2009 Senior External Examination

Physics

Paper Two — Question book

Thursday 5 November 2009
1:00 pm to 3:10 pm

Time allowed

- Perusal time: 10 minutes
- Working time: 2 hours

Examination materials provided

- Paper Two – Question book
- Paper Two – Resource book
- Paper Two – Response book

Equipment allowed

- QSA-approved equipment
- ruler graduated in millimetres
- non-programmable calculator
- graphics/graphing calculator

Paper Two is an open book examination. You may refer to any paper-based material that you have brought into the examination room.

Directions

You may write in this book during perusal time.

Paper Two has two parts:
- Part A: 5 questions (attempt 4 questions only)
- Part B: 4 questions (attempt 2 questions only)

Show all working.

Suggested time allocation

- Part A: 70 minutes
- Part B: 50 minutes

Assessment

Assessment standards are at the end of this book.

After the examination

Take this book when you leave the examination room.
Planning space
Part A

Complex reasoning processes.
Suggested time allocation: 70 minutes.
This part has five questions of equal value. Attempt four questions only. Show all working.
Write your responses in the response book provided.

Question 1

The Andromeda Galaxy is the Milky Way’s nearest large galactic neighbour and can be seen from Earth without using a telescope.

If the distance from Earth to Andromeda is $1.9 \times 10^{22}$ m, how far is this in light years?

Discuss the effective use of light years when describing the vastness of space.

Question 2

When a 60 g tennis ball drops to the ground, it undergoes an average acceleration of $8.2 \text{ m s}^{-2}$ down.

Determine the average frictional force acting on the ball.

(A diagram may be useful.)

Question 3

A pith ball (pith is a cork-like substance) with a mass of 0.15 mg is suspended from a string of negligible mass as shown below.

![Diagram of electric field with pith ball](image)

The electric field is produced by two very large parallel metal plates which are 2 m apart.

Find the potential difference between the plates.

Find the charge on the ball.
**Question 4**

An electron with velocity $1.5 \times 10^7 \text{ ms}^{-1}$ enters an evacuated chamber with a uniform magnetic field of strength 0.10 T.

Determine the force that would act on the electron when it enters the chamber.

Describe, both qualitatively and quantitatively, the path that the electron would then follow.

**Question 5**

When an unstable nucleus undergoes radioactive decay the resulting nucleus is often also unstable. If it is it can then undergo further radioactive decay. This process may continue, involving both alpha and beta emissions, until a stable isotope is reached. This sequence forms a *radioactive decay series.* Four such series have been identified in nature.

The thorium radioactive decay series begins with the $^{232}_{90}$Th nucleus which emits, in succession, one alpha particle, two beta particles, four alpha particles, one beta particle, one alpha particle and one beta particle.

Determine the atomic number and mass number of the final nucleus.

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**End of Part A**
Part B

Complex reasoning processes.

Suggested time allocation: **50 minutes**.

This part has **four** questions of equal value. Attempt **two** questions only. Show all working.
Write your responses in the response book provided.

**Question 6**

A 5 tonne carriage at a theme park is accelerated from rest over a distance of 32 m for 1.1 seconds. (Assume the effects of friction in the acceleration zone are negligible.)

If the coefficient of friction over the remainder of the runway is 0.17, find the speed of the carriage at the end of the runway.

Note: The total length of the runway including the acceleration zone is 250 m.

**Question 7**

A 22.0 g metal spike is fired at 300 ms⁻¹ into a block of wood suspended by two strings of negligible mass. The spike remains embedded in the block.

The impact of the spike knocks the arrangement sideways and it rises through a vertical height of 32.5 cm from its original position.

Use this information to determine the mass of the block of wood.
Question 8

An experiment was performed using standing soundwave patterns to determine the speed of sound.

Two loudspeakers connected to a frequency generator were placed several metres apart facing each other. Four different frequencies were produced and the distance between nodal points was recorded each time.

The results were:

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Distance between nodes (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>66.7</td>
</tr>
<tr>
<td>500</td>
<td>33.3</td>
</tr>
<tr>
<td>1000</td>
<td>16.0</td>
</tr>
<tr>
<td>2000</td>
<td>8.3</td>
</tr>
</tbody>
</table>

On the graph paper provided on page 1 of your response book, use a graphical method with this recorded data to find the speed of sound.

Question 9

An electric heating element is designed with three settings: high, medium and low. Each setting uses one or two 60 Ω resistors to control the current flowing through the element.

Draw a diagram showing the switch settings that match the three different resistor operations.

The heater runs from a standard mains supply of 240 V, and has a power rating of 1200 W on the high setting. What is the resistance of the heating element?

End of Part B

End of Paper Two
Assessment standards from the 2000 Senior External Syllabus for Physics

**Paper Two**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Very High Achievement</th>
<th>High Achievement</th>
<th>Sound Achievement</th>
<th>Limited Achievement</th>
<th>Very Limited Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complex reasoning processes</td>
<td>A high ability to use complex reasoning in challenging situations involving the candidate's understanding of subject matter and a high ability to use scientific processes at an advanced level.</td>
<td>Competence in using complex reasoning in challenging situations involving the candidate's understanding of subject matter and competence in using scientific processes at an advanced level.</td>
<td>Some success in using complex reasoning in challenging situations involving the candidate's understanding of subject matter and some success in using scientific processes at an advanced level.</td>
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<td></td>
</tr>
</tbody>
</table>