Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
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11	
12	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 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 17 May 2012 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. 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 in this section.

1 Distinguish between the *apparent magnitude* of a star and its *absolute magnitude*.

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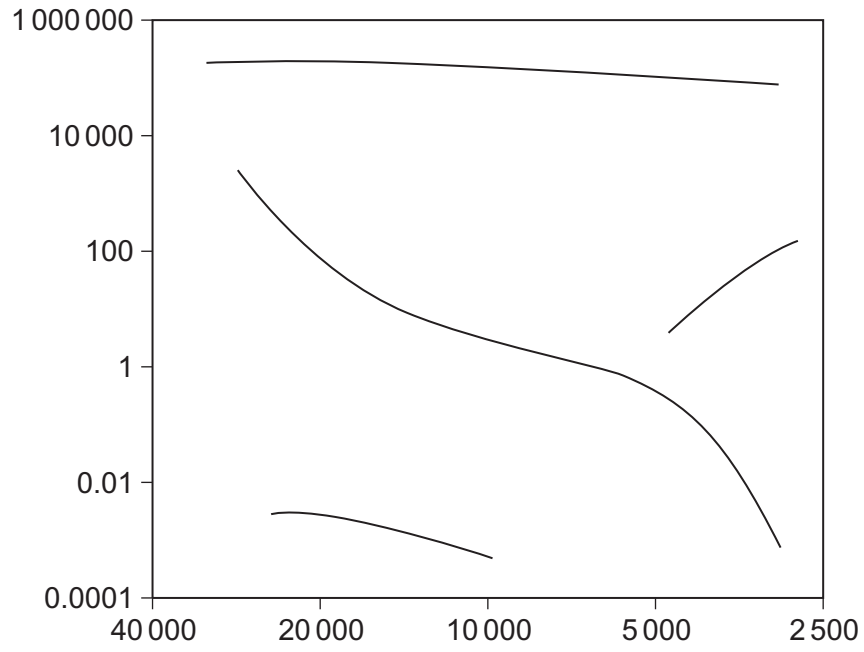
(2 marks)

2 **Figure 1** shows a Hertzsprung-Russell diagram.

Figure 1



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2 (a) Label the axes of the graph in **Figure 1** including units as appropriate.

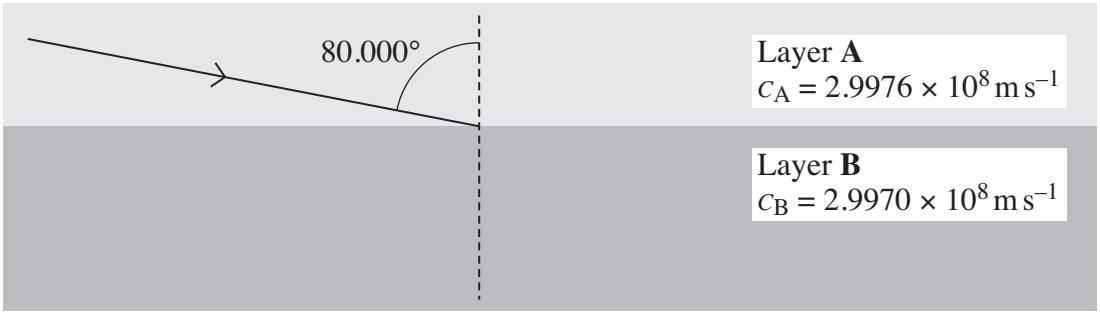
(2 marks)

2 (b) Identify, using a cross (+) and the letter **W**, the position of a white dwarf in **Figure 1**.

(1 mark)

3 In **Figure 2** a radio wave, travelling in a layer of air, **A**, is incident on the interface with another air layer, **B**. The angle of incidence is 80.000°. The speeds of radio waves in the different air layers are shown on the diagram.

Figure 2



3 (a) Calculate the angle of refraction.
Give your answer to an appropriate number of significant figures.

angle of refraction ..... degree
(3 marks)

3 (b) The range of some radio transmissions can be extended by using reflection or refraction in the ionosphere.
State an appropriate wavelength range for the transmission.

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(1 mark)

4 Explain, in terms of wave properties, why light can become polarised when reflected by a mirror but sound does not become polarised when it is reflected by a wall.

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(3 marks)

5 Complete the equation below to show the decay of a free neutron. The proton numbers, nucleon numbers and appropriate symbols of all three particles produced should be shown.

$$^{1}_{0}\text{n} \rightarrow \text{.....} + \text{.....} + \text{.....}$$

(3 marks)

6 (a) State what is produced when an electron and a positron annihilate each other.

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(1 mark)

6 (b) (i) Explain why mass is not necessarily conserved when particles interact or decay.

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(1 mark)

6 (b) (ii) Momentum is conserved in all particle interactions. Name the **three** other conservation laws that are obeyed in **all** nuclear interactions.

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(3 marks)

20

Section B

Answer **all** questions in this section.

There are **50** marks in this section.

7 A bass drum has a diameter of 0.81 m. During a performance in a concert hall, a drum roll lasts for 13 s and produces 5.5 J of sound energy.

7 (a) (i) Calculate the average intensity of the sound produced at the surface of the drum. Give your answer in $W\,m^{-2}$.

average intensity ..... $W\,m^{-2}$

(3 marks)

7 (a) (ii) Sound intensity can be assumed to follow the inverse square law. The most distant member of the audience is 80 m from the drum.
Calculate the intensity of the sound heard 80 m from the drum.

intensity ..... $W\,m^{-2}$

(2 marks)

7 (a) (iii) The person sitting 80 m from the drum experiences the sound at a level of 67 dB. A second person, sitting closer to the drum experiences the sound at a level of 76 dB. Calculate the intensity of the sound at the position of the second person.

intensity ..... $W\,m^{-2}$

(2 marks)

7 (b) Sound intensity may not vary according to the inverse square law, particularly in an enclosed building like a concert hall.
Explain why sound intensity may not be expected to vary according to the inverse square law.

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(2 marks)

8 A radio station samples music that includes frequencies up to 16 kHz for conversion into a digital signal.

8 (a) (i) Calculate the maximum time interval between samples for acceptable sound reproduction.

time interval ..... s

(2 marks)

9

8 (a) (ii) Explain why it is desirable to broadcast frequencies of up to 16 kHz when other broadcasts can operate satisfactorily with frequencies only up to 3 kHz.

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(1 mark)

8 (b) Describe the function of filters in audio systems. Your answer should refer to *high pass filters* and *low pass filters*.

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(3 marks)

8 (c) In the UK, very high frequency (VHF) transmissions use *frequency modulation*. Explain how information is transmitted using frequency modulation.

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(2 marks)

8 (d) State **one** advantage and **one** disadvantage of the use of VHF compared with lower frequency ranges.

advantage .....

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disadvantage .....

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(2 marks)

10

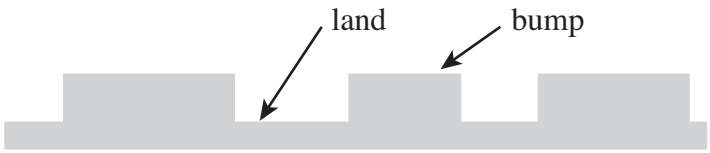
9 (a) Monochromatic light is incident normally on a diffraction grating that has 250 lines per mm. The angle between the two second order maxima is 33.2°. Calculate the wavelength of the light.

wavelength ..... m

(3 marks)

9 (b) A DVD track is a series of lands and bumps as shown in **Figure 3**. Explain how laser light is used to read data from the track.

Figure 3



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(3 marks)

6

10 Describe the structure of hadrons, giving examples of each type.
Go on to describe how the constituent particles are bound together.

The quality of your written communication will be assessed in your answer.

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(6 marks)

6

11 (a) The wave theory of light cannot adequately account for the instantaneous emission of electrons from a metal surface that is illuminated with low intensity electromagnetic radiation.
Explain why, according to the wave theory, there should be a delay in the emission of photoelectrons.

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(3 marks)

11 (b) The variation of maximum electron kinetic energy with frequency of incident radiation was investigated, using caesium as the target metal. The investigation yielded the following data.

maximum electron kinetic energy / eV	**frequency of incident radiation / 10^{14} Hz**
0.9	5.5
1.4	6.9
1.6	7.4
2.0	8.2

11 (b) (i) Explain why there can be no data for radiation below a threshold frequency.

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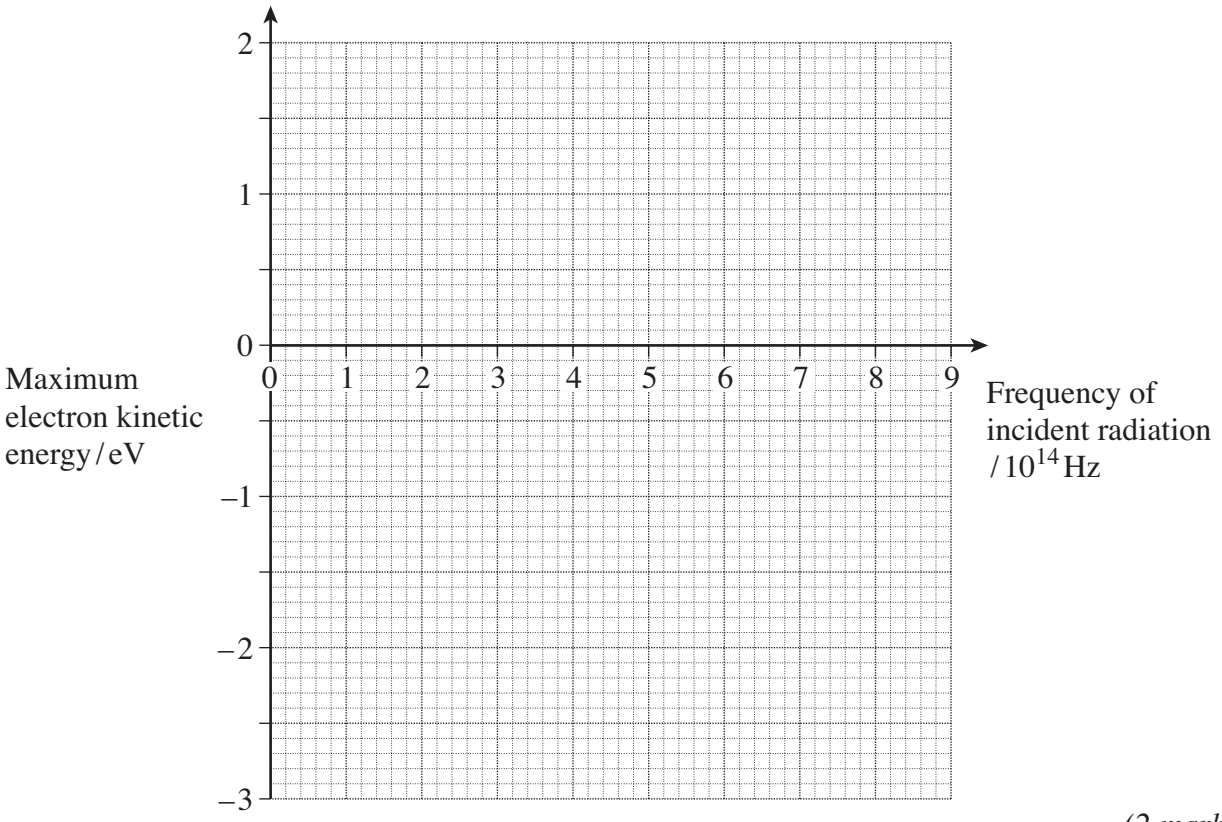
(2 marks)

11 (b) (ii) On the axes below draw a graph of the maximum electron kinetic energy (on the *y*-axis) against the frequency of the incident radiation (on the *x*-axis). Draw a best fit line through the points.



(2 marks)

11 (b) (iii) Use your graph to determine the threshold frequency for caesium.

threshold frequency ..... Hz

(1 mark)

11 (b) (iv) When the experiment was repeated using calcium instead of caesium, the maximum electron kinetic energy was found to be 0.50 eV when the surface was illuminated with radiation of frequency 8.2×10^{14} Hz.
Add this point to your graph and draw the line you would expect to see for calcium.
Label this line **C**.

(1 mark)

11 (b) (v) Use your graph to determine the work function for calcium.

work function for calcium ..... eV

(1 mark)

10

12 (a) J.J. Thompson investigated the nature of cathode rays in discharge tubes.
Suggest how he could have demonstrated that the cathode rays were negatively charged particles.

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(2 marks)

12 (b) In an experiment, electrons are incident on a thin piece of graphite. The electrons emerging from the graphite strike a fluorescent screen and produce the pattern shown in **Figure 4**.

Figure 4

12 (b) State and explain the evidence this provides about the nature of moving electrons.

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(2 marks)

12 (c) High energy electrons may be used to investigate the nature of protons of diameter 2.4×10^{-15} m.

12 (c) (i) Calculate the lowest value of the momentum of the high energy electrons that would be suitable for this investigation.
State an appropriate unit for your answer.

momentum ..... unit .....

(3 marks)

12 (c) (ii) Calculate the kinetic energy of the electrons.

kinetic energy ..... J

(2 marks)

9

END OF QUESTIONS

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