Candidate Name	Centre Number	Candidate Number

WJEC CBAC

GCE AS/A level

1322/01

PHYSICS
ASSESSMENT UNIT PH2: WAVES AND PARTICLES

A.M. WEDNESDAY, 9 June 2010

1½ hours

ADDITIONAL MATERIALS

In addition to this paper, you will require a calculator and a **Data Booklet**.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

For Examiner's use only.		
1.	12	
2.	11	
3.	12	
4.	11	
5.	12	
6.	12	
7.	10	
Total	80	

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INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 80.

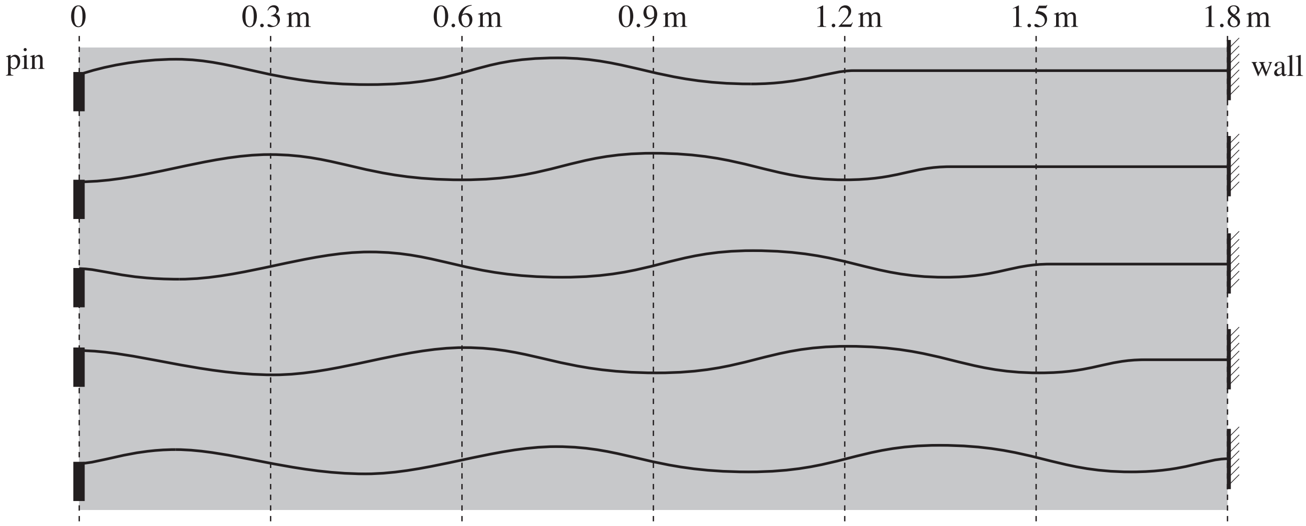
The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all working. Credit is given for correct working even when the final answer is incorrect.

Examiner only

1. A piece of string 1.8 m long is attached at one end to the pin of a vibration generator and, at the other end, to a rigid wall. The diagrams show the string at intervals of 0.0030 s, starting from shortly after the generator has been connected to the signal generator (so the wave has not yet reached the wall).



(a) Calculate

(i) the *speed* of the waves, [2]

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(ii) the *frequency*. [3]

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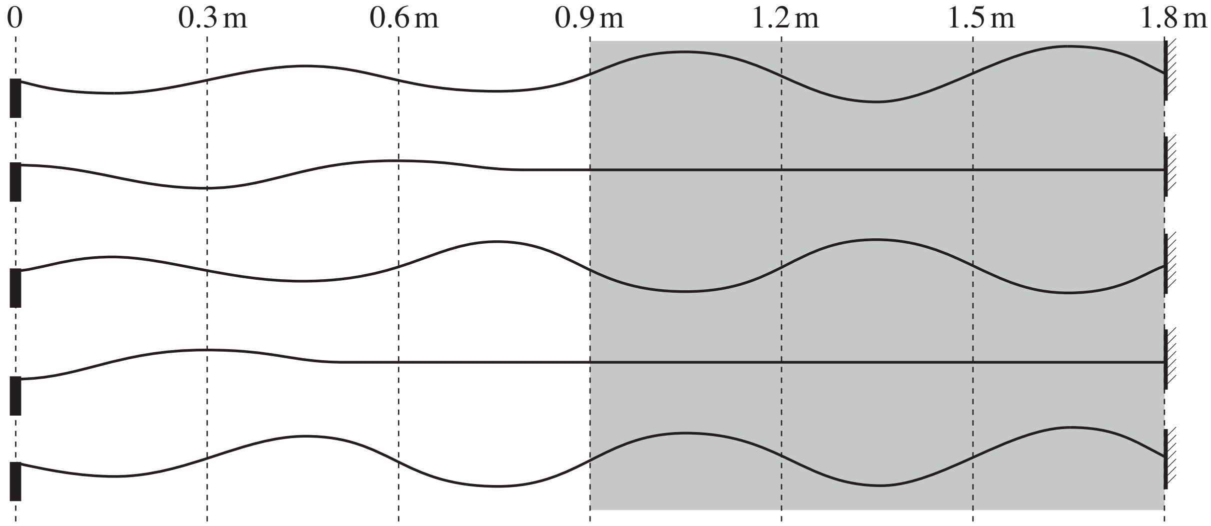
(b) Later on a *stationary wave* develops. **Refer to the shaded area below.**



(i) Write down two distances from the generator at which there are *nodes.* [1]

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(ii) (I) Describe how the *amplitude* of the stationary wave varies with distance along the string. [2]

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(II) Explain whether or not the same description applies to the amplitude of the *progressive* wave (see previous page). [1]

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(c) Explain in terms of *interference* how the stationary wave is formed and, in particular, how *nodes* arise. [3]

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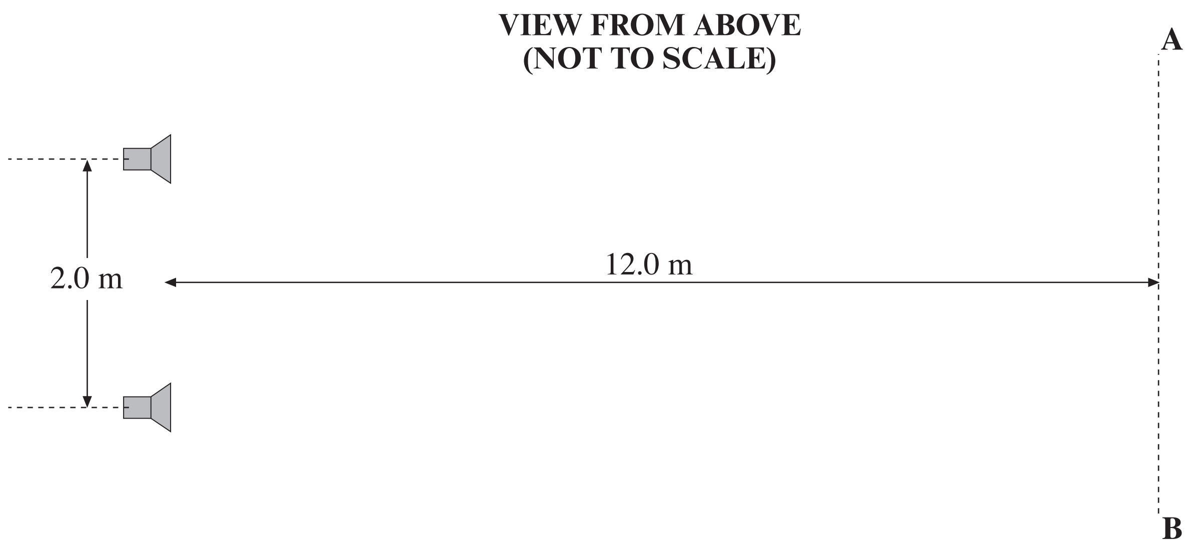
2. Two loudspeakers are placed 2.0 m apart, and facing the same way, in the middle of a playing field, on a calm day. They are connected to the same signal generator, and therefore produce sound of the same frequency.



(a) A student walks slowly along the line **AB**, and hears the sound varying regularly in loudness as he walks. The positions where the sound is loudest are 1.8 m apart.

(i) Use the *Young's fringes* formula to calculate the wavelength of the sound. [2]

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(ii) Suggest why the results would be less reliable if the experiment were performed in a hall, that is surrounded by walls. [1]

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(b) The student now stops at a point where the sound is quietest. The teacher then disconnects **one** of the loudspeakers. The student now hears a louder sound. Explain why the sound is louder. Your answer should mention *phase*. [3]

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(c) The disconnected loudspeaker is reconnected, but with the wires to its terminals swapped over, so that the loudspeakers are now sound sources in *antiphase* (exactly out of phase). What difference will be observed by the student if he repeats the walk of part *(a)*? [1]

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(d) State, giving your reasoning, how the separation between points of quietest sound along AB would change if

(i) the separation of the loudspeakers were doubled (to 4.0 m), [2]

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(ii) the signal generator were adjusted so that the ***frequency*** of sound emitted by the loudspeakers were doubled. [The loudspeaker separation is restored to 2.0 m] [2]

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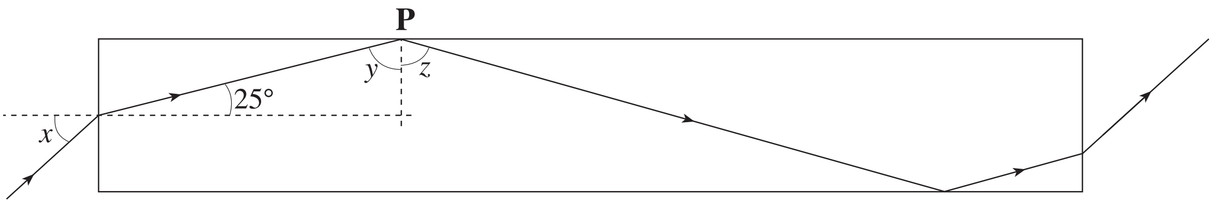
3. A student directs a narrow beam of light on to one end of a glass block, as shown.



(a) (i) Referring to the diagram, calculate the angle of incidence, *x*. [Refractive index of air = 1.00; refractive index of the glass = 1.52.] [3]

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(ii) Calculate the angle *y*. [1]

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(iii) Show that light does not refract into the air at point **P**. [2]

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(iv) (I) The light changes its direction of travel at point **P**. What is the full name for the process involved? [1]

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(II) How does the size of angle *z* compare with the size of angle *y*? [1]

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(b) (i) A glass fibre used for the transmission of data consists of a central glass *core* with a *cladding* of glass of lower refractive index. Suggest one advantage of having a glass cladding rather than simply an air surround. [1]

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(ii) What can be said about the diameter of a *monomode fibre*? [2]

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(iii) Why is such a fibre called *monomode*? [1]

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Examiner only

4. *(a)* (i) What is the *photoelectric effect?* [2]

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(ii) Give an account of the photoelectric effect in terms of photons, electrons and energy, explaining how it leads to *Einstein's photoelectric equation.* [4]

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(b) (i) A zinc surface of work function 4.97×10^{-19} J is irradiated with two frequencies of electromagnetic radiation in turn. For each frequency, show whether or not electrons are emitted from the surface, and if they are emitted, calculate their maximum kinetic energy.

(I) 7.99×10^{14} Hz [2]

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(II) 6.74×10^{14} Hz [1]

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(ii) What would be the maximum kinetic energy of the electrons emitted if the surface were irradiated with both frequencies at once? Explain your reasoning. [2]

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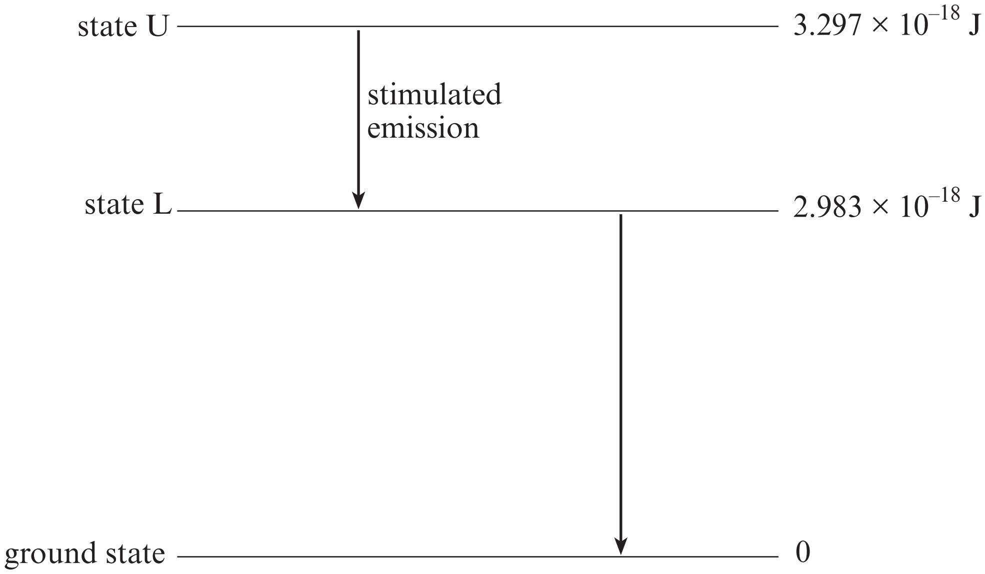
5. In the helium-neon laser, excited helium atoms collide with neon atoms and transfer energy to them. This raises neon atoms from the ground state to the excited *metastable* state, U (see diagram).



Photons are emitted by stimulated emission involving an electron transition between state U and state L.

(a) (i) Calculate the fraction

$$\frac{\text{photon energy}}{\text{energy used to excite atom to level U}}.$$ [2]

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(ii) Calculate the wavelength of the light emitted. [2]

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(b) (i) What causes a stimulated emission event to occur? [2]

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(ii) Describe carefully, in terms of photons, the outcome of such an event. [2]

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Examiner only

(iii) An electron stays in level L for only a very short time, spontaneously dropping to the ground state. Explain why this feature is important to the operation of a laser. [2]

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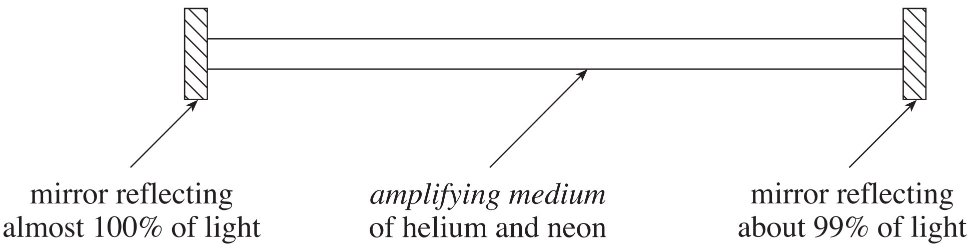
(iv) The mixture of helium and neon is contained in a long cavity with mirrors, as shown in the simplified diagram.



How does this cavity design promote laser operation? [2]

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Turn over.

6. *(a)* In this question, stars may be assumed to radiate as *black bodies*. Define a *black body*. [1]

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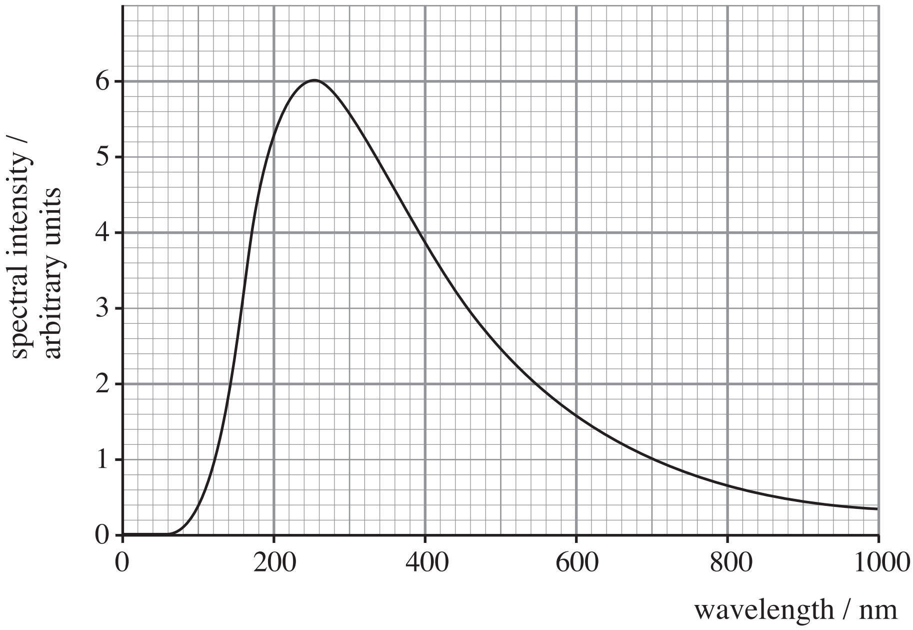
(b) The diagram shows the spectrum of *Rigel* (one of the brightest stars in the night sky).



Show that the surface temperature of Rigel is 10 000 K to one significant figure. [3]

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(c) The *power* emitted by Rigel is found to be 2.53×10^{31} W.

(i) Use Stefan's law to calculate the effective surface area of Rigel. [3]

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(ii) The **radius** of the **Sun** is 6.96×10^8 m. Supporting your explanation with a calculation, explain why Rigel is called a *giant* star. [2]

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(iii) Referring again to the spectrum given in part *(b)*, discuss whether or not Rigel should be classed as a *red* giant. [3]

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QUESTION 7 IS ON PAGE 12

7. When two protons are accelerated to high kinetic energies and collide with each other, the following reaction may occur. [x is an 'unknown' particle.]

$$p + p \longrightarrow p + x + \pi^+$$

(a) The charge on a proton (p) is +*e*.

(i) What is the magnitude of the charge on the π^+ (a pion or π meson) ? [1]

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(ii) Deduce the charge of particle x. [1]

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(b) The π^+ is classed as a *meson*. How is the p classed? [1]

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(c) In the reaction, u quark number and d quark number are each conserved. [$\bar{u}$ is assigned u quark number -1 and $\bar{d}$ is assigned d quark number -1.]

Giving your reasoning, determine the quark make-up of particle x, and hence identify this particle. [4]

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(d) Explain how *lepton* conservation applies in this reaction. [1]

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(e) Discuss which of the forces, *weak, strong*, or *electromagnetic*, is likely to be responsible for the reaction. [2]

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