Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

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General Certificate of Education
June 2006
Advanced Level Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

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

Section B

Thursday 15 June 2006 9.00 am to 10.30 am

For this paper you must have:
- a calculator
- a pencil and ruler

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

Instructions
- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want 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.
- A *Data Sheet* is provided on pages 3 and 4 of Section A. You may wish to detach this perforated sheet at the start of the examination.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers. Questions 2(a) and 4(a) should be answered in continuous prose. Quality of Written Communication will be assessed in these answers.

For Examiner's Use			
Number	Mark	Number	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 approximately **one hour** on this section.

1 (a) Give an equation for the frequency, f, of the oscillations of a simple pendulum in terms of its length, l, and the acceleration due to gravity, g.

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State the condition under which this equation applies.

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(2 marks)

(b) The bob of a simple pendulum, of mass 1.2×10^{-2} kg, swings with an amplitude of 51 mm. It takes 46.5 s to complete 25 oscillations. Calculate

(i) the length of the pendulum,

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(ii) the magnitude of the restoring force that acts on the bob when at its maximum displacement.

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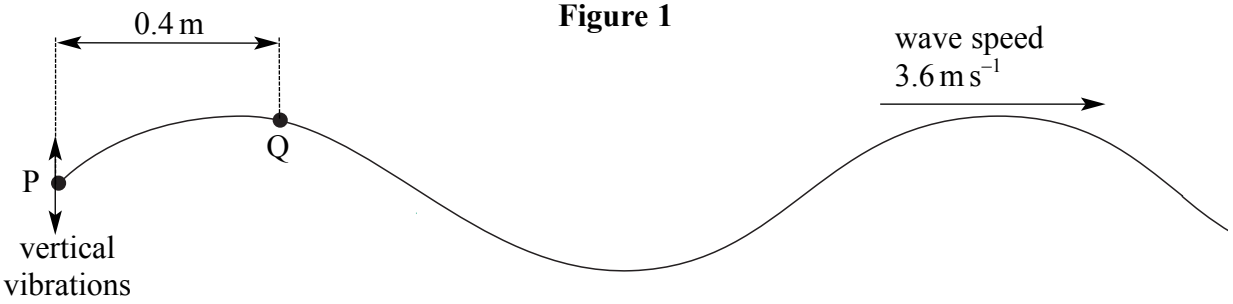
(6 marks)

8

2 Progressive waves are generated on a rope by vibrating vertically the end, P, in simple harmonic motion of amplitude 90 mm, as shown in **Figure 1**. The wavelength of the waves is 1.2 m and they travel along the rope at a speed of 3.6 m s^{-1}. Assume that the wave motion is not damped.

Figure 1



(a) Point Q is 0.4 m along the rope from P. Describe the motion of Q in as much detail as you can and state how it differs from the motion of P. Where possible, give quantitative values in your answer.

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

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(5 marks)

(b) Calculate the maximum speed of point P.

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(3 marks)

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3 (a) (i) Define the *electric field strength*, E, at a point in an electric field.

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(ii) State whether E is a scalar or a vector quantity.

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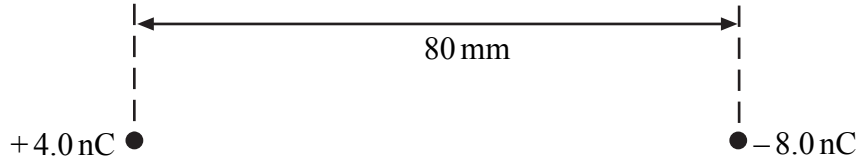
(3 marks)

(b) Point charges of $+4.0\,\text{nC}$ and $-8.0\,\text{nC}$ are placed 80 mm apart, as shown in **Figure 2**.

Figure 2



P

(i) Calculate the magnitude of the force exerted on the $+4.0\,\text{nC}$ charge by the $-8.0\,\text{nC}$ charge.

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(ii) Determine the distance from the +4.0 nC charge to the point, along the straight line between the charges, where the electric potential is zero.

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(4 marks)

(c) Point **P** in **Figure 2** is equidistant from the two charges.

(i) Draw two arrows on **Figure 2** at **P** to represent the directions and relative magnitudes of the components of the electric field at **P** due to each of the charges.

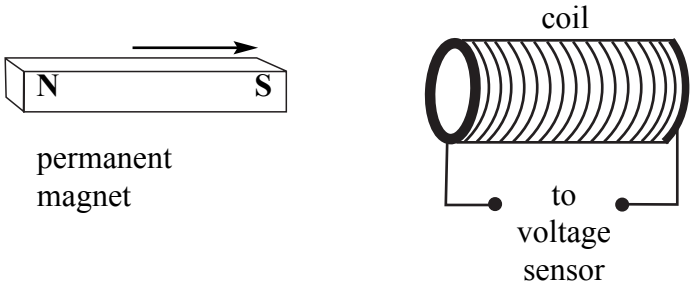
(ii) Hence draw an arrow, labelled **R**, on **Figure 2** at **P** to represent the direction of the resultant electric field at **P**. *(3 marks)*

10

Turn over for the next question

4 (a) In an experiment to illustrate electromagnetic induction, a permanent magnet is moved towards a coil, as shown in **Figure 3**, causing an emf to be induced across the coil.

Figure 3



Using Faraday's law, explain why a larger emf would be induced in this experiment if a stronger magnet were moved at the same speed.

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

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(3 marks)

(b) A conductor of length l is moved at a constant speed v so that it passes perpendicularly through a uniform magnetic field of flux density B, as shown in **Figure 4**.

Figure 4

(i) Give an expression for the area of the magnetic field swept out by the conductor in time Δt.

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(ii) Show that the induced emf, ϵ, across the ends of the conductor is given by

$$\epsilon = B l v.$$

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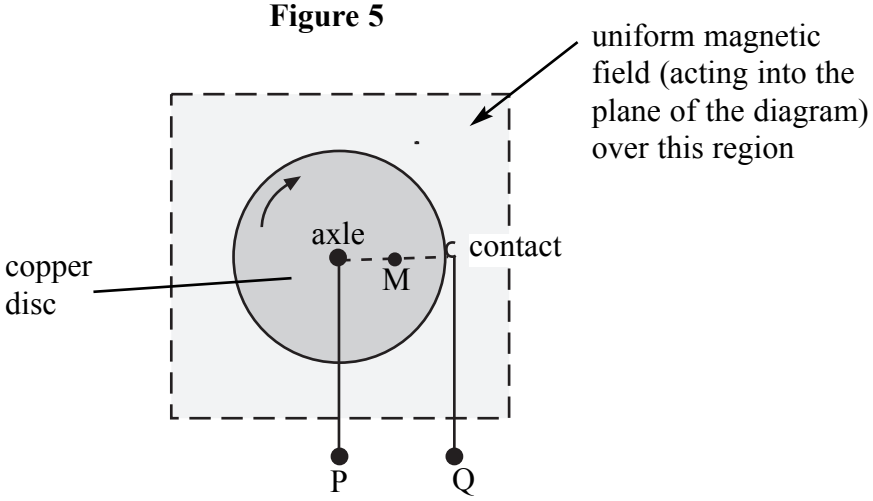
(3 marks)

Question 4 continues on the next page

(c) A simple electrical generator can be made from a copper disc, which is rotated at right angles to a uniform magnetic field, directed into the plane of the diagram (**Figure 5**). An emf is developed across terminals P (connected to the axle) and Q (connected to a contact on the edge of the disc).

Figure 5



The radius of the disc is 64 mm and it is rotated at 16 revolutions per second in a uniform magnetic field of flux density 28 mT.

(i) Calculate the angular speed of the disc.

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(ii) Calculate the linear speed of the mid-point M of a radius of the disc.

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(iii) Hence, or otherwise, calculate the emf induced across terminals P and Q.

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(5 marks)

11

5 (a) When a nucleus of uranium-235 fissions into barium-141 and krypton-92, the change in mass is 3.1×10^{-28} kg. Calculate how many nuclei must undergo fission in order to release 1.0 J of energy by this reaction.

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(2 marks)

(b) A nuclear power station produces an electrical output power of 600 MW. If the overall efficiency of the station is 35%, calculate the decrease in the mass of the fuel rods, because of the release of energy, during one week of continuous operation.

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(4 marks)

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Quality of Written Communication *(2 marks)*

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END OF QUESTIONS

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