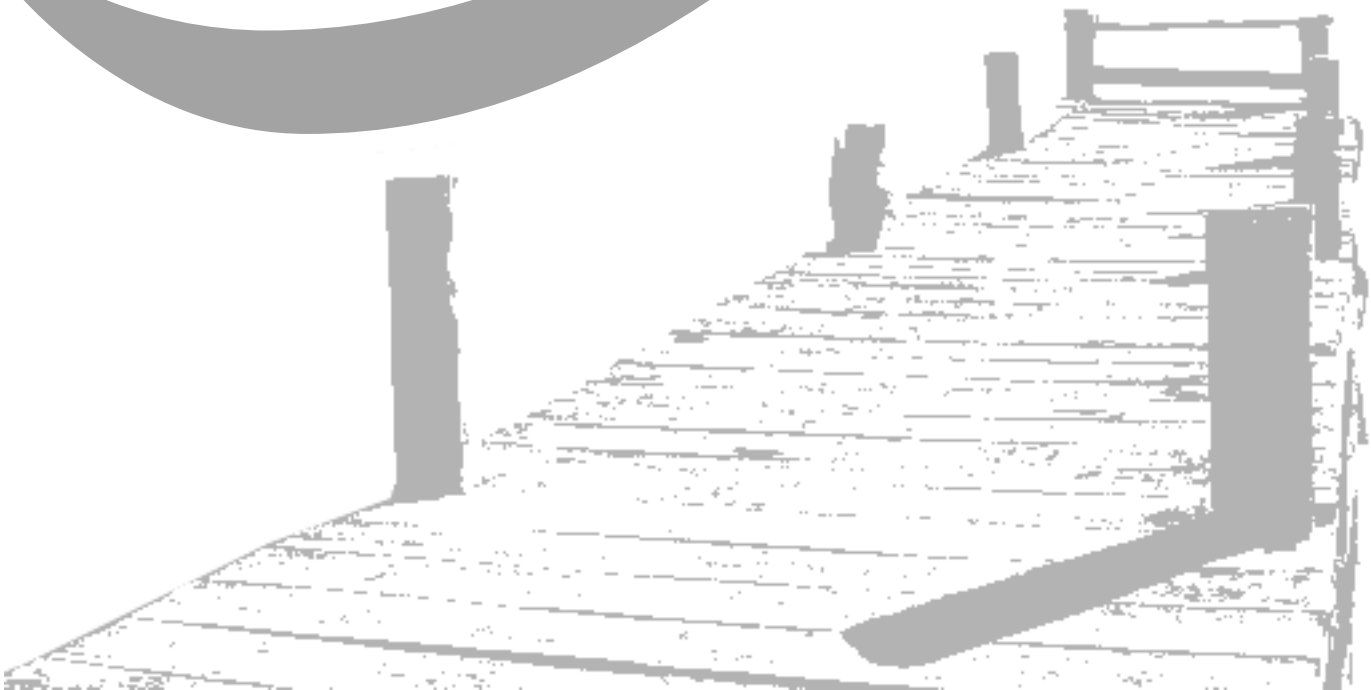
GCE
AS and A Level

# Physics B: Physics In Context

AS exams 2009 onwards
A2 exams 2010 onwards

## Unit 1: Approved specimen question paper

Version 1.1



| Surname | | Other Names | |
|---|---|---|---|
| Centre Number | | | Candidate Number | | | | |
| Candidate Signature | | | | | | | | | |

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General Certificate of Education
2009
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

**version 1.1**

# PHYSICS IN CONTEXT PHYB1
## Unit 1 Harmony and Structure in the Universe:

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

SPECIMEN PAPER

Time allowed: 1 ¼ hours

**Instructions**
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- A *Formulae and Data Booklet* is provided as a loose insert.

**Information**
- The maximum mark for this paper is 70.
- The marks for the questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers. You will be assessed on your quality of written communication where indicated in the question.

| For Examiner's Use | | | |
|---|---|---|---|
| Number | Mark | Number | Mark |
| 1 | | 6 | |
| 2 | | 7 | |
| 3 | | 8 | |
| 4 | | 9 | |
| 5 | | 10 | |
| Total (Column 1) | | | |
| Total (Column 2) | | | |
| TOTAL | | | |
| Examiner's Initials | | | |

**Section A**. There are 20 marks in this section.
Answer **all** questions in the spaces provided.

**1** (a) Name the event which cosmic microwave background radiation provides evidence to support.

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*(1 mark)*

(b) *When we observe the night sky it is like viewing the history of the Universe*.

What might this sentence mean?

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*(2 marks)*

**2** The intensity of a sound is $1.9 \times 10^{-8}$ W m$^{-2}$ at a distance of 0.25 km from the source. Calculate the intensity of the sound at a distance of 0.75 km from the source.

Intensity of sound ..... W m $^{-2}$

*(3 marks)*

**3** Leptons, mesons and baryons are three classes of sub-atomic particles.

(a) Some classes of particles are fundamental; others are not. Circle the correct category for each of these three classes.

| | |
|---|---|
| Leptons | fundamental/not fundamental |
| Mesons | fundamental/not fundamental |
| Baryons | fundamental/not fundamental |

*(1 mark)*

(b) Name the class of particles of which the proton is a member.

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*(1 mark)*

(c) By referring to the charges on up and down quarks, explain how the proton has a charge of + 1*e*.

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*(2 marks)*

**4** (a) What do the abbreviations FM and AM refer to in relation to radio transmission?

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*(2 marks)*

(b) Explain the importance of a carrier wave in radio transmission.

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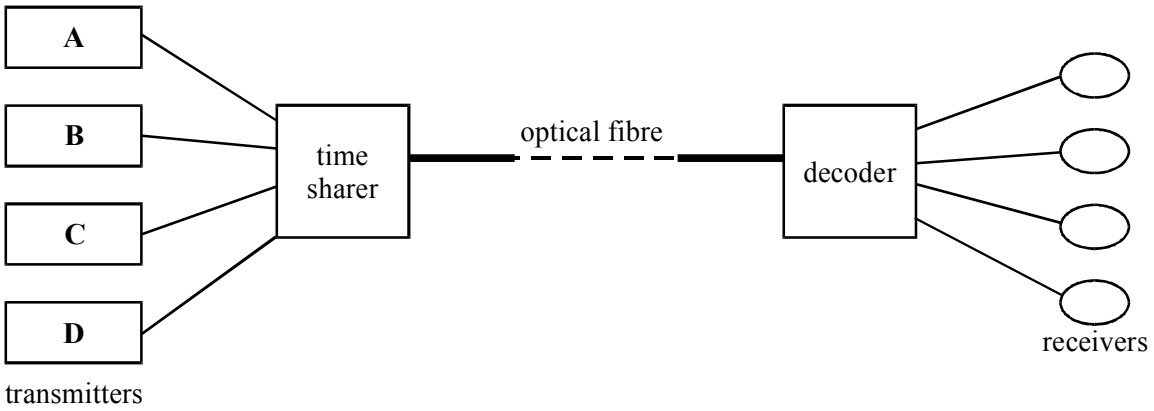
*(2 marks)*

**5** The diagram below shows four radio stations **A**, **B**, **C** and **D** that are producing analogue signals with frequencies up to a maximum of 20 kHz. After sampling, the signals are being transmitted as digital signals down a single optical fibre.




(a) State the base bandwidth needed for each station.

*(1 mark)*

(b) A single optical fibre can transmit $1.5 \times 10^8$ bits per second. Calculate the number of ratio stations transmitting signals up to 20 kHz that could be transmitted using the single fibre. Each time a signal is sampled 8 bits have to be sent down the fibre.

Number of radio stations.....

*(2 marks)*

(c) Explain how a compression technique such as MP3 could be used to benefit the transmission and storing of music files.

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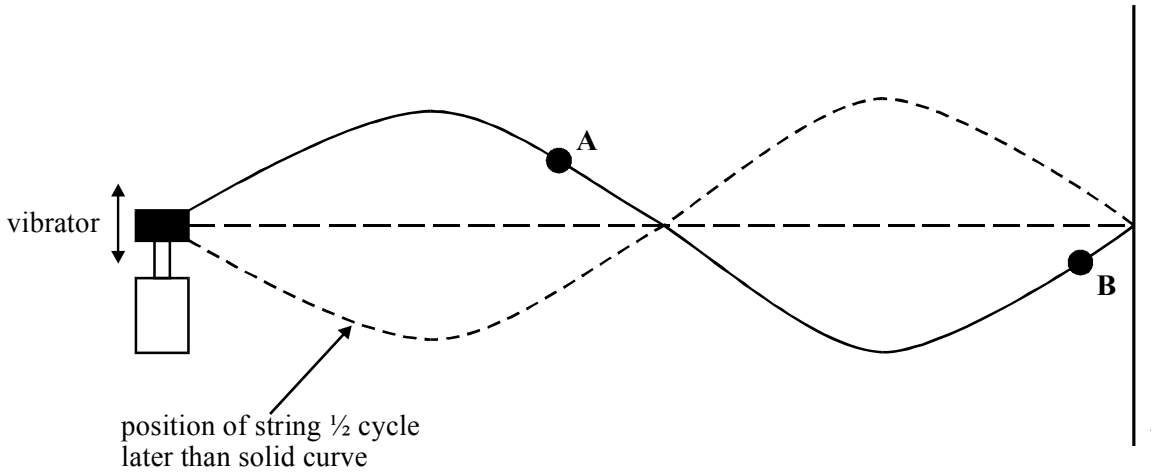
*(3 marks)*

**Section A Total 20 Marks**

**Section B**. There are 50 marks in this section.
Answer **all** questions in the spaces provided.

**6** In testing a particular type of guitar string, a string is stretched and vibrated for a long period of time using a mechanical vibrator as shown in **Figure 1**. The right-hand end of the string is fixed. A stationary wave is produced on the string; the string vibrates in two loops.

**Figure 1**




(a) State the conditions that are necessary for a stationary wave to form on the string.

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*(3 marks)*

(b) Explain how you know that the wave on the string is transverse.

……

*(1 mark)*

(c) Compare the *amplitude and phase* of the oscillations of points **A** and **B** on the string.

*Amplitude* ……

*Phase* ……..

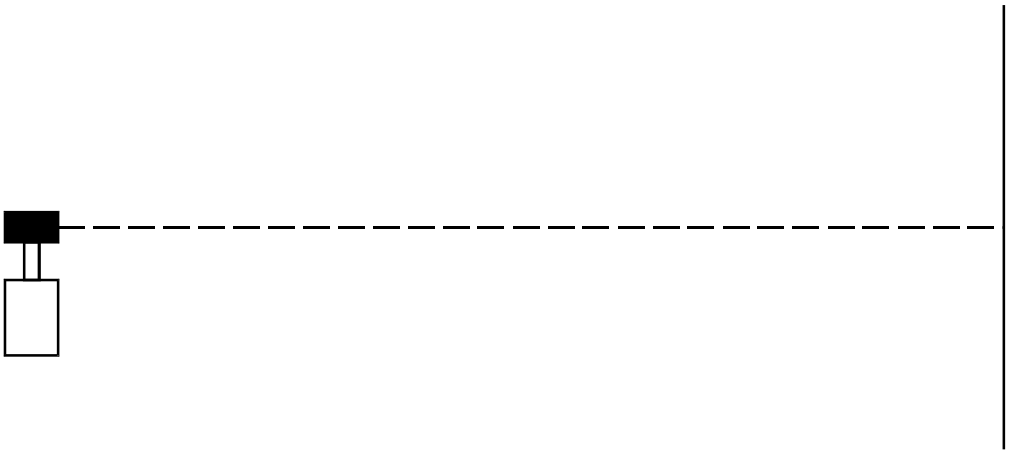
*(2 marks)*

(d) The length of the string is 1.2 m and the speed of the transverse wave on the string is 6.2 m $s^{-1}$.
Calculate the vibration frequency of the vibrator in Hz.

Vibration frequency .....Hz
*(3 marks)*

(e) (i) The frequency of the vibrator is tripled.
Sketch the new shape of the stationary wave on **Figure 2**.

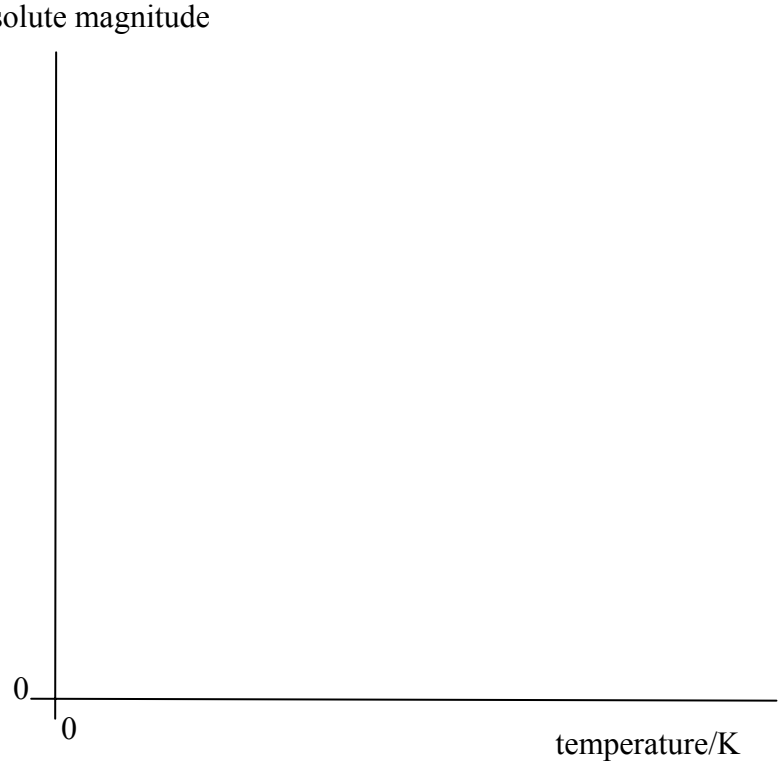
**Figure 2**



(ii) Show on your diagram three points P, Q and R that oscillate in phase.
*(2 marks)*

**Total 11 marks**

**7** (a) Sketch a Hertzsprung-Russell diagram on the axes below. Label the maximum and minimum values of both the absolute magnitude and temperature on the axes. Also label the positions of the main sequence, dwarf and giant stars.




*(4 marks)*

(b) The spectral class of four stars is given in the table.

| star | spectral class |
|---|---|
| Alnitak | O |
| Sirius | A |
| Sun | G |
| Antares | M |

The spectrum of each star contains absorption lines. State what produces the main absorption line in each case.

Alnitak ……..

……

Sirius ……..

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Sun …….

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Antares ……

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*(2 marks)*

(c) Antares and Alnitak have similar absolute magnitudes. State and explain which of the two has the larger diameter.

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*(3 marks)*

**Total 9 marks**

**8** (a) A motorcycle engine emits sound with a frequency of 3500 Hz. The motorcycle is moving towards an observer with a speed of 15 m $s^{-1}$. The speed of sound in air is 330 m $s^{-1}$. Calculate the approximate frequency of the sound heard by the observer. Assume that the speed of the motorcycle is very much less than the speed of sound in air.

*(3 marks)*

(b) Explain how the red shift of light observed by astronomers is useful to them. State what is observed and explain the deductions that can be made from these observations.

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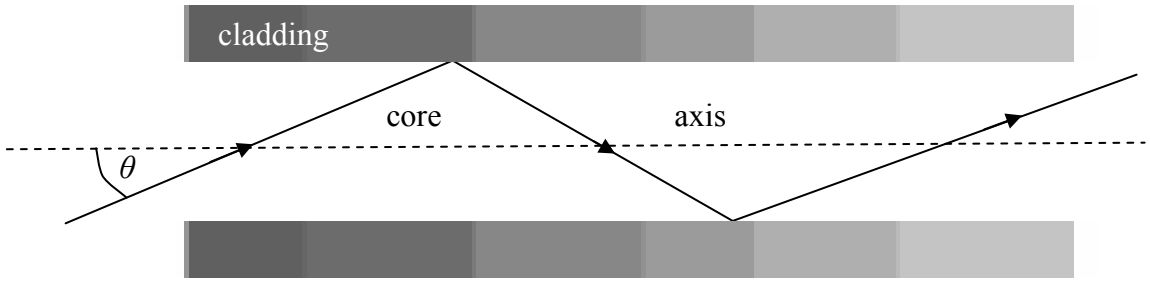
*(4 marks)*

**Total 7 marks**

**9** **Figure 3** represents a section of a step-index optical fibre used for the transmission of a series of digital light pulses.

**Figure 3**




(a) Explain why it is necessary for there to be a difference between the refractive indices of the core and the cladding.

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*(3 marks)*

(b) The angle of acceptance, $\theta$, is the maximum angle, measured from the axis of the core, at which the core of the fibre will contain the ray by total internal reflection. The formula for this is:

$$\sin\theta = \sqrt{n_0^{\,2} - n_c^{\,2}}$$

where, $n_0$ is the refractive index of the core and $n_c$ is the refractive index of the cladding.

(i) Show that the angle of acceptance for a core of refractive index 1.48 and a cladding of refractive index 1.47 is about 10º.

$\theta$ = ……º

(ii) Explain whether it is advantageous to have a larger or smaller angle of acceptance.

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*(5 marks)*

(c) Explain the advantages of using a *graded index optical* fibre when carrying multiple signals which enter the fibre at different angles.

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*(3 marks)*

**Total 11 marks**

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**10** (a) Explain what is meant by the *ultraviolet catastrophe* and how this breakdown of classical physics along with difficulties in explaining both the photoelectric effect and interference ultimately led to the wave-particle duality of light.
The quality of your written answer will be assessed in this question.

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*(6 marks)*

(b) (i) Calculate the longest wavelength of electromagnetic radiation that will cause photoelectric emission at a clean lithium surface.

work function for lithium $\varphi = 4.6 \times 10^{-19}$ J

Longest wavelength =…….m

(ii) Calculate maximum kinetic energy of the electrons emitted when electromagnetic radiation of frequency $8.5 \times 10^{14}$ Hz is incident on the surface.

Maximum energy = ……J

*(6 marks)*

**Total 12 marks**

**Section B Total 50 marks**