Time allowed

• Perusal time: 10 minutes
• Working time: 2 hours 30 minutes

Examination materials provided

• Paper One — Question book
• Paper One — Resource book
• Paper One Part A — Multiple-choice response sheet
• Paper One — Response book

Equipment allowed

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

Directions

You may write in this book during perusal time.

Paper One has two parts:

• Part A — Knowledge of subject matter:
  Section 1 — Multiple choice
  Section 2 — Short response
• Part B — Scientific processes

Attempt all questions.

Suggested time allocation

• Part A: 1 hour 30 minutes
• Part B: 1 hour

Assessment

Paper One assesses the following assessment criteria:

• Knowledge of subject matter
• Scientific processes

Assessment standards are at the end of this book.

After the examination session

Take this book when you leave.
Planning space
Part A — Knowledge of subject matter


Part A is worth 45 marks.

Suggested time allocation: 1 hour 30 minutes.

Section 1 — Multiple choice

Section 1 has 15 questions, each worth one mark. Attempt all questions.

Each question contains four options. Select the option that you think is correct or is the best option. Respond on the multiple-choice response sheet.

Question 1

A series of measurements were recorded as:

\[ a = 3.67, \ b = 0.21, \ c = 2.301 \]

For the equation \( x = b (a + c) \), how many significant figures should be present in the answer?

A 1
B 2
C 3
D 4

Question 2

The graph below shows the motion of a runner over a 20-second time interval.

The velocity \( (v) \) of the runner and the total displacement \( (s) \) are

A \( v = 0 \) \( \text{ms}^{-1} \), \( s = 0 \) m.
B \( v = 20 \) \( \text{ms}^{-1} \), \( s = 100 \) m.
C \( v = 10 \) \( \text{ms}^{-1} \), \( s = 200 \) m.
D \( v = -10 \) \( \text{ms}^{-1} \), \( s = -100 \) m.
**Question 3**

A projectile is fired at an angle of 30° to a horizontal plane with an initial velocity in the same direction of 60 ms\(^{-1}\). The total time of flight for the projectile is closest to

A  5 s.
B  6 s.
C  10 s.
D  12 s.

**Question 4**

Vehicle safety devices such as seat belts and crumple zones are designed to alter physical parameters in the result of an accident. Which of the parameters below is not one of those targeted?

A  Mass
B  Time
C  Force
D  Acceleration

**Question 5**

The space craft *Voyager* continues to move into interstellar space many years after its engine last fired. This is a result of

A  Newton’s first law.
B  Newton’s second law.
C  Newton’s third law.
D  the inverse square law.

**Question 6**

The acceleration due to gravity on the Earth’s moon is 1.62 ms\(^{-2}\). The time it takes to fall a distance of 5 m on the moon is longer than the time it takes to fall 5 m on Earth by an amount closest to

A  1 s.
B  1.5 s.
C  2.5 s.
D  3.5 s.
Question 7
Which of the quantities below is not a derived quantity?

A  Force  
B  Length  
C  Velocity  
D  Momentum

Question 8
A 10 kg mass is dropped from a height of 5 m. Its kinetic energy as it hits the ground is equal to

A  50 J.  
B  98 J.  
C  125 J.  
D  490 J.

Question 9
The wavelength of green light in a vacuum is approximately 510 nm. If the wavelength of green light in a medium is 450 nm, its velocity in that medium is closest to

A  1.13 x 10^8 ms^-1.  
B  2.26 x 10^8 ms^-1.  
C  2.65 x 10^8 ms^-1.  
D  3.77 x 10^8 ms^-1.

Question 10
Two electric charges are separated by a certain distance and experience a force of repulsion, F. If the distance between them is reduced to a third of its original value and one of the charges is doubled, what is the new force?

A  3F  
B  \frac{3F}{2}  
C  18F  
D  \frac{2F}{9}
**Question 11**

Two charged plates have an electric field between them as shown below.

![Diagram](image)

The points of equal field strength are

A  A and C.
B  A, B and D.
C  C and E.
D  A, B, C and D.

**Question 12**

The magnetic field strength 10 cm from a wire carrying a current of 20 A would be closest to

A  $1.0 \times 10^{-8}$ T.
B  $1.0 \times 10^{-9}$ T.
C  $2.0 \times 10^{-5}$ T.
D  $4.0 \times 10^{-5}$ T.

**Question 13**

The strength of the magnetic field within a 20.0 cm long solenoid of 55 turns and carrying a current of 4.2 A is closest to

A  $1.45 \times 10^{-1}$ T.
B  $1.45 \times 10^{-3}$ T.
C  $6.53 \times 10^{11}$ T.
D  $6.53 \times 10^{13}$ T.
**Question 14**

The graph below shows the abundance of isotopes in a sample of molybdenum (atomic number 42).

![Graph showing abundance vs. atomic mass](image)

The most common isotope of molybdenum has

A 58 neutrons.
B 56 neutrons.
C 52 neutrons.
D 50 neutrons.

**Question 15**

A substance has a half-life of 30 years. The initial mass of radioactive nuclei is 25 mg. The mass of the nuclei after 210 years is closest to

A 0.83 mg.
B 0.40 mg.
C 0.20 mg.
D 0.13 mg.

**End of Section 1**
Section 2 — Short response

Section 2 has 11 questions, worth a total of 30 marks. Attempt all questions.

Write your responses in the response book. Show all working.

Question 1

List the number of significant figures in each of these examples.

- a. 4495
- b. 6.023 x 10^23
- c. 0.0034
- d. 8.239

(2 marks)

Question 2

Convert these percentage errors into absolute errors.

- a. 45.6 ± 1.4% cm
- b. 7.45 ± 12% kg

(2 marks)

Question 3

An object rests on an inclined plane that is at an angle of 30° to the horizontal. The friction between the object and the surface of the plane is at maximum 15 N. What would be the minimum mass of the box for it to slide down the plane? Include a diagram in your response.

(4 marks)

Question 4

A 500 kg car travelling at 25 ms^-1 crashes into a barrier and comes to a complete stop in 5 x 10^-3 s. Calculate the average force experienced by the car.

(3 marks)

Question 5

An elevator of mass 300 kg carries 5 people of combined mass 400 kg through a vertical distance of 40 m in a time of 6.0 s. Calculate the work done in moving the elevator through this distance, and the power required to do this.

(4 marks)
Question 6
The diagram below shows a ray of green light moving from one medium into another of different density.

Explain how a ray of red light would behave, given the same angle of incidence in terms of both angle of refraction and velocity, in comparison to the ray of green light.

(2 marks)

Question 7
A double slit experiment used to determine the wavelength of a monochromatic light source has a screen placed 3.50 m away from the slits. If the slits have a 0.00400 mm separation, and the dark fringes on the screen have a uniform 3.50 cm separation, what is the wavelength of the light source?

(3 marks)

Question 8
What work needs to be done to move a charge of $1.5 \times 10^{-15}$ C across a potential difference of $4 \times 10^3$ V?

(2 marks)

Question 9
Information provided on the back of a small electrical kitchen appliance is shown below.

The range of voltages corresponds to the range of the power used by the appliance. Determine the resistance of the appliance.

(2 marks)
Question 10

An electron with a charge of $1.6 \times 10^{-19}$ C enters the Earth’s magnetic field of $40 \times 10^{-6}$ T at an angle of $30^\circ$ to the field lines with a velocity of $3.0 \times 10^6$ ms$^{-1}$. Calculate the force experienced by the electron as a result of interacting with the field.

(2 marks)

Question 11

Balance the following nuclear equations and identify the element X in each case.

a. $^2_1\text{H} + ^2_1\text{H} \rightarrow X + ^1_0\text{n}$

b. $^1_0\text{n} + ^{235}_{92}\text{U} \rightarrow ^{141}_{56}\text{Ba} + X + ^3_0\text{n}$

(4 marks)

End of Section 2

End of Part A
Part B — Scientific processes

Part B assesses scientific processes based on the topics in the Physics Senior External Syllabus 2000 (amended 2003) and practical work undertaken during your study of the subject.

Part B has **eight** questions worth 25 marks. Attempt **all** questions.

Write your responses in the response book. Show all working.

Suggested time allocation: 1 hour.

**Question 1**

The graphs below show how an object’s velocity changes over time in a variety of situations.

A \[ \text{velocity} \]
\[ \text{time} \]

B \[ \text{velocity} \]
\[ \text{time} \]

C \[ \text{velocity} \]
\[ \text{time} \]

D \[ \text{velocity} \]
\[ \text{time} \]

Which graph shows that the object has experienced a net force opposing its motion? Justify your conclusion.

(2 marks)
Question 2

Respond to Question 2 on page 25 of your response book.

The diagrams below show the outputs of a full-wave rectifier and a half-wave rectifier. Both are used to convert AC into DC. The output is fed into a device that produces current via induction, where the current is maximised when the rate of change of voltage is maximised.

On the axes provided in your response book, sketch a wave form that represents the current produced by each device.

(2 marks)
Question 3
The diagram below shows four views of the behaviour of the same light ray in a diamond.

a. How many refractions occur?

b. How many reflections occur? (2 marks)

Question 4
Respond to Question 4 on page 26 of your response book.

The diagram below shows two wave forms travelling in opposite directions with speeds as indicated.

Use the principle of superposition to draw the wave shapes 1.0 s after the time indicated on the diagram. (4 marks)
Question 5

Respond to Question 5 on page 27 of your response book.

A Geiger counter was used to detect radiation given off by a radioactive sample. The number of counts per minute was recorded at 15-minute intervals. The counts obtained were:

<table>
<thead>
<tr>
<th>Time (minutes)</th>
<th>0</th>
<th>15</th>
<th>30</th>
<th>45</th>
<th>60</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count rate per minute</td>
<td>551</td>
<td>477</td>
<td>364</td>
<td>298</td>
<td>262</td>
<td>235</td>
</tr>
</tbody>
</table>

Plot a graph of these results. From your graph, calculate the half-life of this radioactive substance.

(4 marks)

Question 6

A sweet spot is supposedly an area of a tennis racket that provides the largest impulse to a tennis ball when hit, all other things being equal.

Outline a simple experiment that tests the hypothesis that a tennis racket has a sweet spot. Ensure that your experiment includes appropriate controls and variables.

(4 marks)
Question 7

Consider the diagram and graph below.

The diagram shows the wavelengths and frequencies for the electromagnetic spectrum, including visible light.

The graph shows the intensity vs wavelength for the cosmic background radiation, which comes from all areas of space.

a. To which of the categories in the diagram (X-rays, radio waves, etc.) does the maximum intensity radiation of the cosmic background radiation belong? 

(1 mark)

Question 7 continues overleaf
b. The temperature of a star is related to its peak wavelength intensity (or the energy of the peak intensity photons) as shown in the graph below. The energy of the photons is related to their frequency by the equation \( E = hf \).

To which of the categories in the diagram would the peak wavelength intensity belong for a star of temperature 5000 K?

(Note: \( 1 \text{ eV} = 1.6 \times 10^{-19} \text{ J} \))

**Question 8**

The diagram below represents a longitudinal pressure wave moving from left to right through air at a particular moment in time. The vertical axis shows pressure and the horizontal axis represents horizontal displacement from the origin.

For the displacements of 20, 40, 60, 80 and 100 cm, at which points is the pressure increasing?

(2 marks)
### Assessment standards from the Physics Senior External Syllabus 2000 (amended 2003)

**Paper One**

<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>Knowledge of subject matter</td>
<td>A very high ability to recall and apply knowledge in simple situations.</td>
<td>A high ability to recall and apply knowledge in simple situations.</td>
<td>A satisfactory ability to recall and apply knowledge in simple situations.</td>
<td>A limited ability to recall and apply knowledge in simple situations.</td>
<td>A very limited ability to recall and apply knowledge in simple situations.</td>
</tr>
<tr>
<td>Scientific processes</td>
<td>A very high ability to succeed in simple scientific process tasks — collecting and organising data, processing information, making simple judgments, communicating information in various contexts, devising and designing simple/single step investigations.</td>
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