Candidate Name	Centre Number	Candidate Number

GCE A level

1324/01 **New A2**

PHYSICS

PH4: OSCILLATIONS AND FIELDS

P.M. THURSDAY, 28 January 2010

1½ hours

W10 1324 01   1

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**7**	
3.	**7**	
4.	**13**	
5.	**11**	
6.	**11**	
7.	**4**	
8.	**13**	
Total	**80**	

ADDITIONAL MATERIALS

In addition to this examination 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.

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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1. *(a)* Define simple harmonic motion. [2]

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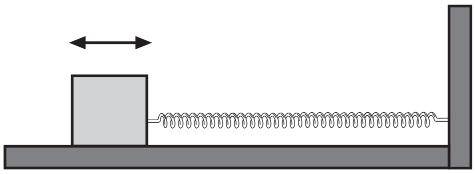
(b) (i) A mass on the end of a light spring performs simple harmonic motion. The stiffness k of the spring is $28{\cdot}5\,\text{N}\text{m}^{-1}$ and the period of oscillation is $0{\cdot}42\,\text{s}$. Calculate the mass. [3]



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(ii) Show that ω, the angular frequency of the oscillation is approximately $15\ \text{rad s}^{-1}$. [1]

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(c) The amplitude of oscillation is 1·30 cm. Calculate

(i) The maximum speed of oscillation. [2]

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(ii) The maximum acceleration. [2]

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(d) The time of oscillation starts when the mass is passing the equilibrium position moving to the right. The position x of the mass at time t is then given by

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

(i) At what time will the acceleration of the mass **first** be of maximum magnitude? [1]

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(ii) Calculate a time when the acceleration of the mass is $2{\cdot}10\,\mathrm{m\,s^{-2}}$ to the left. [3]

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Turn over.

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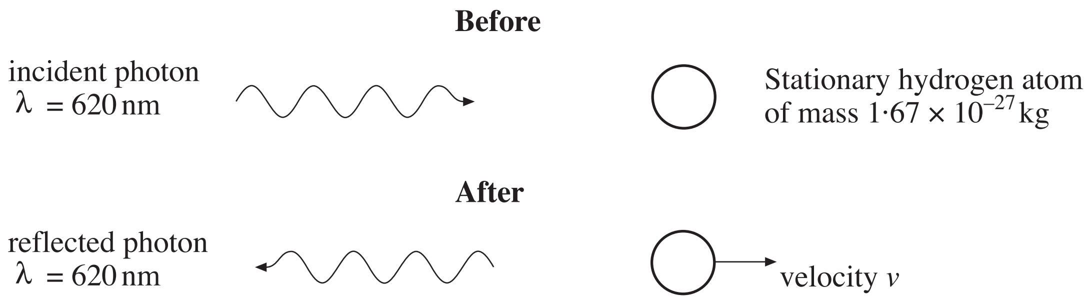
2. A photon of red light of wavelength 620 nm is incident upon a stationary hydrogen atom of mass $1{\cdot}67 \times 10^{-27}$ kg. It then rebounds in the opposite direction with approximately the same wavelength (within 2 significant figures).



(a) Show that the momentum of the incident photon is approximately $1{\cdot}1 \times 10^{-27}\,\mathrm{kg\,m\,s^{-1}}$. [1]

(b) Use the principle of conservation of momentum to calculate the speed of the hydrogen atom after the collision with the photon. [3]

(c) (i) Explain briefly how the above collision seems inconsistent with the principle of conservation of energy. [2]

(ii) If the wavelength information were given to a greater precision, state how the wavelengths of the incident and reflected photons would compare. [1]

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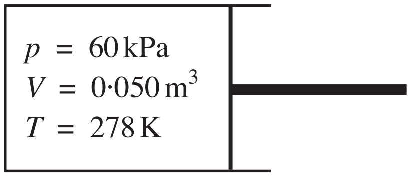
3. A gas is contained in a cylinder as shown.



(a) Show that the amount of gas in the cylinder is approximately 1·3 moles. [2]

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(b) (i) The mass of the gas is 0·171kg. Calculate the root-mean-square speed of the gas particles in the cylinder. [3]

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(ii) Calculate the molar mass of the gas in the cylinder. [2]

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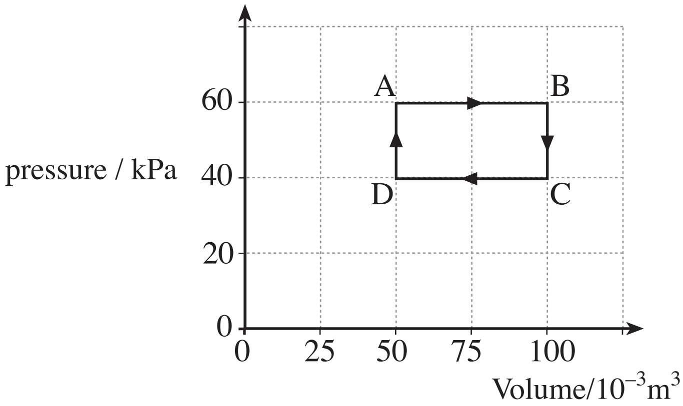
4. A gas undergoes a thermodynamic cycle, ABCDA, as shown in the *p*-*V* diagram.



(a) The first law of thermodynamics can be written in the form $\Delta U = Q - W$

Sate the meaning of **each** term. [2]

ΔU ....

Q ....

W ....

(b) (i) Calculate the work done by the gas during process AB. [2]

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(ii) The temperatures at point A and B are 278 K and 556 K respectively and the amount of gas is 1·3 moles. The internal energy of the gas is given by the equation $U = \frac{3}{2}nRT$.

Calculate the **change** in internal energy of the gas during the process AB. [2]

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(c) (i) How much work is done during process BC? [1]

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(ii) Describe and explain the heat flow during the process BC (no calculations are required). [2]

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(d) (i) Explain why the change in internal energy over the closed cycle ABCDA is zero. [1]

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(ii) Calculate the net heat supplied to the gas over the cycle ABCDA. [3]

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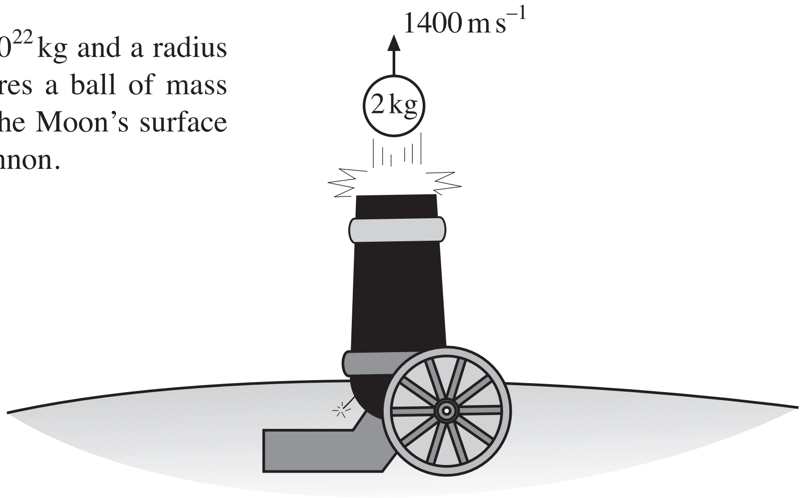
5. The moon has a mass of $7{\cdot}35 \times 10^{22}$ kg and a radius of $1{\cdot}74 \times 10^{6}$ m. An astronaut fires a ball of mass 2·00 kg vertically upwards from the Moon's surface at a speed of 1400 m s^{-1} from a cannon.



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

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(ii) Calculate the weight of the cannon ball on the Moon's surface. [2]

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(b) (i) Calculate the initial kinetic energy of the cannon ball. [1]

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(ii) Show that the initial gravitational potential energy of the cannon ball is –5·6 MJ. [2]

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(iii) Apply the principle of conservation of energy to the cannon ball and calculate the greatest height that the cannon ball reaches above the surface of the Moon. [4]

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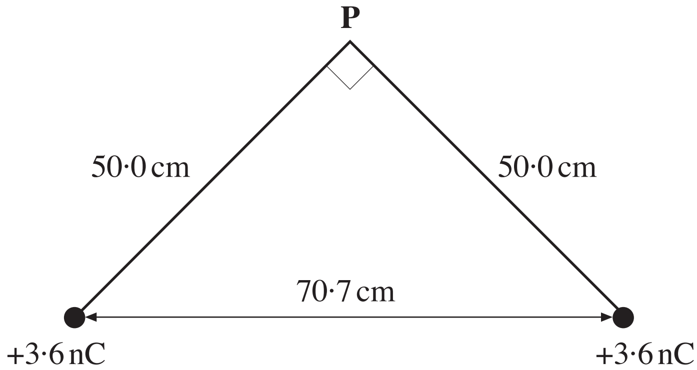

(a) Calculate the force between the two 3·6 nC charges shown above. [2]

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(b) (i) Draw arrows at P to represent the directions of the electric fields due to the two 3·6 nC charges. [1]

(ii) State the direction of the resultant of these two fields. .... [1]

(iii) Calculate the magnitude of the electric field at **P**. [4]

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(c) Calculate the work done when a +1·0 nC charge is brought from a large distance away and placed at **P**. [3]

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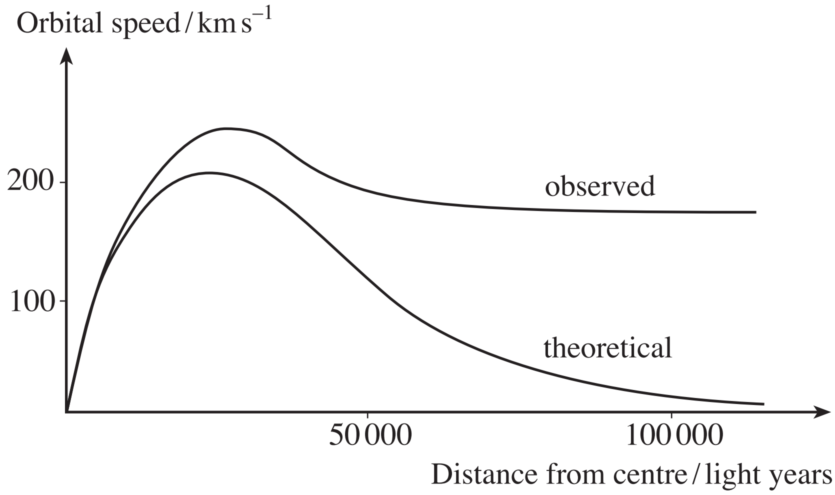
7. The graphs below refer to the orbital speeds of objects in a spiral galaxy. The visible disk of the galaxy extends to about 35 000 light years from the centre. Explain briefly how such graphs are thought to give evidence for the existence of Dark Matter.

The equation $v = \sqrt{\frac{GM}{r}}$ may assist you in your explanation. [4]



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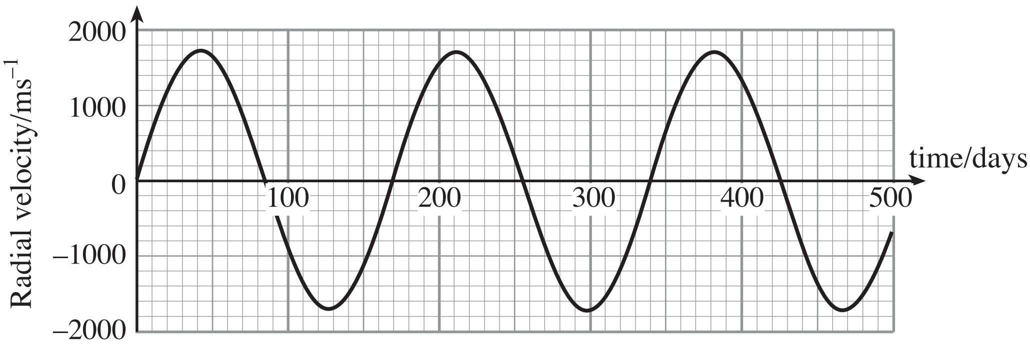
8. In 2008, a brown dwarf star was discovered orbiting a larger star using the following data obtained from spectral observations of the larger star. The graph shows the large star's radial velocity versus time (here, radial velocity is the component of the star's velocity towards the Earth).



(a) With the use of a diagram, explain why this variation in radial velocity occurs. [3]

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(b) (i) From the graph write down the orbital speed of the larger star. .... [1]

(ii) The wavelength of light used to obtain this data via Doppler shift was 600 nm. Calculate the maximum wavelength shift corresponding to the above results. [2]

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(c) (i) From the graph write down the period of orbit. .... [1]

(ii) From your answers to *(b)*(i) and *(c)*(i), show that the radius of the orbit of the larger star is approximately 4×10^9 m. [2]

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(d) The mass of the larger star is $8{\cdot}0 \times 10^{29}$ kg and you may assume that this is far greater than that of the brown dwarf. Use your answer to *(c)*(i) to show that the distance, d, between the larger star and the brown dwarf is around 7×10^{10} m. [2]

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(e) Calculate the mass of the brown dwarf. [2]

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Turn over.

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