Surname	Centre Number	Candidate Number
Other Names		

GCE A level

1324/01

PHYSICS

ASSESSMENT UNIT PH4: OSCILLATIONS AND FIELDS

P.M. MONDAY, 11 June 2012

1½ hours

1324
010001

ADDITIONAL MATERIALS

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

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

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.	12	
3.	11	
4.	10	
5.	11	
6.	13	
7.	11	
Total	80	

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 given is incorrect.

Examiner only

1. *(a)* The first law of thermodynamics may be written $\Delta U = Q - W$.

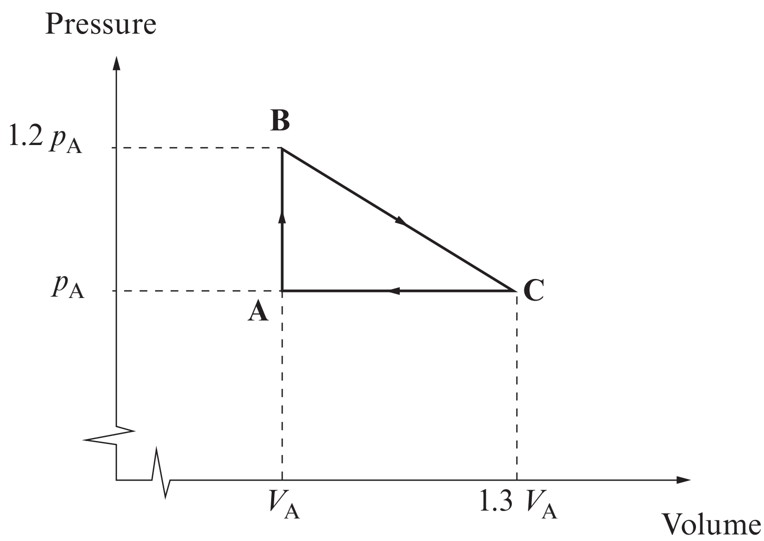
Explain carefully the terms

(i) ΔU .... [1]

(ii) Q .... [1]

(iii) W .... [1]

(b) A sealed container with a leak-proof piston at one end contains 0.40 mole of an ideal gas. The gas is taken around a cycle (**ABCA**).
The pressure and volume of the gas are shown on the graph where $p_A = 1.01 \times 10^5$ Pa and $V_A = 1.00 \times 10^{-2}$ m^3.



Calculate the temperature at point **C**. [2]

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Examiner only

(c) Determine the work done (if any) along the following paths, indicating clearly if it is done **on** or **by** the gas. [4]

(i) **CA**

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(ii) **AB**

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(iii) **BC**

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(d) Determine the total heat transferred if the gas is taken around the cycle **three** times, stating clearly whether it flows in or out of the gas. [3]

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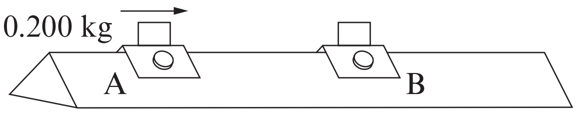
2. *(a)* In a laboratory experiment two gliders A and B lie on a linear air track (friction-free). Glider A, of mass 0.200 kg, is accelerated from rest by a force of 3.00 N acting for 0.150 s.

Before collision



(i) Show that the velocity of glider A after acceleration is 2.25 m s^{-1} to the right. [1]

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(ii) Glider A then collides with a stationary glider B. They stick together and move with a velocity of 1.20 m s^{-1} to the right.
Show that the mass of glider B is 0.175 kg. [2]

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(iii) A second demonstration is used to show an elastic collision. The initial conditions for the acceleration of glider A are exactly the same as in part (i). If the velocities of gliders A and B after the collision are 0.15 m s^{-1} and 2.40 m s^{-1} respectively to the right, show that the collision is elastic. [3]

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Examiner only

(b) A scientist investigates the possibility of using a **totally reflecting** solar sail to power a small spacecraft. Sunlight of typical wavelength 500 nm and intensity 1500 W m^{-2} falls on a sail of area 100 m^2.

(i) Calculate the energy of a photon of wavelength 500 nm. [2]

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(ii) Determine the number of photons arriving at the sail each second. [1]

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(iii) Calculate the force exerted by the sunlight on this totally reflecting sail. [3]

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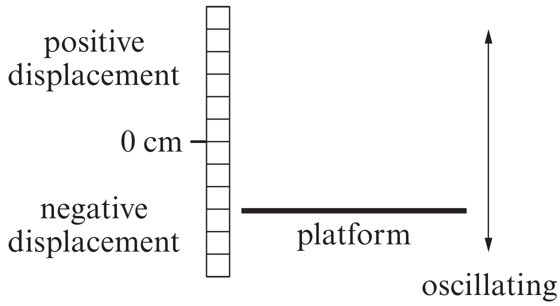
3. A horizontal platform oscillates vertically with simple harmonic motion around a central position with a period 0.40 s and amplitude 5.0 cm.



(a) Define simple harmonic motion. [2]

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(b) Determine

(i) the maximum velocity of the platform; [2]

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(ii) the maximum acceleration of the platform. [2]

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Examiner only

(c) The platform is at its lowest position at time $t = 0$.
The displacement x of the platform at later times is given by the equation:

$$x = A \sin(\omega t + \varepsilon)$$

Rewrite the equation giving correct numerical values for A, ω and ε. [3]

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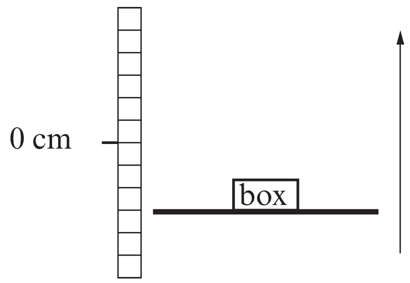
(d)



A small box is carefully placed on the platform when it is at its lowest position. Before the platform reaches its highest position, the box loses contact. Find the displacement at which contact is lost. [2]

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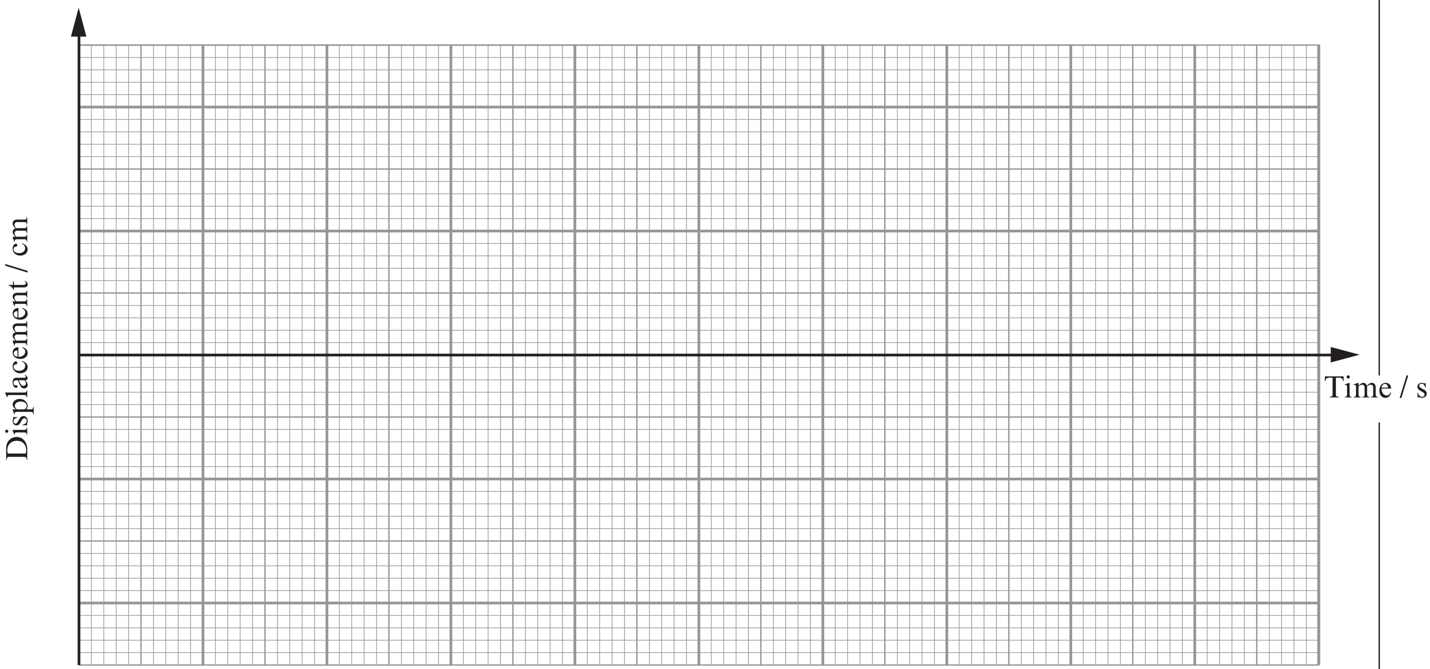
Examiner only

4. *(a)* In a laboratory experiment, a load of mass *m* is supported in equilibrium at the lower end of a spring. The load is raised 2.0 cm from its equilibrium position, and is then released from rest so that it oscillates vertically with a period of 0.50 s. The amplitude then decreases to 1.0 cm after 5 oscillations.

(i) Sketch a displacement–time graph for these 5 oscillations. [3]



(ii) Suggest a cause for the observed damping. [1]

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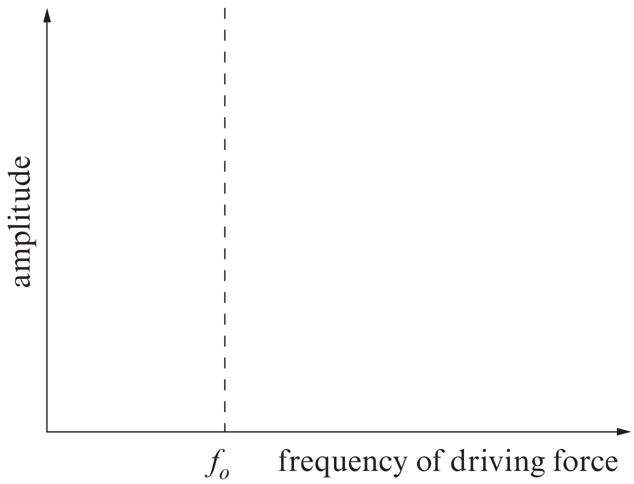
Examiner only

(b) A driving force of frequency f is now applied to the top end of the spring. The frequency of the driver can be varied from zero to a frequency well beyond the natural frequency f_o of the spring system.

(i) Sketch the variation of the amplitude of the motion of the load with the frequency of the driving force on the axes below. Label the curve as A. [1]



(ii) If the damping on the system is increased slightly, sketch the variation of the amplitude with frequency on the same axes. Label this curve as B. [1]

(iii) Explain what is meant by *resonance*. [1]

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(iv) Give a practical example of resonance. Identify the driving force of the system and the responding oscillator. [3]

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Examiner only

5. A canister of volume 0.025 m^3 contains helium gas at a pressure of 3.04×10^5 Pa and a temperature of 280 K. (Relative molecular mass of helium = 4.0)

(a) Calculate:

(i) the number of moles of the gas in the canister; [1]

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(ii) the number of helium molecules in the canister; [1]

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(iii) the density of the gas; [2]

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(iv) the rms speed of the helium molecules. [2]

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Examiner only

(b) The product of the pressure and volume of an ideal gas may be expressed as

$$pV = nRT.$$

The product may also be written in terms of the mean square speed of the molecules as

$$pV = \frac{1}{3}Nm\overline{c^2}.$$

(i) Derive in clear steps a formula that shows how the internal energy of the ideal gas depends on the temperature of the gas. [4]

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(ii) Calculate the internal energy of the helium gas in the canister. [1]

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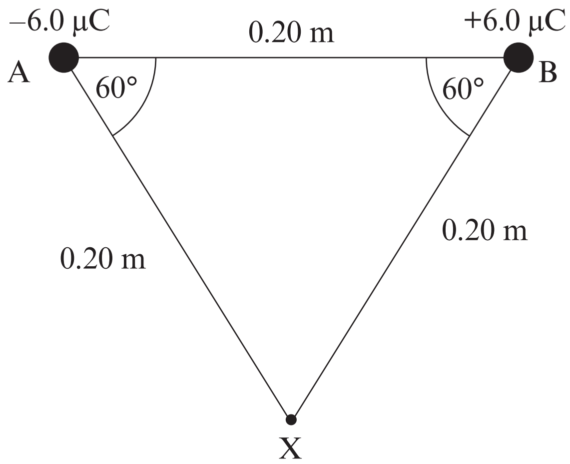
Examiner only

6. Two point charges of –6.0 μC and +6.0 μC are arranged at points A and B respectively as in the diagram. Point X lies as shown, with ABX being an equilateral triangle.



(a) Indicate clearly on the diagram the directions of

(i) the electric field at X due to the charge at A (label it E_A), [1]

(ii) the electric field at X due to the charge at B (label it E_B), [1]

(iii) the resultant (net) electric field at X due to the charges at A and B (label it E_R). [1]

(b) Calculate the magnitude of the resultant electric field at X, showing your working clearly. [3]

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Examiner only

(c) Point Y is at a distance 0.40 m to the right of B.

(i) Determine the electric potential at Y. [3]

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(ii) Calculate the work required to bring a small charge of +2.0 μC from a distant point to Y. [2]

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(iii) The small charge has a mass of $5{\cdot}0 \times 10^{-3}$ kg. If it is released from rest at point Y, determine its speed when it returns to a distant point. [2]

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7.

	Mean radius of planetary orbit / m	Orbital period / year
Earth	149.6×10^9	1.00
Jupiter	778.6×10^9	11.86

(a) State Kepler's three laws of planetary motion. [3]

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(b) Show that the data above are consistent with Kepler's third law. [3]

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(c) Explain what is meant by centripetal acceleration. [1]

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(d) Calculate the mass of the Sun. [4]

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THERE ARE NO MORE QUESTIONS IN THE EXAMINATION