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
- 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
- Part B

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 session

Take this book when you leave.
Planning space
Part A

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

Question 1
Usain Bolt had set the following world records by the end of the 2009 athletics season.

<table>
<thead>
<tr>
<th>Distance (m)</th>
<th>Time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>9.58</td>
</tr>
<tr>
<td>150</td>
<td>14.35</td>
</tr>
<tr>
<td>200</td>
<td>19.19</td>
</tr>
</tbody>
</table>

He ran the last 100 metres of the 150 m event in 8.70 s.

Was he running at the same average pace during each of the world records, and are there any speed zones (40, 50, 60 or 100 km/h) where he could exceed the speed limit? Justify your response.

Question 2
A ball is thrown vertically upwards from the edge of the roof of a 58.0 m tall building. The ball has an initial speed of 15.0 m/s. How much time elapses for the ball to hit the ground? What is the ball’s speed on impact? Justify your response.

Part A continues overleaf
Question 3

Respond to Question 3 on pages 2 and 3 of the response book.

An isosceles prism made of flint glass ($n = 1.62$) is placed in a large glass jar of honey ($n = 1.58$). A ray of light is passed into the prism as shown.

![Diagram of prism and honey](image)

Show, using calculations in conjunction with the diagram, the path of the light ray and the angle that the light emerges from the honey.

Question 4

A model DC winch motor operating at 75% efficiency is connected to a 24.0 V battery. It is drawing 2.50 amps.

Find the greatest mass that can be lifted if the lift speed of the motor is 1.60 m/s.

Question 5

A speaker system has two speakers (1.60 m apart) on the same wall. During testing of the system using sound of frequency 640 Hz, a girl standing midway between the speakers and 8.00 m from the wall notices that when she moves to her left the intensity of the sound drops to almost zero.

a. Explain this reduction in sound intensity using the principles of physics, and determine the wavelength if the velocity of sound was 320 m/s.

b. Find the shortest distance to the left that the girl must move in order for the sound to be at its lowest intensity.

End of Part A
Part B

Complex reasoning processes.
Part B has four questions of equal value. Attempt two questions only. Show all working.
Write your responses in the response book.
Suggested time allocation: 50 minutes.

Question 1
A soccer ball (0.40 kg) is moving to the right at 20.0 m/s, when it is kicked and given a velocity of 30.0 m/s upwards and to the left at an angle of 45.0°.
Find the impulse of the net force, given that the collision time was 0.020 s.
Hint: Use a vector diagram.

Question 2
A pump is being used to create a fountain where the water rises vertically from a jet which has a cross-sectional area of 2.00 cm². The water has a flow rate of 1.00 L/s.
If the power of the pump was doubled, what height would the water rise to?
Your response should include any assumptions made. Ignore frictional forces.

Question 3
In a test using household items, the following were connected in parallel across a 240 V supply:

- A 240 V, 60.0 W globe
- An ammeter showing a reading of 0.80 A in series with a resistor
- A heating element producing 480 J/s.

Draw the circuit.
If the test ran for 30.0 minutes, find the cost of power consumed if power costs 18.5 c per kWh.

Part B continues overleaf
Question 4

The following results were obtained when a lithium photographic plate was illuminated with various wavelengths of light and the stopping potential for the emitted electrons was measured.

<table>
<thead>
<tr>
<th>Wavelength (nm)</th>
<th>Stopping potential (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>375</td>
<td>0.841</td>
</tr>
<tr>
<td>333</td>
<td>1.25</td>
</tr>
<tr>
<td>301</td>
<td>1.65</td>
</tr>
<tr>
<td>273</td>
<td>2.08</td>
</tr>
<tr>
<td>250</td>
<td>2.52</td>
</tr>
</tbody>
</table>

Determine the work function (eV) for lithium using a graphical technique. Draw on the same graph what a similar set of experimental results for sodium (work function $3.50 \times 10^{-19}$ J) would show.

Would the graphs allow a prediction to be made on what would be the more reactive metal?

Explain your reasoning.

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><strong>Complex reasoning processes</strong></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>
<td></td>
<td></td>
</tr>
</tbody>
</table>