1

Government of South Australia

SACE Board of SA

External Examination 2014

2014 PHYSICS

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ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

QUESTION BOOKLET
1
26 pages, 14 questions

Tuesday 4 November: 1.30 p.m.

Time: 3 hours

Part 1 of Section A

Examination material: Question Booklet 1 (26 pages)
Question Booklet 2 (22 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 26 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 22 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	76 marks	75 minutes
	Part 2	74 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.

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

$v_v = v\sin\theta$

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

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

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

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

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

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

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

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

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

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

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

$W = Fs\cos\theta$ — 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

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

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

$W = hf_0$ $f_0 =$ threshold frequency

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

(76 marks)

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

1. The bicycle shown in the photograph below has safety reflectors on its wheels. Each wheel is undergoing uniform circular motion.

Source: © Strixcode | Dreamstime.com (adapted)

Explain why the reflectors are accelerating even though they are travelling at a constant speed.

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___ (2 marks)

2. In a flight archery competition the aim is to shoot the arrow as far as possible.

During such a competition, an arrow is shot with an initial speed of 43.4 m s^{-1}, at an angle of $38.0°$ above the horizontal. The arrow hits a tree at the same height from which it was shot.

Ignore air resistance in all parts of this question.

Source: © iStockphoto.com | subman

(a) Show that the magnitude of the:

- initial horizontal component of the velocity is 34.2 m s^{-1}

- initial vertical component of the velocity is 26.7 m s^{-1}.

(2 marks)

(b) Determine the total time that the arrow is in the air.

Use $g = 9.80 \text{ m s}^{-2}$ for the magnitude of the acceleration due to gravity.

(3 marks)

(c) Calculate the horizontal distance travelled by the arrow.

(2 marks)

(d) Identify the range of angles that would give a greater horizontal distance for the same initial speed.

(2 marks)

3. The motion of a satellite such as the International Space Station (shown below) can be used to obtain a value for the mass of the Earth.

Source: © iStockphoto.com | scibak

(a) The International Space Station completes circular orbits of the Earth with a speed of $7.6 \times 10^3 \text{ m s}^{-1}$ at a radius of 6.8×10^6 m.

Determine the mass of the Earth.

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____ (3 marks)

(b) Explain why the centre of a satellite's circular orbit must coincide with the centre of the Earth.

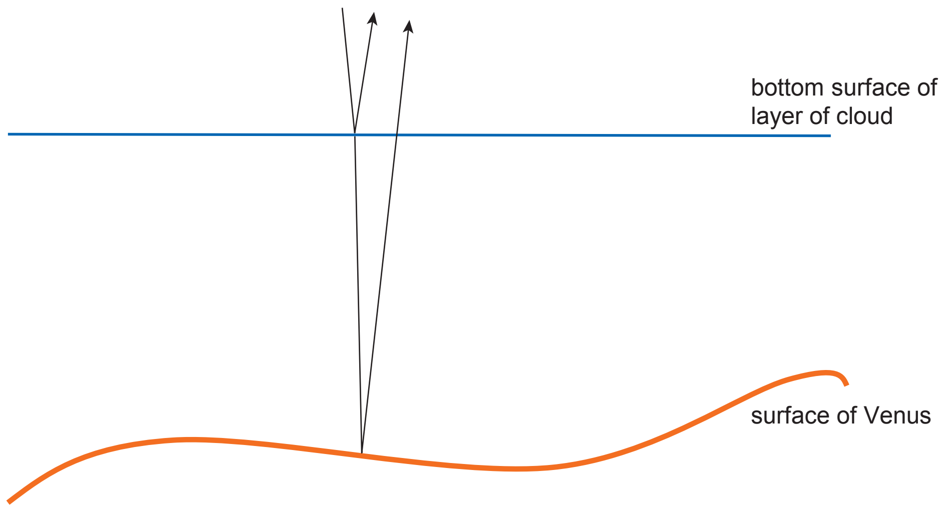
(3 marks)

PLEASE TURN OVER

4. The *Magellan* spacecraft used microwaves to survey, and create maps of, the surface of the planet Venus.

(a) Venus is covered with a thick layer of cloud. Technology similar to the laser airborne depth sounder (LADS) was used by *Magellan* to project microwave pulses downwards, so that they reflected normally off the bottom surface of the layer of cloud and off the surface of Venus. The time difference between the reflected microwave pulses was recorded.

The diagram below shows the paths of the reflected microwave pulses:



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

At a particular location, the two reflected microwave pulses were recorded returning to *Magellan* with a time difference of 2.36×10^{-4} s. The speed of the microwave pulses that reflected off the surface of Venus was $2.98\times10^{8}\ \mathrm{m\,s^{-1}}$.

Determine the distance between the bottom surface of the layer of cloud and the surface of Venus.

(3 marks)

(b) *Magellan* was put into a circular polar orbit around Venus, with a period of 5.64×10^3 s.

(i) Explain why a polar orbit was used for surveying the surface of Venus.

(2 marks)

(ii) Using $v = \frac{2\pi r}{T}$ and $v = \sqrt{\frac{GM}{r}}$, derive $r^3 = \frac{GM}{4\pi^2}T^2$, the relationship between r the radius of the orbit and T the period of rotation for a satellite orbiting Venus. M represents the mass of Venus.

(2 marks)

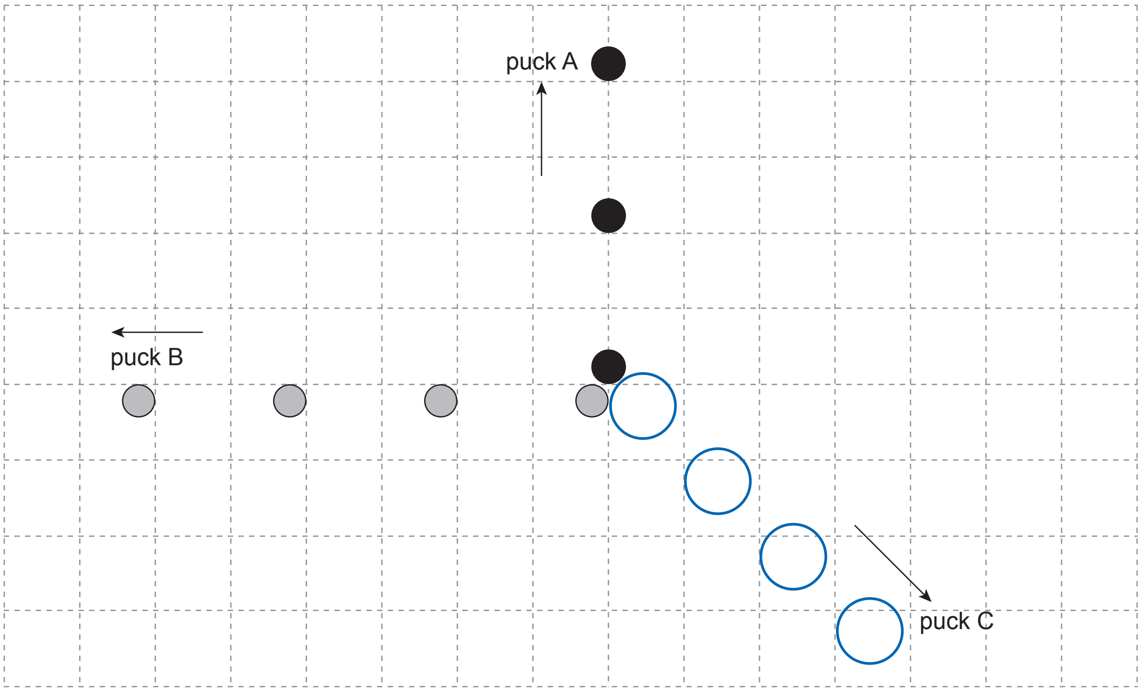
(iii) Using the equation from part (ii), calculate the radius of *Magellan*'s orbit.

The mass of Venus is 4.87×10^{24} kg.

(3 marks)

5. The motion of three pucks on an air table is shown in the multi-image diagram below. The pucks, which magnetically repel each other, were held together and stationary before being released. The mass of puck A is m, the mass of puck B is m, and the mass of puck C is $2m$.

When the pucks were released they moved away from each other, as shown in the diagram. The time between each image is constant.



(a) *On the diagram above*, draw and label momentum vectors for each of the three pucks as they moved away from each other. (3 marks)

(b) With the aid of a vector diagram, determine whether or not momentum was conserved when the pucks were released.

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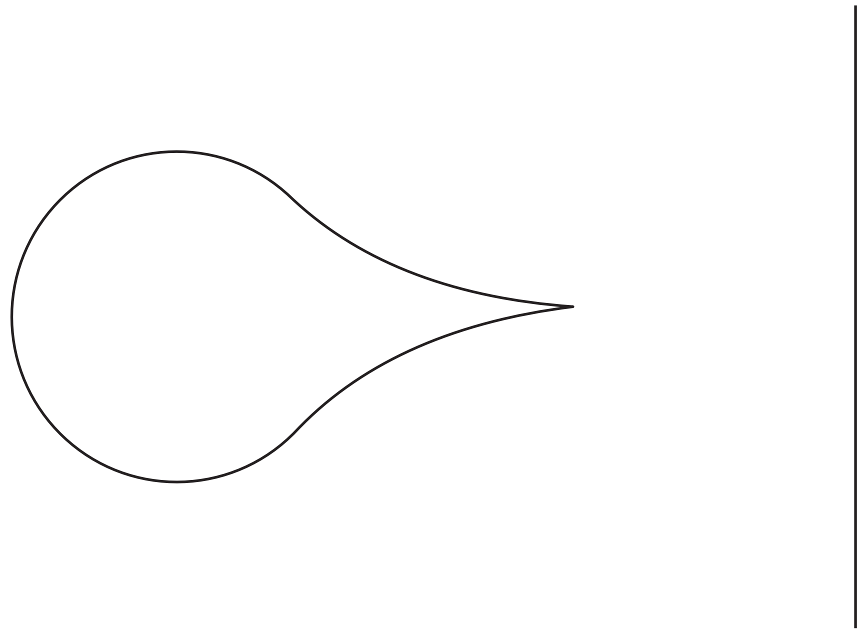
____ (3 marks)

6. An electron in a hydrogen atom orbits a proton at a radius of 5.29×10^{-11} m.

Determine the magnitude of the electric field E created by the proton at the radius at which the electron orbits.

(2 marks)

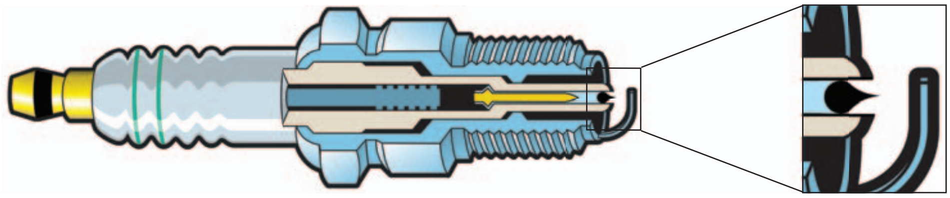
7. (a) The diagram below shows a positively charged conductor with a sharp point near a neutral metal plate:



On the diagram above, sketch the electric field between the conductor and the metal plate.

(3 marks)

(b) Some spark plugs used in motor vehicles have an electrode with a sharp point, as shown in the image below:



Source: © iStockphoto.com|TerrainScan (adapted)

Describe how the strong electric field created by a positively charged electrode with a sharp point can cause a corona discharge.

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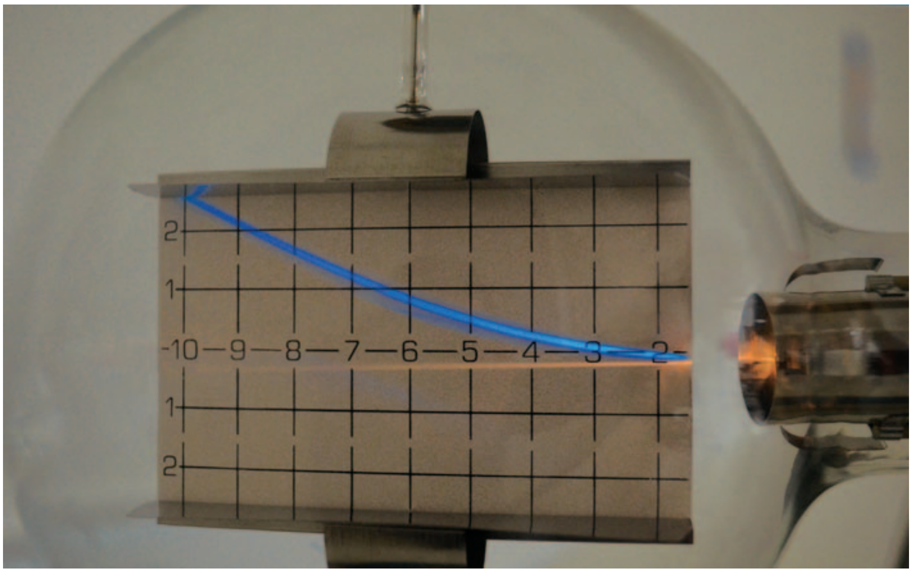
____ (2 marks)

8. A Teltron tube is a device used to accelerate electrons, as shown in the photograph below.

Electrons are deflected when they enter the region between two parallel plates to which a potential difference has been applied.



Explain why electrons will experience an electric force of constant magnitude when they are between two very long parallel plates to which a constant potential difference has been applied.

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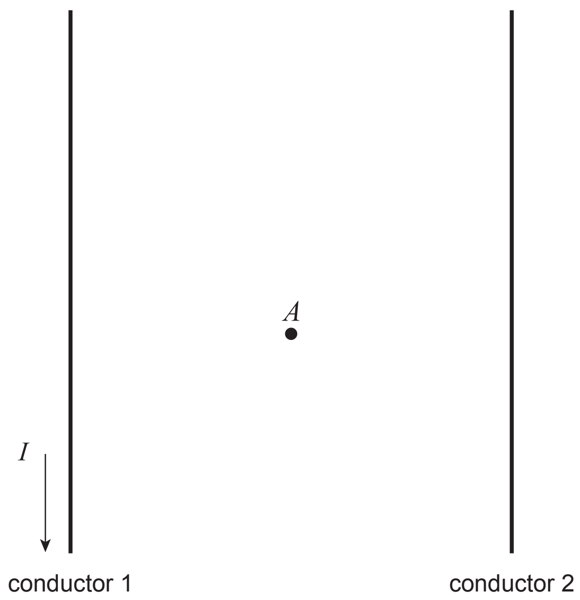
____ (2 marks)

9. The diagram below shows point A, which is midway between conductor 1 and conductor 2. In conductor 1 there is a current I, which is directed towards the bottom of the page. A current of the same magnitude flows in conductor 2.



Determine the direction of the current in conductor 2 that will cause the total magnetic field at point A to be zero.

Justify your answer.

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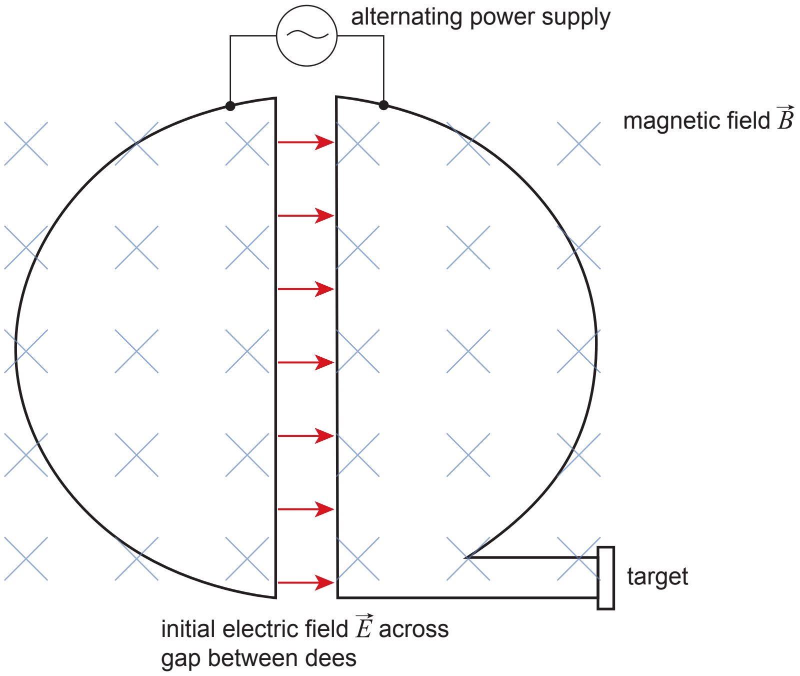
____ (3 marks)

10. The diagram below shows a cyclotron that is used to accelerate positive ions:



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

An ion of mass 3.3×10^{-27} kg and charge 1.6×10^{-19} C is accelerated in the cyclotron, which has a radius of 0.32 m. The magnetic field of the cyclotron has a magnitude of 1.2 T.

(a) Calculate the kinetic energy of the ion as it leaves the cyclotron.

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____ (2 marks)

(b) The kinetic energy of an ion as it leaves a cyclotron does not depend on the potential difference between the dees.

(i) Explain why the ion gains kinetic energy each time it moves across the gap between the dees.

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____ (2 marks)

(ii) Explain why increasing the potential difference between the dees has no effect on the kinetic energy of the ion as it leaves the cyclotron.

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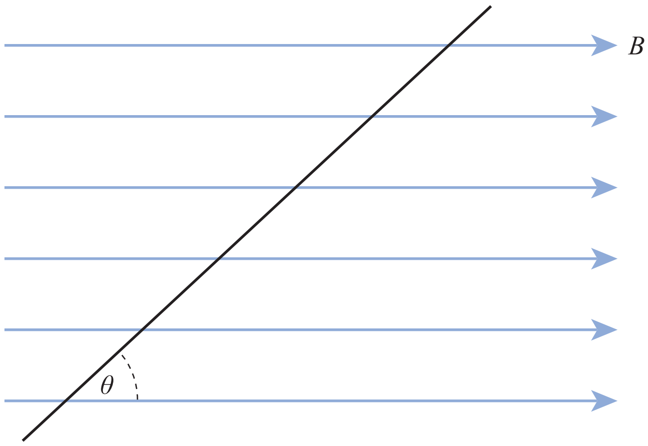
____ (3 marks)

11. An experiment was conducted to investigate the force on a current-carrying conductor in a magnetic field. The diagram below shows the conductor in the magnetic field of magnitude $B = 0.30\,\text{T}$, which is directed to the right of the page:



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

(a) The length of the conductor in the magnetic field was $0.55\ \text{m}$. A current of $0.050\ \text{A}$ flowed through the conductor, causing it to experience a force directed into the page. The magnitude of the force was measured to be $3.8\times10^{-3}\ \text{N}$.

(i) Determine the direction in which the current flowed through the conductor, and indicate the direction on the diagram above. (1 mark)

(ii) Determine the angle θ between the conductor and the magnetic field.

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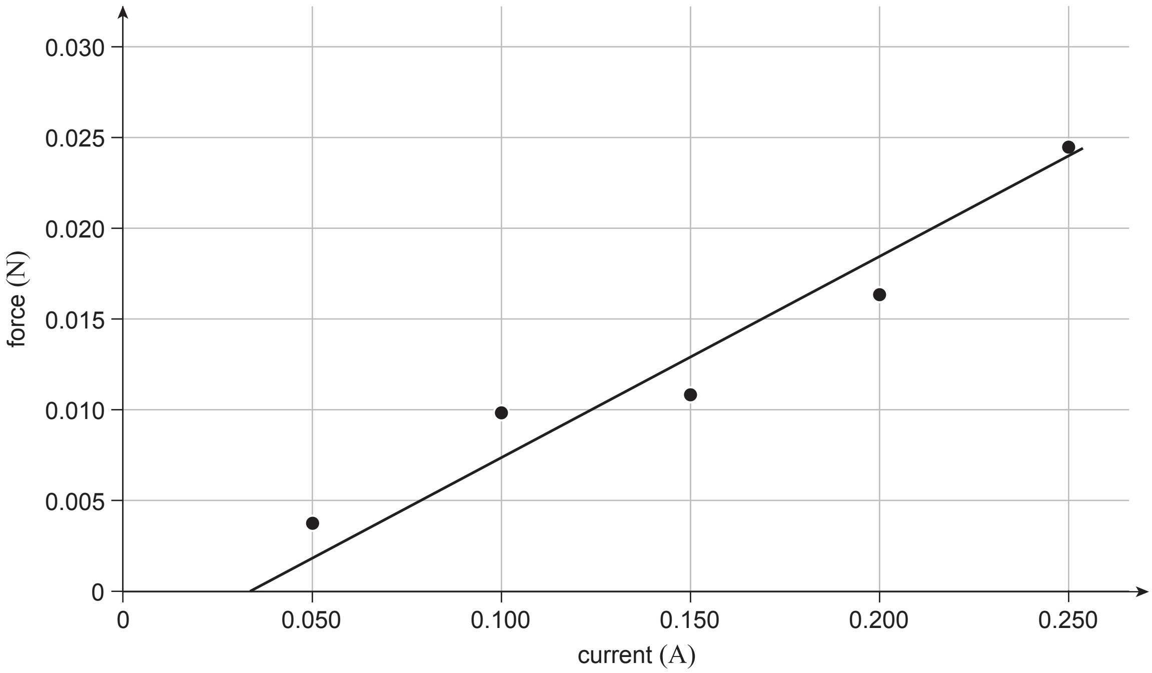
____ (3 marks)

(b) The conductor was then placed so that it was perpendicular to the magnetic field. The force on the conductor was measured for currents of different magnitudes.

The graph below shows the data collected:



Explain why the graph shows the presence of a systematic error.

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____ (2 marks)

PLEASE TURN OVER

12. The path that a charged particle takes in a magnetic field can be used to determine the mass of the particle.

(a) A particle with a charge of 3.2×10^{-19} C enters a magnetic field of magnitude 0.14 T with a velocity of 4.0×10^{5} m s^{-1} that is perpendicular to the magnetic field.

Calculate the magnitude of the force on the particle.

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____ (2 marks)

(b) Explain why charged particles move with uniform circular motion when they enter a magnetic field with a velocity that is perpendicular to the magnetic field.

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____ (3 marks)

(c) (i) Derive the expression $r = \frac{mv}{qB}$ for the radius r of the circular path of a particle that is moving with speed v at right angles to a uniform magnetic field of magnitude B. The particle has charge q and mass m.

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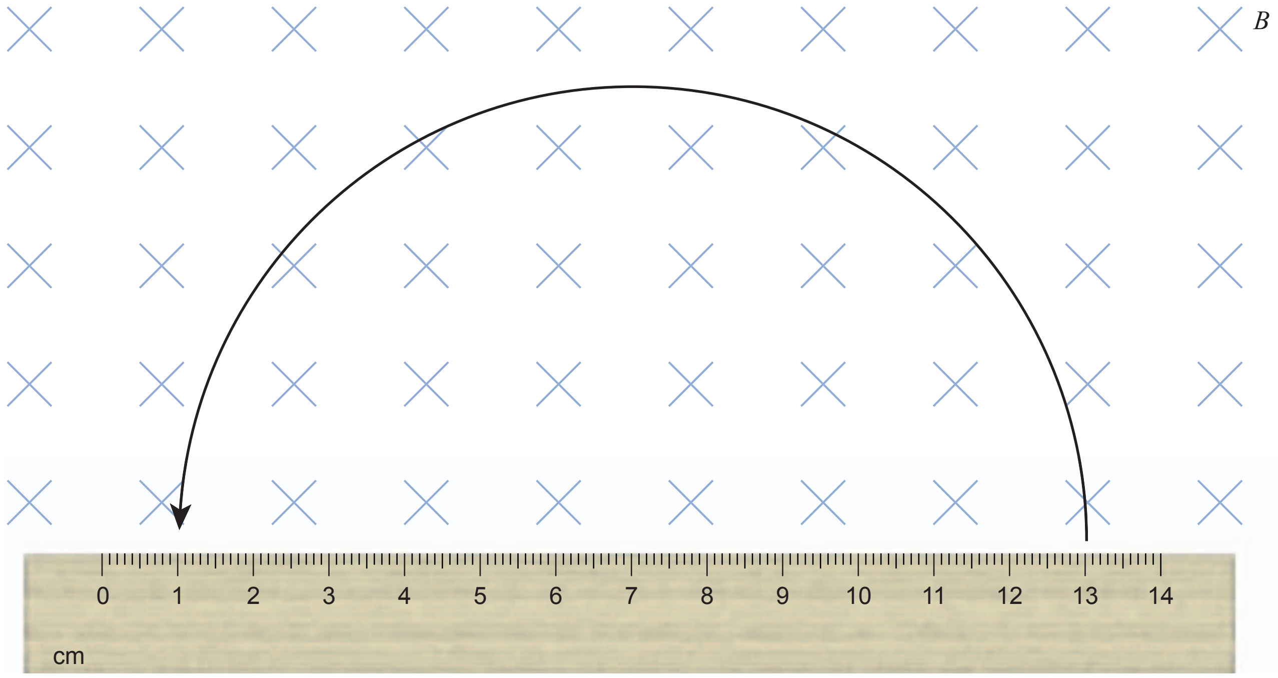
____ (3 marks)

(ii) The diagram below shows the path of a charged particle that has entered a magnetic field of magnitude $B = 0.14\,\mathrm{T}$, which is directed into the page. The initial velocity of the particle was $4.0 \times 10^{5}\ \mathrm{m\,s^{-1}}$, perpendicular to the magnetic field. The particle has a charge of magnitude $3.2 \times 10^{-19}\ \mathrm{C}$.



Using the diagram above, determine the mass of the particle.

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____ (3 marks)

(iii) Determine the sign of the charge of the particle.

____ (1 mark)

13. The photograph below shows a television antenna being positioned so that it receives horizontally polarised electromagnetic waves:

Source: www.jimsantennas.com.au

(a) State the direction of the oscillating electric fields in horizontally polarised electromagnetic waves.

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____ (1 mark)

(b) The antenna shown in the photograph above is oriented to receive the transmissions from nearby city television channels.

State the orientation of an antenna that would receive the transmissions from country television channels a large distance away. Give a reason for your answer.

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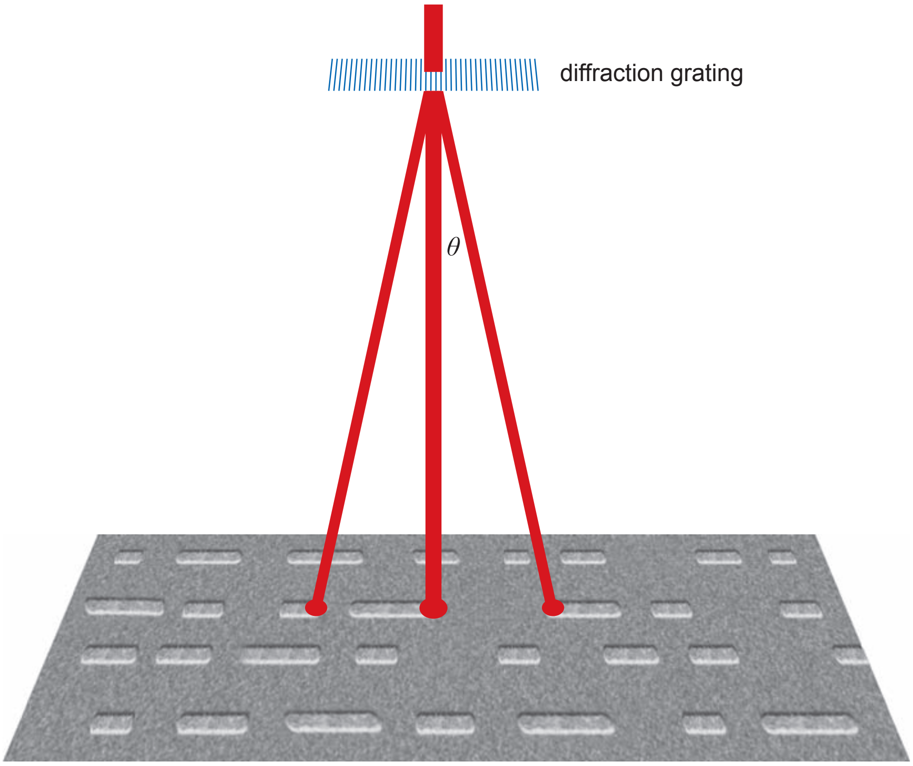
____ (2 marks)

14. The image below shows a laser reading information from the surface of a compact disc. The laser is split into three beams by a diffraction grating to keep it on the correct track of the compact disc.



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

The angle θ between the central maxima and the first-order maxima is $0.023°$. The wavelength of the laser beam is 780 nm.

Determine the distance between the slits of the diffraction grating.

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____ (3 marks)

You may write on this page if you need more space to finish your answers to Part 1 of Section A. Make sure to label each answer carefully (e.g. 4(b)(ii) continued).

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External Examination 2014

2014 PHYSICS

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SACE REGISTRATION NUMBER

SEQ	FIGURES						CHECK LETTER	BIN

PHYSICS

QUESTION BOOKLET

2

22 pages, 11 questions

Tuesday 4 November: 1.30 p.m.

2

Part 2 of Section A

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

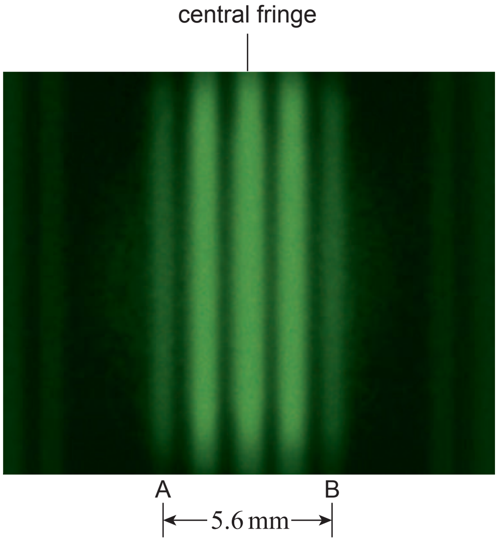
SECTION A

PART 2 (Questions 15 to 25)

(74 marks)

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

15. A two-slit interference experiment was conducted using monochromatic green light. The photograph below shows the interference fringes that were observed:



The distance between the bright fringe labelled A and the bright fringe labelled B was measured as 5.6 mm.

(a) Determine the average distance between adjacent fringes.

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____ (1 mark)

(b) The distance between the two slits was 1.2×10^{-4} m, and the slit-to-screen distance was 0.30 m.

Determine the wavelength of the monochromatic green light.

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____ (3 marks)

(c) Explain how the bright fringe labelled A was produced.

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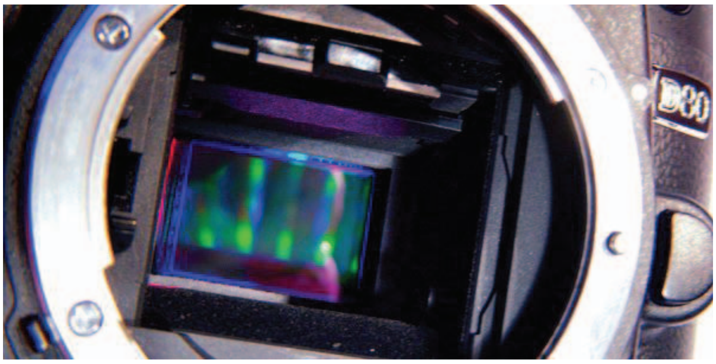
____ (2 marks)

16. Many digital cameras use a sensor that absorbs photons and releases electrons as a result of the photoelectric effect.



Source: www.tested.com © Web Property #5, LLC., All Rights Reserved

Ultraviolet light of frequency 1.9×10^{15} Hz illuminates a sensor. The work function of the sensor is 7.3×10^{-19} J.

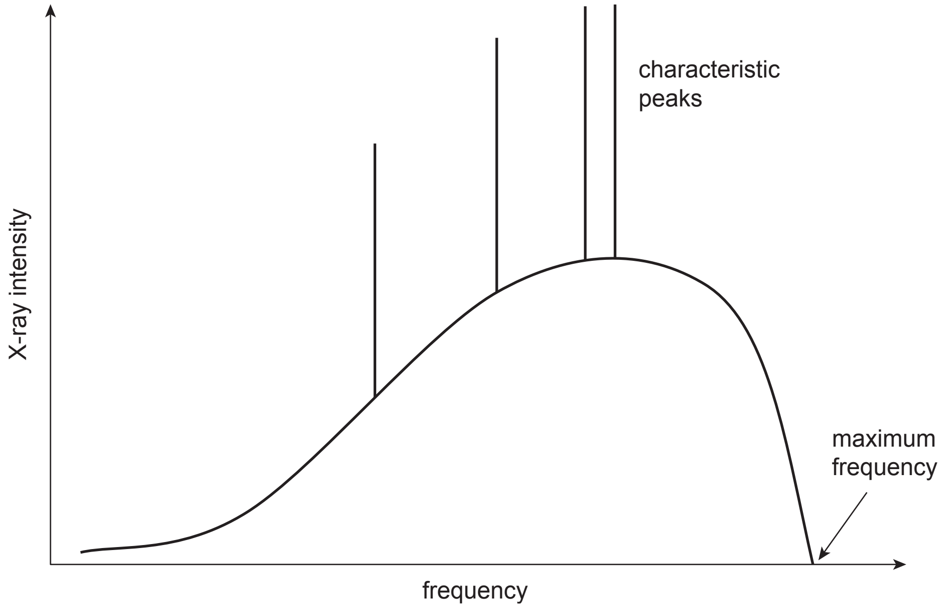
(a) Calculate the maximum kinetic energy of the electrons emitted from the sensor.

(2 marks)

(b) Describe and explain the effect that increasing the intensity of the incident ultraviolet light would have on the number and energy of the emitted electrons.

____ (3 marks)

17. (a) The diagram below shows two main features of the spectrum from an X-ray tube:



Using the law of conservation of energy, explain how a decrease in the potential difference across the X-ray tube changes the maximum frequency.

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____ (3 marks)

(b) The photograph below shows a child being prepared for a dental X-ray. The child is wearing a lead-lined apron to reduce exposure to X-ray radiation.

Source: © iStockphoto.com | slobo

Explain how ionising radiation such as X-rays can damage living matter.

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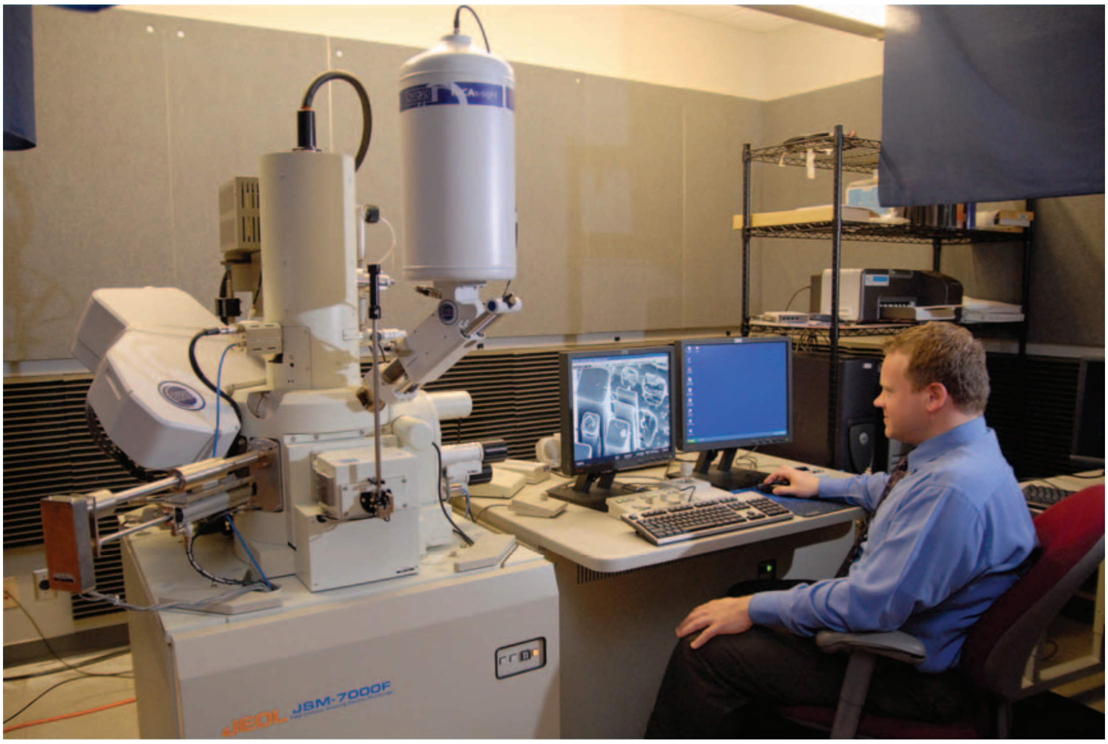
____ (2 marks)

PLEASE TURN OVER

18. The photograph below shows a scanning electron microscope:



Source: http://caf.ua.edu

(a) The electrons in an electron microscope gain energy as they move through a potential difference of $10\ \text{kV}$.

(i) Show that the electrons are accelerated to a speed of $5.9 \times 10^{7}\ \text{m s}^{-1}$.

(4 marks)

(ii) Calculate the wavelength of electrons travelling at a speed of $5.9 \times 10^7 \text{ m s}^{-1}$.

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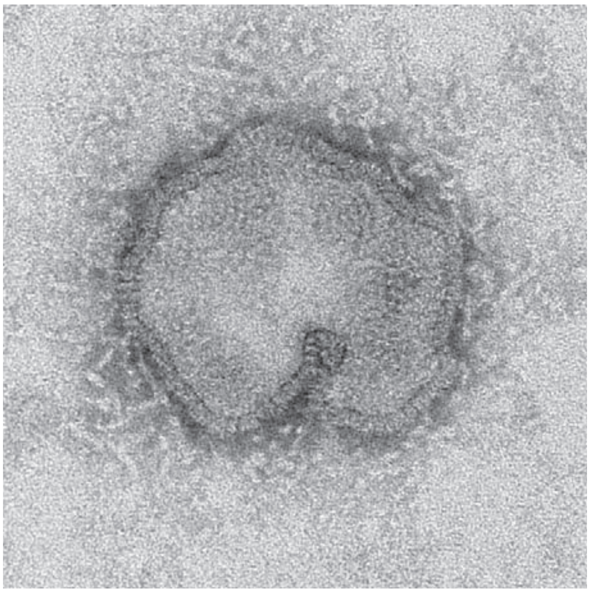
____ (2 marks)

(b) The image below, from an electron microscope, shows an influenza virus. The width of this image is approximately 120 nm.



Source: http://phil.cdc.gov

State why an electron microscope is more effective than a microscope that uses visible light for viewing the influenza virus shown in the image above. Justify your answer.

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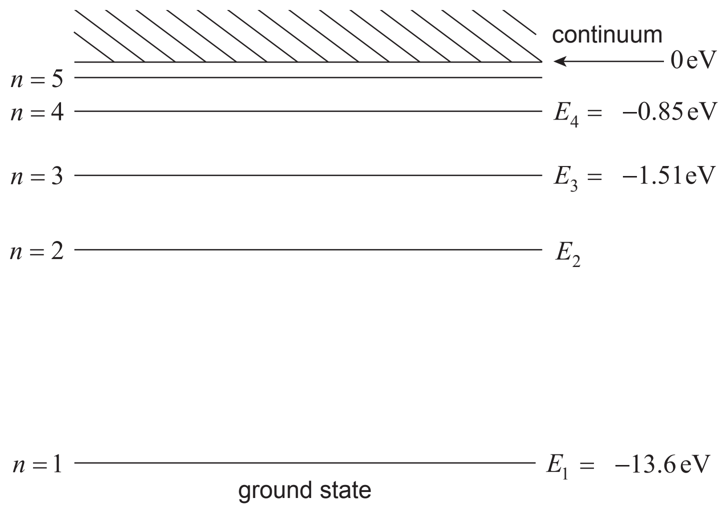
____ (2 marks)

19. The diagram below shows some of the energy states of hydrogen:



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

Some electron transitions to the $n = 2$ state result in the emission of photons.

(a) *On the diagram above*, draw the transition to the $n = 2$ state that releases the smallest-energy photon. (1 mark)

(b) The smallest-energy photon that is emitted in a transition to the $n = 2$ state has a wavelength of 6.56×10^{-7} m.

Show that the energy of this photon is 3.03×10^{-19} J.

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____ (2 marks)

(c) Hence determine the energy of the $n = 2$ state, giving your answer in electronvolts.

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____ (2 marks)

20. When there is a population inversion in the gain medium of a helium–neon laser the rate of stimulated emission exceeds the rate of absorption.

(a) Describe what a population inversion is, and how it is maintained in a helium–neon laser.

(3 marks)

(b) Compare the process of stimulated emission with that of ordinary (or spontaneous) emission.

(3 marks)

21. The copper-64 ($^{64}_{29}\mathrm{Cu}$) radioisotope is being tested as a suitable radioisotope for use in positron emission tomography (PET). Copper-64 decays to an isotope of nickel (Ni) by the emission of a positron, as shown in the reaction below:

$$^{64}_{29}\mathrm{Cu} \longrightarrow {}^{A}_{Z}\mathrm{Ni} + \text{positron} + \mathrm{X}$$

(a) Identify particle X.

____ (1 mark)

(b) State the atomic number (Z) and the mass number (A) of the nickel isotope produced in this reaction.

Z: ____________________

A: ____________________ (2 marks)

22. Plutonium-244 decays via alpha decay to form uranium-240, as shown in the reaction below:

$$^{244}_{94}\text{Pu} \longrightarrow {}^{240}_{92}\text{U} + {}^{4}_{2}\text{He}$$

Using the law of conservation of momentum, show that the alpha particle will move in the opposite direction to, and at approximately sixty times the speed of, the uranium-240 nucleus.

Assume that the plutonium nucleus was initially at rest.

(4 marks)

23. In 1934 South Australian-born physicist Mark (later Sir Mark) Oliphant conducted experiments in which fast deuterons were collided with deuterium targets, thus producing the first demonstration of nuclear fusion. The reaction is shown below:

$$ {}^{2}_{1}H + {}^{2}_{1}H \rightarrow {}^{3}_{1}H + {}^{1}_{1}H $$

(a) The masses of the particles involved in the reaction are:

deuterium ${}^{2}_{1}H$	3.344×10^{-27} kg
tritium ${}^{3}_{1}H$	5.008×10^{-27} kg
hydrogen ${}^{1}_{1}H$	1.673×10^{-27} kg

(i) Find the difference in mass between the reactants and the products, and hence determine if energy is released or absorbed in the reaction.

(3 marks)

(ii) Hence calculate the amount of energy that is released or absorbed in this reaction.

(2 marks)

Tritium (^3_1H) is a radioactive isotope of hydrogen that has a half-life of 12.3 years.

(b) Predict the type of radioactive decay that tritium undergoes. Give a reason for your answer.

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____ (2 marks)

(c) Tritium is present in water and therefore its radioactive decay can be used to determine the age of wines.

It was claimed that a particular bottle of wine had been produced in 1970. Scientists tested the wine and found that it contained approximately one quarter the amount of tritium that was in a similar wine produced in 2014.

Determine whether or not the amount of tritium present supports the age claimed for the wine.

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____ (4 marks)

24. Americium-241 undergoes an alpha decay and produces an isotope of neptunium, as shown in the reaction below. The neptunium undergoes gamma decay.

$$^{241}_{95}\text{Am} \longrightarrow {}^{237}_{93}\text{Np}^{*} + {}^{4}_{2}\text{He}$$

(a) Explain why alpha decay is often accompanied by the emission of gamma rays.

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____ (2 marks)

(b) Write the reaction for the gamma decay of $^{237}_{93}\text{Np}^{*}$.

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____ (1 mark)

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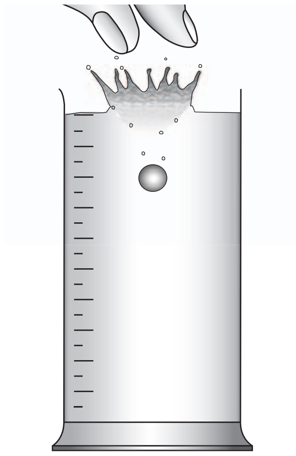
Question 25 begins on page 18.

25. ‘Terminal velocity’ is the speed reached by a falling object when its motion is such that the net upward force of resistance is equal in size and opposite in direction to the downward force of gravity.

Students conducted an experiment to determine the terminal velocity of a small sphere that was dropped into a container of oil. A multi-image photograph recorded the distance fallen every 0.10 s. After initially accelerating downwards, the sphere reached its terminal velocity.

Research by the students indicated that the sphere should reach a terminal velocity of $v_t = 0.25\,\text{m}\,\text{s}^{-1}$.

The students conducted the experiment three times. The table below shows the data they recorded:



Time	Distance Fallen			
	Experiment 1	Experiment 2	Experiment 3	Average
0.10 s	1 cm	1 cm	1 cm	
0.20 s	2.4 cm	2.7 cm	2.4 cm	
0.30 s	5 cm	5 cm	5 cm	
0.40 s	7.8 cm	7.6 cm	8 cm	
0.50 s	10.6 cm	10.6 cm	10.6 cm	
0.60 s	13.4 cm	13.1 cm	13.7 cm	
0.70 s	16.2 cm	16.3 cm	16.1 cm	
0.80 s	19 cm	19 cm	19 cm	

(a) Complete the table above, calculating the average distance fallen for each time. (2 marks)

(b) Suggest one way of improving the presentation of the data in the table above.

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____ (1 mark)

(c) *On page 19*, plot a graph of average distance fallen against time. Draw a line of best fit for the values *when the sphere had reached its terminal velocity*. (6 marks)

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

(3 marks)

(e) State why the gradient of your line of best fit represents the terminal velocity.

(1 mark)

(f) (i) Comment on the accuracy of the experiment.

(1 mark)

(ii) Comment on the precision of the experiment.

(1 mark)

(g) The experiment was repeated with a sphere of the same mass but smaller area of cross section.

Predict, giving reasons, how the motion of this sphere would be different.

(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. 19(b) continued).

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External Examination 2014

2014 PHYSICS

SACE REGISTRATION NUMBER

SEQ	FIGURES	CHECK LETTER	BIN

PHYSICS

QUESTION BOOKLET

3

8 pages, 2 questions

Tuesday 4 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 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 15 marks.
- Question 27, 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.

26. A nuclear power reactor is shown in the photograph below:

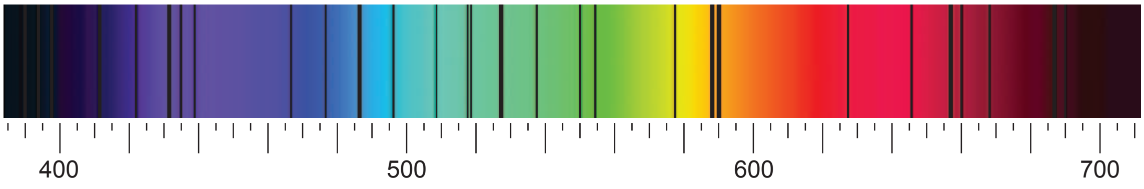
Source: © Xxlphoto | Dreamstime.com

Many nuclear power reactors produce energy through chain reactions of the fission of enriched uranium.

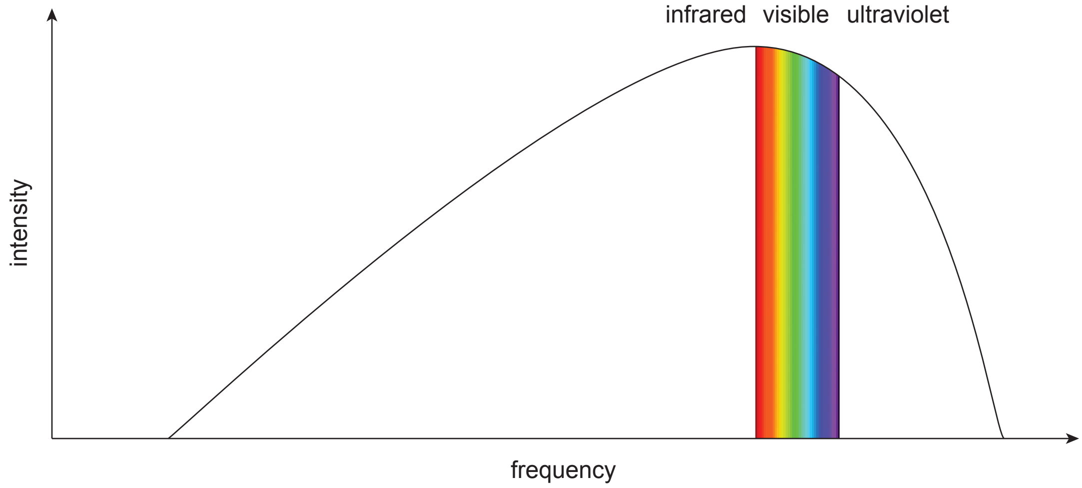
- State what is meant by the term 'enriched uranium', and explain why it is necessary for attaining a continuous chain reaction.
- Discuss *one* advantage and *one* disadvantage of nuclear fission over fossil fuel power stations.

(15 marks)

27. The image below shows the absorption lines (Fraunhofer lines) in the Sun's spectrum:



The image below shows the frequency distribution of the continuous spectra emitted by the Sun:



Astronomers use both the absorption lines and the frequency distribution of the continuous spectra to determine the elements within the atmospheres of stars and the temperatures of stars.

- Explain how line absorption spectra are produced, and how they can be used to identify elements in a gas.
- Describe how the frequency distribution, and hence the dominant colour, of the continuous spectrum radiated by a dense gaseous object such as a star depends on the temperature of the object.

(15 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. 27 continued).

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