Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

For Examiner's Use

General Certificate of Education
June 2008
Advanced Level Examination

PHYSICS (SPECIFICATION A) **PA04**
Unit 4 Waves, Fields and Nuclear Energy

ASSESSMENT and QUALIFICATIONS ALLIANCE

Section B

Wednesday 11 June 2008 9.00 am to 10.30 am

For this paper you must have:
- a pencil and a ruler
- a calculator
- a data sheet insert (enclosed in Section A).

Time allowed: The total time for Section A and Section B of this paper is 1 hour 30 minutes.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The maximum mark for this Section is 45. This includes up to 2 marks for the Quality of Written Communication.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- A *Data Sheet* is provided as a loose insert to Section A.
- Questions 2(a) and 5(a) should be answered in continuous prose. In these questions you will be marked on your ability to use good English, to organise information clearly and to use specialist vocabulary where appropriate.

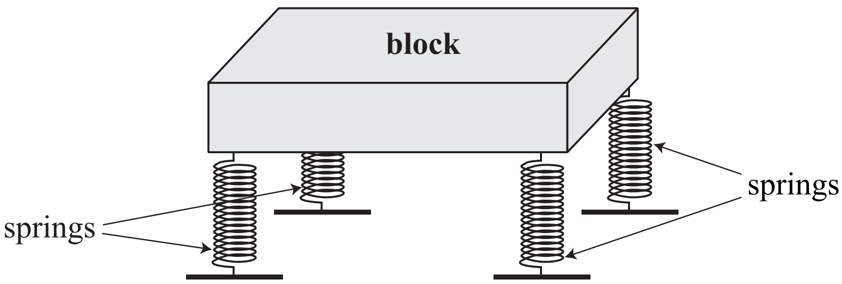
For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
Total (Column 1) →			
Total (Column 2) →			
Quality of Written Communication			
TOTAL			
Examiner's Initials			

Answer **all** questions.

You are advised to spend **one hour** on this section.

1 A simple model for the suspension system of a car represents the car as a rectangular block, the weight of which is supported equally by four identical springs that are fixed rigidly at their lower ends, as shown in **Figure 1**.

Figure 1



1 (a) The mass of the block is 1600 kg, and tests have shown that vertical oscillations of the block have a frequency of 0.92 Hz. Calculate the spring constant of one of the springs.

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(2 marks)

1 (b) In a further test of the model, the whole block is displaced vertically downwards with an initial displacement of 90 mm. The block is then released at time $t = 0$.
You may assume that subsequently the block oscillates vertically with undamped simple harmonic motion.

Calculate, for a time 0.20 s later,

1 (b) (i) the vertical displacement of the block from its equilibrium position,

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1 (b) (ii) the vertical speed of the block.

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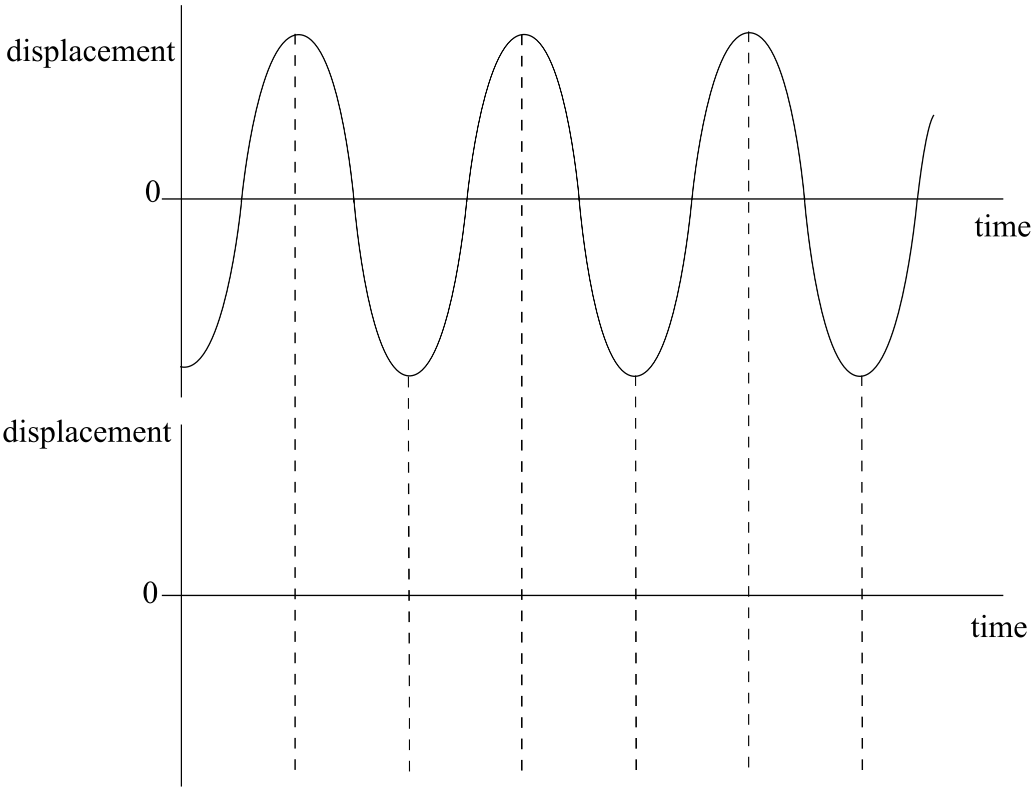
(4 marks)

1 (c) In practice, the vertical oscillations of a car are greatly reduced by fitting dampers (known as shock absorbers) to the suspension system. **Figure 2 s**hows how a graph of displacement against time would appear if there were no damping. Draw a graph on the axes beneath it to show how the oscillations would vary with time for a car fitted with light damping. You should use the same time scale.

Figure 2



(2 marks)

Question 1 continues on the next page

Turn over ▶

1 (d) An experiment is carried out to investigate the rattling of internal components of a car at certain engine speeds. When a loudspeaker connected to an ac source of variable frequency is placed in front of the rear-view mirror, violent vibrations of the mirror are produced when the frequency of the sound waves is 55 Hz.

1 (d) (i) Give the name of this phenomenon.

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1 (d) (ii) Deduce the engine speed, in revolutions per minute, at which the same effect would be likely to occur in the car.

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(2 marks)

10

2 (a) You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

Describe, with the aid of a diagram, the appearance of

2 (a) (i) the interference pattern produced by monochromatic light from a point source after the light has passed through a double slit system,

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2 (a) (ii) the diffraction pattern produced by monochromatic light from a point source after the light has passed through a single slit.

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(4 marks)

Question 2 continues on the next page

Turn over ▸

2 (b) Young's fringes, produced by monochromatic laser light passing through slits 0.60 mm apart, are viewed on a screen. The distance across 20 fringe spacings on the screen is 58 mm. When the screen is moved 0.80 m further away from the slits, the distance across 20 fringe spacings becomes 74 mm.

2 (b) (i) Calculate the fringe width in the original arrangement.

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2 (b) (ii) Show that the original distance from the slits to the screen was 2.9 m.

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2 (b) (iii) Calculate the wavelength of the laser light.

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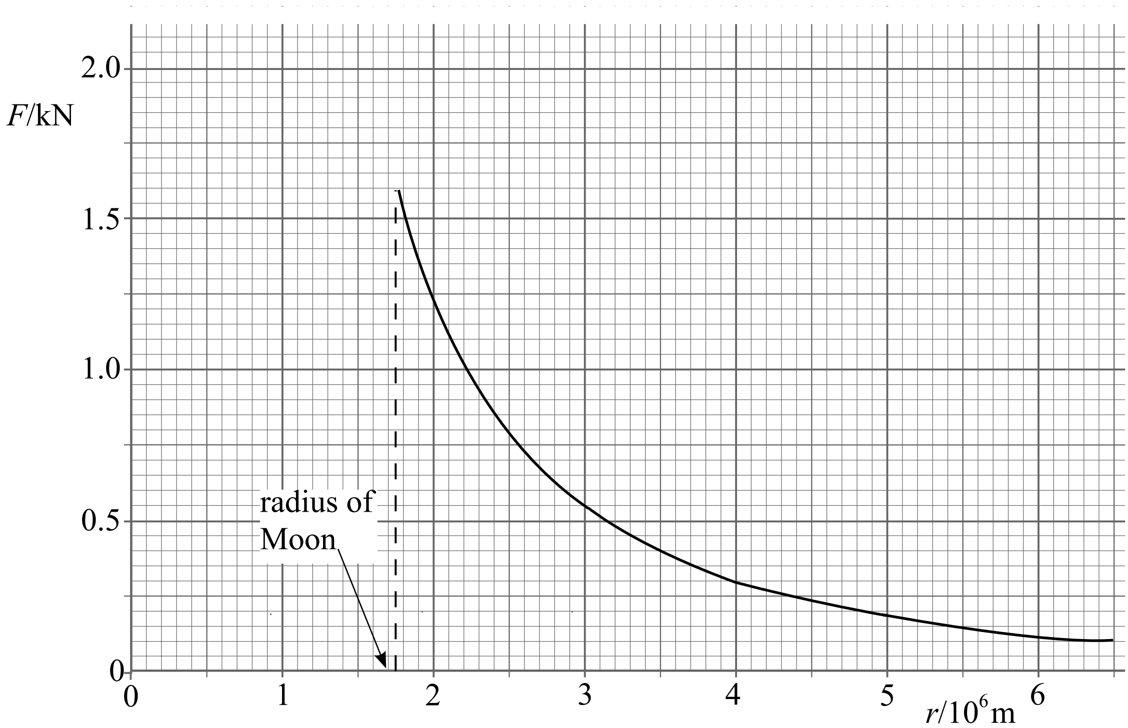
(5 marks)

9

3 (a) The graph shows how the gravitational force F between a 1000 kg mass and the Moon varies with the distance r from the centre of the Moon for points outside its surface.



3 (a) (i) Explain why the graph has this shape for points outside the surface.

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3 (a) (ii) Use data from the graph to determine the mass of the Moon.

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(4 marks)

Question 3 continues on the next page

Turn over ▸

3 (b) (i) From the graph, estimate the potential energy lost by the 1000 kg mass as it falls to the surface of the Moon from a very large distance above it. Explain how you arrive at your estimate.

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3 (b) (ii) By considering the 1000 kg mass as a projectile, calculate the speed at which it should it be thrown vertically upwards from the surface of the Moon if it is to escape from the Moon's gravitational field.

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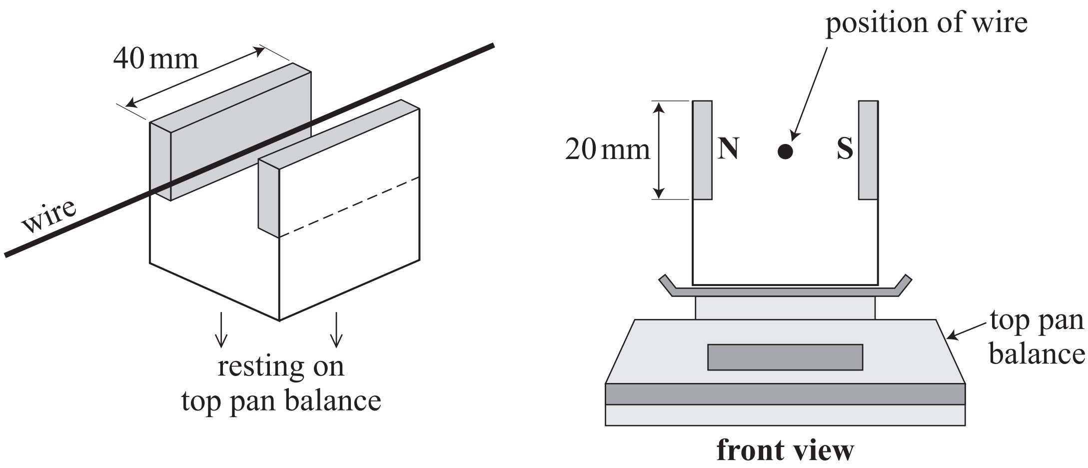
(5 marks)

9

4 A uniform magnetic field is produced by mounting two flat magnets on a U-shaped iron frame, so that the north and south poles are facing, as shown in **Figure 3**. The flux density of the magnetic field is 45 mT and may be assumed to act only over the area of the pole faces, which measure 40 mm by 20 mm. This magnet arrangement rests on the pan of a top pan balance.

Figure 3



4 (a) A horizontal wire is placed in the centre of the magnetic field and aligned to make it perpendicular to the flux lines. When a current is passed through the wire, the balance reading increases by 1.4×10^{-3} kg.

Calculate the current in the wire.

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(2 marks)

Question 4 continues on the next page

Areas outside the box will not be scanned for marking

4 (b) The wire is disconnected from the current source and its ends are connected to a sensitive voltmeter. When the wire is moved rapidly, vertically upwards across the whole magnetic field, cutting all of the flux lines perpendicularly, the voltmeter gives a reading.

Calculate

4 (b) (i) the magnetic flux change experienced by the wire during its movement completely across the magnetic field,

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4 (b) (ii) the time taken for the wire to pass completely across the magnetic field, assuming it is moved at constant speed, if the voltmeter reads 0.15 mV.

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(5 marks)

7

5 (a) You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

In the context of nuclear fission, explain what is meant by

5 (a) (i) a chain reaction,

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5 (a) (ii) critical mass.

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(4 marks)

Question 5 continues on the next page

5 (b) *Moderation* and *cooling* are essential processes in the operation of a nuclear power reactor using thermal neutrons. For each process, name a suitable material that is used to achieve the required effect, and state why it is suitable.

5 (b) (i) moderation

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5 (b) (ii) cooling

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(4 marks)

8

Quality of Written Communication *(2 marks)*

2

END OF QUESTIONS