Surname	Centre Number	Candidate Number
Other Names		2

GCE A level

1324/01

S16-1324-01

PHYSICS – PH4
Oscillations and Fields

A.M. MONDAY, 20 June 2016

1 hour 30 minutes

1324
010001

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**13**	
2.	**12**	
3.	**9**	
4.	**11**	
5.	**11**	
6.	**10**	
7.	**14**	
Total	**80**	

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.

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.

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Answer **all** *questions*.

1. *(a)* State:

(i) Newton's second law of motion; [2]

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(ii) the principle of conservation of momentum. [2]

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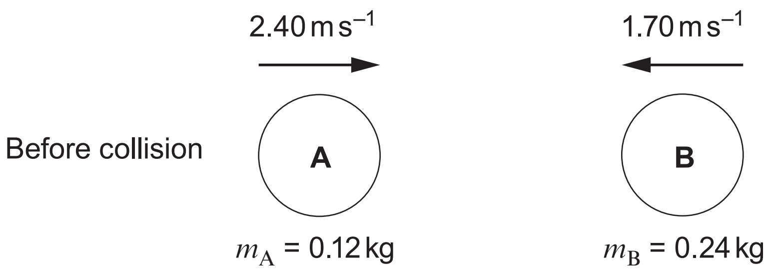
(b) Two discs **A** and **B** of masses $m_A = 0.12\,\text{kg}$ and $m_B = 0.24\,\text{kg}$ on a frictionless horizontal surface slide directly towards each other and collide head-on. Before the collision the speed of disc **A** is $2.40\,\text{m}\,\text{s}^{-1}$ and the speed of disc **B** is $1.70\,\text{m}\,\text{s}^{-1}$.



(i) After the collision the direction of disc **A** is reversed. Its speed is $2.24\,\text{m}\,\text{s}^{-1}$. Determine the speed of disc **B** after collision. [3]

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(ii) Calculate the total kinetic energy lost during the collision. [3]

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(iii) The collision duration is 0.30 s. Calculate the mean force on disc **A and** state its direction. [3]

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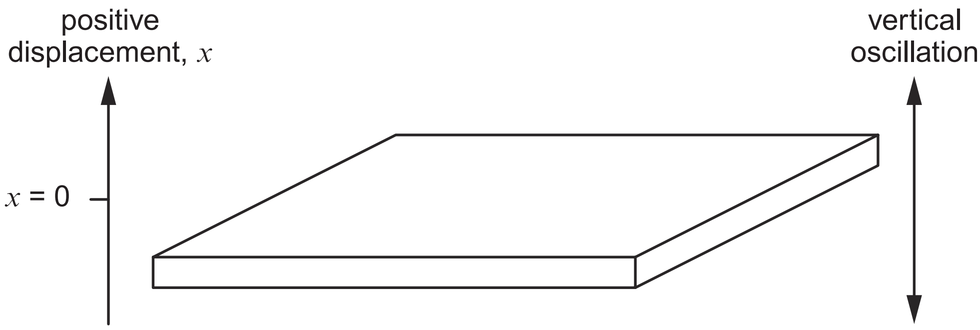
2. A horizontal platform oscillates vertically with Simple Harmonic Motion (shm).



(a) The amplitude, A, of oscillation is 0.030 m. The frequency, f, is 0.50 Hz. State what is meant by:

(i) amplitude, A; [1]

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(ii) frequency, f. [1]

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(b) Taking the platform to be at the centre of oscillation ($x = 0$) when time, $t = 0$ calculate:

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

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(ii) the velocity of the platform at a displacement of $x = + 0.020$ m; [3]

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

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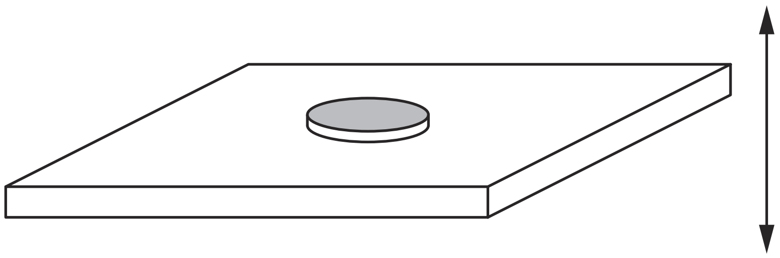
(c) In an experiment a small coin is placed on the platform.



The platform now oscillates at a frequency of 1.00 Hz. The frequency of oscillation is then increased in equal steps of 0.50 Hz, keeping the amplitude constant at 0.030 m. Determine the **lowest** frequency at which the coin loses contact with the platform. Explain your reasoning clearly. [3]

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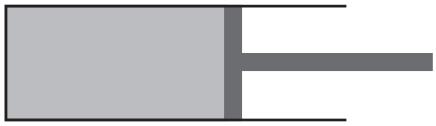
3. Helium gas is contained in a closed cylinder with a leak-proof moveable piston at one end. Initially the volume is $1.2 \times 10^{-3}\,\text{m}^3$, the pressure is 3.0×10^5 Pa and the temperature is 275 K. (Relative molecular mass of helium = 4.0.)



(a) (i) Calculate the mass of the gas in the cylinder. [2]

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(ii) Calculate the rms speed of the molecules. [2]

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(b) The volume of the gas is increased to $1.8 \times 10^{-3}\,\text{m}^3$ at constant pressure. Calculate:

(i) the work done by the gas; [2]

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(ii) the heat supplied to the gas. [3]

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4. A metal saucepan of mass 0.9 kg contains 1.6 kg of water at a temperature of 92 °C. The water and saucepan are in thermal equilibrium, and the saucepan-water system is **isolated from its surroundings**.

(a) Explain what is meant by thermal equilibrium. [2]

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(b) Vegetables of mass 1.1 kg and temperature 17 °C are placed in the water, and the system is left to reach thermal equilibrium once again. Describe in terms of heat flows how thermal equilibrium is reached between the saucepan, water and vegetables. *(Calculations are not required.)* [3]

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(c) Calculate the final temperature of the saucepan, water and vegetables given the specific heat capacities below. [4]

	Specific heat capacity / $J\,kg^{-1}\,°C^{-1}$
Water	4 200
Saucepan	500
Vegetables	3 500

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(d) Explain what will happen to the final temperature if the system is not completely isolated from the surroundings. [2]

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5. The mass of the Moon is 7.34×10^{22} kg and its mean radius is 1.74×10^{6} m.

(a) Calculate the gravitational field strength at the surface of the Moon. [2]

(b) A mass, m, is fired vertically from the surface of the Moon at a speed of $400\,\mathrm{m\,s^{-1}}$. Show that the greatest height above the surface reached by the mass is 51 km. (Hint: use the conservation of energy and $V_g = \frac{-GM}{r}$) [4]

(c) In many applications an approximate value for the height reached by an object is obtained by neglecting the variation in the gravitational field strength with height. Determine the value for the height reached by the object in part *(b)* assuming a gravitational field strength equal to that at the surface of the Moon. [2]

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(d) Hence determine the difference in the heights obtained in parts *(b)* and *(c)* as a percentage of the height given in part *(b)*. [2]

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(e) Discuss whether the use of the approximation in part *(c)* is appropriate in this case. [1]

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6. A small sphere has a charge $q = +\ 1.11 \times 10^{-6}\,\text{C}$.

(a) How many electrons have been removed from the sphere? [2]

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(b) On the grids below sketch curves between distances 0.5 m and 2.0 m from the centre of the sphere for:

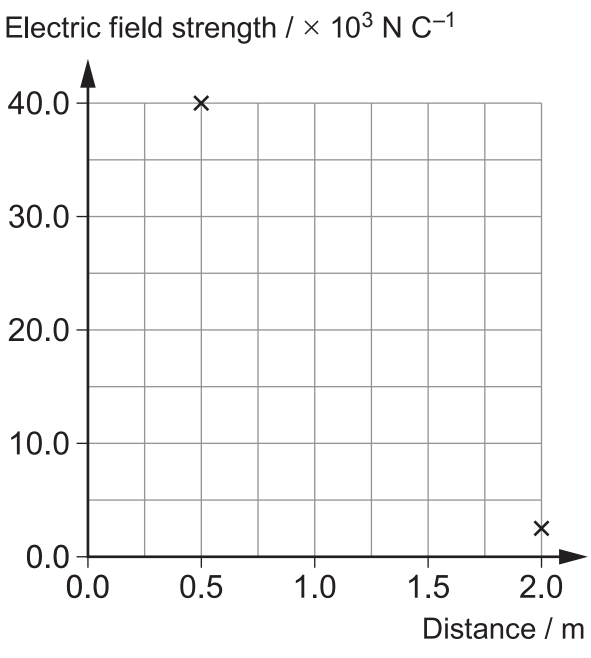
(i) the electric field strength (first grid);

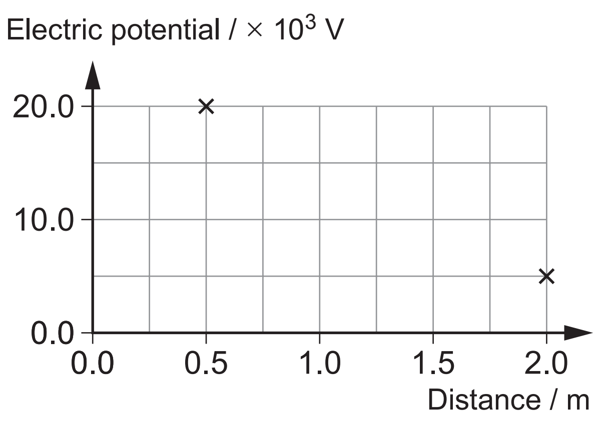
(ii) the electric potential (second grid).

The points at 0.5 m and 2.0 m are already shown. [3]

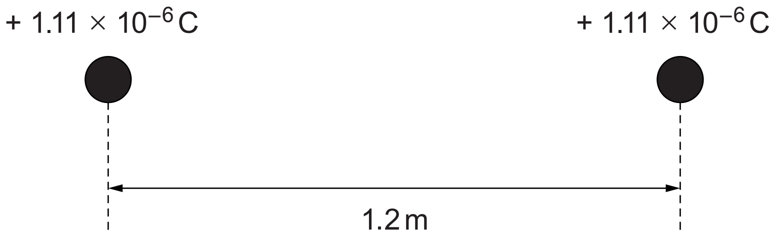
You may wish to use the approximation: $\dfrac{1}{4\pi\varepsilon_0} = 9.0 \times 10^{9}\,\text{F}^{-1}\,\text{m}$.

Space for calculations if needed:





(c) (i) A second identical sphere also has a charge of + 1.11×10^{-6} C. It is brought from a distant point to a distance 1.2 m from the first sphere. Determine the work required to do this. [2]



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(ii) Determine the magnitude of the electric field strength at the point between the two spheres that is 0.7 m from the left-hand side sphere. Show the direction of the field at this point. [3]

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7. A star and its companion planet are in mutual orbit about a common centre of mass. The observed spectrum of the star reveals an orbital speed of $56.0\,\text{m}\,\text{s}^{-1}$ and an orbital period of 4.23 day.

(a) Describe how the spectrum was used to determine the orbital speed **and** orbital period. [4]

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(b) Calculate the distance between the star and the planet given that the mass of the star is $2.21 \times 10^{30}\,\text{kg}$. Assume that the mass of the planet is very much smaller than the mass of the star. [5]

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(c) Calculate the distance of the star from the centre of mass of the system. [2]

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(d) Use your answers in parts *(b)* and *(c)* to determine the mass of the planet. [3]

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END OF PAPER