SSABSA

SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA — EXTERNAL EXAMINATION 2005

2005 PHYSICS

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

QUESTION BOOKLET 1

20 pages, 9 questions

Tuesday 8 November: 9 a.m.

Time: 3 hours

Section A

Part 1

Examination material: Question Booklet 1 (20 pages)
Question Booklet 2 (15 pages)
Question Booklet 3 (7 pages)
one 8-page script book
one SACE registration number label

Approved dictionaries and calculators may be used.

Instructions to Candidates

1. You will have 10 minutes to read the paper. You must not write in your question booklets or script book or use a calculator during this reading time but you may make notes on the scribbling paper provided.
2. This paper is in two sections: Section A is divided between Question Booklet 1 and Question Booklet 2; Section B is in Question Booklet 3.

   Section A (Questions 1 to 19)
   This section consists of short-answer and extended questions.

   Answer Part 1 of Section A (Questions 1 to 9) in the spaces provided in Question Booklet 1. Write on page 20 of Question Booklet 1 if you need more space to finish your answers.

   Answer Part 2 of Section A (Questions 10 to 19) in the spaces provided in Question Booklet 2. Write on page 15 of Question Booklet 2 if you need more space to finish your answers.

   Section B (Questions 20 to 22)
   This section consists of one experimental skills question and two extended-response questions.

   Answer Question 20 in the spaces provided in Question Booklet 3. Write on page 6 of Question Booklet 3 if you need more space to finish your answers.

   Answer Questions 21 and 22 in the separate script book.
3. The allocation of marks and the suggested allotment of time are:

Section A		
Part 1	75 marks	65 minutes
Part 2	75 marks	65 minutes
Section B	50 marks	50 minutes
Total	200 marks	180 minutes

4. The equation sheet is on pages 3 and 4, which you may remove from this booklet.
5. Vector quantities in this paper are represented by symbols in bold type.
6. Marks may be deducted if you do not clearly show all steps in the solution of problems or if you do not define additional symbols. You should use diagrams where appropriate in your answers.
7. Use only black or blue pens for all work other than graphs and diagrams, for which you may use a sharp dark pencil.
8. Attach your SACE registration number label to the box at the top of this page. Copy the information from your SACE registration number label into the boxes on the front covers of Question Booklet 2, Question Booklet 3, and your script book.
9. At the end of the examination, place Question Booklet 2, Question Booklet 3, and your script book inside the back cover of this question booklet.

STUDENT'S DECLARATION ON THE USE OF CALCULATORS

By signing the examination attendance roll I declare that:

- my calculators have been cleared of all memory;
- no external storage media are in use on these calculators.

I understand that if I do not comply with the above conditions for the use of calculators I will:

- be in breach of the rules;
- receive zero marks for the examination;
- be liable to such further penalty, whether by exclusion from future examinations or otherwise, as SSABSA determines.

You may remove this page from the booklet by tearing along the perforations so that you will have the information in front of you for easy reference.

EQUATION SHEET

The following tables show the symbols of common quantities and physical constants used in the equations. Other symbols used are shown next to the equations. Vectors are shown in bold type. If only the magnitude of a vector quantity is used, the symbol is not shown in bold type.

Symbols of Common Quantities

acceleration	$\mathbf{a}$	wavelength	λ	momentum	$\mathbf{p}$
time	t	force	$\mathbf{F}$	electric field	$\mathbf{E}$
displacement	$\mathbf{s}$	charge	q	kinetic energy	K
velocity	$\mathbf{v}$	mass	m	magnetic field	$\mathbf{B}$
period	T	potential difference	ΔV	electric current	I
frequency	f	work done	W		

Physical Constants

Acceleration of gravity at the Earth's surface	$g = 9.8 \text{ m s}^{-2}$	Charge of the electron	$e = 1.60 \times 10^{-19}$ C
Constant of universal gravitation	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$	Mass of the electron	$m_e = 9.11 \times 10^{-31}$ kg
Speed of light in a vacuum	$c = 3.00 \times 10^8 \text{ m s}^{-1}$	Mass of the proton	$m_p = 1.673 \times 10^{-27}$ kg
Coulomb's law constant	$\frac{1}{4\pi\varepsilon_0} = 9.00 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$	Mass of the neutron	$m_n = 1.675 \times 10^{-27}$ kg
Planck's constant	$h = 6.63 \times 10^{-34}$ J s	Mass of the α particle	$m_\alpha = 6.645 \times 10^{-27}$ kg

Section 1: Motion in Two Dimensions

$\mathbf{v} = \mathbf{v}_0 + \mathbf{a}t$ $\mathbf{v}$ = velocity at time t
$\mathbf{v}_0$ = velocity at $t = 0$

$v^2 = v_0^2 + 2as$

$\mathbf{s} = \mathbf{v}_0 t + \frac{1}{2}\mathbf{a}t^2$

$\Delta\mathbf{v} = \mathbf{v}_f - \mathbf{v}_i$ $\mathbf{v}_f$ = final velocity
$\mathbf{v}_i$ = initial velocity

$\bar{\mathbf{a}} = \frac{\Delta\mathbf{v}}{\Delta t}$ $\bar{\mathbf{a}}$ = average acceleration

$a = \frac{v^2}{r}$ r = radius of circle

$v_H = v \cos\theta$

$v_V = v \sin\theta$

$v = \frac{2\pi r}{T}$

$\tan\theta = \frac{v^2}{rg}$

$F = G\frac{m_1 m_2}{r^2}$ r = distance between masses m_1 and m_2

$v = \sqrt{\frac{GM}{r}}$ M = mass of object orbited by satellite
r = radius of orbit

$\mathbf{F} = m\mathbf{a}$

$\mathbf{p} = m\mathbf{v}$

$\mathbf{F} = \frac{\Delta\mathbf{p}}{\Delta t}$

$K = \frac{1}{2}mv^2$

$W = F s \cos\theta$ θ = angle between force $\mathbf{F}$ and displacement $\mathbf{s}$

Section 2: Electricity and Magnetism

$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$ r = distance between charges q_1 and q_2

$\boldsymbol{E} = \frac{\boldsymbol{F}}{q}$

$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$

$W = q\Delta V$

$E = \frac{\Delta V}{d}$ d = distance between plates

$\boldsymbol{a} = \frac{q\boldsymbol{E}}{m}$

$F = I\Delta lB \sin\theta$ θ = angle between field $\boldsymbol{B}$ and current element $I\Delta\boldsymbol{l}$

$F = qvB \sin\theta$ θ = angle between field $\boldsymbol{B}$ and velocity $\boldsymbol{v}$

$r = \frac{mv}{qB}$

$T = \frac{2\pi m}{qB}$

$K = \frac{q^2B^2r^2}{2m}$

Section 3: Light and Matter

$c = f\lambda$ c = speed of light

$d \sin\theta = m\lambda$ d = distance between slits
m = integer (0, 1, 2, . . .)

$\Delta y = \frac{\lambda L}{d}$ Δy = distance between adjacent minima or maxima

L = slit-to-screen distance

$E = hf$

$K_{max} = hf - W$ W = work function of the metal

$f_{max} = \frac{e\Delta V}{h}$ ΔV = tube potential difference

$p = \frac{h}{\lambda}$

Section 4: Atoms and Nuclei

$E_n - E_m = hf$

$A = Z + N$ A = mass number of nucleus
Z = atomic number of nucleus
N = number of neutrons

$E_b = \Delta mc^2$ E_b = binding energy
Δm = mass defect

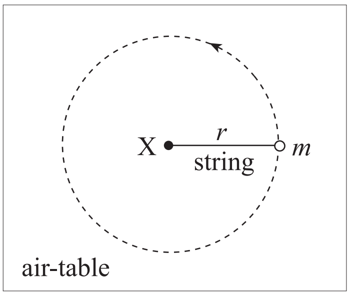
SECTION A

Part 1 (Questions 1 to 9)

(75 marks)

*Answer **all** questions in this part in the spaces provided.*

1. A puck of mass $m = 0.30$ kg is moving with uniform circular motion on a horizontal air-table. The length of the string attached to the puck is $r = 0.10$ m, as shown in the diagram below. The period of the puck's circular motion about point X is 6.28 s.



[*This diagram is not drawn to scale.*]

(a) Identify the force that is causing the centripetal acceleration of the puck.

______________________________ (1 mark)

(b) Show that the magnitude of the tension F in the string is given by $F = \frac{4\pi^2 mr}{T^2}$.

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______________________________ (3 marks)

(c) Hence calculate the magnitude of the tension in the string.

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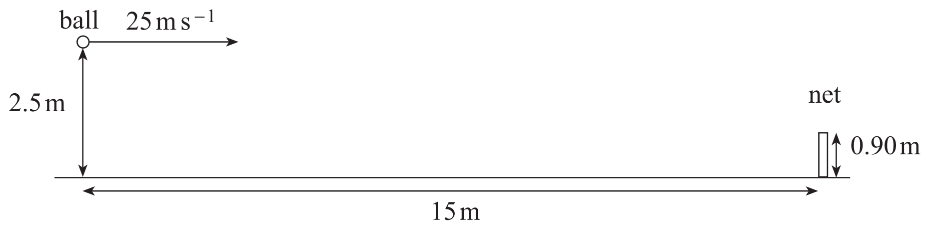
______________________________ (2 marks)

2. A tennis player hits a ball horizontally towards a net of height 0.90 m at an initial speed of 25 m s^{-1}. The ball is hit at a height of 2.5 m above the ground and at a horizontal distance of 15 m from the net, as shown in the diagram below. *Ignore air resistance and any effects of spin.*



[*This diagram is not drawn to scale.*]

(a) Show that the time the ball takes to reach the net is 0.60 s.

(1 mark)

(b) Hence calculate the change in the height of the ball during this time.

(2 marks)

(c) Determine the height at which the ball hits the net.

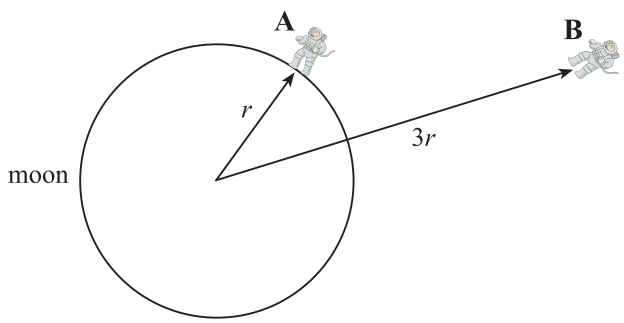
(2 marks)

(d) The tennis player's aim is to hit the ball so that it passes over the net.

State and explain *one* change that needs to be made to the way the ball is hit if the tennis player is to achieve this aim.

(3 marks)

3. Astronaut **A** is on the surface of a moon of radius *r*. Astronaut **B** is at a distance of 3*r* from the centre of the moon, as shown in the diagram below:



[*This diagram is not drawn to scale.*]

Astronaut **A** and astronaut **B** have identical masses. The magnitude of the gravitational force between the moon and astronaut **A** is 195 N.

Calculate, using proportionality, the magnitude of the gravitational force between the moon and astronaut **B**.

(3 marks)

4. A satellite is in a circular polar orbit around the Earth at an altitude of 8.54×10^5 m. The mass of the Earth is 5.97×10^{24} kg and its mean radius is 6.38×10^6 m.

(a) Calculate the orbital speed of the satellite.

(3 marks)

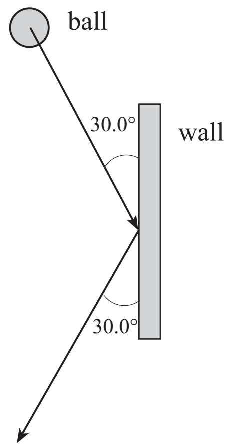
(b) State *two* reasons why low-altitude polar orbits are used in meteorology and surveillance.

(2 marks)

PLEASE TURN OVER

5. A ball of mass 0.010 kg is moving at a speed of 5.0 m s^{-1} when it collides with a wall. The ball bounces off the wall without a change of speed.

The ball is moving at 30.0° to the wall before and after the collision, as shown in the diagram below:



[*This diagram is not drawn to scale.*]

(a) Show that the magnitude of the momentum of the ball before it collides with the wall is 5.0×10^{-2} kgm s^{-1}.

(1 mark)

(b) Using a clearly labelled vector diagram, determine the magnitude and the direction of change in momentum of the ball.

Space for vector diagram.

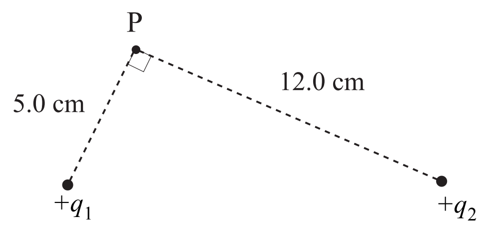
(7 marks)

6. Two positive point charges of equal magnitude q are placed a small distance apart in a vacuum, as shown in the diagram below:

(a) On the diagram above, sketch the electric field lines for the two point charges.

(3 marks)

(b) Two positive point charges of equal magnitude, $q_1 = q_2 = 1.2 \times 10^{-8}$ C, are placed a small distance apart in a vacuum. Point P is a distance of 5.0 cm from q_1 and 12.0 cm from q_2. The lines joining the charges to point P form a right angle, as shown in the diagram below:



[*This diagram is not drawn to scale.*]

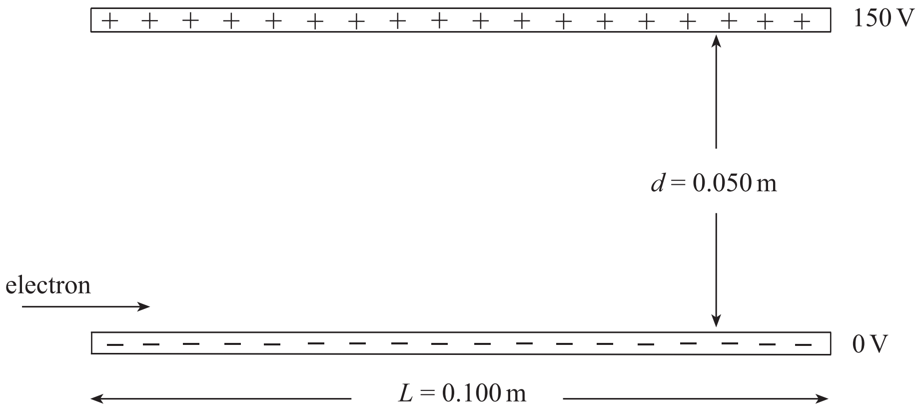
(i) Show that the magnitude of the electric field E_1 at point P, due to point charge q_1, is 4.3×10^4 N C^{-1}.

(2 marks)

(ii) Hence calculate the magnitude of the electric field at point P due to the two point charges, q_1 and q_2.

(4 marks)

7. An electron enters a uniform electric field produced by applying a potential difference of 150 V between two oppositely charged parallel plates in a vacuum. The plates are separated by a distance d = 0.050 m and are of length L = 0.100 m. The initial velocity of the electron is 1.0×10^7 m s^{-1} parallel and near to the negatively charged plate, as shown in the diagram below. *Ignore the effect of gravity.*



[*This diagram is not drawn to scale.*]

(a) Describe and explain the path followed by the electron in the uniform electric field.

(5 marks)

(b) Show that the magnitude of the acceleration of the electron in the uniform electric field is 5.3×10^{14} m s^{-2}.

(3 marks)

(c) The time the electron takes to pass through the uniform electric field is 1.0×10^{-8} s.

Determine the direction of the velocity of the electron as it leaves the uniform electric field.

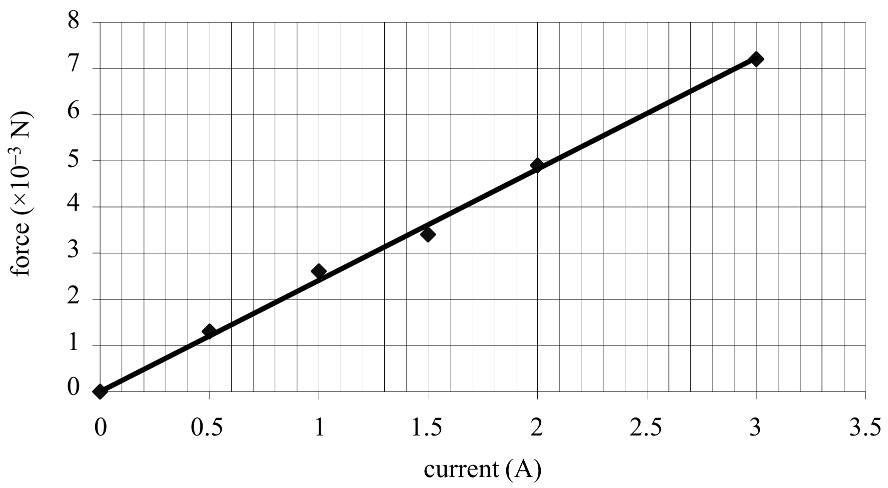
Space for optional vector diagram.

(6 marks)

8. A student investigates the relationship between the force F and the current I in a wire of length l perpendicular to a uniform magnetic field B. The student changes the current in the wire and determines the force on the wire, while keeping the magnetic field constant. An ammeter is used to measure the current in the wire.

The results obtained by the student and the line of best fit drawn through the points are shown in the graph below:

Force versus current



(a) Using the line of best fit drawn above, state and explain the relationship between the two variables, force and current.

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____ (3 marks)

(b) Show that the slope of the line of best fit drawn above should be equal to Bl.

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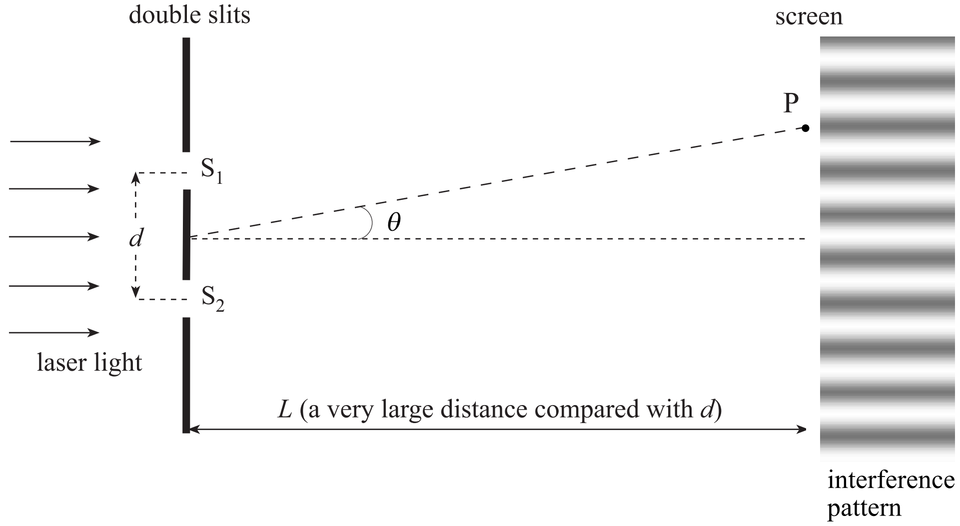
____ (3 marks)

(c) (i) On the graph on the page opposite, draw a line of best fit that could be obtained if there were a significant systematic error in the data. (1 mark)

(ii) State and explain *one* possible source of the systematic error that would produce the line of best fit you have drawn on the graph.

(2 marks)

9. A two-slit interference apparatus, with slit separation d, is shown in the diagram below. A beam of visible laser light of wavelength λ illuminates the slits, S_1 and S_2. An interference pattern is observed on the screen, a distance L from the two slits.



[*This diagram is not drawn to scale.*]

(a) The third minimum of the interference pattern is seen at point P.

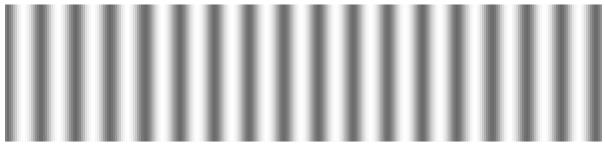
(i) Draw appropriate construction lines on the diagram above, and use them to show that the path difference from the slits to point P is $d \sin \theta$.

(5 marks)

(ii) State the value of $d \sin \theta$ in terms of λ at point P.

(1 mark)

(b) Visible laser light illuminates the slits, S_1 and S_2, with a slit separation $d = 6.5 \times 10^{-2}$ mm. A screen is placed a distance $L = 450$ mm from the slits. The interference pattern observed on the screen is reproduced in the diagram below:



[*This diagram is drawn to scale.*]

(i) Describe how you could minimise the effect of random errors in measuring the distance between adjacent maxima.

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____ (1 mark)

(ii) Hence calculate the distance between adjacent maxima. On the diagram above, clearly mark the points between which you have measured.

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____ (3 marks)

(iii) Hence calculate the wavelength of the laser light. Include the units of the wavelength.

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____ (3 marks)

You may write on this page if you need more space to finish your answers to Part 1 of Section A. Make sure to label each answer carefully (e.g. 7(a) continued).

2005 PHYSICS, Question Booklet 1

Erratum

page 11

Cross out question (b) and refer to the following replacement question:

(b) Using a clearly labelled vector diagram, determine the magnitude and direction of the change in momentum $\Delta\boldsymbol{p}$ of the ball.

SSABSA
SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA
EXTERNAL EXAMINATION 2005

2005 PHYSICS

SACE REGISTRATION NUMBER

SEQ | FIGURES | CHECK LETTER | BIN

PHYSICS

QUESTION BOOKLET

2

15 pages, 10 questions

Tuesday 8 November: 9 a.m.

Section A

Part 2

Write your answers to Part 2 of Section A in this question booklet.

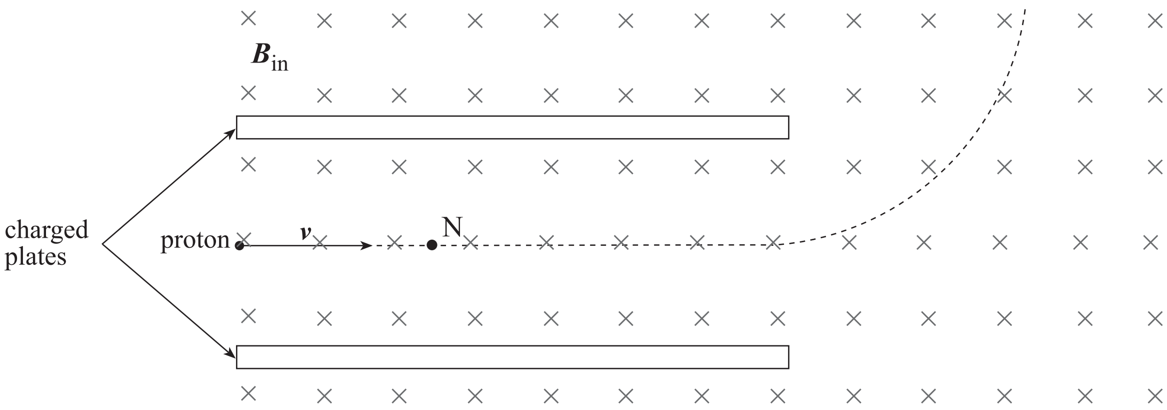
SECTION A

Part 2 (Questions 10 to 19)

(75 marks)

*Answer **all** questions in this part in the spaces provided.*

10. A uniform electric field is set up between two equal and oppositely charged parallel plates. A uniform magnetic field is directed into the page, as shown in the diagram below. Both fields exist in a vacuum. A proton travels between the plates without being deflected. It then enters the region where only the magnetic field is present. *Ignore the effect of gravity.*



[*This diagram is not drawn to scale.*]

(a) On the diagram above, draw and label vectors at point N to show the forces acting on the proton. (3 marks)

(b) Hence use one of Newton's laws of motion to explain why the velocity v of the proton remains constant while it travels between the plates.

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____ (2 marks)

(c) The magnitude of the electric field between the plates is 2.88×10^4 V m^{-1}. The magnitude of the magnetic field is 0.120 T.

(i) Show that the magnitude of the force acting on the proton due to the electric field is 4.61×10^{-15} N.

(1 mark)

(ii) Using the vectors you have drawn in part (a), show that the speed of the proton as it travels between the plates is 2.40×10^5 m s^{-1}.

(3 marks)

(d) The proton enters the region where only the uniform magnetic field is present.

(i) Explain why the proton moves with uniform circular motion in this region.

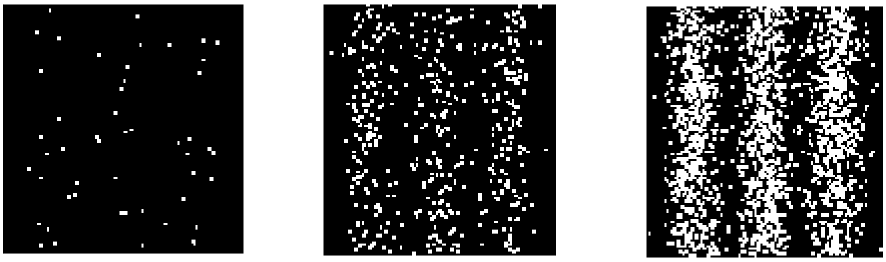
(3 marks)

(ii) Calculate the radius of the path of the proton.

(2 marks)

11. Diagram A below shows three stages in the building up of an interference pattern produced by a coherent light source of very low intensity:

Diagram A



Stage 1 *Stage 2* *Stage 3*

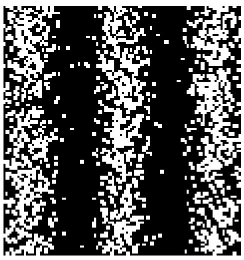
increasing time

(a) State whether the interference pattern shown above was produced by illuminating two slits or a transmission diffraction grating.

____ (1 mark)

(b) Diagram B below shows the interference pattern produced when the same procedure was used with a different coherent light source. All other variables were kept constant.

Diagram B



Stage 3

State and explain which one of the two light sources used had the longer wavelength.

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____ (2 marks)

(c) The light source used to produce the interference pattern shown in Diagram B had a wavelength of 4.50×10^{-7} m.

(i) Calculate the frequency of this light source to the appropriate number of significant figures.

(3 marks)

(ii) The diagrams on the page opposite show that light behaves like particles (called 'photons').

Calculate the magnitude of the momentum of these photons.

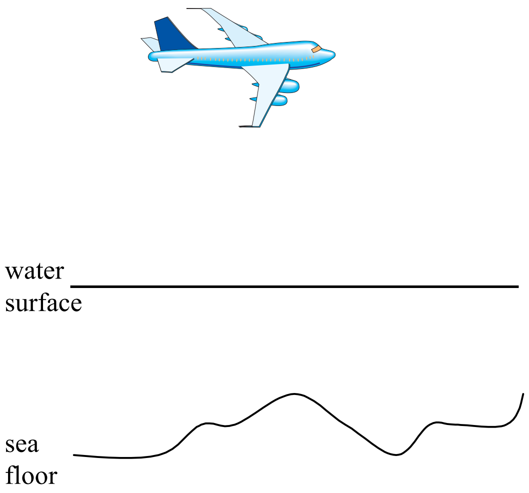
(2 marks)

12. Explain the difference between the terms 'accuracy' and 'precision'.

(2 marks)

13. The laser airborne depth sounder (LADS) is used to determine the depth of a body of water.

(a) Explain, with the aid of the diagram below, how the LADS can be used to determine the depth of sea water.

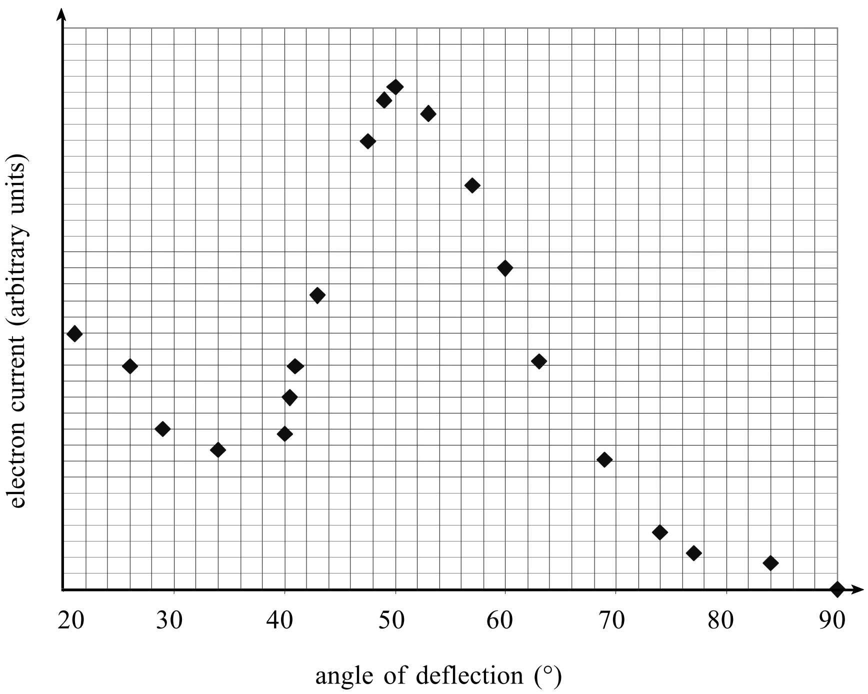


(6 marks)

(b) Justify the use of powerful lasers in the LADS.

(2 marks)

14. In a Davisson–Germer experiment electrons are accelerated by a fixed potential difference and directed onto the surface of a crystal. The electron current detected at various angles of deflection is shown in the graph below:



(a) On the graph above, draw a curve of best fit that shows the trend in the data points.

(1 mark)

(b) Using your curve of best fit, determine the angle of deflection at which the maximum electron current occurs.

____ (1 mark)

(c) State and explain what can be inferred about electrons from this experiment.

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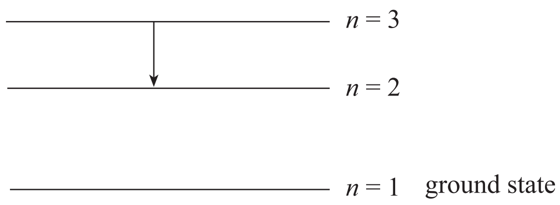
____ (3 marks)

15. A helium–neon gas laser emits photons of frequency $f = 4.74 \times 10^{14}$ Hz. These photons are emitted when an excited neon atom makes a transition from the $n = 3$ to the $n = 2$ energy level, as shown in the diagram below:



(a) Show that the energy of these photons is 1.96 eV.

(2 marks)

(b) Photons of this frequency are produced by stimulated emission in a helium–neon gas laser.

(i) Explain why a population inversion of the neon atoms is necessary in a helium–neon gas laser.

(3 marks)

(ii) Describe what is meant by a metastable state.

(1 mark)

(iii) State which energy level on the diagram above corresponds to the metastable state.

(1 mark)

(c) State two *useful properties* of the light produced by a laser.

(2 marks)

(d) State two *uses* of lasers.

(2 marks)

16. Visible light from a hydrogen discharge tube was viewed using a spectrometer with a diffraction grating that had 5.00×10^2 lines per mm. The spectrometer was used to measure the angular position of the first-order maxima of the first three visible emission lines.

(a) Each angular position was measured several times and averaged.

State the purpose of averaging measurements.

(1 mark)

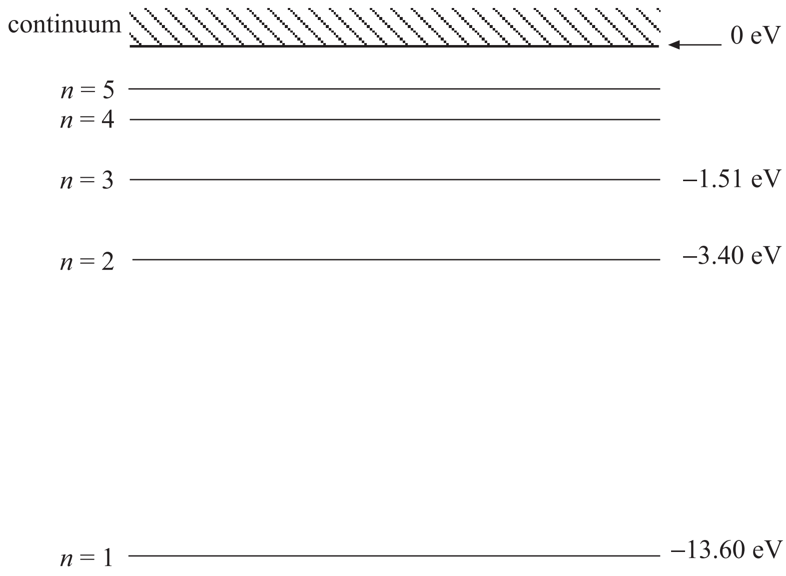
The wavelengths λ were calculated from the average measured angular positions θ. The energies E were calculated from the wavelengths λ. The results of these calculations are shown in the table below:

θ (°)	λ (m)	E (eV)
19.2	6.58×10^{-7}	1.89
14.1	4.88×10^{-7}	2.55
12.6	4.53×10^{-7}	2.86

(b) For the angular position $\theta = 19.2°$, show that the wavelength has been correctly calculated in the table above.

(2 marks)

(c) Some of the known energy levels for hydrogen are shown in the diagram below:



[*This diagram is not drawn to scale.*]

(i) On the diagram above, draw the transitions that correspond to the first three visible emission lines recorded in the table on the page opposite. (2 marks)

(ii) Using the table, determine the energy of the n = 4 level. Clearly show the steps used in your method.

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____ (2 marks)

(d) (i) On the energy level diagram above, draw and label with an S the transition that corresponds to the series limit for the emission series ending in the n = 3 state. (1 mark)

(ii) State the region of the electromagnetic spectrum in which this series limit occurs.

____ (1 mark)

(e) Absorption lines from hydrogen are observed in the visible part of the Sun's spectrum. Explain the presence of these lines.

(4 marks)

17. A common isotope of uranium is ${}^{238}_{92}U$.

(a) State the mass number of this isotope.

______________________________ (1 mark)

(b) Calculate the number of neutrons in this isotope.

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______________________________ (1 mark)

(c) State why ${}^{235}_{92}U$ has the same chemical properties as ${}^{238}_{92}U$.

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______________________________ (1 mark)

18. Many smoke detectors use a small quantity of the isotope americium-241. The half-life of americium-241 is 432 years.

Calculate how many years it will take for the activity of americium-241 in a smoke detector to decrease to 6.25% of its initial activity.

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______________________________ (2 marks)

19. (a) The following equation shows a fusion reaction that occurs in the Sun. Two hydrogen isotopes, ${}^{1}_{1}H$ and ${}^{2}_{1}H$, combine to produce a helium nucleus in an excited state, ${}^{3}_{2}He^{*}$.

$$ {}^{1}_{1}H + {}^{2}_{1}H \longrightarrow {}^{3}_{2}He^{*} $$

The masses of the particles are:

$$ {}^{1}_{1}H = 1.67262 \times 10^{-27} \text{ kg} $$

$$ {}^{2}_{1}H = 3.34359 \times 10^{-27} \text{ kg} $$

$$ {}^{3}_{2}He^{*} = 5.00642 \times 10^{-27} \text{ kg.} $$

(i) Calculate the energy, in MeV, that would be released during this reaction.

(4 marks)

(ii) Explain why the hydrogen nuclei must have high kinetic energies for fusion to take place.

(3 marks)

(b) State and explain *one* advantage of nuclear fusion over nuclear fission as a source of power.

(2 marks)

You may write on this page if you need more space to finish your answers to Part 2 of Section A. Make sure to label each answer carefully (e.g. 11(c)(i) continued).

SSABSA

SENIOR SECONDARY ASSESSMENT BOARD OF SOUTH AUSTRALIA

EXTERNAL EXAMINATION 2005

2005 PHYSICS

SACE REGISTRATION NUMBER

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PHYSICS

QUESTION BOOKLET

3

7 pages, 3 questions

Tuesday 8 November: 9 a.m.

Section B

Write your answers to Question 20 in this question booklet.
Write your answers to Questions 21 and 22 in the separate script book.

SECTION B (Questions 20 to 22)

(50 marks)

Answer Question 20 in the spaces provided in this question booklet.

20. An experiment is carried out using an X-ray tube. The potential difference ΔV across the tube is varied and the minimum wavelength λ_{min} produced is measured. The results are shown in the table below:

ΔV (× 10^4 V)	λ_{min} (× 10^{-11} m)	$f_{max} = c/\lambda_{min}$
5.00	2.47	
6.00	2.09	
7.00	1.78	
8.00	1.55	
9.00	1.38	

(a) Complete the table above by calculating each of the values of f_{max}. (2 marks)

(b) State the independent variable in this experiment.

____ (1 mark)

(c) On the page opposite, plot a graph of f_{max} on the vertical axis against ΔV on the horizontal axis, and draw a line of best fit. (6 marks)

(d) Using your line of best fit, determine the maximum-frequency X-ray that would be produced with a potential difference of 4.00 × 10^4 V. Clearly label on the graph the point you have used.

____

____

____

____ (2 marks)

(e) Calculate the gradient of your line of best fit, clearly labelling on the graph the points you have used. State the units of the gradient.

(3 marks)

(f) Using the gradient you calculated in part (e) and the expected relationship between f_{max} and ΔV in an X-ray tube, determine the value of Planck's constant h.

(4 marks)

You may write on this page if you need more space to finish your answers to Question 20. Make sure to label your answers carefully (e.g. 20(e) continued).

Questions 21 and 22 are extended-response questions. Answer these questions in the separate script book.

In answering these questions, you should:

- *communicate your knowledge clearly and concisely;*
- *use physics terms correctly;*
- *present information in an organised and logical sequence;*
- *include only information that is related to the question.*

You may use clearly labelled diagrams that are related to your answer.

21. A car is moving with constant velocity along a flat horizontal road before a collision brings the car to rest. A built-in safety feature increases the time the car takes to come to rest.
    - Identify the forces acting on the car *before* the collision. Describe the relationship between the forces when the car is moving with constant velocity.
    - Explain, using the momentum form of Newton's second law of motion, how the safety feature reduces the likelihood of injury to the driver.

(16 marks)

22. Carbon-14 is a radioisotope with a half-life of 5730 years. Carbon-14 is produced by the bombardment of atmospheric nitrogen with neutrons.
    - Explain why the ratio of carbon-14 to carbon-12 decreases in an organism after death.
    - Describe how the half-life of carbon-14 can be used to determine the age of a dead organism.

(16 marks)