

2014 Senior External Examination

Physics

Paper One — Question book

Monday 10 November 2014

9 am to 11:40 am

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

- QCAA-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 assesses knowledge of subject matter and its simple application based on the topics in the Physics Senior External Syllabus 2000 (amended 2003).

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 taken during an experiment to determine the acceleration (a) of an object.

Initial velocity (u)	3.57 ms^{-1}
Final velocity (v)	12.50 ms^{-1}
Time (t)	5.401 s

The equation for acceleration in this case is

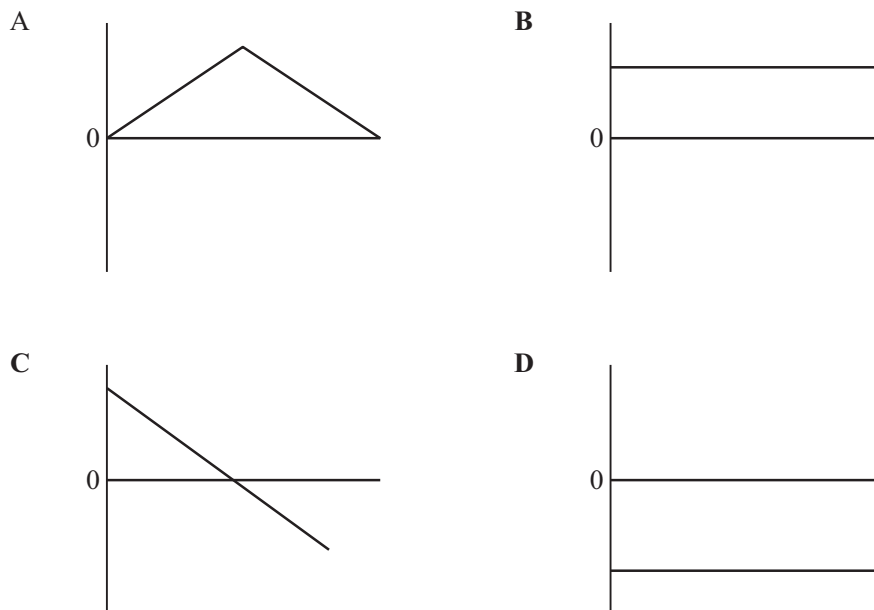
$$a = \frac{v - u}{t}$$

How many significant figures should be present in the answer?

- A** 1
- B** 2
- C** 3
- D** 4

Question 2

Which of the velocity vs time graphs shown below best represents an object thrown upward with an initial velocity and allowed to return to its starting position?



Question 3

A projectile is fired vertically with an initial velocity of 9.8 ms^{-1} and then returns to its starting point. The total time of flight for the projectile is closest to

- A** 4.0 s.
- B** 2.0 s.
- C** 1.0 s.
- D** 0.5 s.

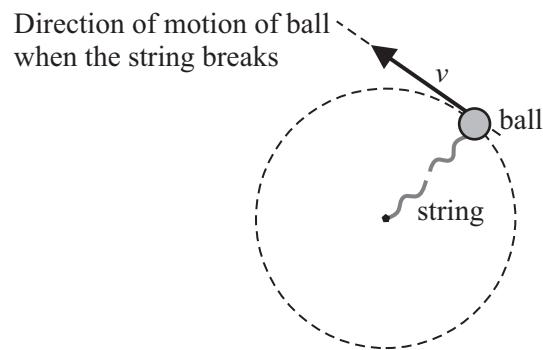
Question 4

Which statement below best describes the function of a seat belt in a car in terms of the force experienced by the driver and the time over which the force acts?

- A** To minimise force and time.
- B** To maximise force and time.
- C** To minimise force and maximise time.
- D** To maximise force and minimise time.

Question 5

When a mass on a string is spun horizontally, the mass travels in a circle. If the string breaks, the mass moves off at a tangent to the circle as indicated in the diagram below.



This phenomenon is best described using

- A Newton's first law of motion.
- B the law of action and reaction.
- C the concept of centrifugal force.
- D the concept of conservation of angular momentum.

Question 6

If the Earth preserved its mass but occupied a sphere only half its current diameter what would a person, who normally weighs 500N, weigh on the surface of this alternative Earth?

- A 250 N
- B 500 N
- C 1000 N
- D 2000 N

Question 7

Which of the following is not expressed as an appropriate SI unit?

- A Metres
- B Newton second
- C Joules per second
- D Kilometres per hour

Question 8

A body initially at rest in a space free of gravitational fields explodes into two pieces moving away from each other with the same speed. Which of the following is not true of the two pieces?

- A They have the same mass.
- B They move along the same axis.
- C They have the same momentum.
- D They have the same kinetic energy.

Question 9

If water waves enter a shallower medium, which of the following will occur?

- A The frequency will decrease, but the wavelength will increase.
- B The frequency will increase, but the wavelength will decrease.
- C The frequency will remain the same, but the wavelength will increase.
- D The frequency will remain the same, but the wavelength will decrease.

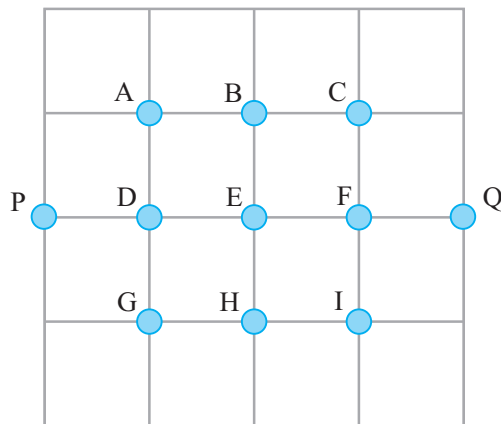
Question 10

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

- A $3F$
- B $\frac{3F}{2}$
- C $18F$
- D $\frac{2F}{9}$

Question 11

Two positive electric point sources of equal charge, P and Q, are positioned on a grid as shown below.

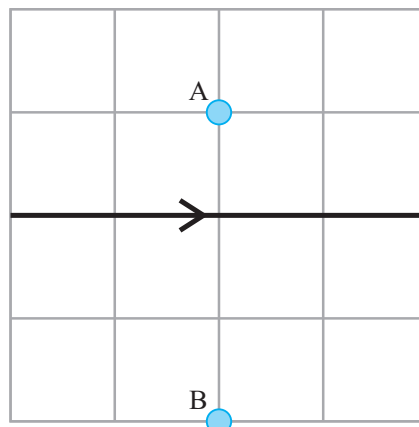


Which of the points below experience an electric field of equal strength?

- A** A, C, G and I
- B** D, B, F and H
- C** B, E and H
- D** A, E and I

Question 12

A magnetic field exists around a current carrying wire as indicated in the diagram below. At point A, the field strength is 2.0×10^{-5} T directed out of the paper.



At point B, the magnetic field would be

- A** 5.0×10^{-6} T into the paper.
- B** 1.0×10^{-5} T into the paper.
- C** 2.0×10^{-5} T out of the paper.
- D** 4.0×10^{-5} T out of the paper.

Question 13

The strength of the magnetic field within a 40.0 cm long solenoid of 100 turns and carrying a current of 5.0 A is closest to

- A 1.57×10^{-3} T.
- B 1.57×10^{-2} T.
- C 1.00×10^{-5} T.
- D 1.41×10^{-4} T.

Question 14

When nuclei undergo beta emission, there is a

- A decrease in the number of neutrons and increase in the number of protons.
- B increase in the number of neutrons and decrease in the number of protons.
- C decrease in the number of protons and neutrons.
- D increase in the number of protons and neutrons.

Question 15

A radioactive substance has a half-life of 30 years. What percentage of the original radioactive material remains after 120 years?

- A 4.00%
- B 6.25%
- C 12.5%
- D 25.0%

End of Section 1

Section 2 — Short response

Section 2 has **10** questions, worth a total of 30 marks. Attempt **all** questions.

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

Question 1

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

- a. 0.6743
- b. 9.0×10^{15}

(2 marks)

Question 2

Convert the percentage error below into an absolute error.

$$423.6 \pm 2.0\% \text{ m}$$

(2 marks)

Question 3

A 900 kg car travelling at 20 ms^{-1} crashes into a barrier and comes to a complete stop in $8 \times 10^{-1} \text{ s}$.

Calculate:

- a. the magnitude of the impulse experienced by the car
- b. the work done by the barrier in stopping the car.

(5 marks)

Question 4

A crane lifts a mass of 2.3 tonnes through a vertical distance of 30 m in a time of 20 s.

Calculate:

- a. the work done in moving the mass through this distance
- b. the power required to do this.

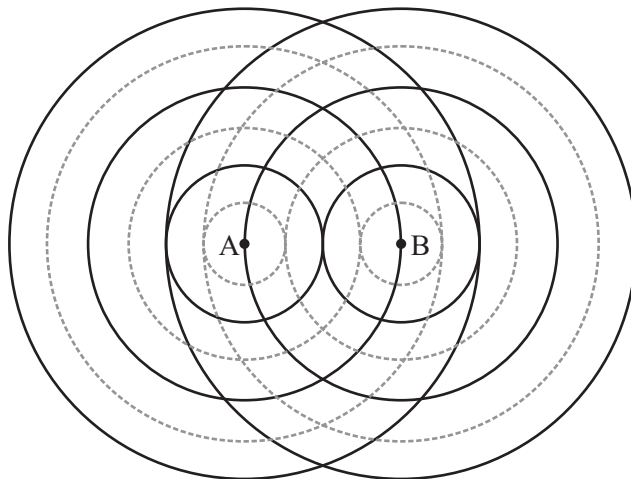
(4 marks)

Question 5

Respond to this question on page 25 of your response book.

Two in-phase point sources, A and B, generate water waves as indicated in the diagram below. Solid lines indicate crests and dotted lines indicate troughs.

Draw in a minimum of four of the nodal lines created by the interference of the two sources.



(2 marks)

Question 6

A two-point light source interference experiment used to determine the wavelength of monochromatic light source has a screen placed 4.20 m away.

If the slits have a 5.00×10^{-5} m separation, and the dark fringes on the screen have a uniform 2.80 cm separation, what is the wavelength of the light source?

(3 marks)


Question 7


What work needs to be done to move a mass of 5 g with a charge of 2.8×10^{-15} C across a potential difference of 5×10^3 V?

(3 marks)

Question 8

Labels from two electrical appliances are shown below.

Model SG620
230-240V ~ 50Hz 1850-2000W
Patented Reg Design Applied 
Made in China
DO NOT IMMERSE IN ANY LIQUID

Model: KOT500
230-240V~50Hz 1100-1200W
Q00194 
Made in China 139

Which appliance can draw the highest current? Show all working.

(3 marks)

Question 9

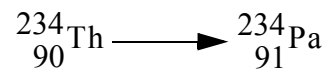
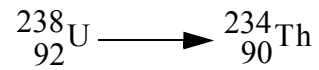
An electron having a charge of $1.6 \times 10^{-19} \text{ C}$ enters a magnetic field of strength $5.0 \times 10^{-4} \text{ T}$ at an angle of 45° to the field lines with a velocity of $1.5 \times 10^3 \text{ ms}^{-1}$.

Calculate the force experienced by the electron as a result of interacting with the field.

(2 marks)

Question 10

Identify the types of radioactive decay that occur in each of the transitions below. Explain your reasoning.



(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.

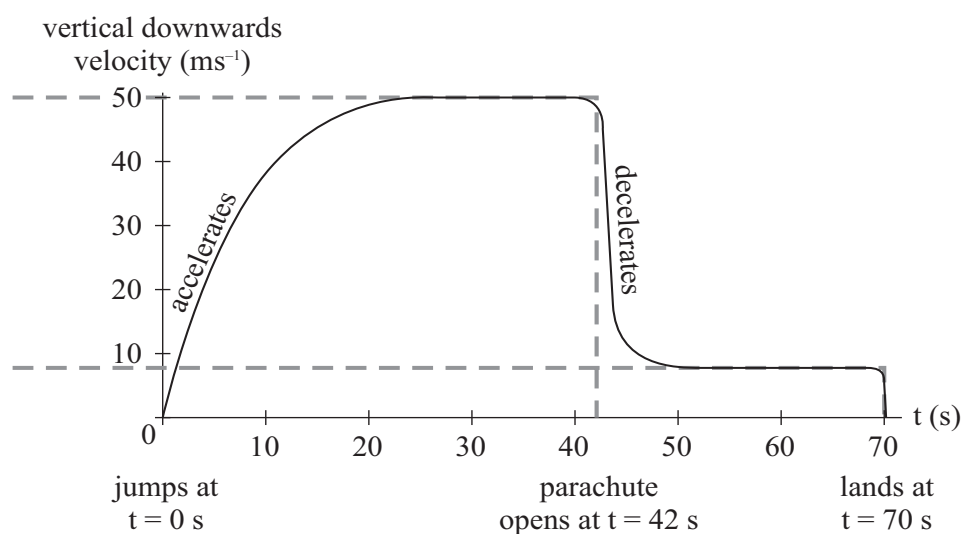
Part B has **six** questions, worth a total of 25 marks. Attempt **all** questions.

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

Suggested time allocation: **1 hour**.

Question 1

Consider the velocity vs time graph for a parachute jump shown below. During which period or periods would the parachutist experience the smallest net force?

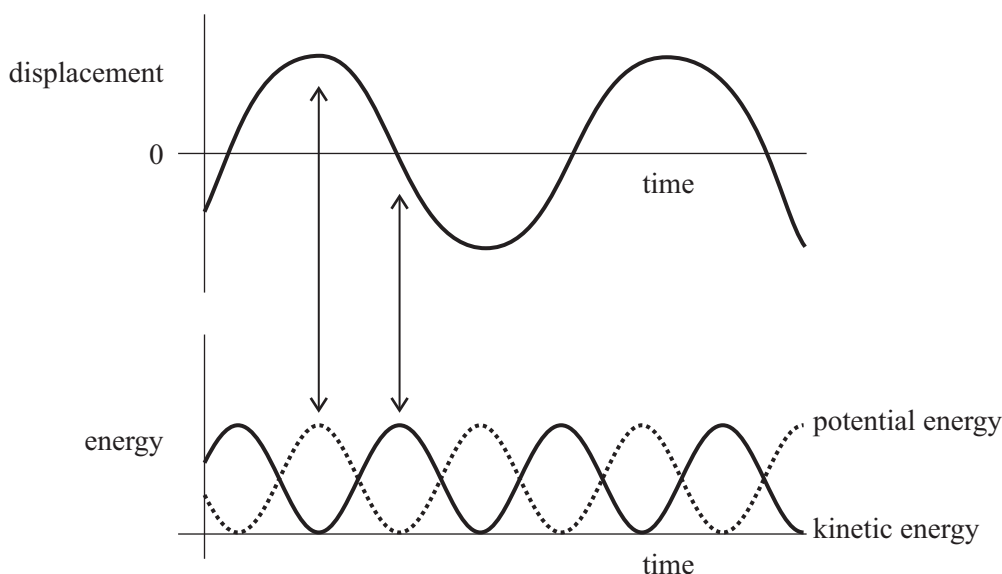


(2 marks)

Question 2

Respond to this question on page 25 of your response book.

The graphs below relate to a simple pendulum. The first graph represents the pendulum as it moves through various displacements from its equilibrium position. The second graph represents the interplay between potential and kinetic energy.

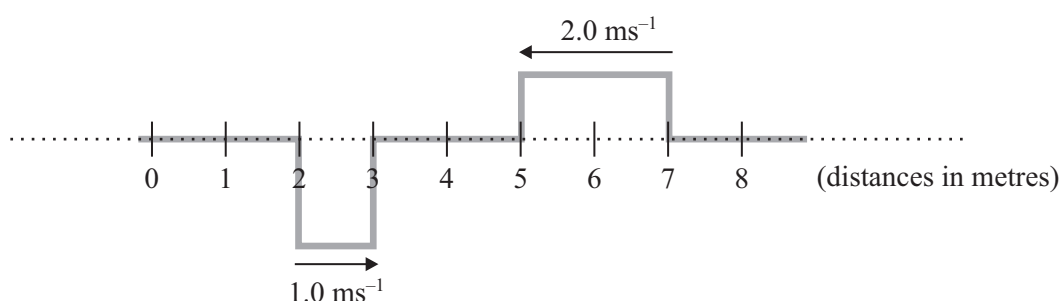


- Mark a point on the first graph that indicates a time when the pendulum is moving away from its equilibrium position. Label this point 'A'.
 - Draw in the line on the second graph representing total system energy over time.
 - Redraw the second graph on the axes provided in the response book, showing how the graphs would develop over time as the pendulum lost energy. Include the line for total energy.
- (4 marks)

Question 3

Respond to this question on page 26 of your response book.

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



- Draw the position of the waves 1.0 second after the time indicated above.
- Use the principle of superposition to sketch the resultant wave.

(4 marks)

Question 4

Respond to this question 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 5-hour intervals. The counts obtained were:

Time (hours)	0	5	10	15	20
Count rate	320	170	90	50	30

- Plot a graph of these results. Indicate on the graph the half-life of this radioactive substance.
- Identify a candidate isotope from the table below.

Table of isotope half-lives	
Isotope	10^3 seconds
fluorine-18	6.59
mendelevium-257	19.9
erbium-165	37.3
sodium-24	53.9

(5 marks)

Question 5

Michael is often interrupted while making his coffee. Sometimes it is a few minutes between when he makes it and when he can drink it. He would like to know if the coffee would remain hot for longer if he delayed putting in the milk until just before he was ready to drink it, or whether he should put the milk in when he first makes it.

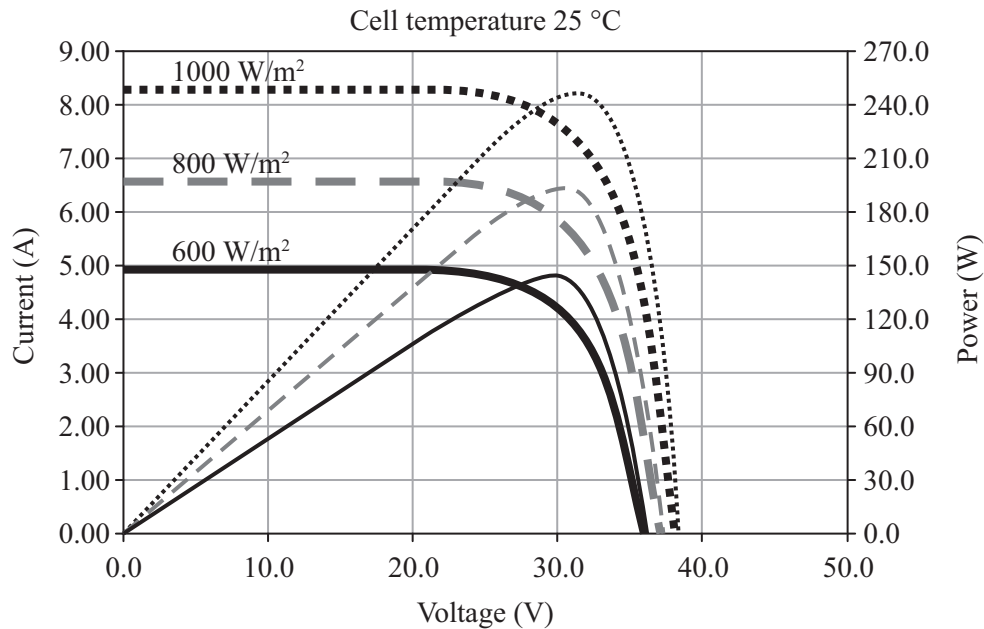
Design an experiment that will determine if the coffee will be hotter if the milk goes in just before he drinks it or when the coffee is first made. Ensure that your experiment contains proper controls and variables.

(5 marks)

Question 6

The diagram below shows the characteristic current, voltage and power curve for a solar cell at 25 °C with light of various intensities shining on it (measured in watts per square metre). The higher the light intensity, the higher the current produced.

The thinner lines represent the power output of the cells and relate to the right axis.



- What is the approximate voltage of the cell under which maximum power production occurs for the 800 Wm^{-2} light intensity?
- Explain why the power production graphs have a constant gradient before the maximum in terms of the behaviour of the voltage and current.
- Is the increase in current of the cell directly proportional to the intensity of the light shining on it? Justify your response.

(5 marks)

End of Part B

End of Paper One

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

Paper One

Criteria	Very High Achievement	High Achievement	Sound Achievement	Limited Achievement	Very Limited Achievement
Knowledge of subject matter	A very high ability to recall and apply knowledge in simple situations.	A high ability to recall and apply knowledge in simple situations.	A satisfactory ability to recall and apply knowledge in simple situations.	A limited ability to recall and apply knowledge in simple situations.	A very limited ability to recall and apply knowledge in simple situations.
Scientific processes	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.	A 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.	A satisfactory 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.	A limited ability to succeed in simple scientific process tasks.	A very limited ability to succeed in simple scientific process tasks.

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