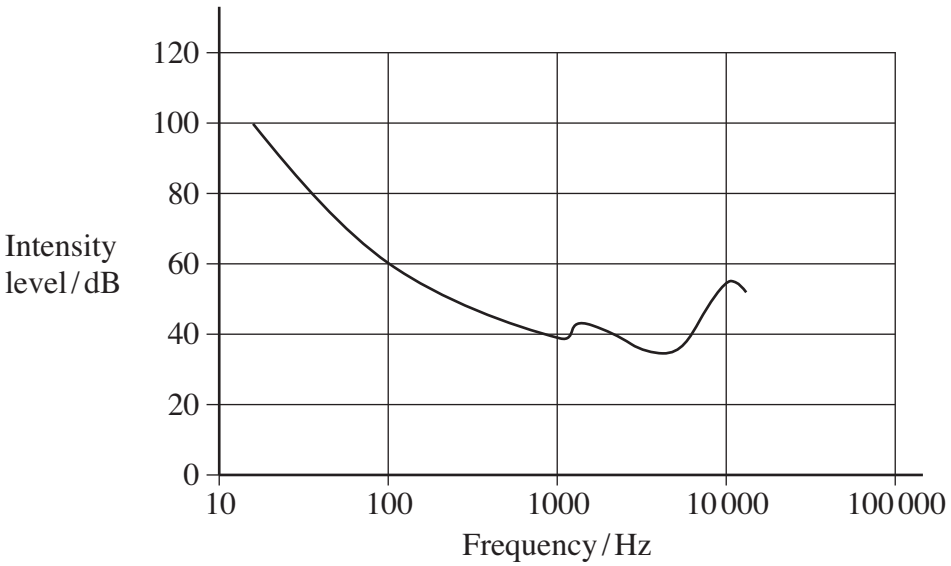
72 dB .....

66 dB .....

(2 marks)

1 (b) The graph below shows a curve of equal loudness for a young person with good hearing.

1 (b) (i) Sketch on the graph another curve for sound perceived to be of equal loudness to the original curve's sound for the same person when they are significantly older.



(2 marks)

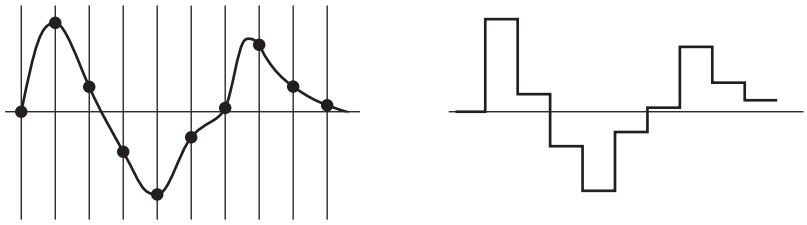
1 (b) (ii) State **one** factor, apart from age, that can cause deterioration in hearing.

.....

(1 mark)

2 (a) **Figure 1** shows an analogue signal and its conversion to a digital signal.

Figure 1



Analogue signal Digital signal

2 (a) State **two** ways in which the quality of the digital signal could be improved.

first way .....

second way .....

(2 marks)

2 (b) (i) State why compression techniques are used when transmitting data for radio or television.

.....

.....

(1 mark)

2 (b) (ii) Briefly describe **one** technique for compressing a signal.

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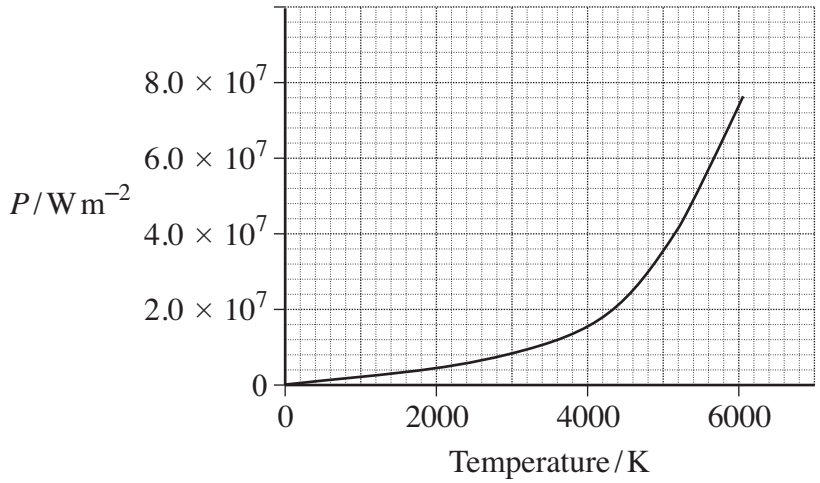
(1 mark)

Turn over for the next question

3 **Figure 2** shows how the power radiated per square metre by a black body varies with temperature.

Figure 2



A star has a radius of 8.0×10^8 m and a surface temperature of 5.2×10^3 K.
Use data from **Figure 2** to calculate the luminosity of the star.
Give your answer to an appropriate number of significant figures.

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luminosity ..... W

(4 marks)

4 **(i)** What is meant by the term *quasar*?

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(1 mark)

4 **(ii)** State **two** characteristics of a quasar.

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(2 marks)

5 **(i)** Calculate the critical angle for light travelling from water to air.

refractive index of water = 1.3

refractive index of air = 1.0

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critical angle ..... degrees

(2 marks)

5 **(ii)** Optical fibres used in communications are often *graded index* fibres.
What is meant by graded index?

.....

.....

(1 mark)

20

Turn over for the next question

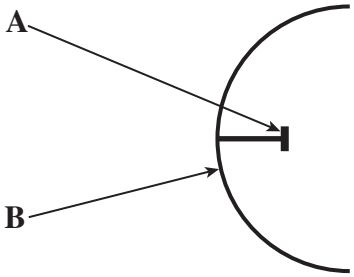
Section B

Answer **all** questions in this section.

There are 50 marks for this section.

6 **Figure 3** shows a satellite's transmission dish.

Figure 3



6 (a) Name the labelled parts of the dish.

A .....

B .....

(2 marks)

6 (b) The footprint of a geosynchronous satellite has a diameter of 1200 km. The orbital height of the satellite is 3.7×10^7 m.

6 (b) (i) Show that the diffraction angle, θ, producing this satellite's footprint is approximately 0.9°.

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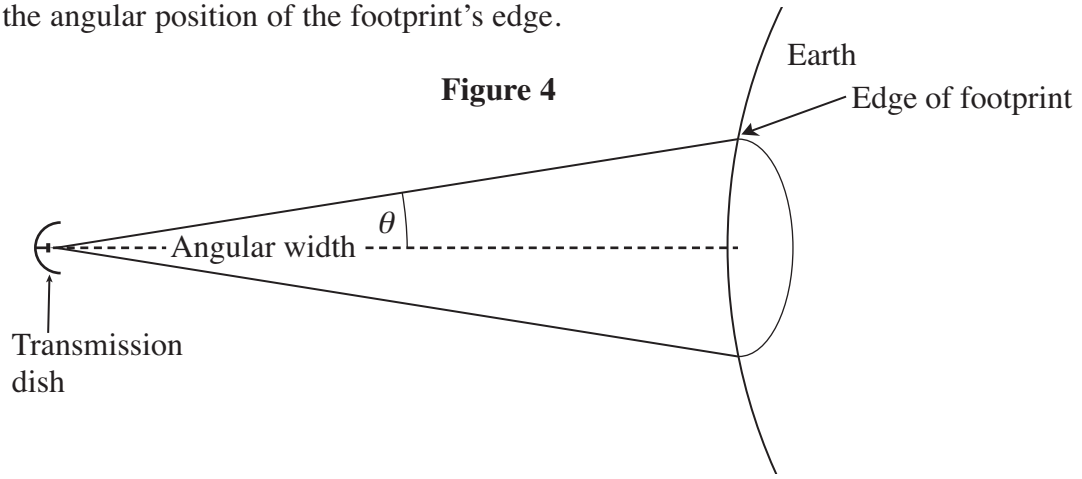
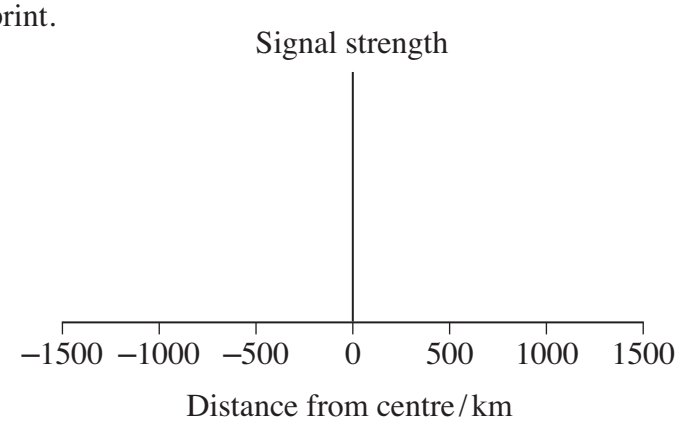
(2 marks)

6 (b) (ii) **Figure 4** shows the satellite's footprint where θ, the diffraction angle, corresponds to the angular position of the footprint's edge.

Figure 4



On the axes below, sketch the variation in signal strength with distance from the centre of the footprint.



(3 marks)

6 (b) (iii) The satellite broadcasts radio waves of wavelength 2.4×10^{-2} m.
Calculate the diameter of the transmission dish.

diameter ..... m

(3 marks)

6 (b) (iv) State **one** advantage and **one** disadvantage of increasing the diameter of the transmission dish.

Advantage .....

.....

Disadvantage .....

.....

(2 marks)

12

7 (a) (i) A piano string has a tension of 681 N. It vibrates with a fundamental frequency (first harmonic) of 92.5 Hz and has a mass per unit length of 1.87×10^{-2} kg m^{-1}.
Calculate the length of the string.

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.....

length of string ..... m

(3 marks)

7 (a) (ii) **Figure 5** shows a string stretched between fixed ends.
Draw onto **Figure 5** the first overtone (second harmonic) mode of vibration.

Figure 5

(1 mark)

7 (a) (iii) State how you could make a string on a stringed instrument vibrate in this mode of vibration.

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(2 marks)

7 (b) Describe how you would investigate the variation of the fundamental frequency (first harmonic) of a string with its length.
State which variable(s) you would need to control and how you would do so.
You may wish to assist your account by drawing a diagram.

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(4 marks)

10

8 (a) State what is seen when Brownian motion is viewed, under a microscope, using smoke in air.
Explain how the observations support the idea of the kinetic theory of gases.

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

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(6 marks)

8 (b) (i) It is not possible to observe quarks directly.
Describe how it has been shown experimentally that protons are made up of quarks.

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(2 marks)

8 (b) (ii) The equations below show the decay of a Λ^0 particle and the quark structure of the particles involved.

$$\Lambda^0 \longrightarrow \pi^- + p$$
$$sud \longrightarrow \bar{u}d + uud$$

Use the conservation of charge and baryon numbers to demonstrate that the decay is feasible.

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(2 marks)

8 (b) (iii) The equation below shows that strangeness is not conserved in the decay of a Λ^0 particle.
Comment on why the reaction can happen despite the fact that strangeness is not conserved.

$$(-1)+0+0 \longrightarrow 0+0 + 0+0$$

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(2 marks)

12

Turn over for the next question

9 (a) A hydrogen atom relaxes into its ground state of –13.6 eV. As it does so, it releases a photon of electromagnetic radiation with an energy of 10.2 eV.

9 (a) (i) Calculate the energy level of the atom before it relaxed to the ground state.

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energy level ..... eV

(1 mark)

9 (a) (ii) Show that the photon energy is approximately 1.6×10^{-18} J.

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(1 mark)

9 (a) (iii) Calculate the wavelength of the radiation emitted.

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wavelength ..... m

(3 marks)

9 (a) (iv) State the region of the electromagnetic spectrum to which this radiation belongs.

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(1 mark)

9 (b) Explain what is meant by the absorption spectrum of a star and how it gives useful information to astronomers.

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(3 marks)

9

Turn over for the next question

10 (a) Explain what is meant by red shift and why it gives evidence for the Big Bang theory.

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(3 marks)

10 (b) (i) Explain what is meant by dark matter.

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(2 marks)

10 (b) (ii) Explain why the study of dark matter is important to the understanding of the fate of the Universe.

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(2 marks)

7

END OF QUESTIONS

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