Government of South Australia

SACE Board of SA

External Examination 2009

2009 PHYSICS

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

QUESTION BOOKLET

1

23 pages, 13 questions

Tuesday 3 November: 9 a.m.

Time: 3 hours

Part 1 of Section A

Examination material: Question Booklet 1 (23 pages)
Question Booklet 2 (20 pages)
Question Booklet 3 (8 pages)
one SACE registration number label

Approved dictionaries and calculators may be used.

Instructions to Students

1. You will have 10 minutes to read the paper. You must not write in your question booklets 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 divided between Question Booklet 2 and Question Booklet 3.

   Section A (Questions 1 to 24)
   This section consists of short-answer and extended questions.
   Answer Part 1 of Section A (Questions 1 to 13) in the spaces provided in Question Booklet 1.
   Write on page 23 of Question Booklet 1 if you need more space to finish your answers.
   Answer Part 2 of Section A (Questions 14 to 24) in the spaces provided in Question Booklet 2.
   Write on page 20 of Question Booklet 2 if you need more space to finish your answers.

   Section B (Questions 25 to 27)
   This section consists of one experimental skills question and two extended-response questions.
   Answer Part 1 of Section B (Question 25) in the spaces provided in Question Booklet 2.
   Write on page 20 of Question Booklet 2 if you need more space to finish your answers.
   Answer Part 2 of Section B (Questions 26 and 27) in the spaces provided in Question Booklet 3.
   Write on page 8 of Question Booklet 3 if you need more space to finish your answers.

3. The allocation of marks and the suggested allotment of time are:

Section A		
Part 1	74 marks	74 minutes
Part 2	56 marks	56 minutes
Section B		
Part 1	20 marks	15 minutes
Part 2	30 marks	35 minutes
Total	180 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 indicated by arrows over the symbols.

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 and Question Booklet 3.

9. At the end of the examination, place Question Booklet 2 and Question Booklet 3 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;
- have my marks for the examination cancelled or amended;
- be liable to such further penalty, whether by exclusion from future examinations or otherwise, as the SACE Board of South Australia determines.

Remove this page from the booklet by tearing along the perforations and keep the information in front of you for reference.

EQUATION SHEET

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

Symbols of Common Quantities

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

Magnitude of Physical Constants

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

Section 1: Motion in Two Dimensions

$\vec{v} = \vec{v}_0 + \vec{a}t$ — $\vec{v}$ = velocity at time t; $\vec{v}_0$ = velocity at $t = 0$

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

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

$v_H = v \cos\theta$ — θ = angle to horizontal

$v_v = v \sin\theta$

$v = \frac{2\pi r}{T}$ — r = radius of circle

$\Delta\vec{v} = \vec{v}_f - \vec{v}_i$ — $\vec{v}_f$ = final velocity; $\vec{v}_i$ = initial velocity

$\vec{a}_{\text{ave}} = \frac{\Delta\vec{v}}{\Delta t}$ — $\vec{a}_{\text{ave}}$ = average acceleration

$a = \frac{v^2}{r}$

$\tan\theta = \frac{v^2}{rg}$ — θ = banking angle

$F = G\frac{m_1 m_2}{r^2}$ — 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

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

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

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

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

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

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

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

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

$W = q\Delta V$

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

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

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

$r = \frac{mv}{qB}$ — r = radius of circle

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

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

Section 3: Light and Matter

$v = f\lambda$ — v = speed of light

$d \sin\theta = m\lambda$ — d = distance between slits; θ = angular position of mth maximum; m = integer (0, 1, 2, . . .)

$\Delta y = \frac{\lambda L}{d}$ — Δy = distance between adjacent minima or maxima; L = slit-to-screen distance

$d = \frac{1}{N}$ — N = number of slits per metre of grating

$E = hf$ — E = energy of photon

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

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

$W = hf_0$ — f_0 = threshold frequency

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

Section 4: Atoms and Nuclei

$E_n - E_m = hf$ — $E_n - E_m$ = energy difference

$A = Z + N$ — A = mass number; Z = atomic number; N = number of neutrons

$E = mc^2$ — E = energy

TABLE OF PREFIXES

Refer to the following table when answering questions that involve the conversion of units:

Prefix	Symbol	Value
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
centi	c	10^{-2}
milli	m	10^{-3}
micro	µ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

SECTION A

Part 1 (Questions 1 to 13)

(74 marks)

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

1. A baseball is thrown horizontally at a speed of 34 m s^{-1}. The baseball travels for 0.62 s before landing on the ground. *Ignore air resistance in this question.*

Source: www.sptimes.com

(a) State the horizontal component of velocity of the baseball when it lands, and give a reason for your answer.

(2 marks)

(b) Show that the vertical component of velocity of the baseball when it lands is 6.1 m s^{-1}.

(2 marks)

(c) Determine, with the aid of a labelled vector diagram, the direction of the velocity of the baseball when it lands on the ground. (State the angle in degrees below the horizontal.)

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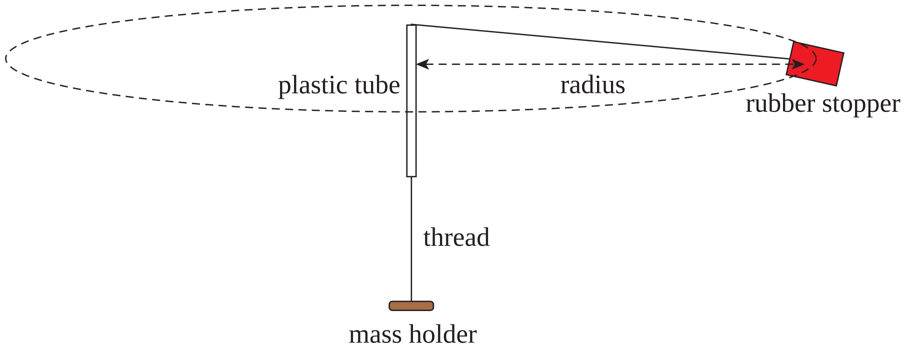
____ (3 marks)

2. A group of students attach a rubber stopper to a length of thread. The thread is passed through a short plastic tube that is held vertically. A mass holder is attached to the other end of the thread, as shown in the diagram below. The rubber stopper moves in a circular path in a horizontal plane at a constant speed.



(a) Explain why the rubber stopper accelerates even though its speed is constant.

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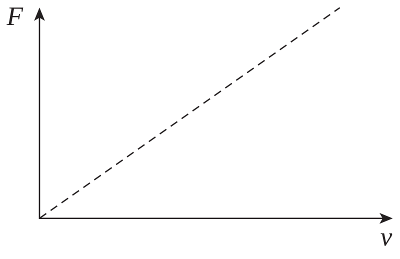
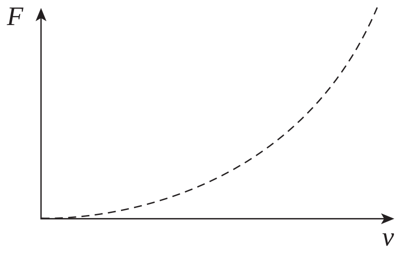
____ (2 marks)

(b) The students keep the radius of rotation constant *and* measure the time taken for ten revolutions in order to determine the speed of the rubber stopper. Masses are placed on the mass holder to vary the force F that causes the centripetal acceleration of the rubber stopper.

State which one of Graph A and Graph B below shows the expected relationship between the force F and the speed v. Explain your answer.



Graph A



Graph B

Graph that shows the expected relationship between F and v:_____

Explanation:____

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____ (3 marks)

3. The centripetal acceleration of the Earth in its orbit around the Sun has a magnitude of 5.90×10^{-3} m s^{-2}. This acceleration is caused by the gravitational force that the Sun exerts on the Earth.

The mass of the Earth is 5.97×10^{24} kg and the mean radius of the Earth's orbit around the Sun is 1.50×10^{11} m.

(a) Show that the magnitude of the gravitational force that the Sun exerts on the Earth is 3.52×10^{22} N.

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____ (1 mark)

(b) Hence determine the mass of the Sun.

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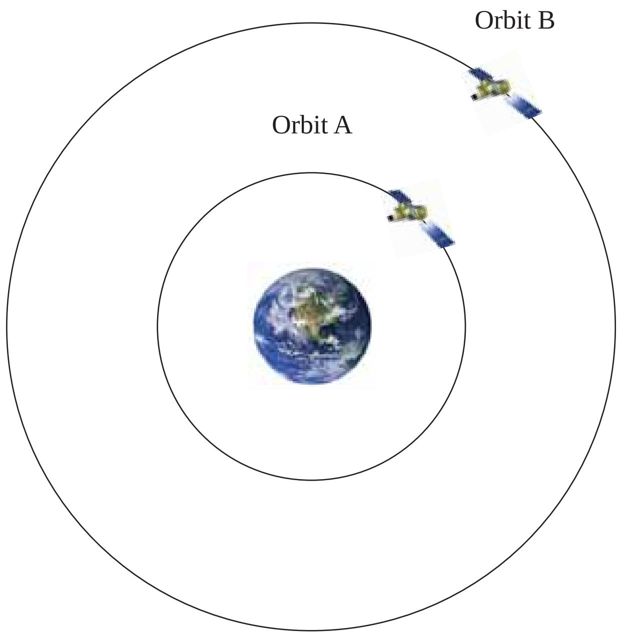
____ (3 marks)

4. Two satellites are moving in circular orbits around the Earth, Orbit A and Orbit B, as shown in the diagram below. The radius of Orbit B is double the radius of Orbit A.



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

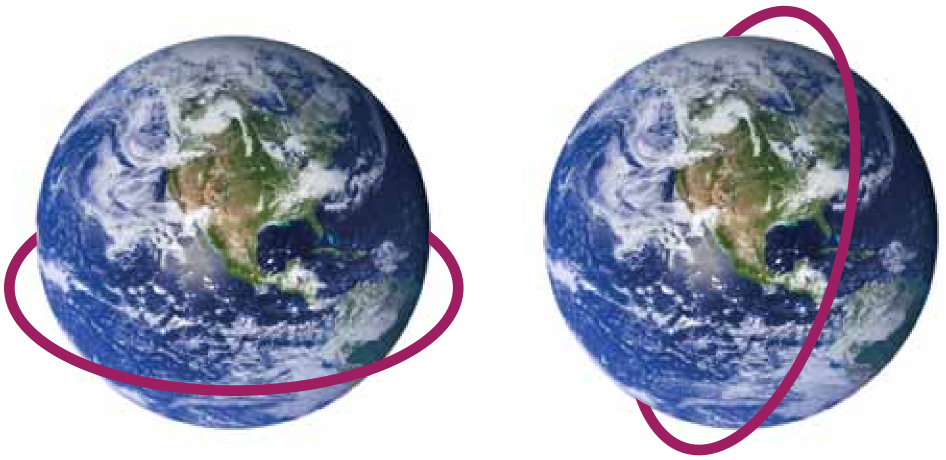
(a) Calculate the ratio $\dfrac{\text{speed of satellite in Orbit A}}{\text{speed of satellite in Orbit B}}$.

(3 marks)

(b) Explain why the centripetal acceleration of a satellite in an orbit of constant radius is independent of the mass of the satellite.

(2 marks)

(c) The diagram below shows two circular paths around the Earth. Path 1 is not a possible satellite orbit. Path 2 is a low-altitude polar orbit.



Path 1 **Path 2**

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

(i) Explain why Path 1 is not a possible satellite orbit.

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____ (3 marks)

(ii) State *one* reason why satellites in low-altitude polar orbits are often used for surveillance, and explain your answer.

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____ (2 marks)

5. The Iridium satellite network consists of sixty-six communication satellites orbiting the Earth at a radius of 7.18×10^{6} m, with a speed of 7.46×10^{3} m s^{-1}.

On 10 February 2009 the Iridium 33 satellite collided with the Russian Cosmos 2251 satellite above Siberia.

The damaged Iridium 33 satellite was replaced in the network by a spare satellite that was orbiting at a lower radius.

(a) Calculate the time that a satellite in the Iridium network takes to complete one orbit of the Earth. Give your answer to the correct number of significant figures.

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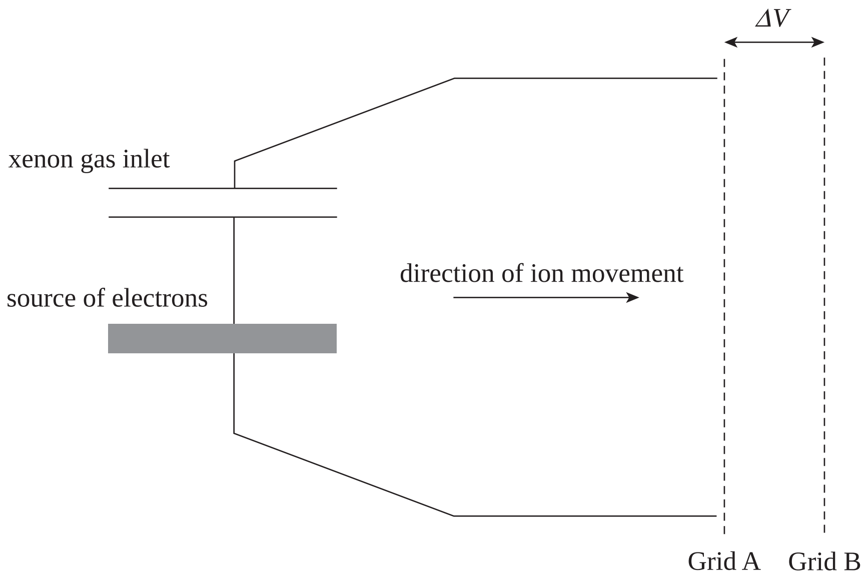
___ (3 marks)

(b) The diagram below shows an ion thruster, which may be used to change the speed of a satellite, through the emission of charged particles. Positive xenon ions are accelerated by the potential difference ΔV in the region between Grid A and Grid B as they move towards the right of the diagram.



(i) State whether Grid B must be positively charged or negatively charged for the speed of the ions to be increased.

____ (1 mark)

(ii) The xenon ions have a mass of 2.2×10^{-25} kg and a charge of 1.6×10^{-19} C.

The potential difference in the ion thruster in the region between Grid A and Grid B increases the speed of an ion by 44 km s^{-1}.

Calculate the potential difference between Grid A and Grid B. *Assume that the ion enters the region between the grids with negligible speed.*

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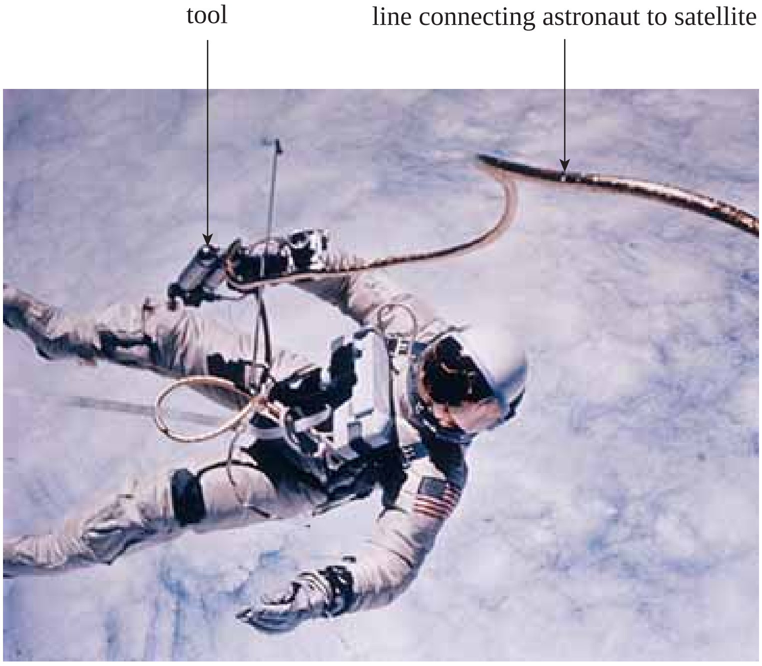
____ (4 marks)

6. A satellite is in orbit around the Earth.

An astronaut makes a spacewalk to repair the satellite. The astronaut is at rest relative to the satellite.

The line connecting the astronaut to the satellite breaks. To return to the satellite, the astronaut throws a tool directly away from the satellite. *Ignore the effect of gravity*.



Source: http://nssdc.gsfc.nasa.gov

(a) Using the law of conservation of momentum, explain why throwing the tool away from the satellite enables the astronaut to return to the satellite.

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____ (3 marks)

(b) Explain how the speed of the tool, after it is thrown, differs from the speed of the astronaut.

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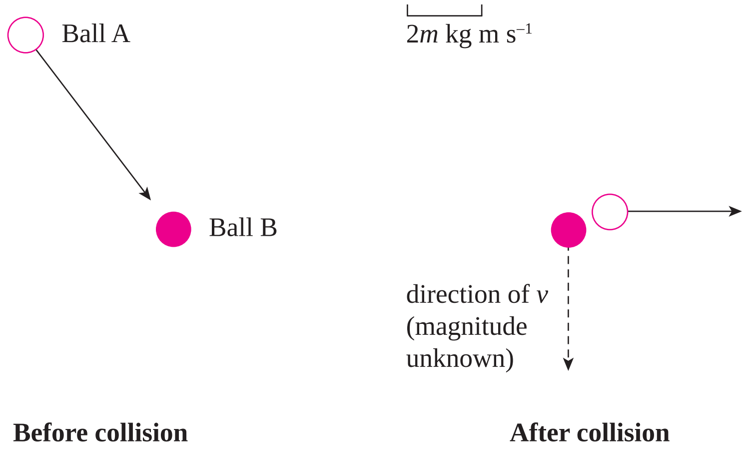
____ (2 marks)

7. The diagram below shows two balls, before and after a collision. Ball A of mass m is travelling with a speed of 5.0 m s^{-1} when it collides with Ball B of mass $2m$, which is stationary. The momentum of Ball A before and after the collision is drawn using a scale of 1 centimetre to represent $2m$ kg m s^{-1}. *The collision occurs in the absence of external forces.*



After the collision Ball A moves off with a speed of 3.0 m s^{-1}, and Ball B moves off with a speed of v. The two balls move with paths perpendicular to each other.

Determine, using a vector subtraction, the speed v of Ball B after the collision.

(5 marks)

PLEASE TURN OVER

8. Two point charges, q_1 and q_2, have *equal magnitude* but opposite charge. The charges are placed in a vacuum, as shown in the diagram below:

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

(a) Draw the electric field lines around charges q_1 and q_2. (3 marks)

(b) The charges are 12.0 cm apart and exert an electric force of magnitude 2.09×10^2 N on each other.

Show that the magnitude of each of the charges is 1.83×10^{-5} C.

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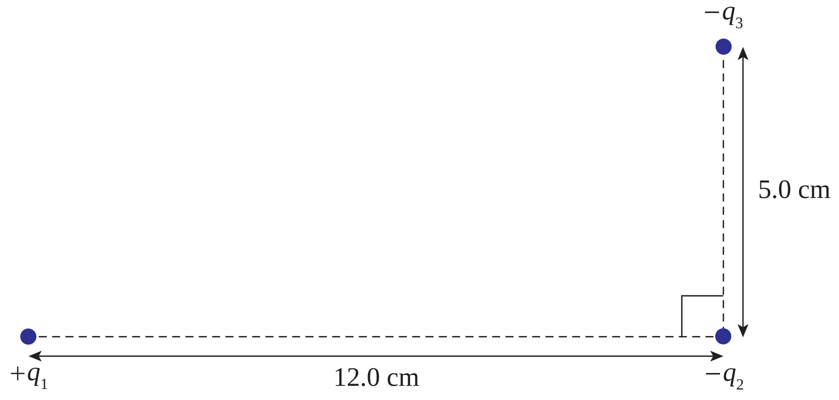
____ (3 marks)

(c) A third point charge, $q_3 = -1.20 \times 10^{-5}$ C, is now placed 5.0 cm from charge q_2, as shown in the diagram below. The line joining q_1 with q_2 is perpendicular to the line joining q_3 with q_2.



(i) Calculate the magnitude of the electric force on charge q_2 due to charge q_3.

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____ (2 marks)

(ii) (1) Draw and label a vector diagram that shows each of the electric forces acting on charge q_2.

(2 marks)

(2) Use the diagram that you have drawn for part (ii)(1) to determine the magnitude of the resultant electric force on charge q_2.

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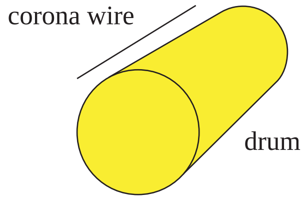
____ (2 marks)

9. The diagram below shows the drum of a photocopier and a corona wire used in the photocopying process:



Describe the action of the corona wire in charging the photoconductive surface of the drum.

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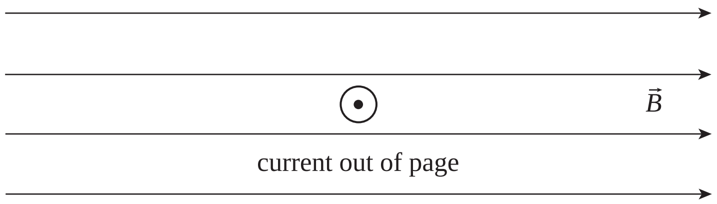
____ (3 marks)

10. (a) The diagram below shows a straight conductor carrying a current perpendicularly out of the page:

current out of page

Draw the direction of the magnetic field at point A. (1 mark)

(b) The straight conductor carries a current of 2.5×10^{-3} A. The conductor is now placed in a uniform magnetic field $\vec{B} = 0.30\ \text{T}$, directed to the right, as shown in the diagram below:



Determine the magnetic force acting on a 0.15 m length of the conductor.

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____ (3 marks)

(c) The orientation of the conductor is now changed so that the direction of the current is to the right.

Explain how the magnetic force acting on the conductor would change.

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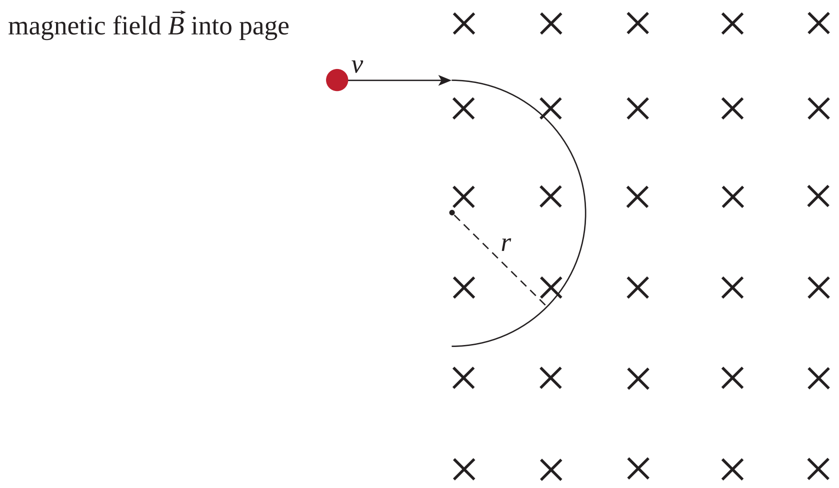
____ (2 marks)

11. An electron enters a uniform magnetic field $\vec{B}$ in a vacuum, as shown in the diagram below:



Show that the kinetic energy of an electron moving in a circular path of radius r in a uniform magnetic field of magnitude B is given by

$$K = 1.40 \times 10^{-8} \, r^2 \, B^2$$

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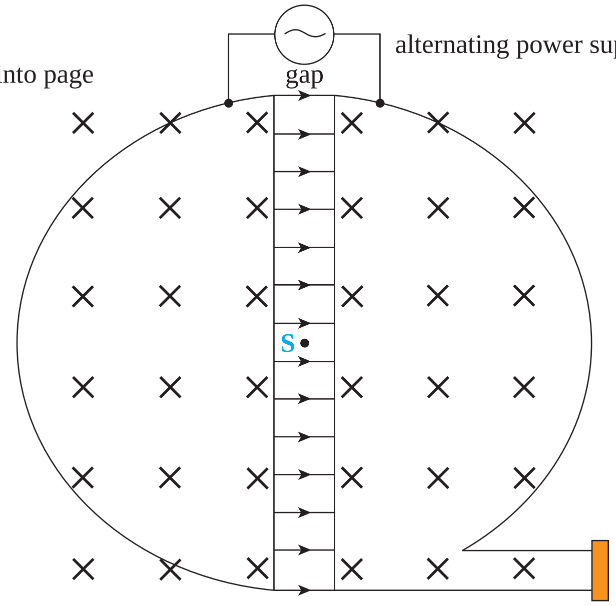
____ (2 marks)

12. The diagram below shows a cyclotron. Positive hydrogen ions are injected between the dees at point S and accelerated to high speeds before they strike the target, which contains the isotope oxygen-18 $\left({}^{18}_{8}\mathrm{O}\right)$.



(a) Describe the purpose of the magnetic field.

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______________________________________ (2 marks)

(b) Explain why the hydrogen ions must be accelerated to high speeds to produce the radioisotope fluorine-18 $\left({}^{18}_{9}\mathrm{F}\right)$.

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______________________________________ (2 marks)

13. (a) Describe the relation between the oscillating electric and magnetic fields and the direction of travel of an electromagnetic wave.

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______________________________________ (2 marks)

(b) The electric field vector $\vec{E}$ of a polarised electromagnetic wave is perpendicular to the ground.

State the orientation of an antenna if it is to receive this electromagnetic wave effectively.

______________________________________ (1 mark)

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. 6(a) continued).

Government
of South Australia

SACE
Board of SA

External Examination 2009

2009 PHYSICS

SACE REGISTRATION NUMBER			
SEQ	FIGURES	CHECK LETTER	BIN

PHYSICS

QUESTION BOOKLET

2

20 pages, 12 questions

Tuesday 3 November: 9 a.m.

Part 2 of Section A and Part 1 of Section B

Write your answers to Part 2 of Section A and Part 1 of Section B in this question booklet.

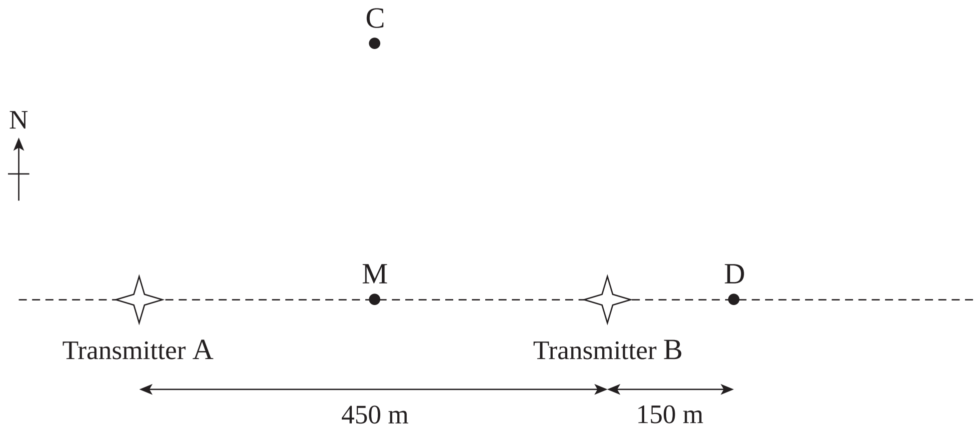
SECTION A

Part 2 (Questions 14 to 24)

(56 marks)

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

14. Vertically polarised radio waves of wavelength $\lambda = 300$ m are emitted from two radio transmitters, Transmitter A and Transmitter B. The waves are emitted in phase, with equal amplitudes. The two transmitters are separated by a distance of 450 m, as shown in the diagram below. Point M is halfway between the transmitters.



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

(a) Point C is due north of point M.

(i) State the path difference at point C in terms of the wavelength of the radio waves.

______________________________ (1 mark)

(ii) Hence explain the resultant amplitude of the radio waves at point C.

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______________________________ (2 marks)

(b) Point D is 150 m due east of Transmitter B.

(i) State the path difference at point D in terms of the wavelength of the radio waves.

______________________________ (1 mark)

(ii) Hence explain the resultant amplitude of the radio waves at point D.

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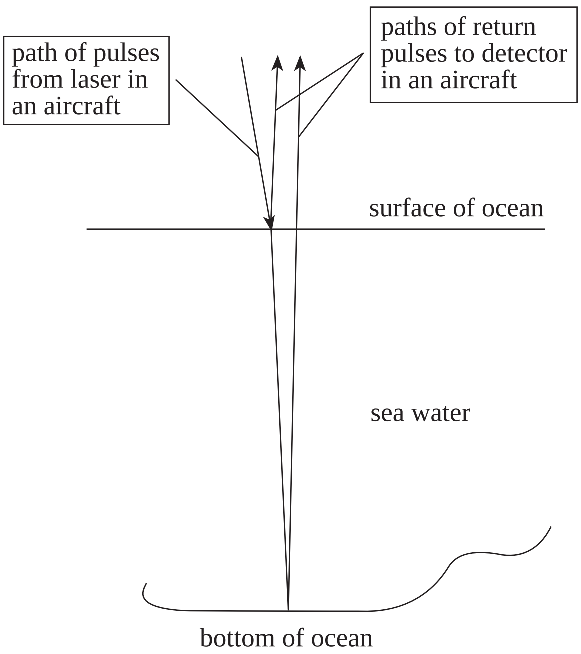
____ (2 marks)

15. Pulsed laser light from a laser airborne depth sounder (LADS) is used to measure the depth of a body of water.

(a) The diagram below shows the path of laser pulses:



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

The time difference between the return pulses at the detector is 352 ns. The speed of light in sea water is 2.30×10^8 m s^{-1}.

Calculate the depth of the water at this location.

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____ (3 marks)

(b) State two properties of laser light that make it useful in LADS.

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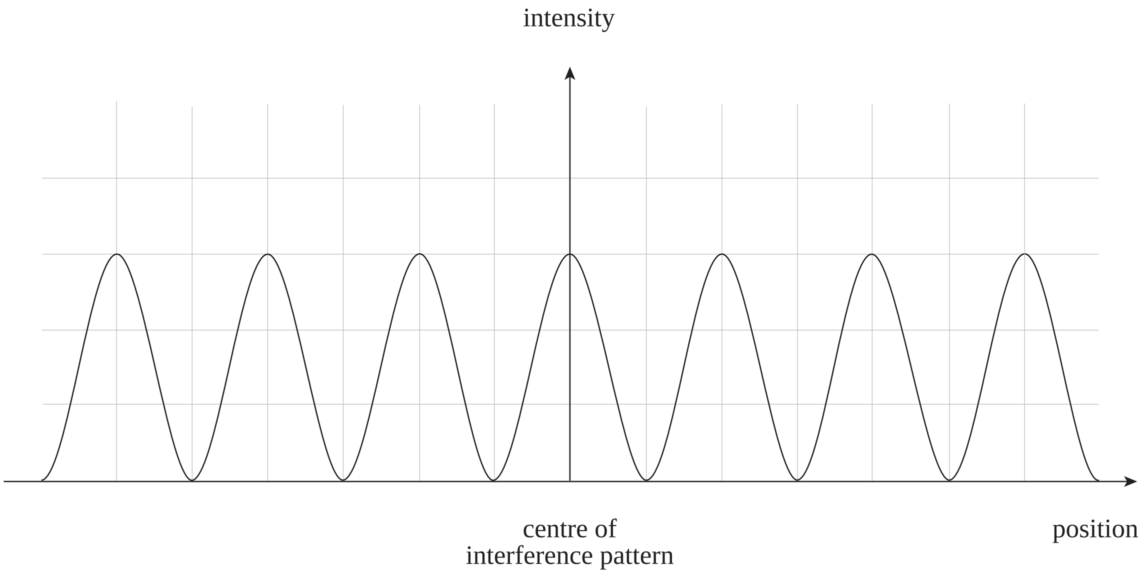
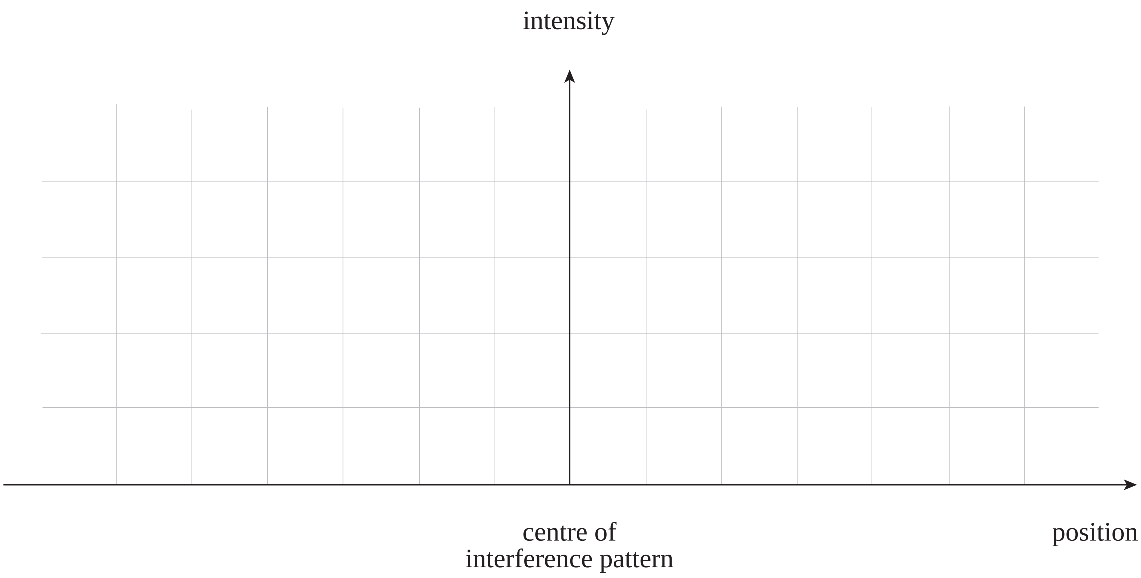
____ (2 marks)

16. A student conducts a two-slit interference experiment, using slits separated by a distance *d*. The slits are illuminated by a coherent light source with a wavelength of 450 nm. A graph of the intensity distribution for this experiment is shown below:



(a) The student repeats the experiment, using the same apparatus but replacing the light source. The new coherent light source has an intensity similar to that of the previous light source. However, the wavelength of the new light source is 675 nm.

On the grid below, draw a graph of the intensity distribution that this light source would produce.



(2 marks)

(b) State the effect on the distance between adjacent maxima if the distance *d* were doubled.

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____ (1 mark)

17. When laser light is shone on a transmission diffraction grating, a pattern consisting of a number of bright maxima is seen. Part of the pattern is shown below:

(a) Explain, in terms of interference, how a first-order maximum is produced.

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______________________________________ (2 marks)

(b) Explain why there is negligible intensity between the maxima in the pattern shown above.

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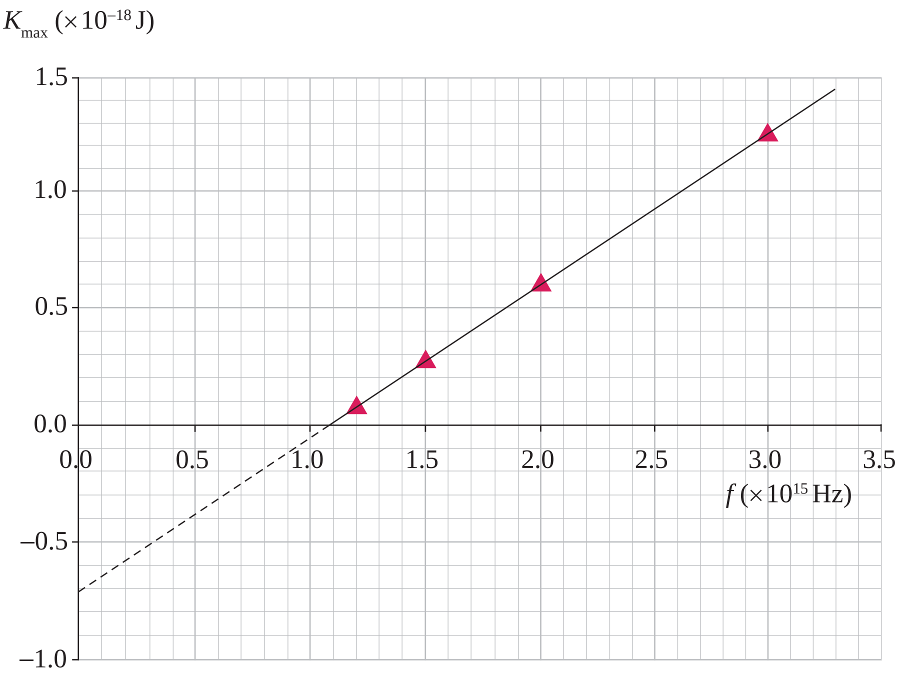
______________________________________ (2 marks)

18. An experiment is carried out to measure the maximum kinetic energy of the electrons emitted when an iron surface is illuminated by light of various frequencies. The results obtained from the experiment and the line of best fit are shown in the graph below:



(a) (i) State the value of the horizontal axis intercept of the line of best fit.

____ (1 mark)

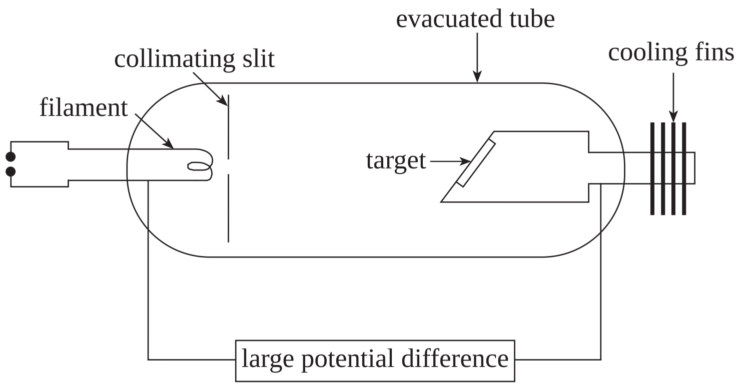
(ii) State the quantity represented by this value.

____ (1 mark)

(b) When the experiment is carried out a second time the iron surface is replaced with a different material that has a smaller work function.

On the axes above, draw a line showing the results you would expect to obtain from the second experiment. (2 marks)

19. A simple X-ray tube is shown in the diagram below:



(a) State the purpose of the following features of the X-ray tube:

(i) Filament.

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____ (1 mark)

(ii) Large potential difference.

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____ (1 mark)

(b) (i) Show that the maximum frequency produced by an X-ray tube is given by $f_{max} = \frac{e\Delta V}{h}$, where ΔV is the potential difference across the X-ray tube.

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____ (3 marks)

(ii) Calculate the potential difference necessary to produce X-rays with a maximum frequency of 2.36×10^{19} Hz.

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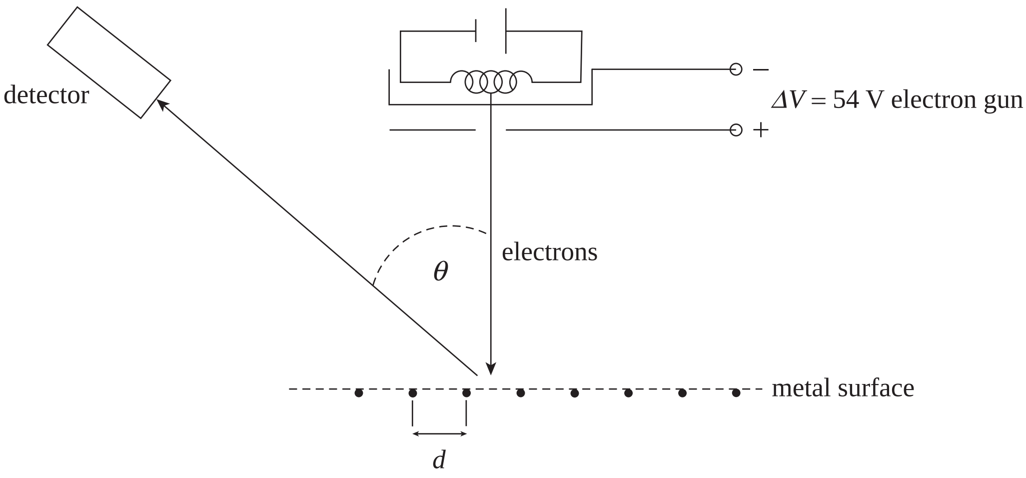
____ (2 marks)

PLEASE TURN OVER

20. (a) Calculate the speed of an electron with a kinetic energy of 54 eV.

(3 marks)

(b) In an experiment similar to that carried out by Davisson and Germer, 54 eV electrons are directed normally towards a metal surface in a vacuum, as shown in the diagram below. The spacing *d* between atoms in the surface is 0.23 nm. The wavelength of the electrons is 1.7×10^{-10} m.



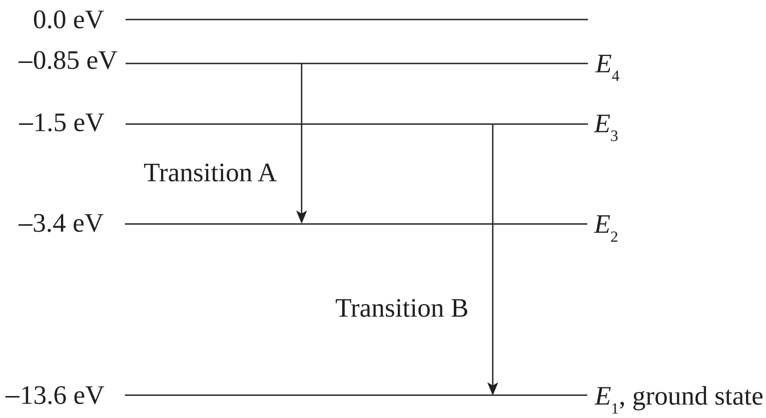
The number of electrons that reach the detector at various angles θ is recorded.

Calculate the angle of the first-order maxima.

(3 marks)

21. Part of the visible line emission spectrum for hydrogen is shown below:

The diagram below shows some of the energy levels of hydrogen:



(a) Two transitions that produce photons, Transition A and Transition B, are shown on the energy level diagram above.

State, with a reason, which transition produces the photons that form line T.

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____ (2 marks)

(b) (i) Define the term ‘ionisation energy’.

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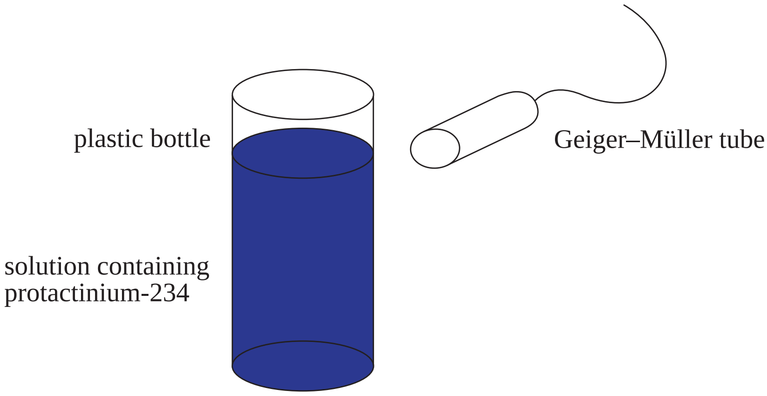
____ (2 marks)

(ii) State the ionisation energy of hydrogen.

____ (1 mark)

22. An experiment is carried out to determine the half-life of the radioisotope protactinium-234 $\left({}^{234}_{91}\text{Pa}\right)$.

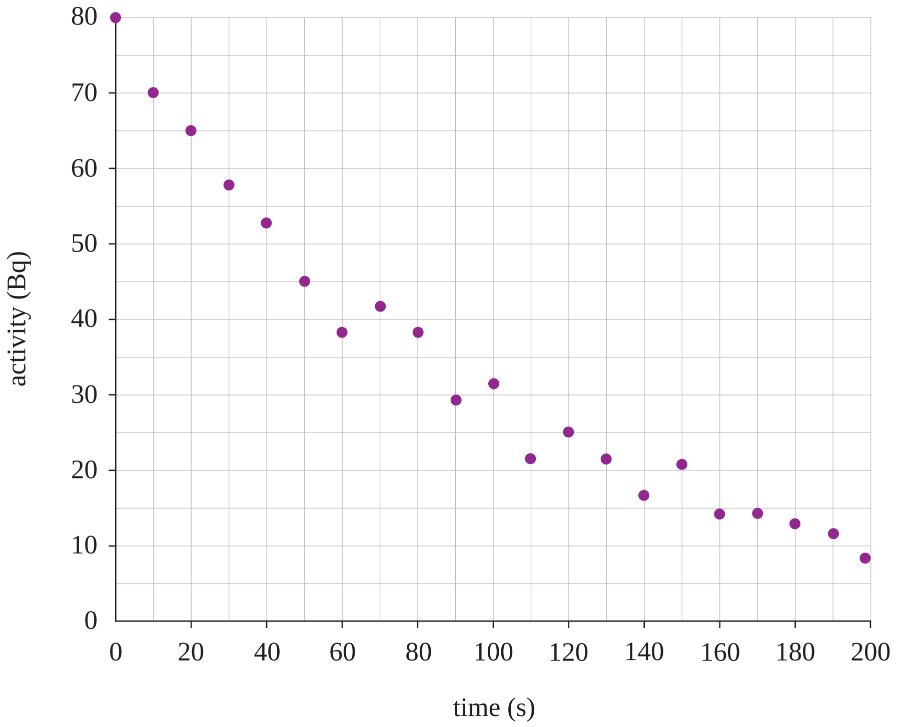
A Geiger–Müller tube detects radiation emitted by the protactinium-234 as it decays into uranium-234 $\left({}^{234}_{92}\text{U}\right)$, as shown in the diagram below:



(a) Write the equation for the decay of protactinium-234 into uranium-234.

____ (2 marks)

(b) The graph below shows the activity of protactinium-234, determined using the apparatus shown on page 12:



(i) On the graph above, draw a line or curve of best fit for the data. (2 marks)

(ii) Using your line or curve of best fit, determine the half-life of protactinium-234. Clearly indicate on the graph the points that you have used.

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____ (2 marks)

(iii) State why scatter of data points is expected in a radioactivity experiment.

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____ (1 mark)

23. Fluorine-18 is used as a tracer in positron emission tomography (PET) scans. The photograph below shows a patient undergoing a PET scan:

Source: www.webmd.com

(a) The PET scanner creates an image after detecting 0.512 MeV photons.

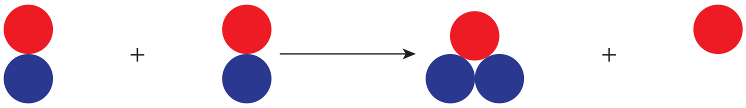
Explain how the beta plus decay of fluorine-18 can result in the production of these photons.

____ (3 marks)

(b) Calculate the frequency of a 0.512 MeV photon.

____ (3 marks)

24. Two deuterium nuclei undergo a nuclear fusion reaction that produces a tritium nucleus and a proton, as shown below:



$^{2}_{1}H$ $^{2}_{1}H$ $^{3}_{1}H$ $^{1}_{1}p$

Mass of deuterium $^{2}_{1}H$ $= 3.34451 \times 10^{-27}$ kg

Mass of tritium $^{3}_{1}H$ $= 5.00875 \times 10^{-27}$ kg

Mass of proton $^{1}_{1}p$ $= 1.67396 \times 10^{-27}$ kg

Calculate the energy released by this reaction.

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____ (3 marks)

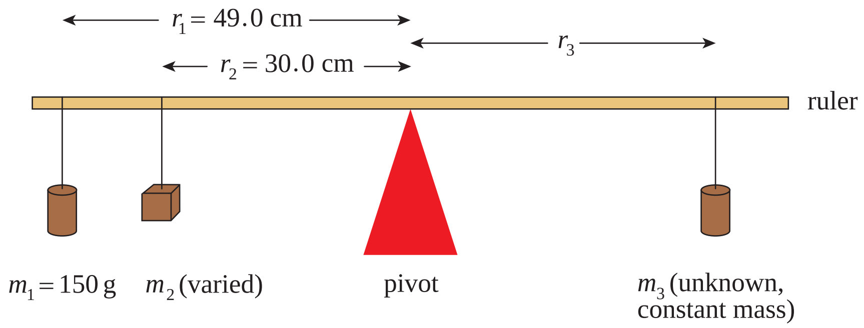
SECTION B

Part 1 (Question 25)

(20 marks)

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

25. A group of students carry out an experiment to determine an unknown, constant mass, m_3. A metre ruler is set up with a pivot at its midpoint. Three masses, m_1, m_2, and m_3, are hung from the metre ruler, as shown in the diagram below:



The mass $m_1 = 150$ g and its distance from the pivot, $r_1 = 49.0$ cm, are held constant throughout the experiment. The mass m_2 is varied but its distance from the pivot, $r_2 = 30.0$ cm, is held constant. The distance of the mass m_3 from the pivot, r_3, is then adjusted so that the ruler is balanced and remains horizontal.

The data recorded in the experiment are shown in the table below:

m_2 (g)	r_3 (cm)			
	Measurement 1	Measurement 2	Measurement 3	Average
50	32.8	32.0	31.2	
75	34.5	37.5	33.0	
100	39.0	36.0	39.0	
125	39.7	40.1	41.2	
150	43.0	45.5	40.5	

You may leave masses in grams and distances in centimetres in answering this question.

(a) Complete the table above by calculating the average measurement of r_3 for each mass m_2. (2 marks)

(b) On page 17, plot the average measurements of r_3 on the vertical axis versus mass m_2 on the horizontal axis, and draw a line of best fit. (6 marks)

(c) (i) State the type of experimental errors that the students have attempted to minimise by averaging a number of measurements of r_3.

(1 mark)

(ii) Explain, using the graph you have drawn for part (b) and the data in the table on page 16, whether or not the experimental errors of this type have been reduced.

(2 marks)

(d) Determine the gradient of your line of best fit. Include the units of the gradient.

(3 marks)

(e) State the equation of your line of best fit in terms of r_3 and m_2.

(2 marks)

(f) The ruler will be balanced when:

$$m_1 r_1 + m_2 r_2 = m_3 r_3.$$

Using this expression and the equation of your line of best fit from part (e), determine the mass m_3.

(4 marks)

PLEASE TURN OVER

You may write on this page if you need more space to finish your answers to Part 2 of Section A or to Part 1 of Section B. Make sure to label each answer carefully (e.g. 23(a) continued).

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External Examination 2009

2009 PHYSICS

SACE REGISTRATION NUMBER

SEQ	FIGURES	CHECK LETTER	BIN

PHYSICS

QUESTION BOOKLET

3

8 pages, 2 questions

Tuesday 3 November: 9 a.m.

Part 2 of Section B

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

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SECTION B

Part 2 (Questions 26 and 27)

(30 marks)

Questions 26 and 27 are extended-response questions. Answer ***both*** *questions.*

Write your answers in this question booklet:

- Question 26, on pages 4 and 5, is worth 14 marks.
- Question 27, on pages 6 and 7, is worth 16 marks.

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 questions.

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

26. A spectrometer fitted to a telescope separates light of different frequencies produced by a star, forming an absorption spectrum, as shown below. By analysing this absorption spectrum, astronomers can identify the elements in the star.

- Describe how the absorption lines in the spectrum of the star are produced.
- Explain why this absorption spectrum can be used to identify the elements in the star.

(14 marks)

27. Electric fields and magnetic fields have different effects on the motion of charged particles.

A positive ion enters a uniform electric field $\vec{E}$. The velocity of the ion is perpendicular to the electric field, as shown in Diagram A below.

A positive ion enters a uniform magnetic field $\vec{B}$. The velocity of the ion is perpendicular to the magnetic field, as shown in Diagram B below.

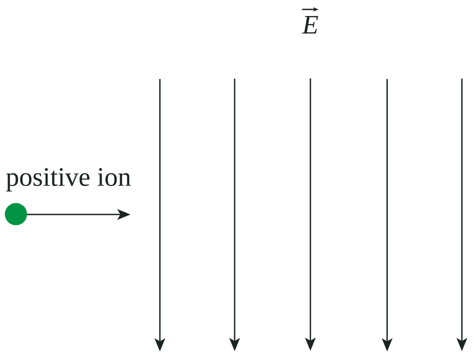

Diagram A

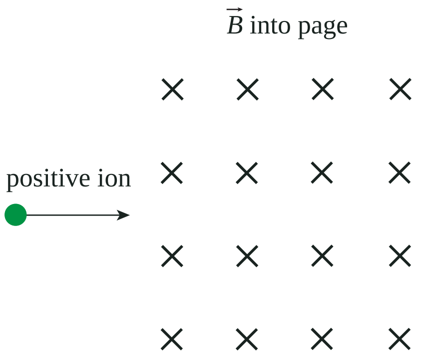

Diagram B

- Describe and explain the shape of the path of the positive ion in the electric field in Diagram A.
- Describe and explain the shape of the path of the positive ion in the magnetic field in Diagram B.

Ignore the effects of gravity and air resistance. (16 marks)

You may write on this page if you need more space to finish your answers to Questions 26 and 27. Make sure to label each answer carefully (e.g. 26 continued).

PHYSICS 2009

ERRATUM

Question Booklet 1
Page 20, Question 11

In the printed examination paper the character ^{2} was missing from the end of the equation that precedes the answer lines. The error has been corrected in this electronic version of the paper.