Government
of South Australia

SACE
Board of SA

External Examination 2012

2012 PHYSICS

ATTACH SACE REGISTRATION NUMBER LABEL
TO THIS BOX

QUESTION BOOKLET
1
24 pages, 14 questions

Thursday 1 November: 1.30 p.m.

Time: 3 hours

Part 1 of Section A

Examination material: Question Booklet 1 (24 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 in Question Booklet 3.

   Section A (Questions 1 to 25)
   This section consists of questions of different types (e.g. short answer, graphical interpretation, and data and practical skills).
   Answer Part 1 of Section A (Questions 1 to 14) in the spaces provided in Question Booklet 1.
   Write on page 24 of Question Booklet 1 if you need more space to finish your answers.
   Answer Part 2 of Section A (Questions 15 to 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.

   Section B (Questions 26 and 27)
   This section consists of two extended-response questions.
   Answer Section B 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	72 marks	70 minutes
	Part 2	78 marks	78 minutes
Section B			
		30 marks	32 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, if you give answers with an inappropriate number of significant figures or with incorrect units, 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 results 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 time $t = 0$

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

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

$v_H = v\cos\theta$ — 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

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

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

$F = qvB\sin\theta$ $\theta =$ 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
$\theta =$ angular position of mth maximum
$m =$ integer $(0, 1, 2, \ldots)$

$\Delta y = \frac{\lambda L}{d}$ $\Delta y =$ 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

$f_{max} = \frac{e\Delta V}{h}$ $\Delta V =$ 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}

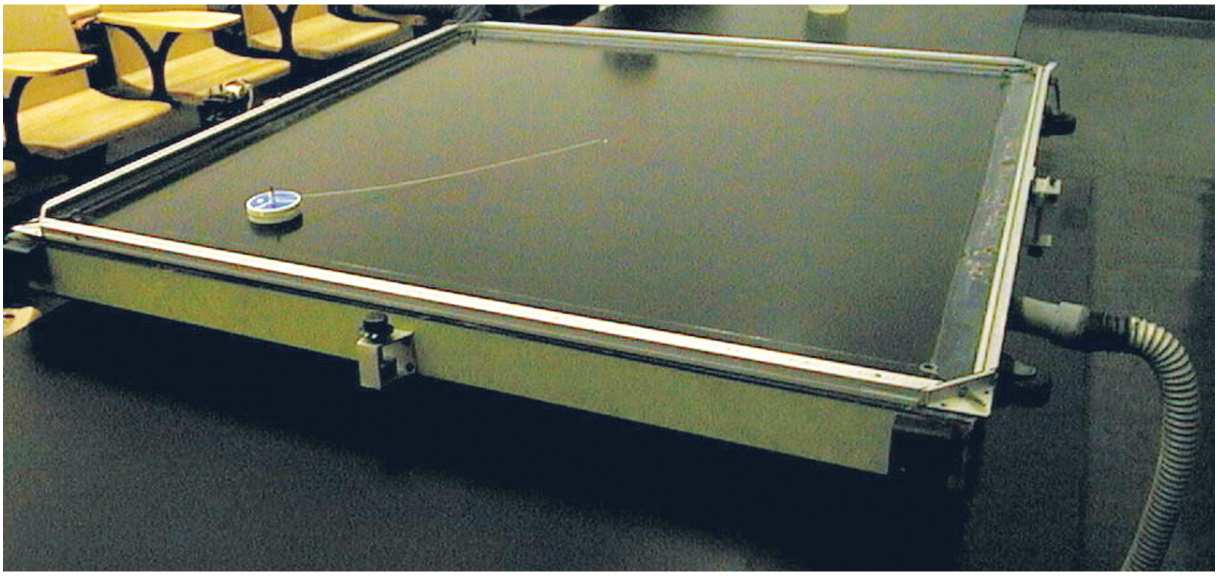
SECTION A

PART 1 (Questions 1 to 14)

(72 marks)

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

1. A piece of string is used to attach a puck to the centre of an air-table, as shown in the photograph below:



Source: www.columbia.edu/cu/physics/

The puck has a mass of $0.035\,\mathrm{kg}$. It is made to move around the centre of the air-table in uniform circular motion, with a speed of $2.4\,\mathrm{m\,s^{-1}}$. The radius of the circular path is $0.32\,\mathrm{m}$.

(a) State the force on the string that causes the centripetal acceleration of the puck.

____ (1 mark)

(b) Calculate the magnitude of the force that causes the centripetal acceleration of the puck.

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____ (3 marks)

2. The photograph below shows an athlete competing in a javelin throw:

Source: © iStockphoto.com/songbird839

A javelin is thrown from a shoulder height of $1.50\,m$. The initial velocity of the javelin is $25.0\,m\,s^{-1}$, at an angle of $40.0°$ above the horizontal.

Ignore air resistance in all parts of this question.

(a) Show that the vertical component of the initial velocity of the javelin is $16.1\,m\,s^{-1}$.

____ (1 mark)

(b) Calculate the maximum height of the javelin above the ground.

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____ (4 marks)

(c) Athletes competing in a javelin throw try to achieve the maximum range.

Describe and explain the effect that increasing the launch height of a javelin has on the maximum range.

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____ (3 marks)

3. Velodromes are cycle-racing tracks with banked curves that enable cyclists to travel at high speeds, as shown in the photograph below:

This image of a cyclist on a track with a banked curve cannot be reproduced here for copyright reasons.

Source: http://popmiseryblog.blogspot.com.au

(a) *On the diagram below*:

(i) draw a vector to show the normal force $\vec{F}_n$ on a bicycle travelling with uniform circular motion around a banked curve. (1 mark)

(ii) resolve the normal force vector into its horizontal and vertical components, labelling each component. (2 marks)

Source: Image adapted from iStockphoto.com/steamroller_blues

(b) (i) State why the vertical component of the normal force vector has a magnitude of mg, where m is the total mass of the cyclist and the bicycle.

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____ (1 mark)

(ii) Derive the equation $\tan\theta = \frac{v^2}{rg}$, relating the banking angle θ to the speed v at which the cyclist is travelling and the radius of curvature r.

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____ (3 marks)

(c) A cyclist is travelling around a banked curve in a velodrome. The banked curve has a radius of $26\,\mathrm{m}$ and a banking angle of $42°$.

Calculate the maximum speed at which the cyclist can travel around the banked curve without relying on friction.

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____ (3 marks)

4. In November 2012 parts of the world will experience a total solar eclipse. During such an eclipse the Earth, the Moon, and the Sun are in a straight line. The Moon is between the Earth and the Sun.

In this alignment the distance between the Earth and the Moon is 3.85×10^{8} m, and the distance between the Moon and the Sun is 1.50×10^{11} m.

The mass of the Earth is 5.97×10^{24} kg.

The mass of the Moon is 7.35×10^{22} kg.

The mass of the Sun is 1.99×10^{30} kg.

Source: © iStockphoto.com/oversnap

Determine the magnitude of the ratio $\frac{\text{force on the Moon due to the Earth}}{\text{force on the Moon due to the Sun}}$.

____ (4 marks)

5. The QuickBird satellite is used to create images of the Earth. One such image is shown below left. The satellite orbits at an altitude of $482\,\text{km}$, and has a mass of 9.5×10^{2} kg.

The International Space Station (shown in the image below right) orbits at an altitude of $390\,\text{km}$, and has a mass of 4.2×10^{5} kg.

Source: www.digitalglobe.com/product-samples
© 2012 Digital Globe, Inc.

Source: © iStockphoto.com/scibak

(a) State whether the QuickBird satellite orbits the Earth at a faster or slower speed than the International Space Station. Give a reason for your answer.

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____ (2 marks)

(b) State any effect that the different masses of the satellites will have on their speeds. Give a reason for your answer.

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____ (2 marks)

(c) State one advantage of the QuickBird satellite's low-altitude orbit.

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____ (1 mark)

6. Diagram 1 shows the momentum vector of ball A before it collides with ball B, which is stationary:

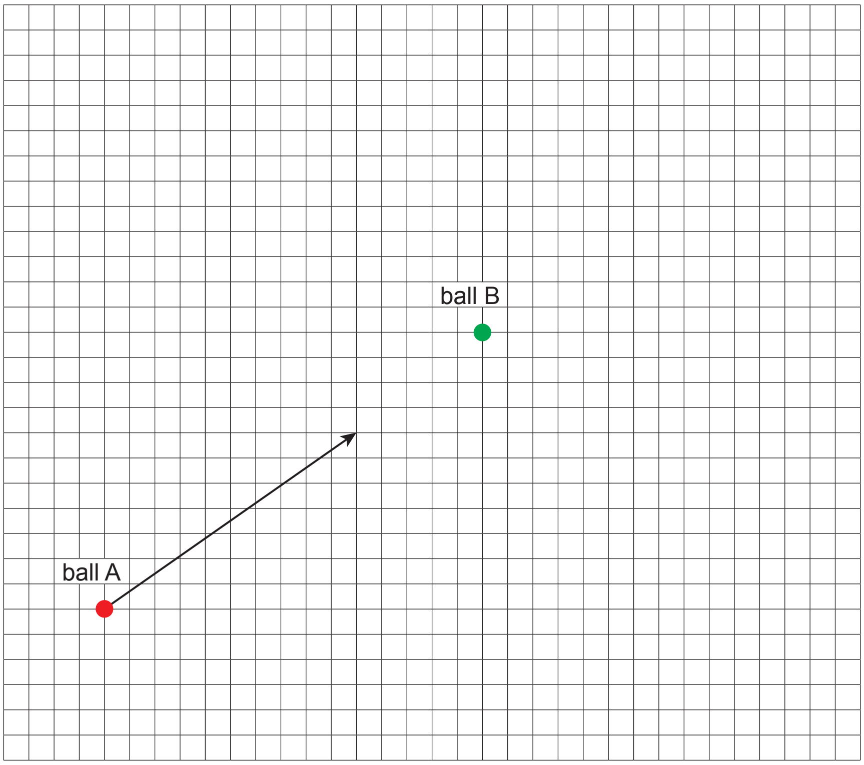


Diagram 1

Diagram 2 shows the momentum vector of ball A after the collision:

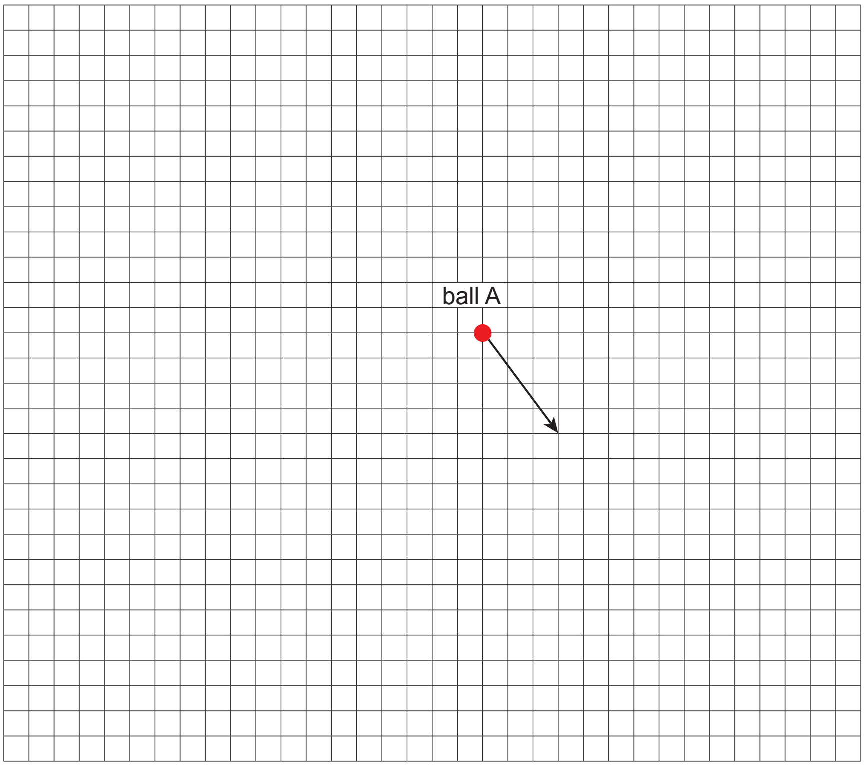


Diagram 2

On Diagram 2 on the page opposite, draw the momentum vector of ball B after the collision.
Show your working.

Assume an isolated system.

(4 marks)

7. Solar sails can use the photons from the Sun to accelerate a spacecraft.

(a) Explain, with the aid of vector diagrams, why photons experience a greater change in momentum when they are reflected from, rather than absorbed by, a solar sail.

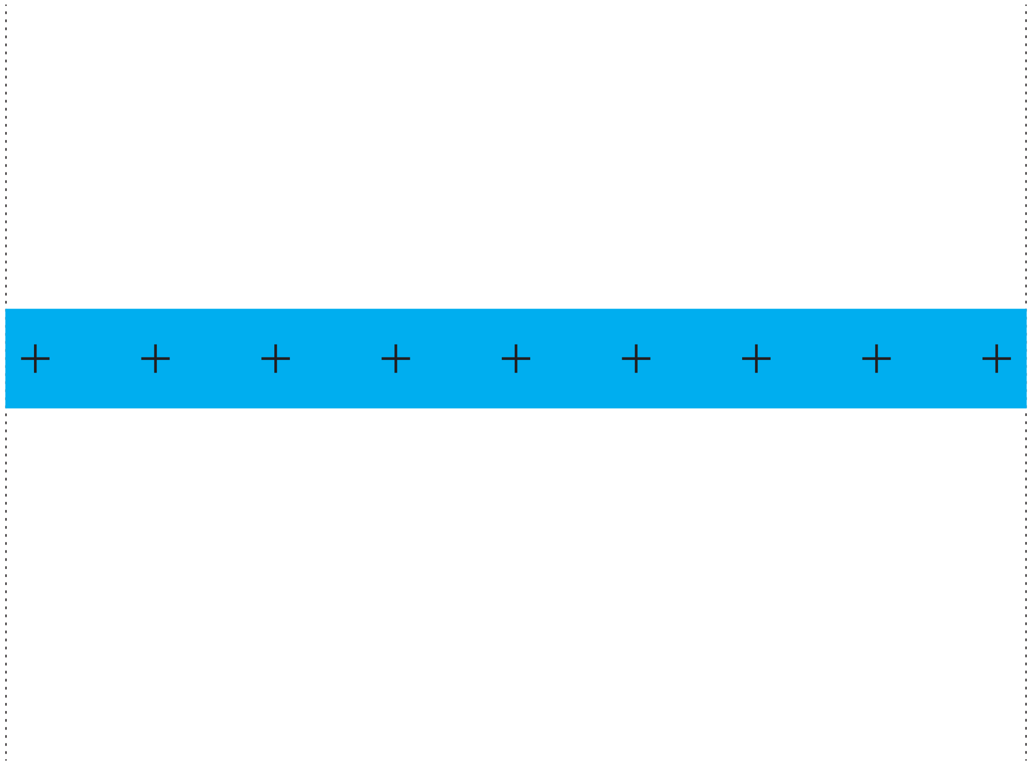
Consider only photons that are normally incident on the sail.

(4 marks)

(b) Hence, explain why a solar sail that reflects photons will undergo a greater acceleration than a solar sail that absorbs photons.

(2 marks)

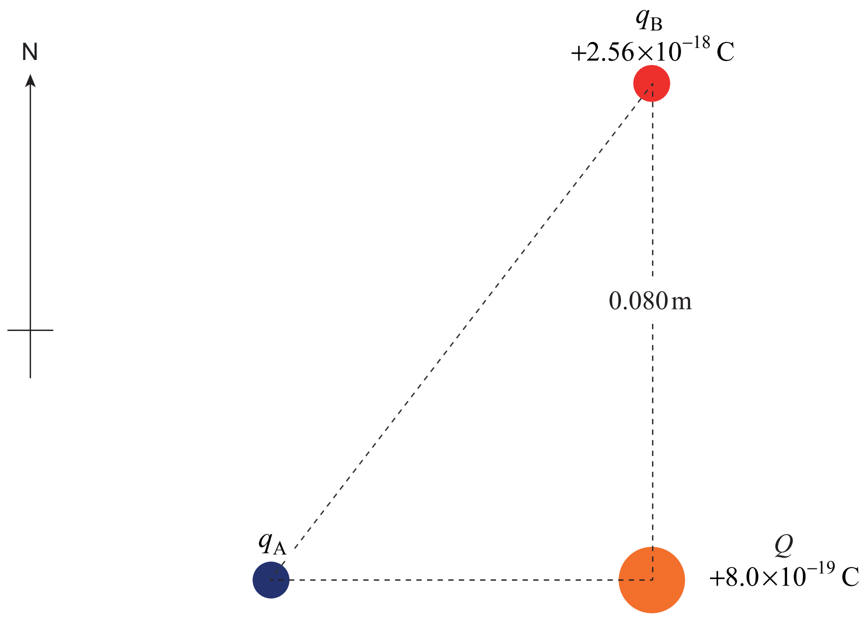
8. The diagram below shows a section of an infinitely long, positively charged conducting plate:



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

On the diagram above, draw the electric field due to the positively charged conducting plate in the region between the dotted lines. (3 marks)

9. The diagram below shows three point charges positioned at the corners of a right-angled triangle. The direction of north is also shown on the diagram.



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

Charge q_B, which has a magnitude of $+2.56\times10^{-18}$ C, is 0.080 m from charge Q. The magnitude of charge Q is $+8.0\times10^{-19}$ C.

Charge Q experiences a force, towards the east, of magnitude 2.9×10^{-24} N due to q_A.

(a) Calculate the magnitude of the force that charge Q experiences due to q_B.

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______________________________________ (2 marks)

(b) Calculate the magnitude and direction of the total force acting on charge Q.

(5 marks)

10. The diagram below shows two parallel conductors. The conductors carry currents I_1 and I_2 in the directions shown.

Each conductor is within the magnetic field created by the other conductor.

Determine, giving reasons, whether the two conductors attract or repel each other.

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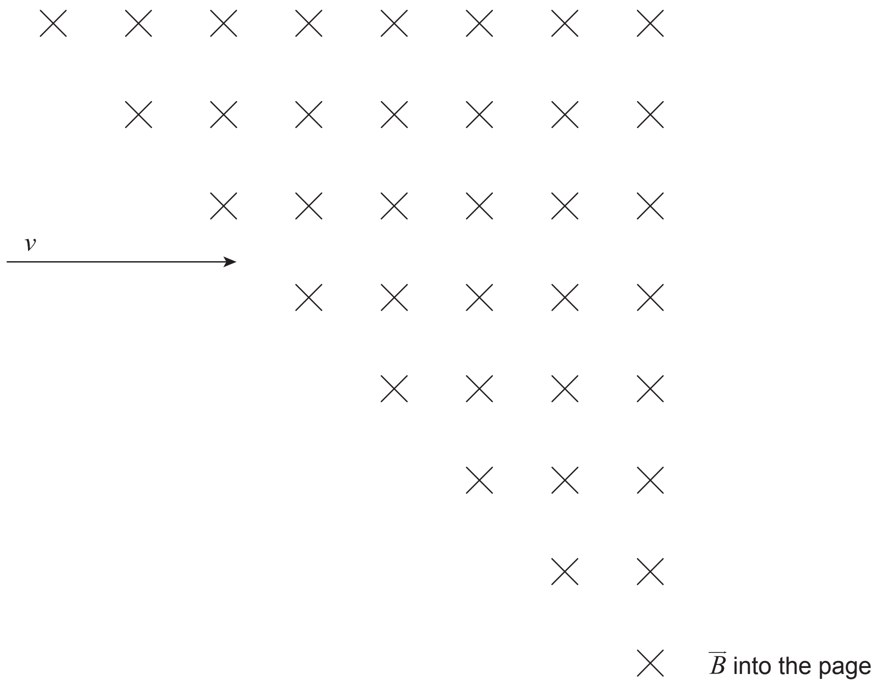
____ (3 marks)

11. The diagram below shows a uniform magnetic field directed into the page. The magnitude of the magnetic field is $B = 2.5 \times 10^{-2}$ T. An electron, travelling with a speed of $v = 1.45 \times 10^{6}\ \mathrm{m\,s^{-1}}$ in the plane of the page, enters the magnetic field.



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

(a) *On the diagram above*, sketch the path taken by this electron in the magnetic field. (1 mark)

(b) Calculate the magnitude of the magnetic force acting on the electron.

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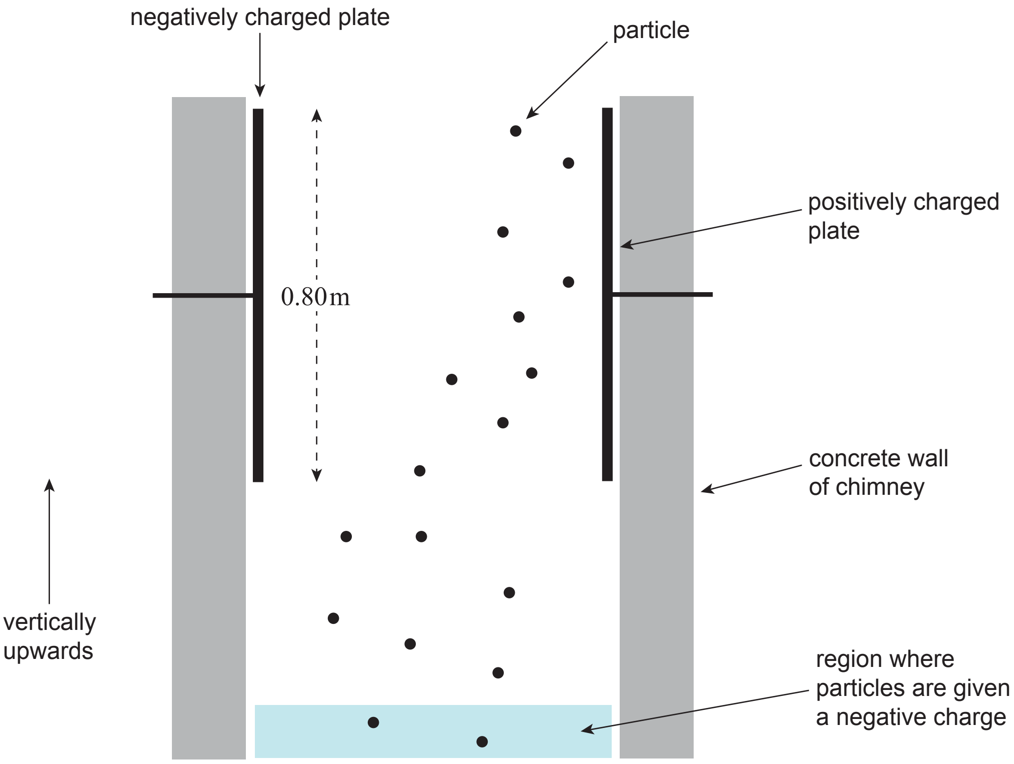
____ (2 marks)

12. Electrostatic precipitators are used in industrial chimneys to remove dust particles from emissions produced as a result of smelting processes.

The diagram below shows an electrostatic precipitator that uses a corona discharge to give the particles a charge of -1.6×10^{-19} C. The particles then enter the region between two oppositely charged parallel plates. The positively charged plate acts as a particle collector.



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

The parallel plates, which are separated by a distance of $0.45\,\text{m}$, are $0.80\,\text{m}$ in length. The potential difference between the plates is $6.0\times10^{4}\,\text{V}$.

Ignore air resistance and the effect of gravity in all parts of this question.

(a) Calculate the magnitude of the force acting on a singly charged particle between the parallel plates.

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____ (3 marks)

(b) Show that a particle travelling vertically upwards at $2.0\,\mathrm{m\,s^{-1}}$ takes $0.40\,\mathrm{s}$ to travel across the electric field between the parallel plates.

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____ (1 mark)

(c) A singly charged particle travelling vertically upwards at $2.0\,\mathrm{m\,s^{-1}}$ enters the electric field exactly halfway between the parallel plates.

Determine the greatest possible mass of such a particle that can be collected by the positively charged plate.

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____ (5 marks)

13. A television channel broadcasts waves with a horizontal plane of polarisation.

Source: Photograph by Nedim Ardoğa, http://en.wikipedia.org/wiki/File

(a) State the orientation of the oscillating magnetic field in such waves.

_______________________________________ (1 mark)

(b) Calculate the wavelength of television signals broadcast at 64.25 MHz.

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_______________________________________ (3 marks)

14. Explain why light from an incandescent light bulb is not monochromatic.

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____(2 marks)

Source: © Noahgolan/Dreamstime.com

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. 12(a) continued).

Government of South Australia

SACE Board of SA

External Examination 2012

2012 PHYSICS

SACE REGISTRATION NUMBER			
SEQ	FIGURES	CHECK LETTER	BIN

PHYSICS

QUESTION BOOKLET

2

20 pages, 11 questions

Thursday 1 November: 1.30 p.m.

Part 2 of Section A

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

SACE
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AUSTRALIA

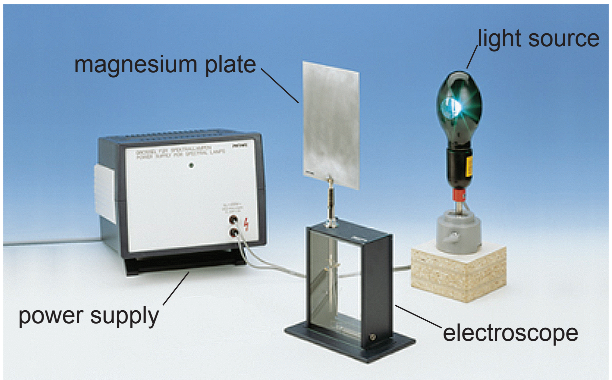
SECTION A

PART 2 (Questions 15 to 25)

(78 marks)

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

15. The photograph below shows the equipment used in an experiment to investigate the photoelectric effect:



Source: Adapted from www.phywe.com

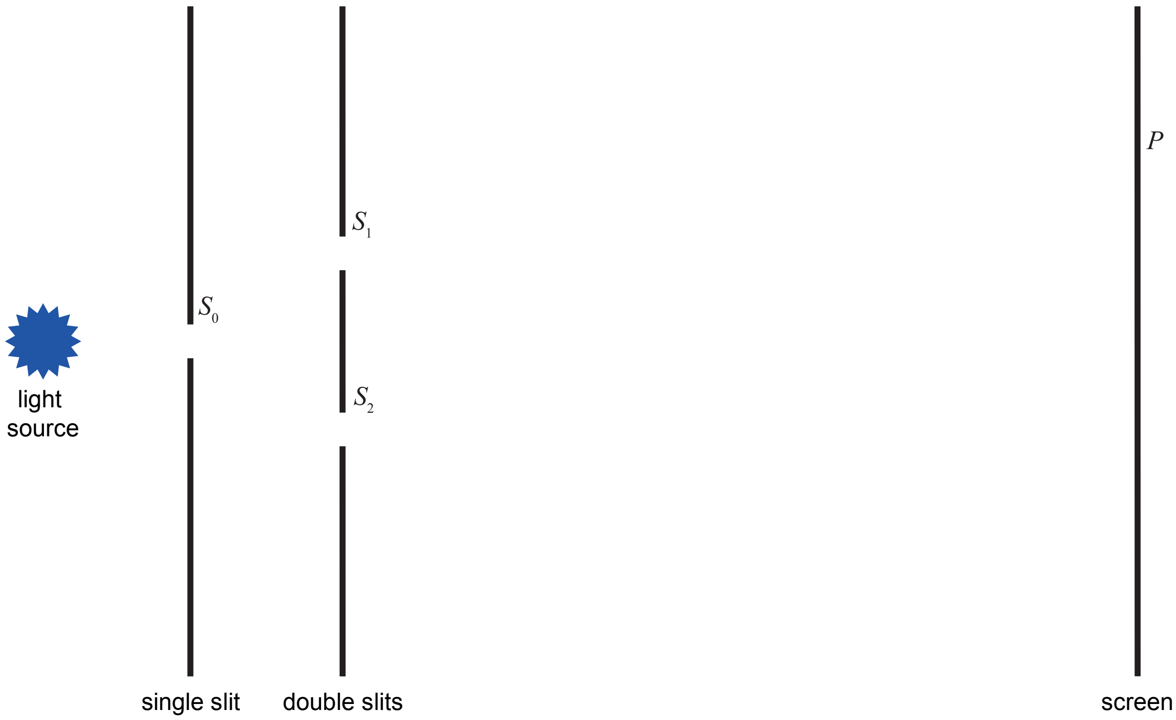
A magnesium plate is illuminated by light of frequency 2.0×10^{15} Hz. The electroscope shows that electrons are emitted from the magnesium plate.

The work function of magnesium is 3.66 eV.

Calculate the maximum speed of the emitted electrons.

(4 marks)

16. The diagram below shows a two-slit arrangement for investigating the interference of light. Monochromatic blue light passes through a single slit S_0 before illuminating two narrow slits S_1 and S_2. An interference pattern is seen on the screen.



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

(a) *On the diagram above*, draw the beams of light that travel from slits S_1 and S_2 to point P on the screen. Indicate the path difference between the two beams of light. (1 mark)

(b) Derive $d \sin\theta = m\lambda$ for two-slit interference, where d is the distance between slits S_1 and S_2 and θ is the angular position of the mth maximum.

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____ (3 marks)

(c) The wavelength of the monochromatic blue light is 4.70×10^{-7} m and the distance between slits S_1 and S_2 is 1.8×10^{-4} m.

Calculate the angle of the third-order maxima.

(3 marks)

(d) The monochromatic blue light source is removed and replaced with a laser that produces red light.

(i) State why the single slit S_0 is not needed when the laser is used.

(1 mark)

(ii) Describe, giving reasons, the effect that the change of light source has on the distance between adjacent maxima on the screen.

(3 marks)

17. Dentists can use X-rays to detect tooth decay, as shown in the photograph below:

Source: © Diego.cerv…/Dreamstime.com

(a) When taking an X-ray image, the dentist can control the settings of the filament current and of the potential difference across the X-ray tube.

Identify, giving reasons, which of these settings would be used to reduce the exposure time to the X-rays.

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____ (3 marks)

(b) State one other way in which dentists can reduce their exposure to ionising radiation.

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____ (1 mark)

18. In the Davisson–Germer experiment electrons were projected at the surface layers of a crystal lattice.

(a) Calculate the wavelength of electrons travelling at a speed of $4.36\times10^{6}\ \text{m}\,\text{s}^{-1}$.

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______________________________________ (2 marks)

(b) Explain how the results of the Davisson–Germer experiment demonstrated the wave behaviour of low-energy electrons.

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______________________________________ (2 marks)

19. The diagram below shows the line emission spectra of four elements for the range 400 nm to 700 nm:

Hydrogen

Helium

Lithium

Sodium

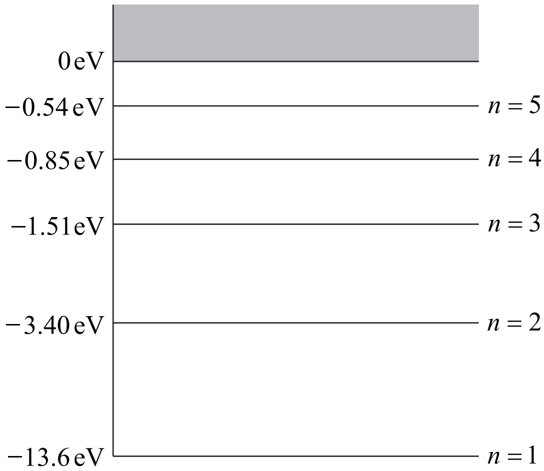
The diagram below shows the line emission spectrum of a mixture of gases for the same range as for the diagram above:

Source: All images on this page adapted from http://chemistry.bd.psu.edu

Identify, giving reasons, two elements present in the mixture of gases.

(2 marks)

20. The diagram below shows some of the energy levels of hydrogen at room temperature:



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

Gaseous hydrogen is bombarded by photons of energies $12.50\,\text{eV}$ and $12.09\,\text{eV}$.

(a) State why the photons of energy $12.50\,\text{eV}$ will not be absorbed by the hydrogen.

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____ (1 mark)

(b) A photon of energy $12.09\,\text{eV}$ collides with the electron in a hydrogen atom in its ground state. As a result of the collision the electron undergoes a transition to an excited state before it returns to the ground state.

(i) *On the diagram above*, draw all possible transitions for the electron as it returns to the ground state. (2 marks)

(ii) State the smallest-energy photon that could be emitted as the electron returns to the ground state after this excitation.

____ (1 mark)

21. An unstable nucleus of uranium-238 $\left({}^{238}_{92}\text{U}\right)$ decays to a thorium isotope via alpha decay.

(a) Balance the decay reaction below by writing the atomic and mass numbers.

$$^{238}_{92}\text{U} \longrightarrow \quad \text{Th} \quad + \quad \alpha$$

(3 marks)

(b) Explain why the alpha particles emitted by this type of radioactive decay have a range of discrete energies.

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____ (3 marks)

(c) A series of alpha and beta minus decays starts with uranium-238 and ends with $^{206}_{82}\text{Pb}$, a stable isotope of lead. There are eight alpha decays in this series of decays.

Determine the number of beta minus decays in the series of decays.

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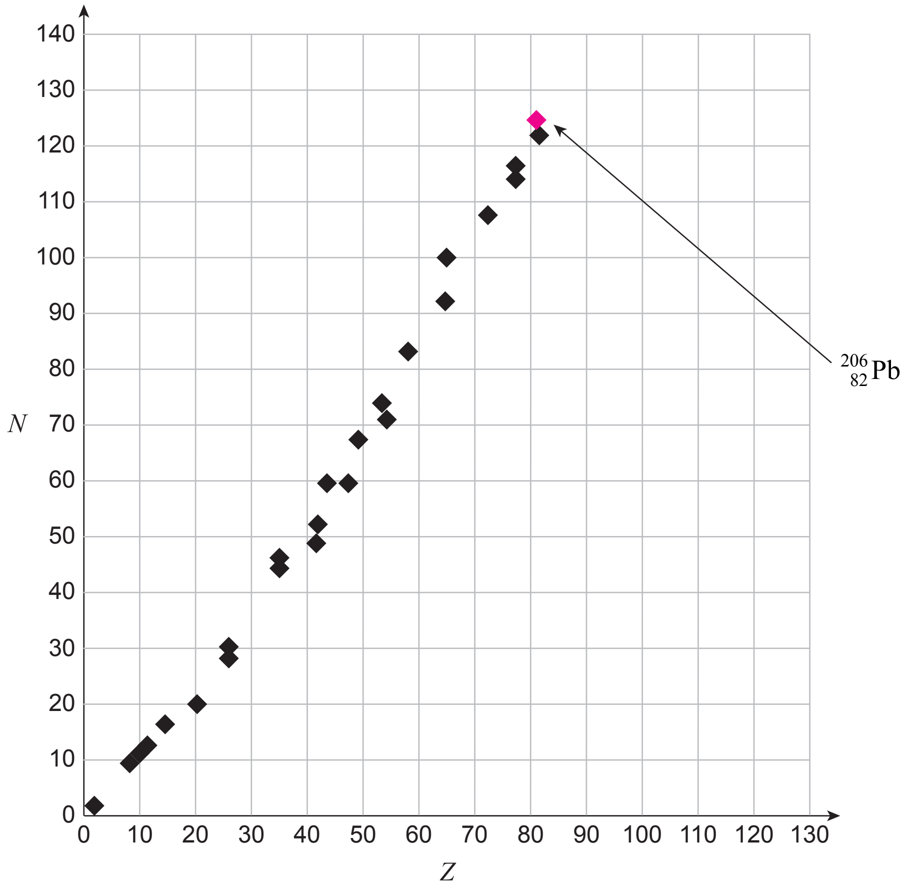
____ (3 marks)

(d) The diagram below shows a graph of N (the number of neutrons) against Z (atomic number) for some stable nuclei:



(i) *On the graph above*, write the symbol $\beta-$ to indicate the position of an unstable nucleus that is likely to undergo a beta minus decay. (1 mark)

(ii) The position of the nucleus $^{206}_{82}Pb$ is indicated on the diagram.

Explain how it is possible to have stable nuclei despite the strong repulsive electrostatic force between the 82 protons in this nucleus.

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____ (2 marks)

22. The radioisotope oxygen-15 $\left({}^{15}\text{O}\right)$ is used in positron emission tomography (PET) scans because it undergoes a beta plus decay in which a positron is emitted.

(a) State the other particle emitted in the beta plus decay of oxygen-15.

____ (1 mark)

(b) Explain how the emission of a positron by oxygen-15 can lead to the production of gamma rays.

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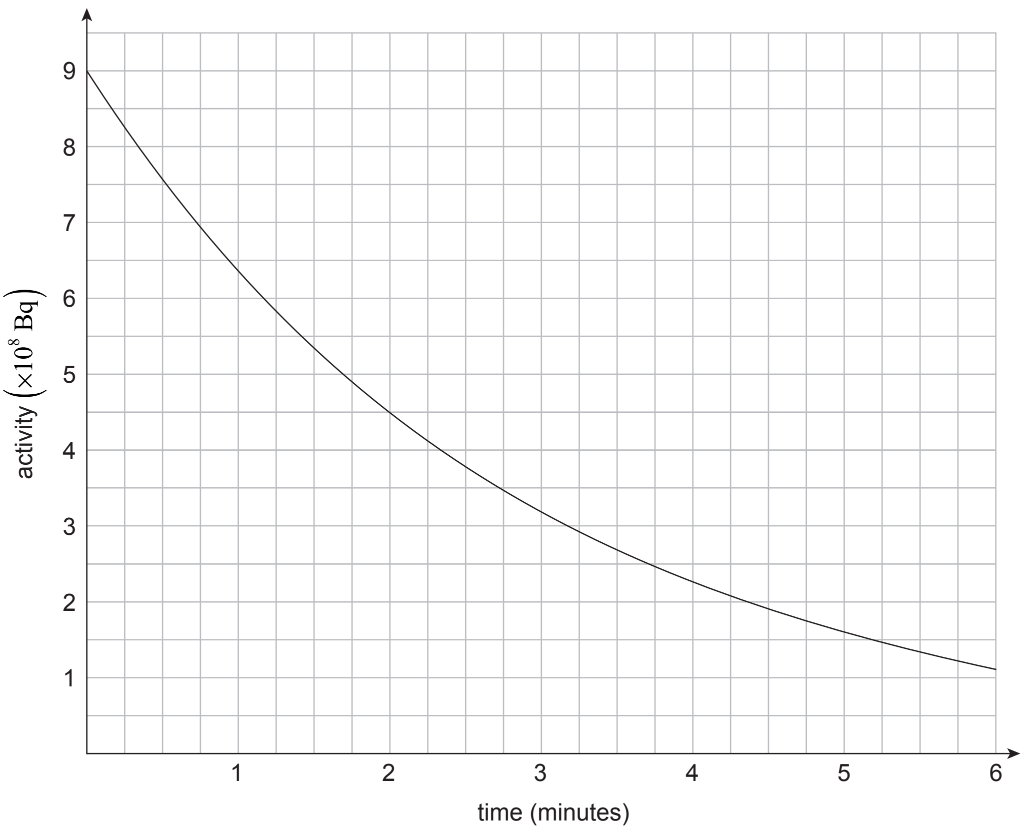
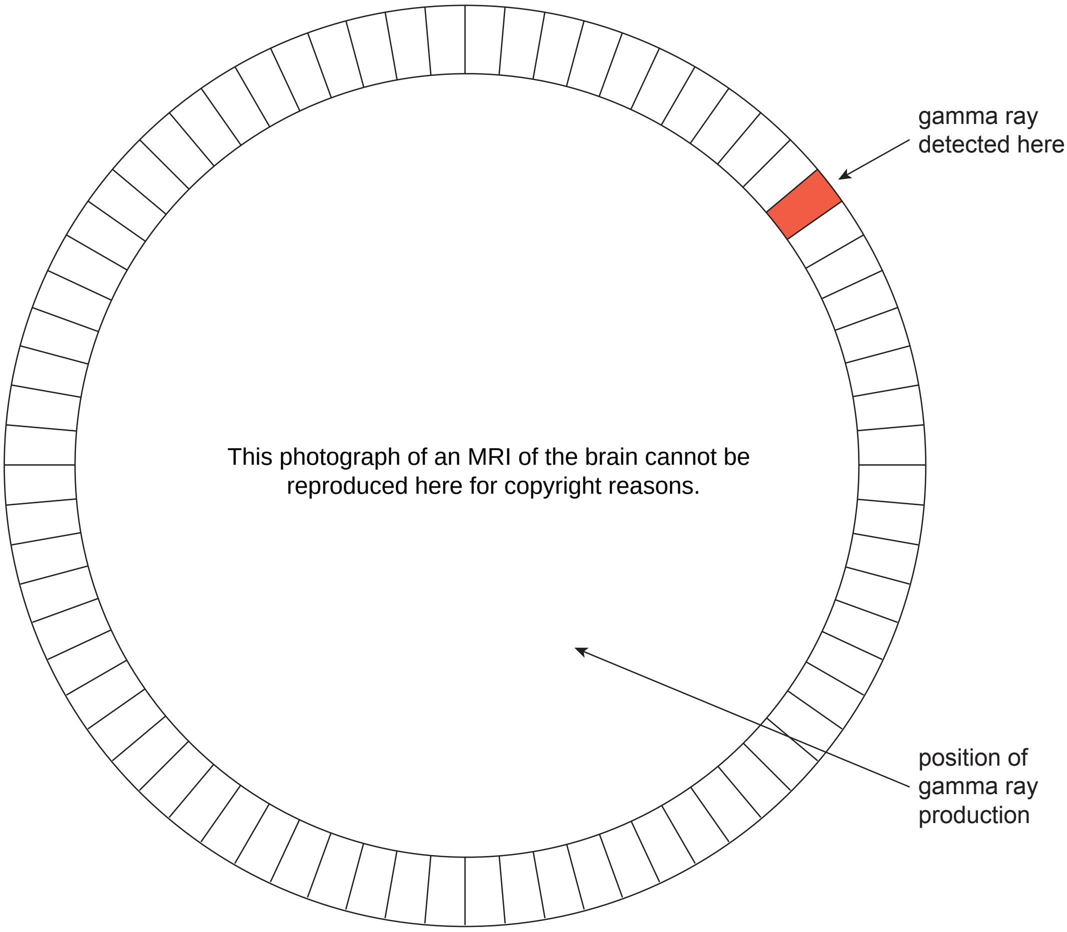
____ (2 marks)

(c) The graph below shows changes over 6 minutes in the activity of ${}^{15}\text{O}$-labelled water given to a patient undergoing a PET scan:



On the graph above, show how the activity of ${}^{15}\text{O}$-labelled water with an initial activity of $6.0\times10^{8}\,\text{Bq}$ would change over 6 minutes. (3 marks)

(d) The diagram below shows the ring of photon detectors used in a PET scan, with the position of gamma ray production indicated. The diagram also shows the position at which one gamma ray is detected.



Source: Image adapted from www.giblip.org

On the diagram above, indicate the position at which another gamma ray should be detected.

(1 mark)

23. Uranium found in nature consists primarily of two isotopes: uranium-235 and uranium-238. Naturally occurring uranium contains approximately 0.7% of the uranium-235 isotope.

(a) Explain why the uranium fuel for a fission power reactor needs to be enriched.

(2 marks)

(b) One method of enriching uranium fuel involves using a laser to ionise uranium-235 atoms.

Calculate the energy given to a uranium-235 atom by a laser photon with a wavelength of 502 nm.

(3 marks)

24. Scientists believe that, in some massive stars, two carbon nuclei can undergo fusion reactions. One possible reaction is shown below:

$$^{12}_{6}C + ^{12}_{6}C \longrightarrow ^{23}_{12}Mg + ^{1}_{0}n$$

The masses of the particles involved in this reaction are shown below:

$$^{12}_{6}C = 1.9921\times10^{-26}\,kg$$

$$^{23}_{12}Mg = 3.8172\times10^{-26}\,kg$$

$$^{1}_{0}n = 1.6749\times10^{-27}\,kg.$$

Determine whether energy is absorbed or released in this reaction, and calculate the amount of energy that is absorbed or released.

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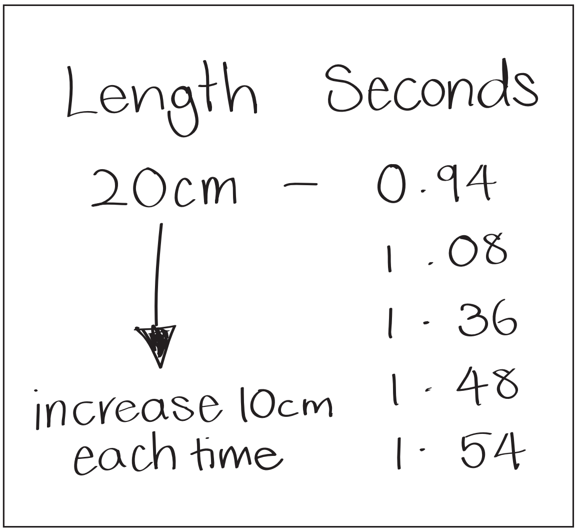
____ (5 marks)

25. Students conduct an experiment in which the period of a pendulum is used to determine the acceleration of gravity.

A simple pendulum is set up with different lengths of string L. The pendulum is set swinging with a small displacement and the period T is recorded by using a lightgate connected to a computer.

The photograph (right) shows the equipment used in the experiment.

The data recorded by the students conducting the experiment are shown below:


Length Seconds
20cm — 0.94
1.08
1.36
increase 10cm 1.48
each time 1.54

This image of a experiment using a pendulum to determine the acceleration of gravity cannot be reproduced here for copyright reasons.

Source: Adapted from www.phys.ufl.edu/demo/3

(a) *In the space below*, display the students' data in a table, including a column of T^2 values.

(3 marks)

(b) Identify the independent variable in the experiment.

____ (1 mark)

(c) *On the page opposite*, plot a graph showing the relationship between L and T^2.
Include a line of best fit. (6 marks)

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

(3 marks)

(e) The period T of a pendulum of length L is given by:

$$T = 2\pi\sqrt{\frac{L}{g}}.$$

Using the gradient of your line of best fit, determine the acceleration due to gravity g.

(3 marks)

(f) Suggest, giving reasons:
- one improvement that would increase the accuracy of the experiment
- one improvement that would increase the precision of the experiment.

(4 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. 17(a) continued).

Government of South Australia

SACE Board of SA

External Examination 2012

2012 PHYSICS

SACE REGISTRATION NUMBER

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PHYSICS

QUESTION BOOKLET

3

8 pages, 2 questions

Thursday 1 November: 1.30 p.m.

Section B

Write your answers to Section B in this question booklet.

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SECTION B (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 question.

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

26. The photograph below shows the cyclotron in the Musée des Arts et Métiers in Paris:

This photograph of the cyclotron in the Musee des Arts Et Metiers in Paris cannot be reproduced here for copyright reasons.

Source: www.mhs-science.org.uk

The magnetic field in the dees of a cyclotron causes ions to undergo circular motion so that they cross between the dees many times. As a result the ions gain a high kinetic energy.

- Explain why the ions move with uniform circular motion each time they are in one of the dees.
- Describe the relationship between the final kinetic energy of the ions and the radius of the cyclotron. (14 marks)

27. In the photoelectric effect the emitted electrons have a range of energies. In the production of X-rays the X-ray photons also have a range of energies.

- Explain the range of kinetic energies of the electrons emitted in the photoelectric effect when monochromatic light is used.
- Explain the range of energies in the spectrum of X-rays when the potential difference across the X-ray tube is constant. (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 2012

ACKNOWLEDGMENT

The image of a TV Station in Karaman, Turkey for question 13, page 22, booklet 1 is reproduced under a Creative Commons ShareAlike 3.0 Unported License.

The orignal photograph can be found at
http://en.wikipedia.org/wiki/File:TV_station,_Karaman,_Turkey.jpg