

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
TOTAL	



General Certificate of Education
Advanced Level Examination
January 2013

Physics A

PHYA4/2

Unit 4 Fields and Further Mechanics Section B

Wednesday 16 January 2013 1.30 pm to 3.15 pm

For this paper you must have:

- a calculator
- a ruler
- a Data and Formulae Booklet (enclosed).

Time allowed

- The total time for both sections of this paper is 1 hour 45 minutes.
You are advised to spend approximately one hour on this section.

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.
- Do all rough work in this book. Cross through any work you do not want to be marked
- Show all your working.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this section is 50.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
 - use good English
 - organise information clearly
 - use specialist vocabulary where appropriate.



Answer **all** questions in the spaces provided.
You are advised to spend approximately **one hour** on this section.

1 (a) State **one** similarity and **one** difference between an elastic collision and an inelastic collision.

similarity

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difference

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(2 marks)

1 (b) An unstable isotope of neodymium, ${}^{144}_{60}\text{Nd}$, decays into an isotope of cerium, Ce, by emitting an α particle.

1 (b) (i) Complete the following decay equation.



(1 mark)

1 (b) (ii) The α particle is emitted from a stationary ${}^{144}_{60}\text{Nd}$ nucleus at a speed of $9.3 \times 10^6 \text{ m s}^{-1}$. Calculate the recoil speed of the daughter nucleus.

recoil speed m s^{-1}

(2 marks)



1 (b) (iii) Show that, when a stationary ${}^{144}_{60}\text{Nd}$ nucleus decays, the kinetic energy of the recoiling cerium nucleus is only about 3% of the kinetic energy of the emitted α particle.

(3 marks)

8

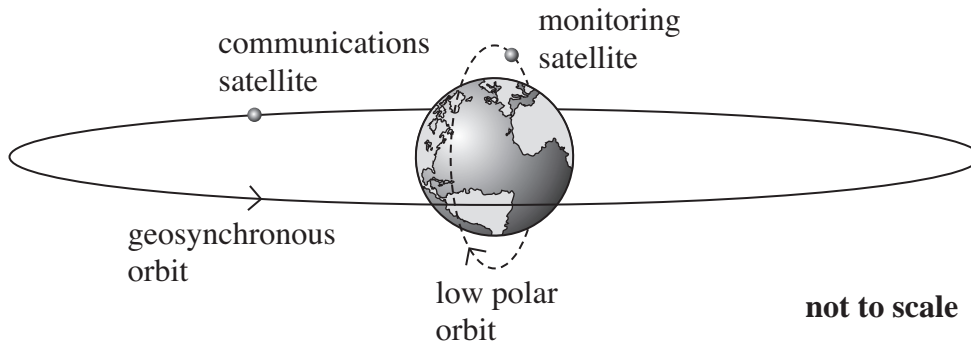
Turn over for the next question

Turn over ►



2 **Figure 1** shows the orbits of two Earth satellites, a communications satellite in a geosynchronous orbit and a monitoring satellite in a low orbit that passes over the poles.

Figure 1



2 (a) The time period, T , of any satellite in a circular orbit around a planet is proportional to $r^{3/2}$, where r is the radius of its orbit measured from the centre of the planet. For a satellite in a low orbit that passes over the poles of the Earth, T is 105 minutes when r is 7370 km.

2 (a) (i) Calculate the height above the surface of the Earth, in km, of a satellite in a geosynchronous circular orbit.
Give your answer to an appropriate number of significant figures.

height above surface km
(4 marks)



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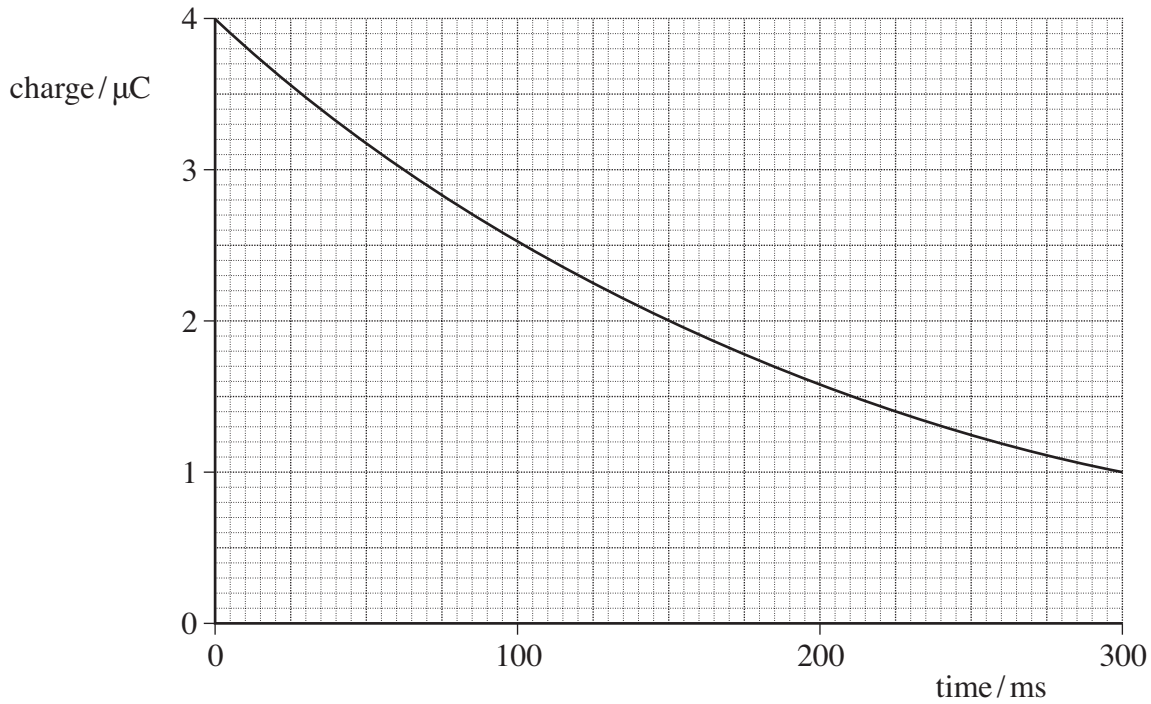
(6 marks)

12



3 **Figure 2** shows how the charge stored by a capacitor varies with time when it is discharged through a fixed resistor.

Figure 2



3 (a) Determine the time constant, in ms, of the discharge circuit.

time constant ms
(3 marks)

3 (b) Explain why the rate of discharge will be greater if the fixed resistor has a smaller resistance.

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(2 marks)

5

Turn over ►



4 (a) State, in words, Coulomb's law.

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(2 marks)

4 (b) Figure 3 shows two point charges of +4.0 nC and +6.0 nC which are 68 mm apart.

Figure 3



4 (b) (i) Sketch on Figure 3 the pattern of the electric field surrounding the charges.

(3 marks)

4 (b) (ii) Calculate the magnitude of the electrostatic force acting on the +4.0 nC charge.

magnitude of force N
(2 marks)



4 (c) (i) Calculate the magnitude of the resultant electric field strength at the mid-point of the line joining the two charges in **Figure 3**.
State an appropriate unit for your answer.

electric field strength unit
(4 marks)

4 (c) (ii) State the direction of the resultant electric field at the mid-point of the line joining the charges.

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(1 mark)

12

Turn over for the next question

Turn over ►



5 (a) State Lenz's law.

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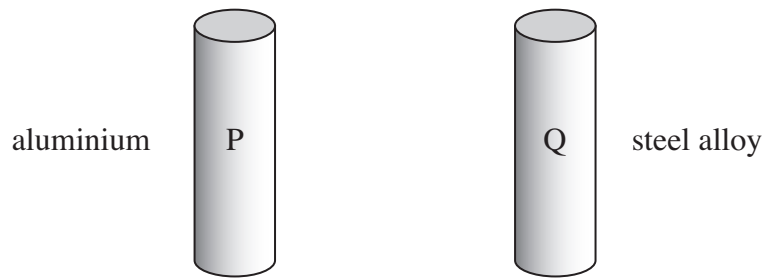
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(2 marks)

5 (b) **Figure 4** shows two small, solid metal cylinders, **P** and **Q**. **P** is made from aluminium. **Q** is made from a steel alloy.

Figure 4



5 (b) (i) The dimensions of **P** and **Q** are identical but **Q** has a greater mass than **P**. Explain what material property is responsible for this difference.

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(1 mark)



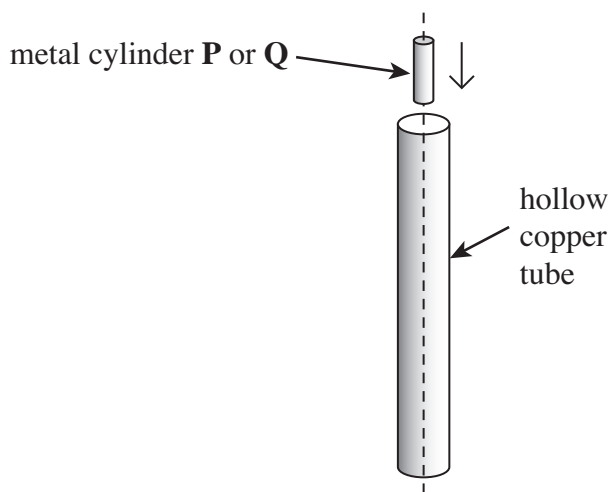
5 (b) (ii) When **P** and **Q** are released from rest and allowed to fall freely through a vertical distance of 1.0 m, they each take 0.45 s to do so. Justify this time value and explain why the times are the same.

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(2 marks)

5 (c) The steel cylinder **Q** is a strong permanent magnet. **P** and **Q** are released separately from the top of a long, vertical copper tube so that they pass down the centre of the tube, as shown in **Figure 5**.

Figure 5



The time taken for **Q** to pass through the tube is much longer than that taken by **P**.

5 (c) (i) Explain why you would expect an emf to be induced in the tube as **Q** passes through it.

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(2 marks)

Turn over ►



5 (c) (ii) State the consequences of this induced emf, and hence explain why **Q** takes longer than **P** to pass through the tube.

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(3 marks)

5 (d) The copper tube is replaced by a tube of the same dimensions made from brass. The resistivity of brass is much greater than that of copper. Describe and explain how, if at all, the times taken by **P** and **Q** to pass through the tube would be affected.

P:

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Q:

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(3 marks)

13

END OF QUESTIONS

