1

Government of South Australia

SACE Board of SA

External Examination 2015

2015 PHYSICS

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ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

QUESTION BOOKLET
1
26 pages, 15 questions

Tuesday 3 November: 1.30 p.m.

Time: 3 hours

Part 1 of Section A

Examination material: Question Booklet 1 (26 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 26)
   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 15) in the spaces provided in Question Booklet 1.
   Write on page 26 of Question Booklet 1 if you need more space to finish your answers.
   Answer Part 2 of Section A (Questions 16 to 26) 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 27 and 28)
   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	77 marks	75 minutes
	Part 2	73 marks	75 minutes
Section B			
		30 marks	30 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.

You may remove this page from the booklet by tearing along the perforations and you may refer to it during the examination.

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	$e = 1.60\times10^{-19}\ \text{C}$
Constant of universal gravitation	$G = 6.67\times10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$	Mass of the electron	$m_e = 9.11\times10^{-31}\ \text{kg}$
Speed of light in a vacuum	$c = 3.00\times10^{8}\ \text{m s}^{-1}$	Mass of the proton	$m_p = 1.673\times10^{-27}\ \text{kg}$
Coulomb's law constant	$\frac{1}{4\pi\varepsilon_0} = 9.00\times10^{9}\ \text{N m}^2\ \text{C}^{-2}$	Mass of the neutron	$m_n = 1.675\times10^{-27}\ \text{kg}$
Planck's constant	$h = 6.63\times10^{-34}\ \text{J s}$	Mass of the α particle	$m_\alpha = 6.645\times10^{-27}\ \text{kg}$

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

$F = I\Delta lB\sin\theta$ $\theta =$ 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

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

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

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 15)

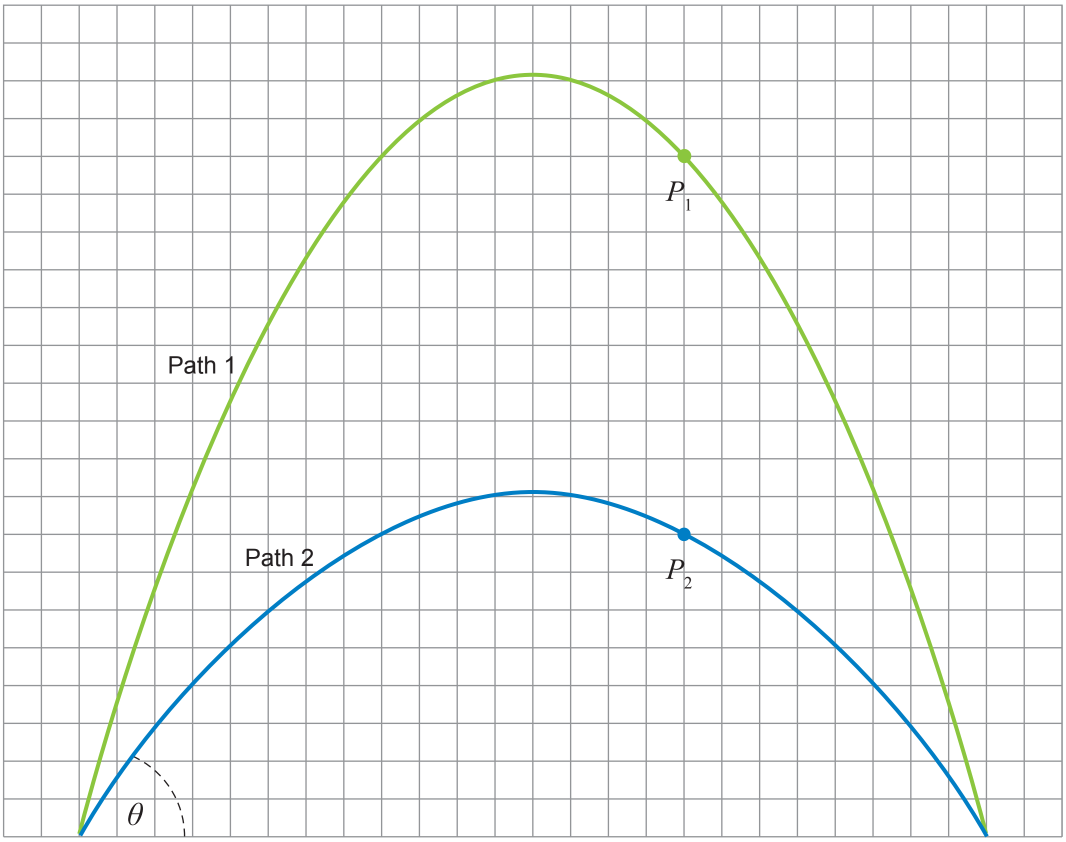
(77 marks)

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

1. The diagram below shows the paths of two projectiles that experience negligible air resistance.

   Path 1 shows the path of a projectile that was launched with an initial speed of $21\ \mathrm{m\,s^{-1}}$ at an angle of $55°$ above the horizontal.

   Path 2 shows the path of a projectile that was launched with an initial speed of $21\ \mathrm{m\,s^{-1}}$ at an angle of θ above the horizontal.



   (a) *On the diagram above*, draw vectors to show the direction and magnitude of the acceleration of each projectile at points P_1 and P_2. (2 marks)

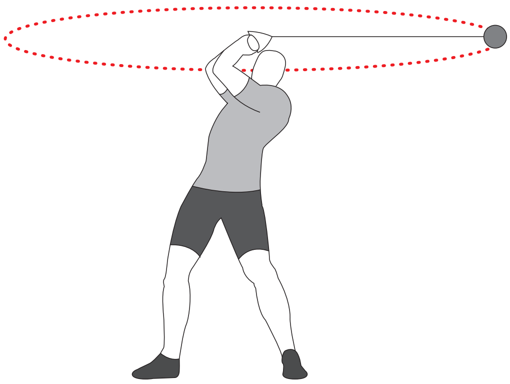
   (b) State the size of angle θ.

   ______________________________ (1 mark)

2. A hammer thrower rotates a heavy ball attached to a wire in a horizontal path with uniform circular motion.

The ball is swung at a speed of 20.0 m s^{-1}.

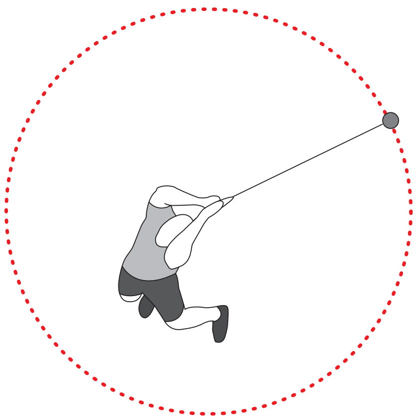
The ball has a mass of 7.26 kg and rotates at a radius of 1.25 m.



(a) Determine the magnitude of the force that causes the centripetal acceleration of the ball.

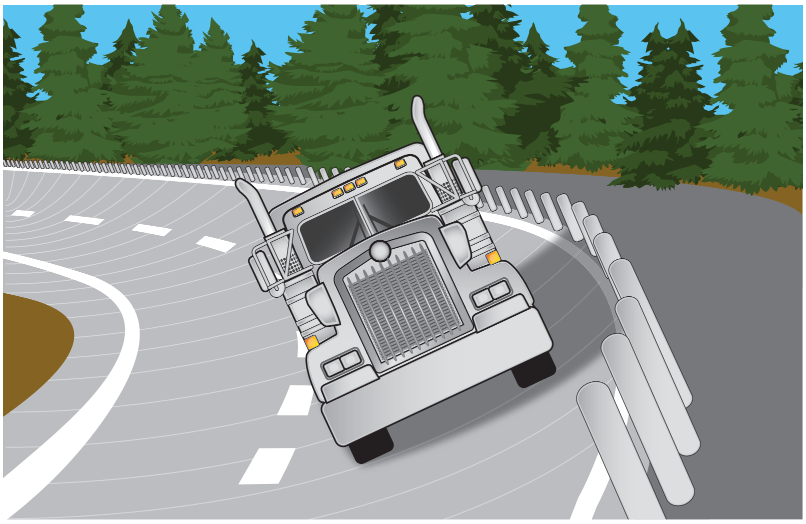
(3 marks)

(b) The diagram below shows a hammer thrower seen from above:



On the diagram above, draw and label vectors to show the velocity and the force on the ball as it is swung anticlockwise. (2 marks)

3. The image below shows a truck travelling around a banked curve:



(a) Explain how the banked curve causes centripetal acceleration, which reduces the truck's reliance on friction between the tyres and the road.

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___ (3 marks)

(b) The banked curve has a radius of 120 m. The truck is travelling at a constant speed of 17 $m\,s^{-1}$.

Calculate the banking angle that will enable the truck to travel around the banked curve without relying on friction.

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___ (3 marks)

4. Satellites in geostationary orbits are often used for monitoring weather. Australia receives weather information from Multi-functional Transport Satellites (MTSAT satellites).

An MTSAT satellite has a mass of 2905 kg, and orbits the Earth at a radius of $4.216 \times 10^{7} \text{ m}$.

(a) Calculate the magnitude of the gravitational force that the Earth exerts on the satellite. The mass of the Earth is $5.972 \times 10^{24} \text{ kg}$.

(2 marks)

(b) Calculate the speed of the satellite.

(2 marks)

(c) State why the satellite must orbit in the same direction as that in which the Earth rotates.

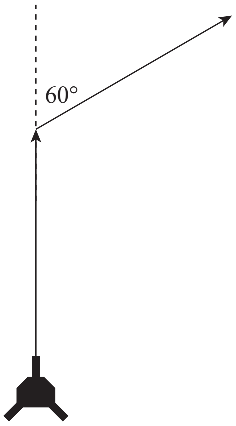
(1 mark)

5. In November 2014 the *Philae* lander was launched from the *Rosetta* spacecraft to travel through space to land on the surface of a comet, as shown in the image below:

Source: http://en.wikipedia.org, DLR German Aerospace Center Creative Commons Attribution 3.0 Germany (CC BY 3.0 DE),

As the lander was travelling through space, an engine thruster was fired to change the lander's direction by $60°$. The speed of the lander was $1.5\ \mathrm{m\,s^{-1}}$, which remained constant.

In the space below, draw a vector diagram to show the change in velocity of the lander. Use the vector diagram to determine the magnitude of the change in velocity.



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____ (3 marks)

6. (a) In a one-dimensional collision, Particle A (of mass m) travels with momentum of magnitude p_1 before colliding with stationary Particle B. After the collision, Particle B moves off with momentum of magnitude p_2 and Particle A moves off at speed v.

Assume that the collision occurs in an isolated system.

Using the law of conservation of momentum, show that the final speed of Particle A is given by:

$$v = \frac{p_1 - p_2}{m}.$$

(3 marks)

(b) In nuclear fission power reactors, neutrons are slowed by colliding with particles of a suitable moderator. A commonly used moderator is deuterium.

In an experiment, scientists fired neutrons directly at deuterium particles. The neutrons had an initial speed of 1.42×10^7 m s^{-1}.

(i) Show that the initial momentum of the neutrons p_1 was 2.38×10^{-20} kg m s^{-1}.

(1 mark)

Multiple trials of the experiment were conducted and the average momentum of the deuterium particles after the collisions was determined to be 1.13×10^{-20} kg m s^{-1}.

(ii) Using the formula from part (a), determine the average speed of the neutrons after colliding with the deuterium particles.

____ (2 marks)

(iii) Hence state why deuterium is a suitable moderator for use in nuclear fission power reactors.

____ (1 mark)

7. (a) When an electron is placed at a distance of 2.0×10^{-9} m from a point charge q, it experiences a repulsive force of 1.7×10^{-10} N.

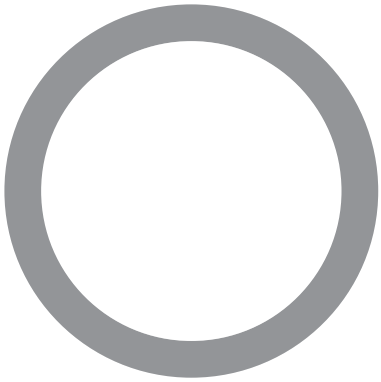
Determine the magnitude and sign of point charge q.

(4 marks)

(b) Using proportionality, determine the force on the electron if the distance between the electron and point charge q is doubled.

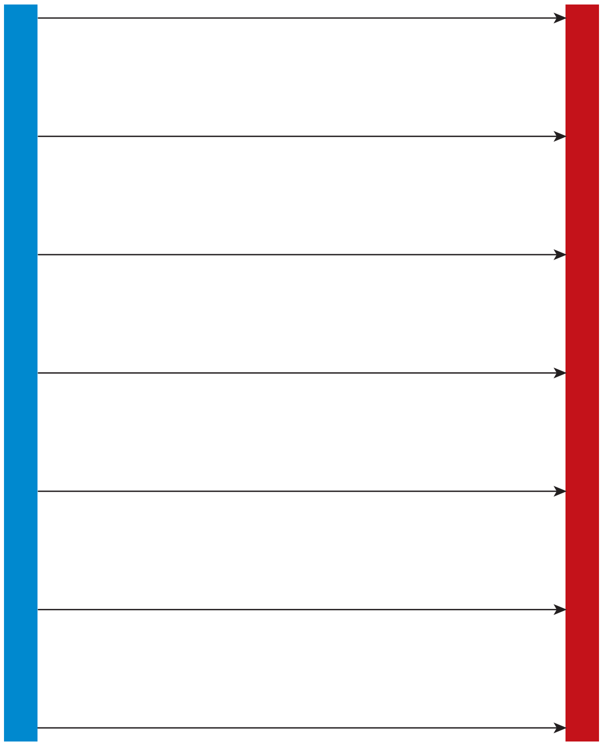
(3 marks)

8. The diagram below shows a negatively charged hollow spherical conductor:



On the diagram above, sketch the electric field lines produced by the negatively charged conductor. (2 marks)

9. A uniform electric field is created by two oppositely charged parallel plates, as shown in the diagram below:



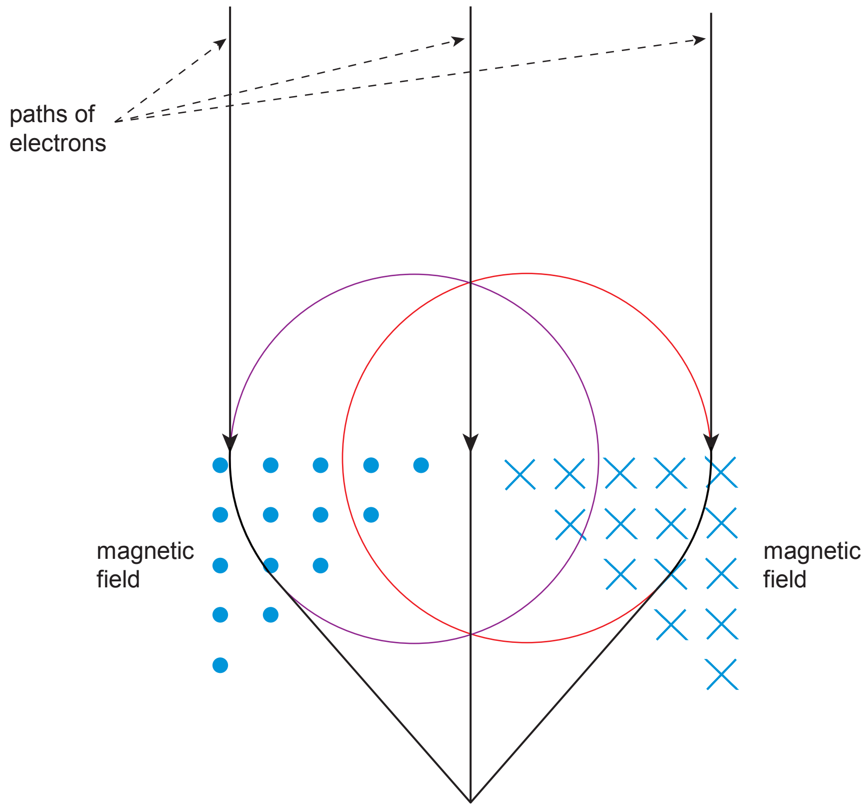
[*This diagram is not drawn to scale.*]

This electric field has a magnitude of $2.0 \times 10^4 \text{ Vm}^{-1}$ and is used to accelerate charged particles.

Compare the time a proton would take to travel 1.2×10^{-2} m in the electric field with the time an alpha particle would take to travel the same distance. Assume that both particles start at rest. Justify your answer.

(3 marks)

10. One way to focus electrons in an electron microscope is to use two triangular uniform magnetic fields of equal magnitude B, as shown in the diagram below:



When the electrons are in the magnetic fields they travel with uniform circular motion of radius r.

(a) Explain why an electron moves with uniform circular motion when it enters a magnetic field with a velocity that is perpendicular to the magnetic field.

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____ (3 marks)

Question 10 continues on page 16

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(b) (i) Derive the equation $r = \frac{mv}{qB}$ for the radius r of the circular path of electrons that are moving at speed v at right angles to a uniform magnetic field of magnitude B. The electrons have a charge of q and a mass of m.

(2 marks)

(ii) The magnitude of the magnetic field is $B = 2.31\ \text{T}$ and the radius of the circular path is $r = 1.46 \times 10^{-4}\ \text{m}$.

Hence show that the magnitude of the momentum p of the electrons is $5.40 \times 10^{-23}\ \text{kg m s}^{-1}$.

(2 marks)

(c) Calculate the wavelength of electrons with momentum of 5.40×10^{-23} kg m s^{-1}.

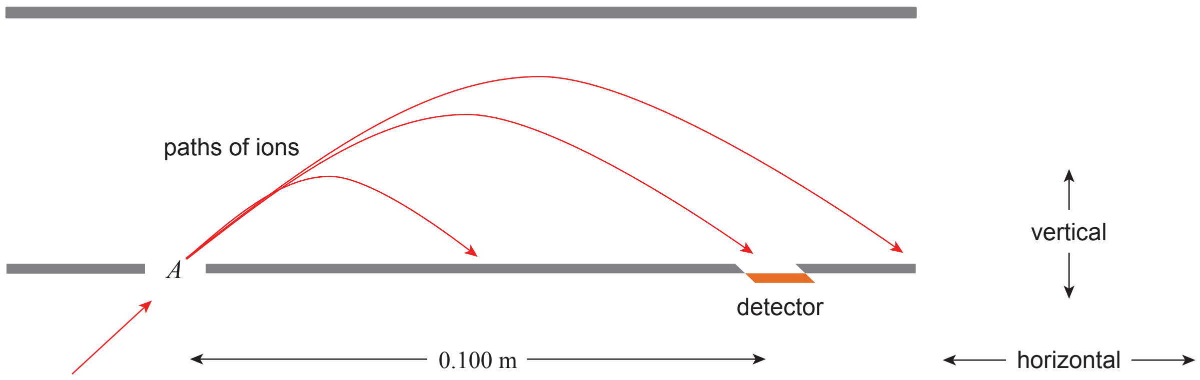
(2 marks)

(d) State how the wavelength you calculated in part (c) allows electron microscopes to achieve high resolutions.

(1 mark)

11. The diagram below shows a parallel-plate energy analyser. Ions enter the electric field created by the parallel plates at point A. Only those ions with a particular energy per unit charge will reach the detector. The distance from point A to the detector is 0.100 m.

The diagram shows the orientation of the plates.



The magnitude of the electric field between the parallel plates is 2.07×10^{4} N C^{-1}.

A beam of ions with a charge of 1.60×10^{-19} C and a mass of 2.20×10^{-25} kg enters the electric field.

(a) Show that the magnitude of the acceleration experienced by the ions is 1.51×10^{10} m s^{-2}.

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____ (2 marks)

(b) One ion enters the electric field with a speed of 3.90×10^{4} m s^{-1} at an angle of $42.3°$ to the plates.

(i) Show that the magnitude of the:

- initial horizontal component of the velocity of the ion is 2.88×10^{4} m s^{-1}.

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- initial vertical component of the velocity of the ion is 2.62×10^{4} m s^{-1}.

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____ (2 marks)

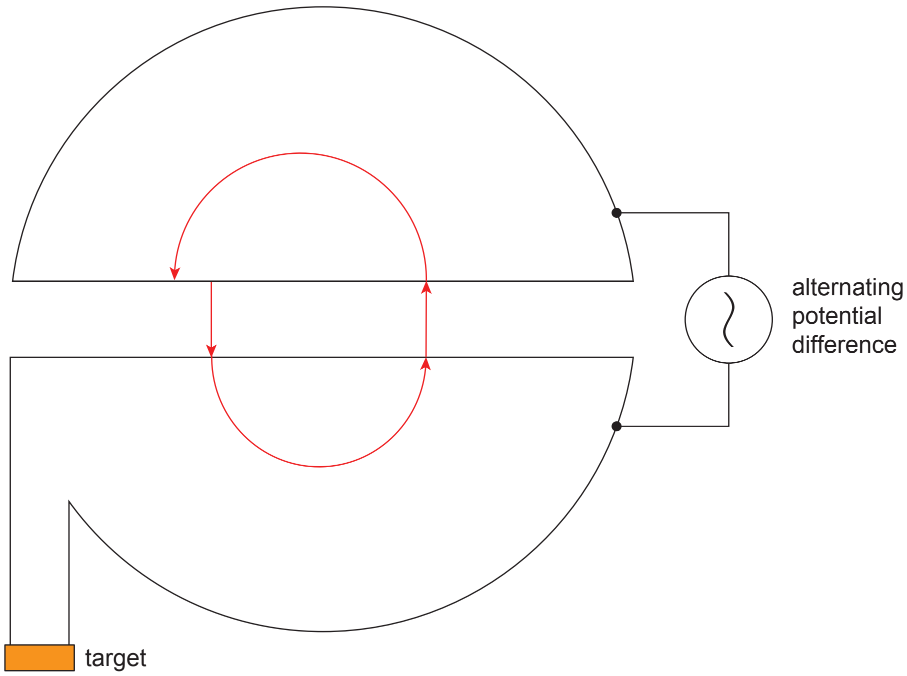
(ii) Determine the time of flight from when the ion enters the electric field at point A until it collides with the lower plate.

(3 marks)

(iii) Calculate the horizontal distance that the ion travels in the electric field, and determine whether or not it reaches the detector.

(2 marks)

12. The diagram below shows a cyclotron that accelerates negative ions with a charge of magnitude 1.6×10^{-19} C and a mass of 1.7×10^{-27} kg:



(a) State the direction of the magnetic field in the cyclotron above that would cause the negative ions to move in an anticlockwise direction.

____ (1 mark)

(b) The magnetic field in the cyclotron has a magnitude of 0.83 T.

Calculate the period of the circular motion of the ions.

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____ (2 marks)

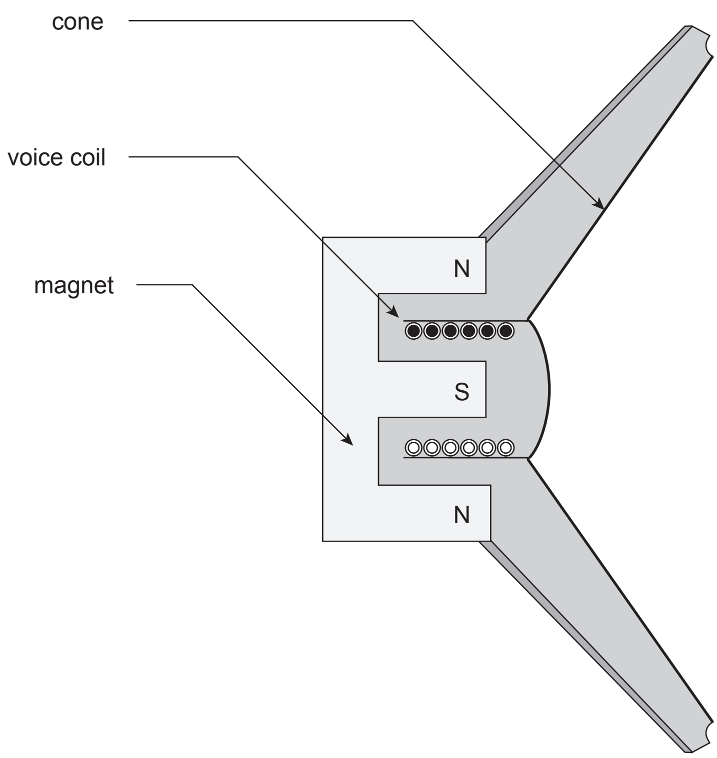
(c) The alternating potential difference in a cyclotron creates an electric field between the dees.

A different cyclotron with the same radius as the one referred to on page 20 is used to accelerate the same type of ions. The magnitude of the magnetic field in this cyclotron is greater than $0.83\ \text{T}$.

State how the stronger magnetic field would change the frequency at which the electric field between the dees must be reversed. Give a reason for your answer.

____ (2 marks)

13. The diagram below shows the main components of a moving-coil loudspeaker:



Explain the action of the moving-coil loudspeaker.

____ (3 marks)

14. Hot metal from a furnace is an incandescent source of white light.

Source: © Liujunrong | Dreamstime.com

Explain why light from an incandescent source is neither coherent nor monochromatic.

____ (3 marks)

15. Amateur radio enthusiasts in many parts of the world use radio waves with a frequency of 136 kHz. Vertical transmitting antennas are used to produce the radio waves.

Source: www.wilowud.net, Creative Commons Attribution 2.0 Generic (CC BY 2.0)

(a) State the orientation of the oscillating electric and magnetic fields of the electromagnetic waves from a vertical antenna.

Electric fields: ____

Magnetic fields: ____ (2 marks)

(b) Show that the wavelength of a radio signal with a frequency of 136 kHz is approximately 2.2 km.

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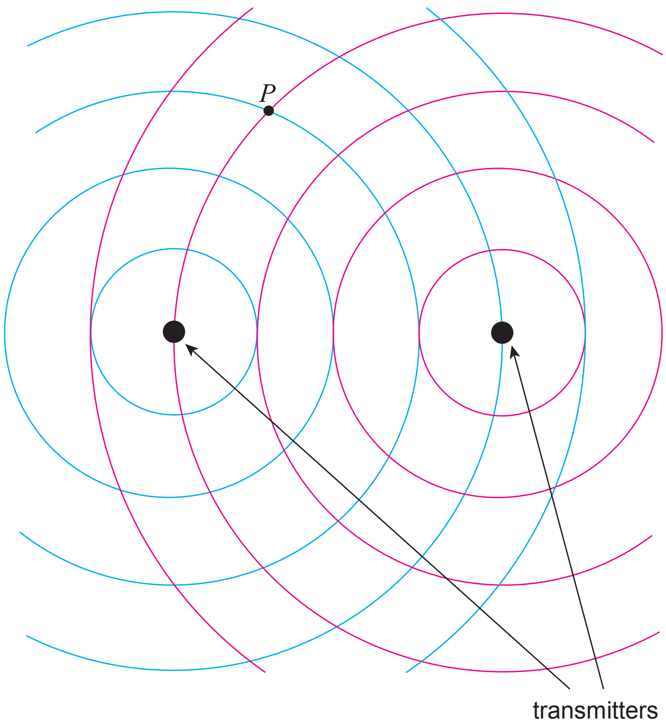
____ (2 marks)

(c) Two transmitters of radio waves with a frequency of $136\ \text{kHz}$ are separated by a distance of $8.8\ \text{km}$. The radio waves emitted in phase by these transmitters are shown in the diagram below.

The spacing between the lines on the diagram equals the wavelength of the radio waves.



State whether the radio waves from the two transmitters undergo constructive or destructive interference at point P.

Give a reason for your answer.

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___ (2 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. 3(b) continued).

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External Examination 2015

2015 PHYSICS

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PHYSICS

QUESTION BOOKLET

2

20 pages, 11 questions

Tuesday 3 November: 1.30 p.m.

Part 2 of Section A

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

2

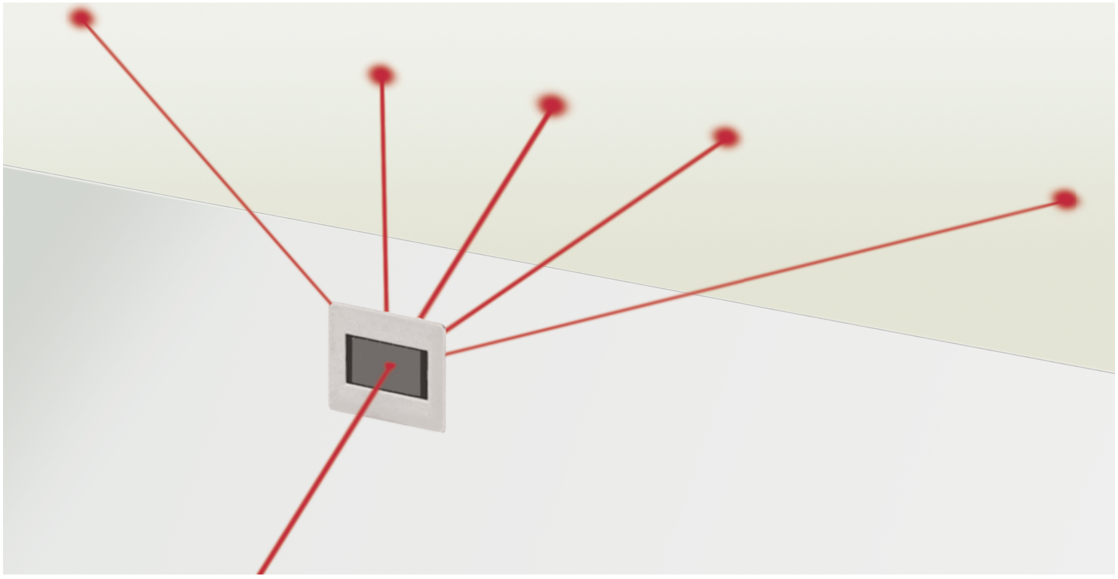
SECTION A

PART 2 (Questions 16 to 26)

(73 marks)

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

16. In an experiment, red laser light with a wavelength of 6.50×10^{-7} m was directed normally at a transmission diffraction grating, as shown in the image below. A first-order maximum was recorded at an angle of $32°$.



(a) Calculate the distance between the slits in the diffraction grating.

(3 marks)

(b) The same diffraction grating was used in a second experiment. A different laser, which produces blue light, was used in this experiment.

Describe the effect of the different wavelength on the angle of the first-order maxima.

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____ (2 marks)

(c) Describe and explain the central and first-order maxima in the pattern produced when the diffraction grating is illuminated by white light.

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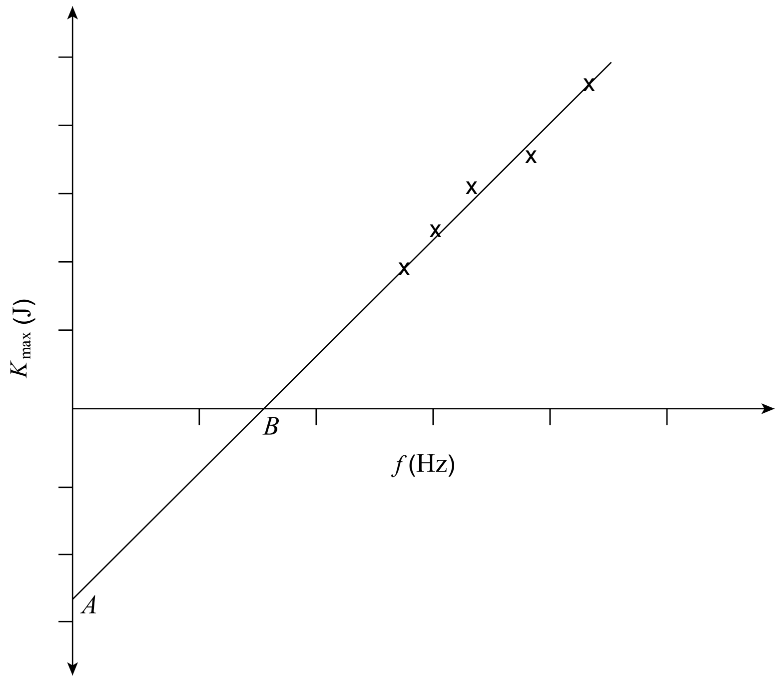
____ (3 marks)

17. Coherent light with a wavelength of 5.89×10^{-7} m illuminates two slits, producing an interference pattern seen on a screen 0.28 m away. The distance between adjacent maxima in the interference pattern is 0.66 mm.

Determine the distance between the slits.

(3 marks)

18. In an experiment on the photoelectric effect the maximum kinetic energy K_{max} of the emitted electrons was measured for different frequencies f of light incident on a cathode. The graph below was drawn using the data that were collected:



The line of best fit intersects the K_{max} axis at A and the f axis at B.

(a) Identify the physical significance of A and B.

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____ (2 marks)

(b) Explain how a value for Planck's constant h can be obtained by relating the equation $K_{max} = hf - W$ to the graph above.

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____ (2 marks)

19. The photograph below shows a scientist using a handheld X-ray fluorescence analyser to study a historical artefact:

Source: www.fieldmuseum.org

(a) X-rays with frequencies in the range 4.7×10^{18} Hz to 1.4×10^{19} Hz are used in X-ray fluorescence.

Explain the continuous range of frequencies in the spectrum of X-rays produced by an X-ray tube operating at a fixed potential difference ΔV.

(3 marks)

(b) Calculate the potential difference ΔV necessary to produce X-rays with a maximum frequency of 1.4×10^{19} Hz.

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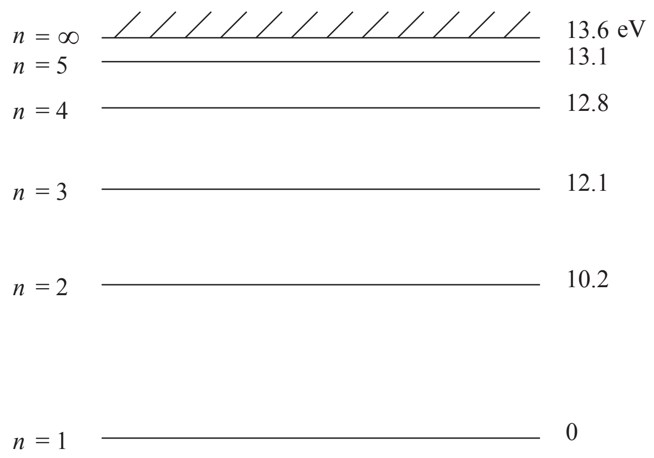
____ (3 marks)

20. (a) Determine the energy of photons with a wavelength of 478 nm. Give your answer in eV.

(3 marks)

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



(b) *On the diagram above*, draw and label the:

- transition within hydrogen atoms that would cause the *emission* of photons with a wavelength of 478 nm
- transition within hydrogen atoms that would result from the *absorption* of photons with a wavelength of 478 nm. (2 marks)

(c) State whether or not a line corresponding to photons with a wavelength of 478 nm would feature in the absorption spectra of hydrogen at room temperature. Justify your answer.

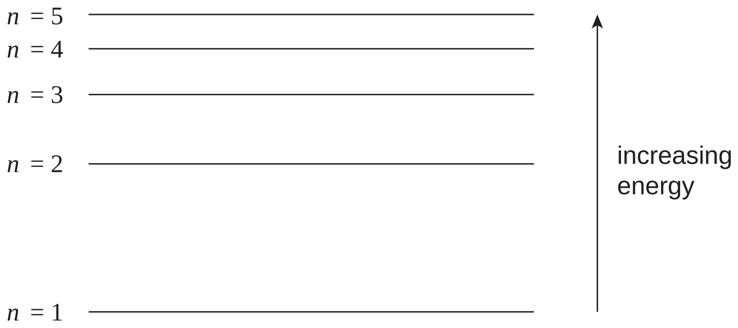
(2 marks)

21. One of the security features of Australian banknotes is serial numbers that fluoresce when observed under ultraviolet light.

This image cannot be reproduced here for copyright reasons.
It can be located online at:
http://www.rba.gov.au/publications/bulletin/2014/mar/images/graph-0314-1-a1.gif

Source: www.rba.gov.au

Using the energy-level diagram below, explain the process of fluorescence.



(3 marks)

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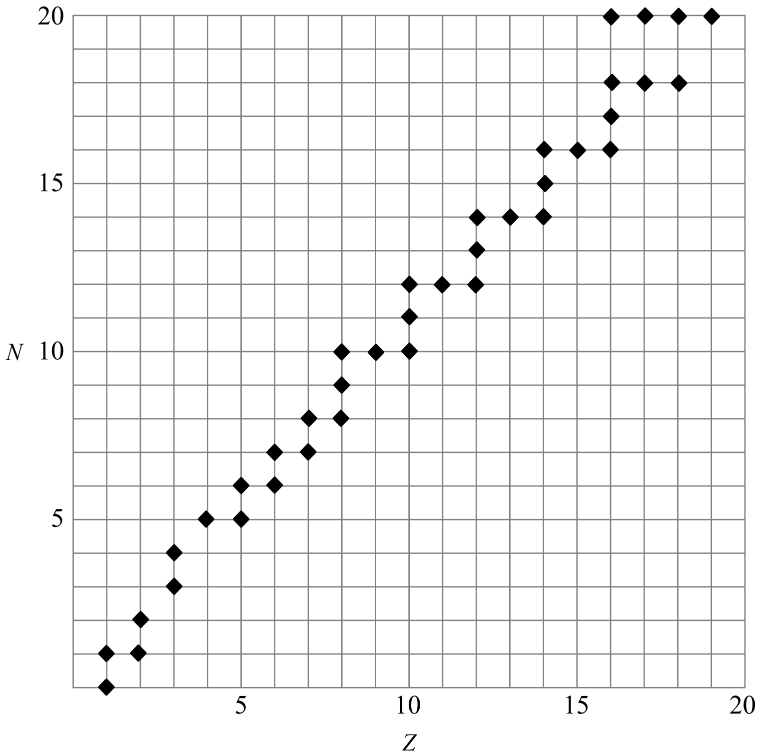
22. The radioisotope ${}^{18}_{9}\mathrm{F}$ is produced when oxygen-18 absorbs a proton. The radioisotope ${}^{18}_{9}\mathrm{F}$ undergoes beta plus decay, and is used as a tracer radioisotope in positron emission tomography (PET) scans.

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



On the diagram above, indicate the position of ${}^{18}_{9}\mathrm{F}$. (1 mark)

(b) Describe how the beta plus decay of the radioisotope ${}^{18}_{9}\mathrm{F}$ can result in the production of photons through positron–electron annihilation.

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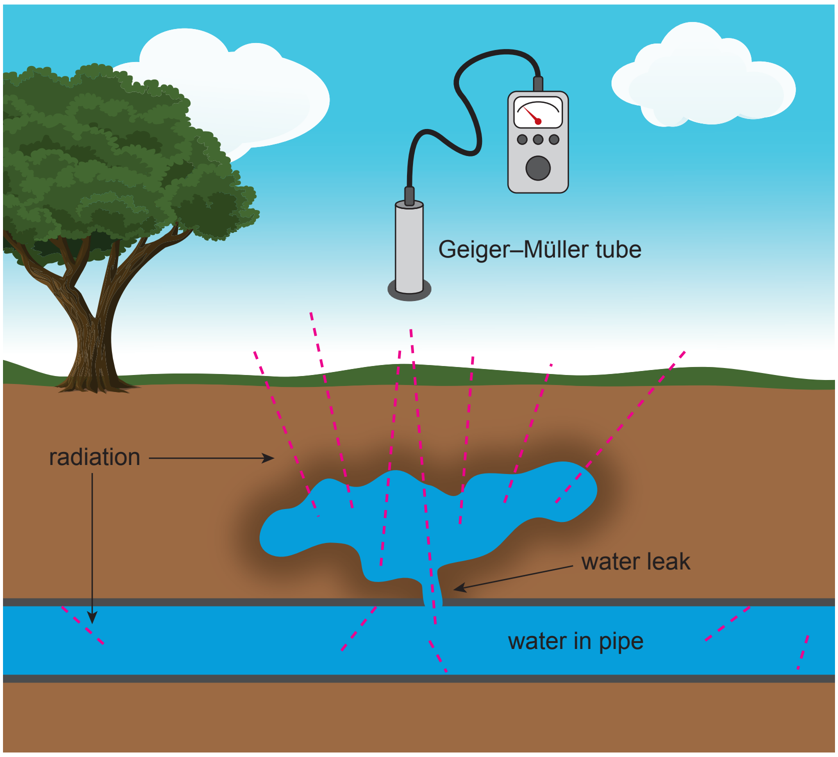
____ (2 marks)

(c) Describe how a ring of photon detectors in a PET scanner allows the location of a tracer radioisotope in a human body to be determined.

(3 marks)

23. The radioisotope sodium-24 ($^{24}_{11}Na$) is used for detecting leaks from underground metal water pipes because it undergoes beta minus decay.

When a leak is suspected, sodium-24 is added to the water supply and flows through the metal water pipe. Radiation from the leak can be detected using a Geiger–Müller tube.



Source: Adapted from www.passmyexams.co.uk

(a) Write the reaction for the beta minus decay of $^{24}_{11}Na$ to an isotope of magnesium (Mg).

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____ (2 marks)

(b) Explain why a radioisotope that undergoes beta minus decay, rather than one that undergoes alpha decay, would be used for detecting water leaks.

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____ (2 marks)

24. Some control rods for nuclear fission power reactors are made of an alloy containing silver.

(a) State the purpose of control rods for nuclear fission power reactors, and hence state the property of silver that makes it suitable for use in control rods.

(2 marks)

(b) Exposure to neutrons in a nuclear fission power reactor causes silver to become radioactive. The resulting silver radioisotope has a half-life of 420 years.

(i) Determine the time needed for the activity of the silver radioisotope to drop to 3.125% of its initial value.

(3 marks)

(ii) Using your answer to part (b)(i), describe *one* disadvantage of nuclear fission power reactors.

(1 mark)

25. Most of the helium in the universe was produced shortly after the big bang, through the reaction:

$$^{2}_{1}\text{H} + ^{2}_{1}\text{H} \rightarrow ^{4}_{2}\text{He}$$

(a) Identify the type of nuclear reaction shown above.

(1 mark)

(b) A single occurrence of the reaction shown above releases 3.87×10^{-12} J of energy.

The mass of $^{4}_{2}\text{He}$ is 6.645×10^{-27} kg.

(i) Determine the difference in mass between the products and the reactants.

(2 marks)

(ii) Hence determine the mass of one $^{2}_{1}\text{H}$ particle.

(2 marks)

(c) Using the properties of the nuclear force, explain why the temperatures shortly after the big bang must have been very high.

(3 marks)

26. Students undertook an experiment to determine the strength of a magnet. They placed a horseshoe magnet on electronic scales and arranged a length of wire so that it was perpendicular to the magnetic field. The current flowing through the wire was set to $1.5\ \text{A}$. The measurement on the scales was used to determine the force.

The students obtained measurements for different lengths of wire.

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

Length of Wire L (cm)	Mass Measurement Shown on Scales m ($\times 10^{-4}$ kg)	Force F (N)
1.0	2.4	
1.5	3.0	
2.0	4.2	
2.5	5.3	
3.0	5.9	

(a) Using $F = mg$, complete the table above by calculating the values for the force, where m is the mass measurement shown on the scales. (2 marks)

(b) On page 17, plot a graph of force versus length. Include a line of best fit. (6 marks)

Question 26 continues on page 19.

You may use this page if you wish to replace the graph you have plotted on page 17.

(c) Calculate the gradient of your line of best fit. Include the units of the gradient.

____ (3 marks)

(d) Using the gradient of your line of best fit, determine the magnitude of the magnetic field.

____ (3 marks)

(e) At the conclusion of the experiment, the magnetic field of the magnet was measured as $0.13\ \mathrm{T}$.

Comment on the accuracy of the experiment.

____ (1 mark)

(f) The experiment was repeated with the same equipment, but with the angle between the wire and the magnetic field less than $90°$.

Predict how the results of this second attempt at the experiment would differ from those of the first attempt. Justify your answer.

____ (3 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. 18(b) continued).

Government of South Australia

SACE Board of SA

External Examination 2015

2015 PHYSICS

SACE REGISTRATION NUMBER

SEQ	FIGURES	CHECK LETTER	BIN

PHYSICS

QUESTION BOOKLET

3

8 pages, 2 questions

Tuesday 3 November: 1.30 p.m.

Section B

Write your answers to Section B in this question booklet.

3

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SECTION B (Questions 27 and 28)

(30 marks)

*Questions 27 and 28 are extended-response questions. Answer **both** questions.*

Write your answers in this question booklet:

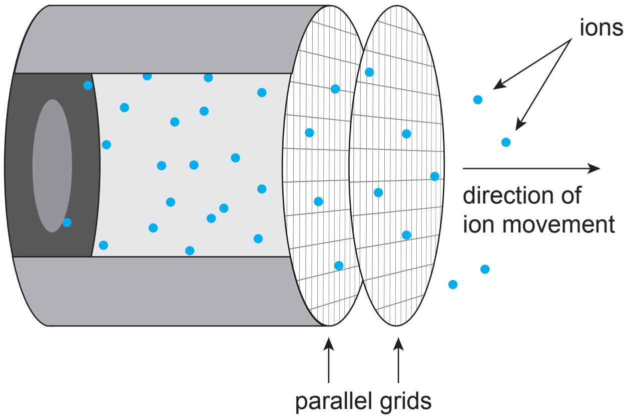
- Question 27, on pages 4 and 5, is worth 15 marks.
- Question 28, on pages 6 and 7, is worth 15 marks.

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.

27. Some spacecraft use ion thrusters to change their speed. An ion thruster uses a uniform electric field created by a potential difference between two parallel grids to accelerate ions, which are then emitted from the back of the spacecraft.

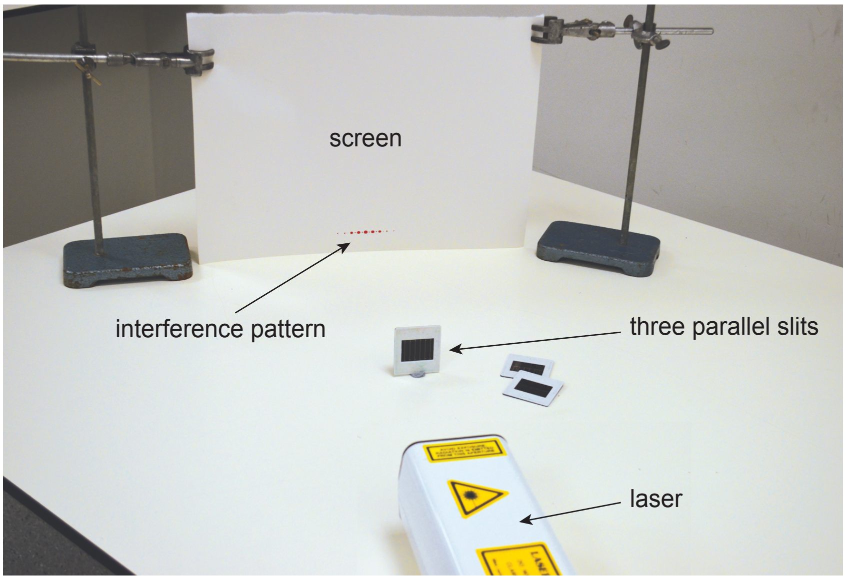


- Describe how a uniform electric field can increase the kinetic energy of a charged particle.
- Using the law of conservation of momentum, explain the change in the speed of a spacecraft as a result of the emission of ions from an ion thruster.

(15 marks)

28. After studying the interference pattern produced by light from a helium–neon laser illuminating two parallel slits, a group of students illuminated *three* parallel, equally spaced slits.

The photograph below shows the equipment used by the students:



The students observed the interference pattern shown below:

The interference pattern can be investigated further by conducting another experiment using a helium–neon laser.

Identify *one* variable that could affect the interference pattern shown.

Design an experiment to investigate the effect of this variable on the interference pattern.

(15 marks)

You may write on this page if you need more space to finish your answers to Questions 27 and 28. Make sure to label each answer carefully (e.g. 28 continued).