| Surname | | Other Names | |
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| Centre Number | | Candidate Number | |
| Candidate Signature | | | |

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General Certificate of Education
June 2007
Advanced Level Examination

AQA ASSESSMENT and QUALIFICATIONS ALLIANCE

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

**Section B**

Thursday 14 June 2007 9.00 am to 10.30 am

**For this paper you must have:**
- a calculator
- a pencil and a 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 to be marked.

**Information**
- The maximum mark for this section is 45.
- Two of these marks will be awarded for using good English, organising information clearly and using specialist vocabulary where appropriate.
- 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.
- Questions 3(b) 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 | | | |
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| 3 | | | |
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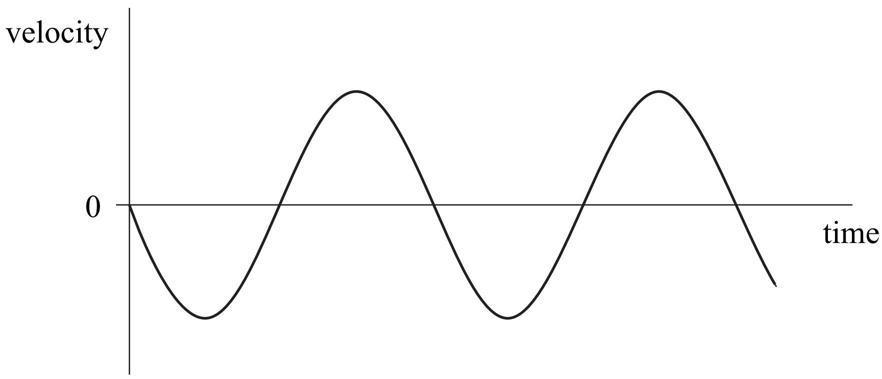
| Total (Column 1) → | | | |
| Total (Column 2) → | | | |
| Quality of Written Communication | | | |
| TOTAL | | | |
| Examiner's Initials | | | |

Answer **all** questions.

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

**1**

**Figure 1**




(a) A graph of velocity against time for a body moving with simple harmonic motion is shown in **Figure 1**.

(i) On **Figure 1**, mark with letter P a point at which the displacement of the body from its equilibrium position is zero, and mark with letter Q a point at which the displacement has its maximum positive value.

(ii) On **Figure 1**, mark with letter R a point where the magnitude of the acceleration of the body has its greatest value. Explain how this can be deduced from **Figure 1**.

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*(4 marks)*

(b) The spring constant of a helical spring is $28\,\mathrm{N\,m^{-1}}$. A 0.40 kg mass is suspended from the spring and set into simple harmonic motion of amplitude 60 mm.

Calculate

(i) the static extension produced by the 0.40 kg mass,

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(ii) the maximum potential energy stored in the spring during the first oscillation.

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*(4 marks)*

8

**Turn over for the next question**

**2** (a) A particle that moves uniformly in a circular path is accelerating yet moving at a constant speed.

Explain this statement by reference to the physical principles involved.

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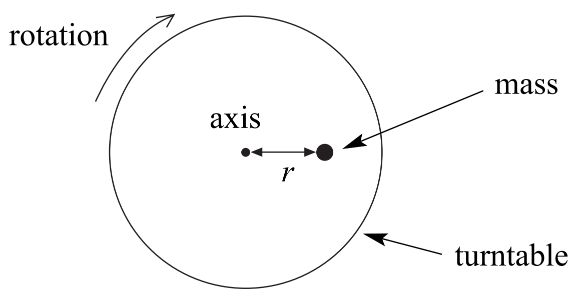
*(3 marks)*

(b) **Figure 2**




A 0.10 kg mass is to be placed on a horizontal turntable that is then rotated at a fixed rate of 78 revolutions per minute. The mass may be placed on the table at any distance, $r$, from the axis of rotation, as shown in **Figure 2**.

If the maximum frictional force between the mass and the turntable is 0.50 N, calculate the maximum value of the distance $r$ at which the mass would stay on the turntable at this rate of rotation.

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*(4 marks)*



7

**Turn over for the next question**

**3** (a) Distinguish between the *nodes* and *antinodes* that can be seen when stationary waves are formed on a vibrating string.

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*(2 marks)*

(b) **Figure 3**

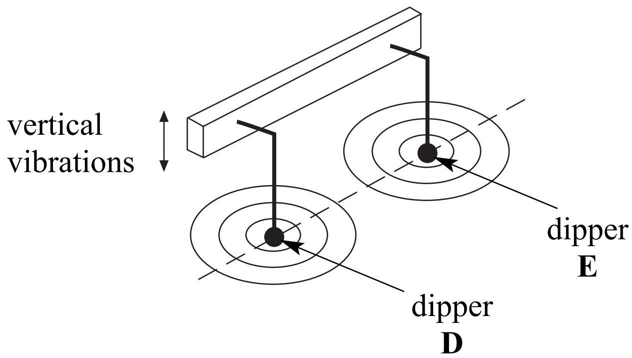


**Figure 3** shows two dippers, **D** and **E**, mounted on the same vibrating beam. The dippers touch the surface of the shallow water in a ripple tank. When the beam vibrates, waves travel outwards in all directions on the surface of the water from each dipper.

Explain why a stationary wave will be formed on the surface of the water along the line joining **D** and **E**.

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

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*(4 marks)*

(c) When the beam vibrates at a certain frequency, the distance between two adjacent nodes along the line between **D** and **E** is 12 mm. When the frequency of vibration is increased by 2.0 Hz, the distance between two adjacent nodes is decreased to 10 mm.

Calculate

(i) the frequency at which the beam vibrated originally,

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(ii) the speed at which the waves travelled on the surface of the water.

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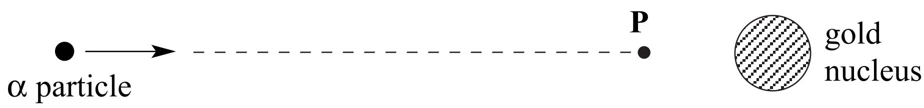
*(4 marks)*

10

**Turn over for the next question**

**4** **Figure 4**




In a Rutherford scattering experiment, an α particle approaches a gold nucleus along the straight line joining their centres and comes momentarily to rest at point **P**, as shown in **Figure 4**.
The α particle then returns along its previous path.

(a) The distance from the centre of the gold nucleus $^{197}_{79}Au$, to the point **P** is $3.0 \times 10^{-14}$ m.

For the point **P**

(i) show that the strength of the electric field associated with the charge of the nucleus is $1.3 \times 10^{20}\ V\,m^{-1}$,

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(ii) calculate the magnitude of the force acting on the α particle,

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(iii) calculate the electric potential due to the charge of the nucleus.

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*(5 marks)*

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(b) (i) State the energy changes of the α particle during its interaction with the gold nucleus.

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(ii) Calculate the initial kinetic energy, in J, of the α particle, explaining your reasoning.

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*(4 marks)*

9

**Turn over for the next question**

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

(i) Describe the physical process of *nuclear fusion*.

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(ii) Describe the physical process of *nuclear fission*.

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(iii) Explain why each of these processes releases energy.

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*(6 marks)*

(b) Energy is also released by radioactive decay, such as the decay of radon-220 as represented by the equation

$$^{220}_{86}\text{Rn} \rightarrow {}^{216}_{84}\text{Po} + \alpha$$

Calculate the energy released, in J, by the decay of one nucleus of radon-220.

| | | |
|---|---|---|
| mass of $^{220}$Rn nucleus | = | 219.96410 u |
| mass of $^{216}$Po nucleus | = | 213.94899 u |
| mass of $\alpha$ particle | = | 4.00150 u |

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*(3 marks)*

9

**Quality of written communication** *(2 marks)*

2

**END OF QUESTIONS**

**There are no questions printed on this page**