Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
A1	
A2	
A3	
A4	
A5	
B6	
B7	
B8	
B9	
B10	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
January 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

Wednesday 13 January 2010 9.00 am to 10.15 am

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. Answers written in margins or on blank pages will not be marked.
- 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.

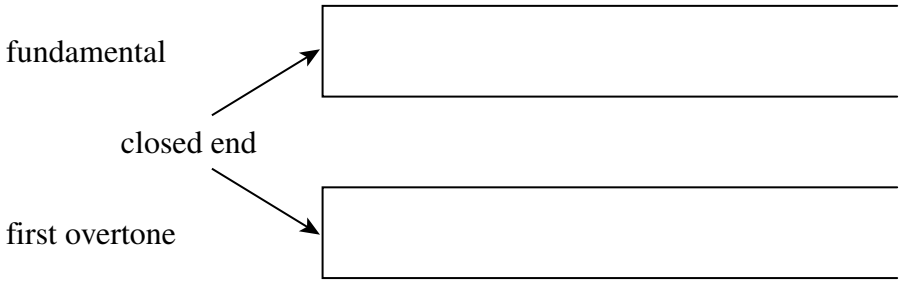
Advice
- You are advised to spend about 20 minutes on **Section A** and about 55 minutes on **Section B**.

Section A

Answer **all** questions in this section.

There are 21 marks in this section.

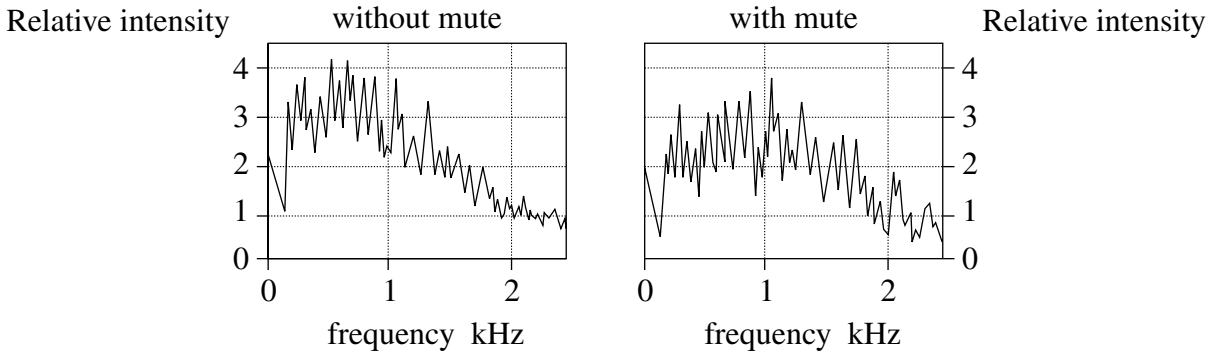
1 (a) Draw diagrams to represent the standing waves for the fundamental frequency (first harmonic), and the first overtone (third harmonic) in the pipes below.



(2 marks)

1 (b) A mute is a device that alters the sound produced by a musical instrument.
Figure 1 shows frequency spectra for two notes of equal pitch, played on the same instrument, with and without a mute.

Figure 1



State **two** ways in which the notes will sound different.
Relate each difference to the information in **Figure 1**.

first difference .....

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second difference .....

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(2 marks)

1 (c) Describe how the sound of a musical instrument can be synthesised electronically.

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(2 marks)

2 A diffraction grating has 300 lines per mm. It is illuminated with monochromatic light of wavelength 540 nm.
Calculate the angle of the 2nd order maximum, giving your answer to the appropriate number of significant figures.

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angle ..... degrees
(4 marks)

3 (a) Describe how some radio waves can travel beyond the horizon by following the Earth's curvature.

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State the name of a radio wave with a wavelength suitable for these waves.

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(2 marks)

3 (b) Describe how *sky waves* travel beyond the horizon.

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State the name of a radio wave with a wavelength suitable for sky waves.

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(2 marks)

Turn over ▶

4 (a) State the role of *exchange particles* in the creation of forces between particles.

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(1 mark)

4 (b) Complete the table below to show an exchange particle that is responsible for each of the forces mentioned.

force	**exchange particle responsible**
weak nuclear force	
strong force	
electromagnetic force	

(3 marks)

5 The most intense radiation from a star has a wavelength of 4.2×10^{-7} m.
Calculate the surface temperature of the star. Give an appropriate unit in your answer.

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temperature .....

(3 marks)

21

Please turn over for the next question

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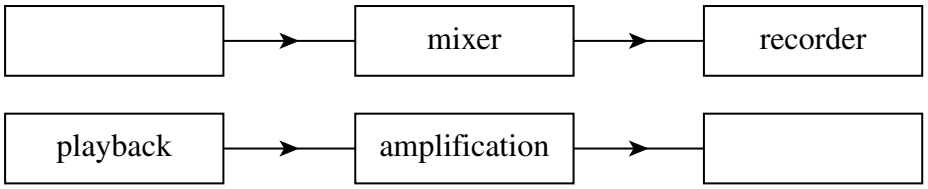
Section B

Answer **all** questions in this section.

There are 49 marks in this section.

6 (a) (i) The flow diagrams below show the principal stages for recording and playing back music.
Complete the flow diagrams.



(2 marks)

6 (a) (ii) Explain the purpose of the *mixer*.

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(1 mark)

6 (a) (iii) Explain the purpose of *amplification*.

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(1 mark)

6 (b) Describe how an analogue signal is sampled and converted to a digital signal.

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(3 marks)

6 (c) (i) An analogue signal carrying music contains frequencies up to 20 kHz. The signal is sampled for conversion into a digital signal.
Calculate the maximum time period that should be used between samples.

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time period ..... s
(2 marks)

6 (c) (ii) The analogue signal from part (c)(i) amplitude modulates a carrier signal of frequency 198 kHz.
Calculate the upper and lower limits of frequency that must be broadcast to accommodate the bandwidth.

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lower limit ..... Hz upper limit ..... kHz
(2 marks)

11

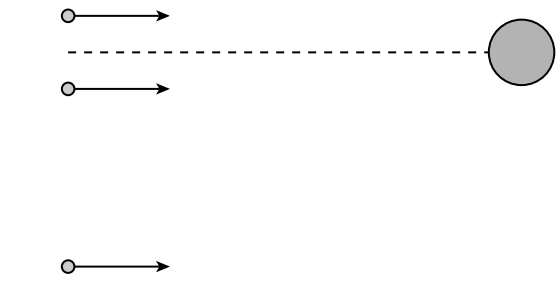
Turn over for the next question

7 (a) (i) Radium – 226 ($^{226}_{88}Ra$) can decay by alpha emission to form radon (Rn).
Write the equation for the decay, showing the proton and nucleon numbers for the alpha particle and for the radon.

(2 marks)

7 (a) (ii) **Figure 2** shows a gold nucleus with three alpha particles approaching it, as in the Rutherford alpha scattering experiment. All three alpha particles have the same initial energy.
Complete the path of each alpha particle.

Figure 2



key

alpha particle

gold nucleus

(3 marks)

7 (b) Describe the observations that were made in the alpha scattering experiment and the deductions that followed, relating to the nature of the atom.

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

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(6 marks)

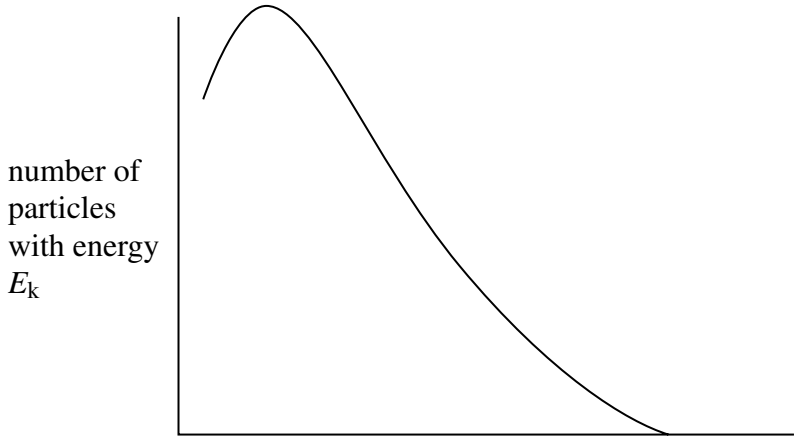
Question 7 continues on the next page

7 (c) (i) Radium – 227 ($^{227}_{88}$Ra) can decay by β^- emission to form actinium (Ac) and an antineutrino.
Write the equation for the decay, showing the proton and nucleon numbers for the beta particle, the antineutrino and for the actinium.

(3 marks)

7 (c) (ii) **Figure 3** shows a typical energy spectrum for β^- decay.

Figure 3



Explain why this graph suggests that neutrinos or antineutrinos exist.

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(2 marks)

16

8 (a) The Sun is a main sequence star and is expected to become a red giant. Describe how a main sequence star is formed.

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(3 marks)

8 (b) Describe fully what will happen in the Sun that will make it change from a main sequence star into a red giant.

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(3 marks)

6

9 (a) When illuminated with electromagnetic waves, a metal surface can exhibit the photoelectric effect. The maximum wavelength that causes the emission of photoelectrons with zero kinetic energy is 6.8×10^{-7} m.

9 (a) (i) Show that the threshold frequency for the surface is approximately 4.4×10^{14} Hz.

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(2 marks)

9 (a) (ii) Show that the work function for the surface is approximately 2.9×10^{-19} J.

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(2 marks)

9 (a) (iii) Calculate the maximum kinetic energy of electrons emitted from the surface when it is illuminated with ultraviolet radiation of frequency 7.8×10^{14} Hz.

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maximum kinetic energy ..... J

(2 marks)

9 (b) Explain why the photoelectric effect cannot be explained by the wave theory of light.

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(2 marks)

8

Turn over for the next question

10 (a) Complete the table by naming **one** example of each type of particle.

type of particle	example
lepton	
baryon	
meson	

(3 marks)

10 (b) The following reaction cannot occur.

$$\pi^+ + n \rightarrow p + \pi^-$$

10 (b) (i) State and explain which conservation law would be broken by this reaction.

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(2 marks)

10 (b) (ii) State and explain **one** conservation law that would **not** be broken in this reaction.

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(1 mark)

10 (c) Describe what happens when a proton and an antiproton collide.

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(2 marks)

END OF QUESTIONS

8

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