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
June 2015

Physics A PHYA4/2

Unit 4 Fields and Further Mechanics
Section B

Thursday 11 June 2015 9.00 am to 10.45 am

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

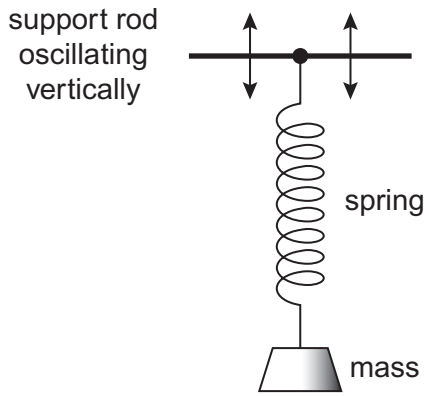
Section B

Answer **all** questions.

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

1 (a) A mass is attached to one end of a spring and the other end of the spring is suspended from a support rod, as shown in **Figure 1**.

Figure 1



The support rod oscillates vertically, causing the mass to perform forced vibrations. Under certain conditions, the system may demonstrate resonance.

Explain in your answer what is meant by forced vibrations and resonance. You should refer to the frequency, amplitude and phase of the vibrations.

[4 marks]

forced vibrations .....

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resonance .....

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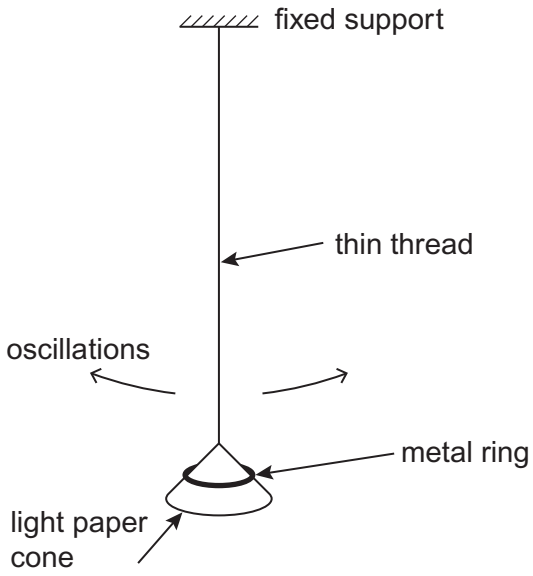
1 (b) A simple pendulum is set up by suspending a light paper cone (acting as the pendulum bob) on the end of a length of thin thread. A metal ring may be placed over the cone to increase the mass of the bob, as shown in **Figure 2**.

Figure 2



The bob is displaced and released so that it oscillates in a vertical plane. The oscillations are subject to damping.

1 (b) (i) Are the oscillations of the pendulum more heavily damped when the cone oscillates with the metal ring on it, when it oscillates without the ring, or does the presence of the ring have no effect on the damping of the oscillations? Tick (✓) the correct answer.

[1 mark]

cone oscillates with ring	
cone oscillates without ring	
ring has no effect	

1 (b) (ii) Explain your answer to part (b)(i).

[3 marks]

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

[2 marks]

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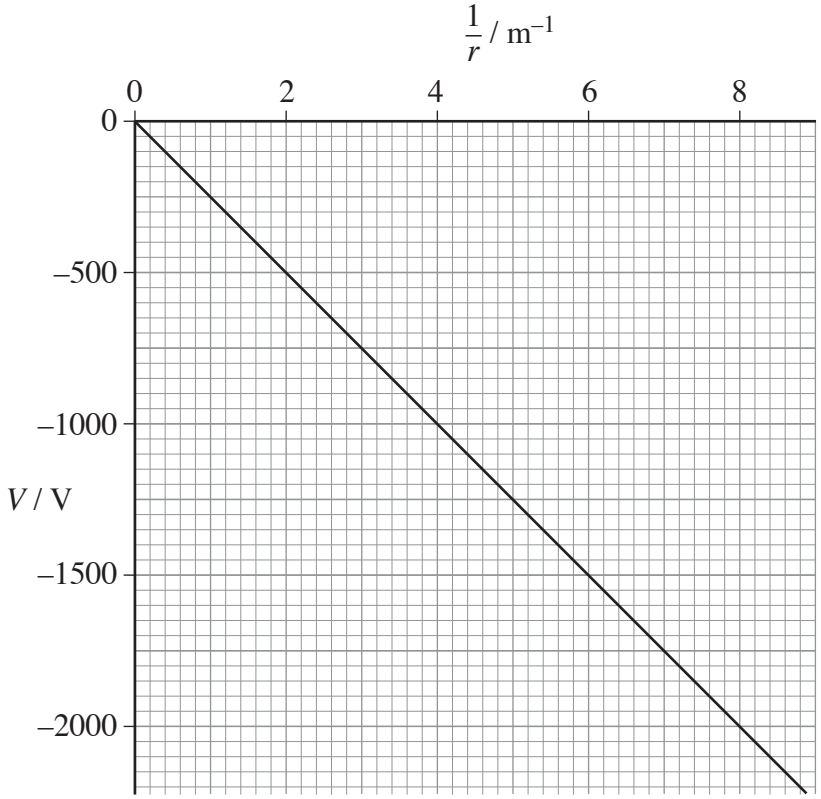
2 (b) **Figure 3** shows how the electric potential, V, varies with $\frac{1}{r}$, where r is the distance from a point charge Q.

Figure 3



State what can be deduced from the graph about how V depends on r and explain why all the values of V on the graph are negative.

[2 marks]

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2 (c) (i) Use data from the graph (**Figure 3**) to show that the magnitude of Q is about $30\ \text{nC}$.

[2 marks]

2 (c) (ii) A $+60\ \text{nC}$ charge is moved from a point where $r = 0.20\ \text{m}$ to a point where $r = 0.50\ \text{m}$. Calculate the work done.

[2 marks]

work done ..... J

2 (c) (iii) Calculate the electric field strength at the point where $r = 0.40\ \text{m}$.

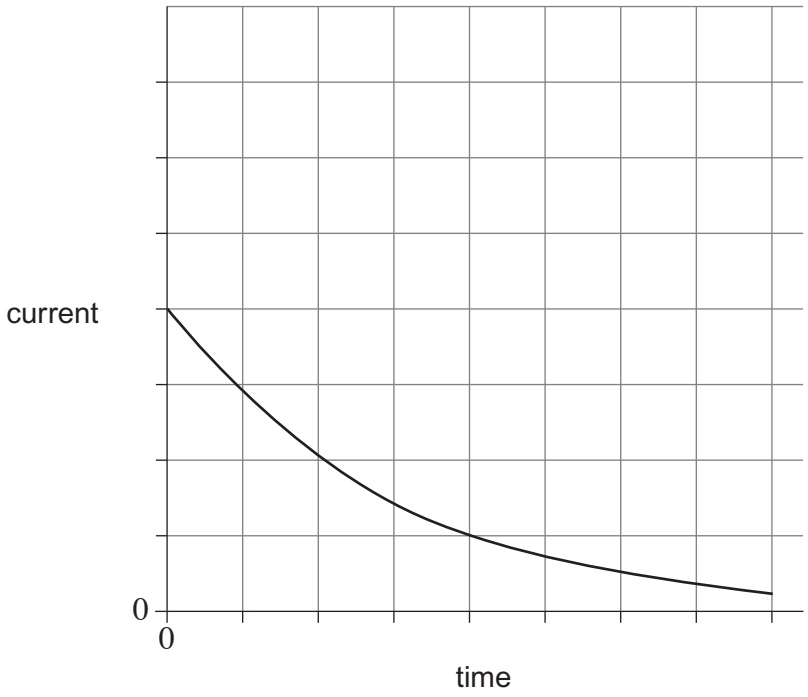
[2 marks]

electric field strength ..... V m^{-1}

10

3 (a) **Figure 4** shows how the current varies with time as a capacitor is discharged through a 150 Ω resistor.

Figure 4



3 (a) (i) Explain how the initial charge on the capacitor could be determined from a graph of current against time.

[1 mark]

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3 (a) (ii) The same capacitor is charged to the same initial potential difference (pd) and then discharged through a $300\ \text{k}\Omega$ resistor. Sketch a second graph on the same axes above to show how the current varies with time in this case.

[3 marks]

3 (b) In an experiment to show that a capacitor stores energy, a student charges a capacitor from a battery and then discharges it through a small electric motor. The motor is used to lift a mass vertically.

3 (b) (i) The capacitance of the capacitor is $0.12\ \text{F}$ and it is charged to a pd of $9.0\ \text{V}$.
The weight of the mass raised is $3.5\ \text{N}$.
Calculate the maximum height to which the mass could be raised.
Give your answer to an appropriate number of significant figures.

[4 marks]

maximum height ..... m

3 (b) (ii) Give **two** reasons why the value you have calculated in part (b)(i) would not be achieved in practice.

[2 marks]

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2 .....

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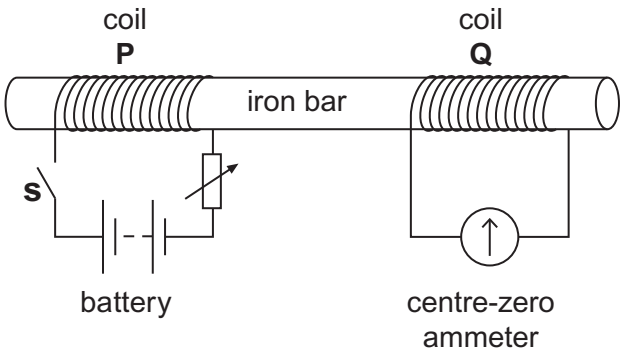
4 (a) **Figure 5** shows two coils, **P** and **Q**, linked by an iron bar. Coil **P** is connected to a battery through a variable resistor and a switch **S**. Coil **Q** is connected to a centre-zero ammeter.

Figure 5



4 (a) (i) Initially the variable resistor is set to its minimum resistance and **S** is open. Describe and explain what is observed on the ammeter when **S** is closed.

[3 marks]

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4 (a) (ii) With **S** still closed, the resistance of the variable resistor is suddenly increased. Compare what is now observed on the ammeter with what was observed in part (a)(i). Explain why this differs from what was observed in part (a)(i).

[2 marks]

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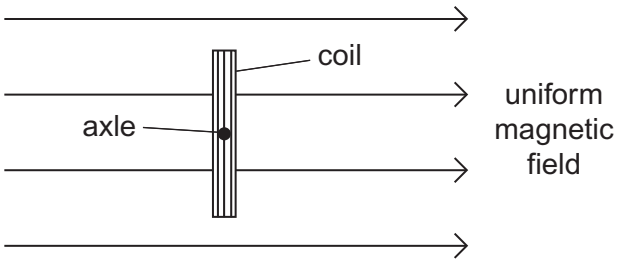
4 (b) **Figure 6** shows a 40-turn coil of cross-sectional area 3.6×10^{-3} m^2 with its plane set at right angles to a uniform magnetic field of flux density 0.42 T.

Figure 6



4 (b) (i) Calculate the magnitude of the magnetic flux linkage for the coil.
State an appropriate unit for your answer.

[2 marks]

flux linkage ..... unit .....

4 (b) (ii) The coil is rotated through 90° in a time of 0.50 s.
Determine the mean emf in the coil.

[2 marks]

mean emf V

9

5 A lead ball of mass $0.25\ \text{kg}$ is swung round on the end of a string so that the ball moves in a horizontal circle of radius $1.5\ \text{m}$. The ball travels at a constant speed of $8.6\ \text{m s}^{-1}$.

5 (a) (i) Calculate the angle, in degrees, through which the string turns in $0.40\ \text{s}$.

[3 marks]

angle ..... degree

5 (a) (ii) Calculate the tension in the string.
You may assume that the string is horizontal.

[2 marks]

tension ..... N

5 (b) The string will break when the tension exceeds $60\ \text{N}$.
Calculate the number of revolutions that the ball makes in one second when the tension is $60\ \text{N}$.

[2 marks]

number of revolutions .....

5 (c) Discuss the motion of the ball in terms of the forces that act on it. In your answer you should:

- explain how Newton's three laws of motion apply to its motion in a circle
- explain why, in practice, the string will not be horizontal.

You may wish to draw a diagram to clarify your answer.

The quality of your written communication will be assessed in your answer.

[6 marks]

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END OF QUESTIONS