Government of South Australia

SACE Board of SA

External Examination 2011

2011 PHYSICS

ATTACH SACE REGISTRATION NUMBER LABEL TO THIS BOX

QUESTION BOOKLET 1

23 pages, 14 questions

Wednesday 2 November: 9 a.m.

Time: 3 hours

Part 1 of Section A

Examination material: Question Booklet 1 (23 pages)
Question Booklet 2 (18 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 23 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 18 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	73 marks	70 minutes
	Part 2	75 marks	75 minutes
Section B			
		32 marks	35 minutes
Total		180 marks	180 minutes

4. The equation sheet is on pages 3 and 4, which you may remove from this booklet.

5. Vector quantities in this paper are indicated by arrows over the symbols.

6. Marks may be deducted if you do not clearly show all steps in the solution of problems, 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

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

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

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

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

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

Section 3: Light and Matter

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

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

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

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

$E = hf$ E = energy of photon

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

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

$W = hf_0$ f_0 = threshold frequency

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

Section 4: Atoms and Nuclei

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

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

$E = mc^2$ E = energy

TABLE OF PREFIXES

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

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

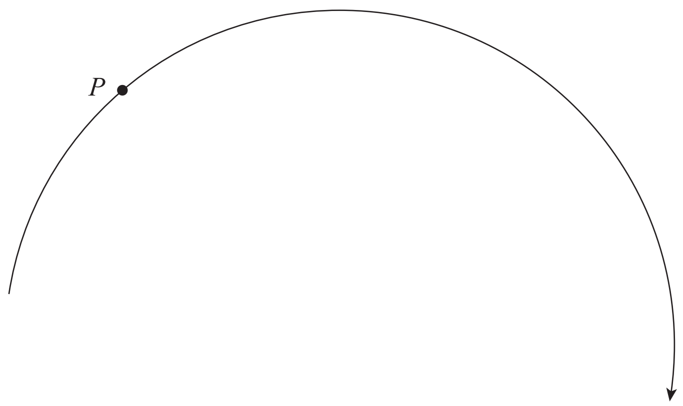
SECTION A

PART 1 (Questions 1 to 14)

(73 marks)

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

1. The diagram below shows a section of the path of an object moving with uniform circular motion in a clockwise direction:



(a) *On the diagram above*, draw and label arrows at point P to indicate the direction of the:

(i) instantaneous velocity $\vec{v}$ of the object. (1 mark)

(ii) instantaneous acceleration $\vec{a}$ of the object. (1 mark)

(b) The object is travelling with a speed of $5.0\,\mathrm{m\,s^{-1}}$. The radius of the circular path is $12\,\mathrm{m}$. Calculate the magnitude of the instantaneous acceleration $\vec{a}$ of the object.

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____ (2 marks)

2. A projectile is launched horizontally from a height of $2.4\,\mathrm{m}$ above ground level, with an initial velocity of magnitude $v_0 = 65\,\mathrm{m\,s^{-1}}$. *Ignore the effects of air resistance in parts (a) to (c) of this question*.

(a) State the magnitude of the horizontal component of the velocity of the projectile when it hits the ground. Justify your answer.

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____ (2 marks)

(b) Show that the time of flight of the projectile is $0.70\,\mathrm{s}$.

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____ (2 marks)

(c) Calculate the range of the projectile.

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____ (2 marks)

(d) The photograph below shows four people playing badminton:

Source: www.dreamstime.com

During a badminton match a shuttlecock is hit at a height of $2.4\,\mathrm{m}$ above ground level. It then moves horizontally with an initial velocity of magnitude $v_0 = 65\,\mathrm{m\,s^{-1}}$. Air resistance increases the time of flight of the shuttlecock to more than $0.70\,\mathrm{s}$.

Explain why air resistance increases the time of flight of the shuttlecock.

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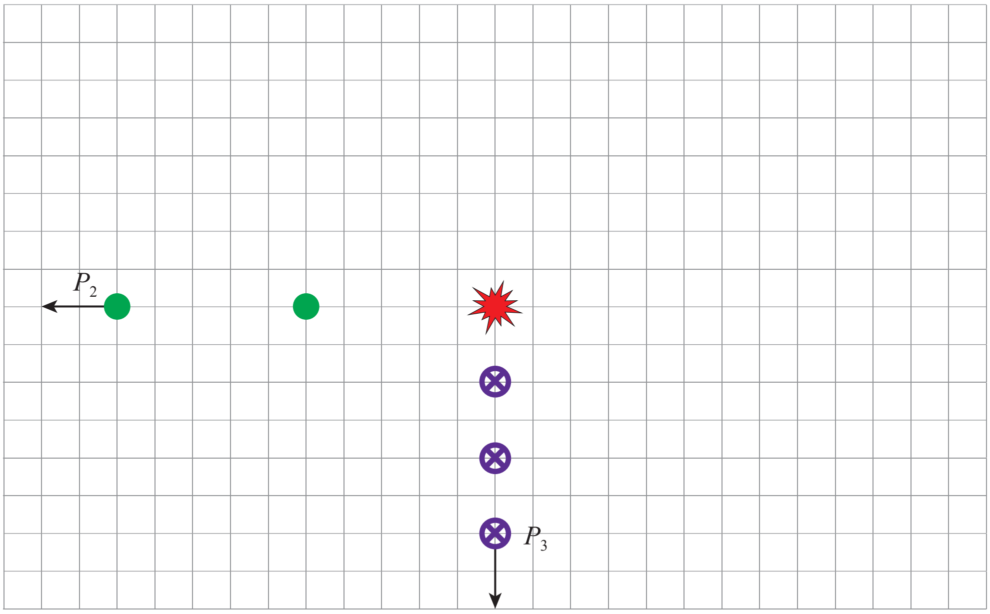
____ (2 marks)

3. A stationary object explodes into three pieces. Piece P_1 and piece P_2 both have a mass m, and piece P_3 has a mass $2m$.

The multi-image diagram below shows the motion of piece P_2 and piece P_3 after the explosion. *Assume an isolated system.*



Determine the position of the first image for piece P_1 after the explosion, indicating the position on the diagram above. Show your working.

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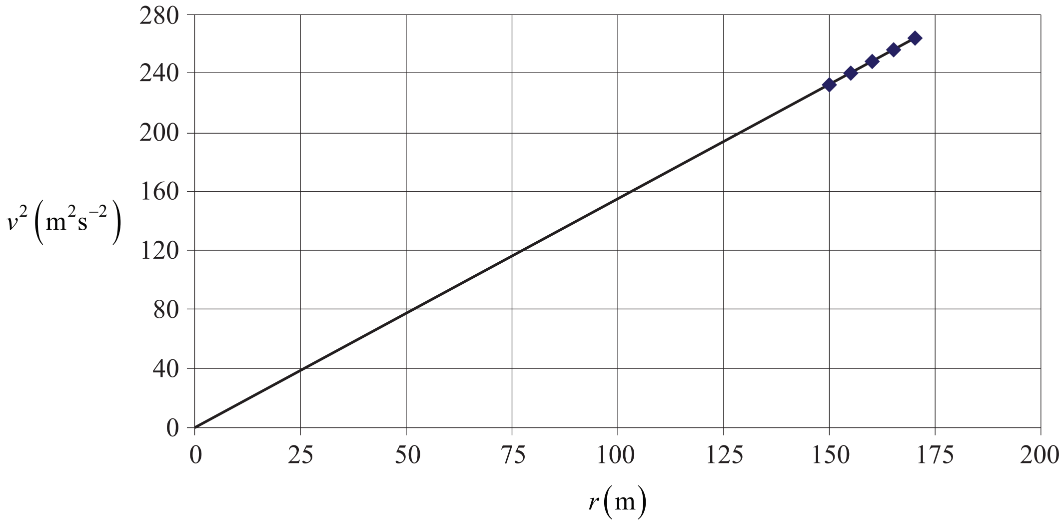
____ (5 marks)

4. A motor-racing track has banked quarter-circle turns. Racing cars travel around the turns at different radii and speeds.

Data are collected on the occasions when the centripetal acceleration is not caused by the frictional force on the tyres.

The graph below shows the data collected. The line of best fit has a gradient of magnitude 1.55.

Source: www.dreamstime.com



(a) State the units of the gradient of the line of best fit.

____ (1 mark)

(b) State the equation of the line of best fit.

____ (1 mark)

(c) Using the equation of the line of best fit, calculate the banking angle of the turns.

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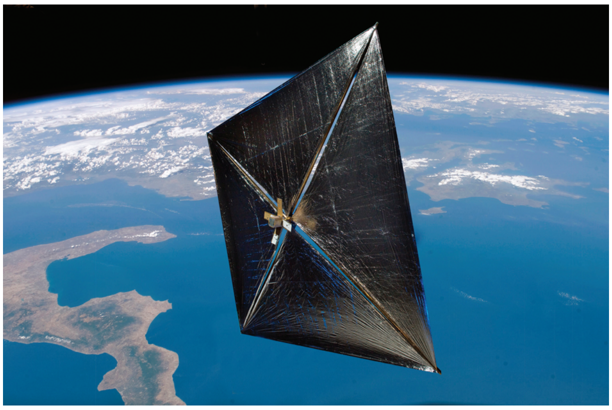
____ (4 marks)

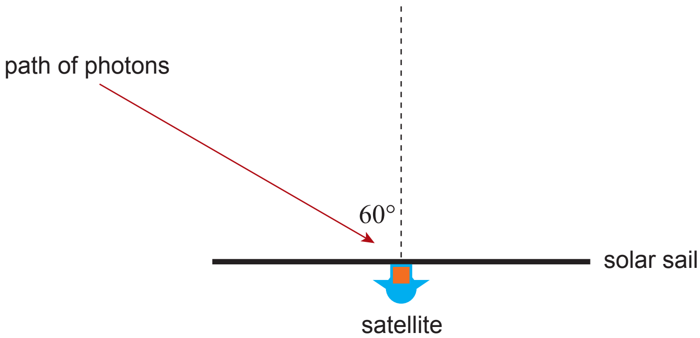
5. The image below shows a satellite with a solar sail:



Source: http://science.nasa.gov

The NASA satellite NanoSail-D was in a stable orbit around the Earth between January and April 2011.

Photons, each with a momentum of $1.14 \times 10^{-27}\ \mathrm{kg\,m\,s^{-1}}$, were incident on the solar sail at an angle of $60°$, as shown in the diagram below:



(a) Calculate the wavelength of the photons.

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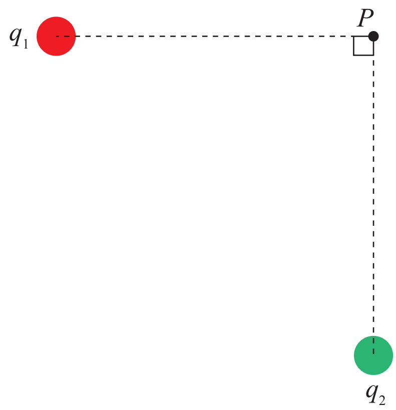
____ (2 marks)

(b) *Using a vector diagram*, calculate the change in momentum of one of the photons if it reflects from the sail without loss of energy.

(4 marks)

6. The diagram below shows two point charges in a vacuum. Charge q_1 has a positive charge of magnitude $2.0\,\mu\text{C}$ and charge q_2 has a negative charge of magnitude $5.0\,\mu\text{C}$. Point P is equidistant from the two charges, and forms a right angle with the two charges.



The magnitude of the electric field at point P due to q_1 is $1.02 \times 10^7\ \text{N}\,\text{C}^{-1}$.

(a) Using proportionality, show that the magnitude of the electric field at point P due to q_2 is $2.55 \times 10^7\ \text{N}\,\text{C}^{-1}$.

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____ (2 marks)

(b) (i) *On the diagram above*, draw an arrow to show the approximate direction of the total electric field at point P. (1 mark)

(ii) Calculate the magnitude of the total electric field at point P.

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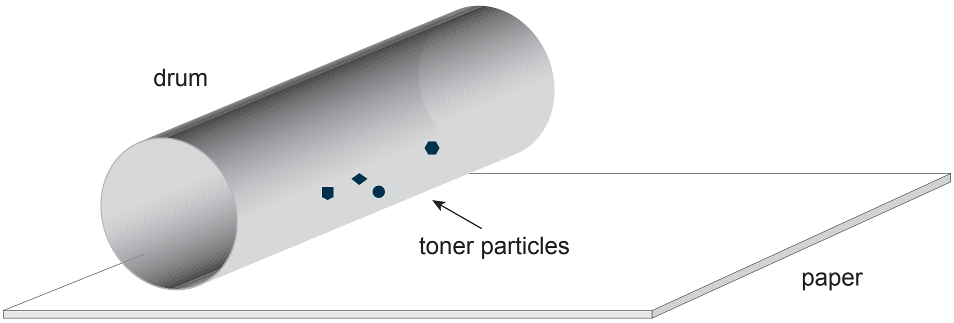
____ (4 marks)

7. Toner particles on the drum of a photocopier experience a force of 3.22×10^{-9} N towards the paper. The particles have a charge of 1.44×10^{-14} C.



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

Calculate the magnitude of the electric field at the surface of the drum.

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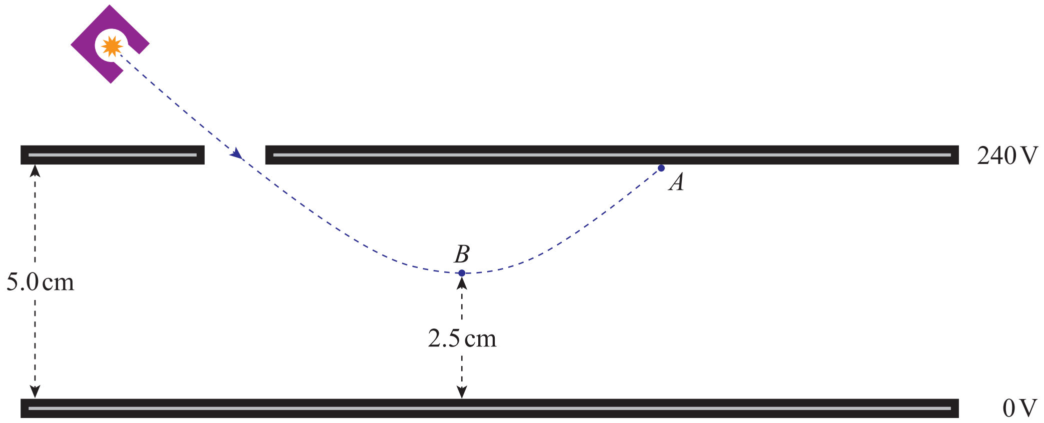
____ (2 marks)

8. A uniform electric field is set up between two parallel conducting plates which are $5.0\,\mathrm{cm}$ apart, and which have a potential difference of $240\,\mathrm{V}$ between them. An electron is emitted from a radioactive source and travels through an opening in the upper plate. The electron travels through the electric field and strikes the upper plate at point A, as shown in the diagram below. *Ignore end effects and the effect of gravity*.



The minimum distance of $2.5\,\mathrm{cm}$ between the electron and the lower plate occurs when the electron is at point B.

(a) The radioactive source of electrons is strontium-90 $\left({}^{90}_{38}\mathrm{Sr}\right)$, which decays to an isotope of yttrium.

State the atomic number and the mass number of the isotope of yttrium.

Atomic number: ___________

Mass number: ___________ (2 marks)

(b) (i) Calculate the magnitude of the electric field between the parallel plates.

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______________________________ (2 marks)

(ii) Calculate the work done by the electric field as the electron moves from point B to point A.

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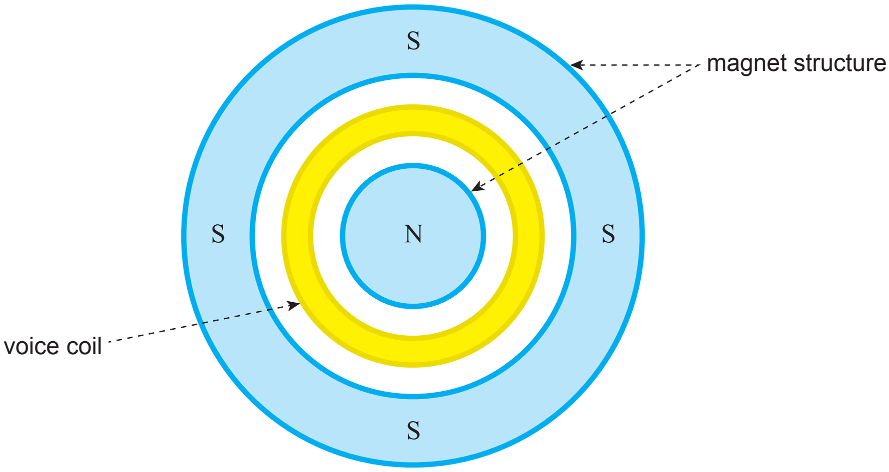
______________________________ (3 marks)

9. A moving-coil loudspeaker contains a magnet structure and a voice coil. The voice coil is positioned between the poles of the magnet structure, as shown in the diagram below:

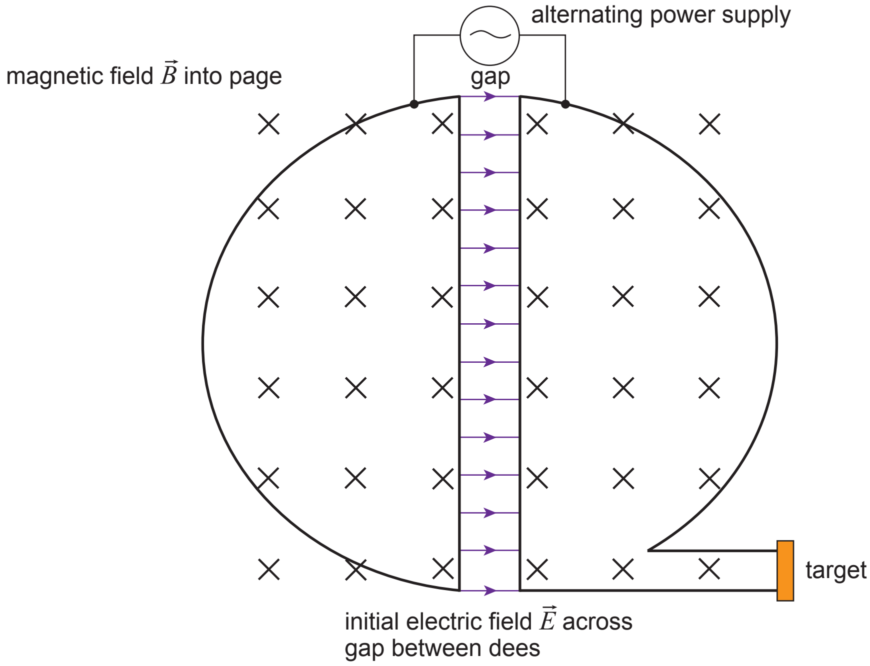


(a) *On the diagram above*, draw the magnetic field lines of the magnet structure. (2 marks)

(b) State the direction of the force on the voice coil when the current inside it is flowing in a clockwise direction.

____ (1 mark)

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



(a) State whether this cyclotron is used to accelerate positive ions or negative ions. Give a reason for your answer.

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____ (2 marks)

(b) Describe the purpose of the electric field and the purpose of the magnetic field in accelerating the ions to high energies.

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____ (3 marks)

(c) The ions accelerated in the cyclotron have a charge of magnitude 3.20×10^{-19} C. The electric field across the gap between the dees is due to a potential difference of $30.0\,\text{kV}$. The ions emerge from the cyclotron with a kinetic energy of $14.4\,\text{MeV}$.

Determine the number of complete rotations that the ions make in the cyclotron.

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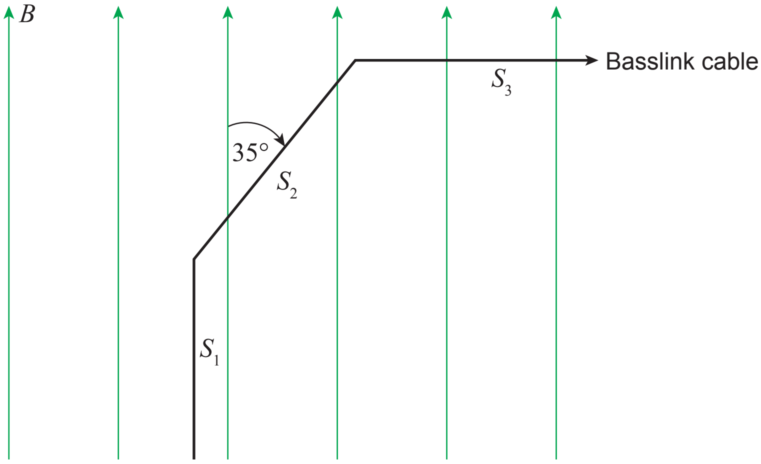
____ (4 marks)

11. The Basslink Interconnector is an undersea electricity cable that runs across Bass Strait between the states of Victoria and Tasmania.

The cable carries an electric current of $1250\,\mathrm{A}$.

The diagram below shows three sections of the cable and the component of the Earth's magnetic field in the plane of the cable. The magnitude of the magnetic field B is $3.1\times10^{-5}\,\mathrm{T}$.



(a) List the three sections of cable, S_1, S_2, and S_3, in order of increasing force due to the Earth's magnetic field.

____ (1 mark)

(b) Calculate the force per unit length on section S_2 of the cable.

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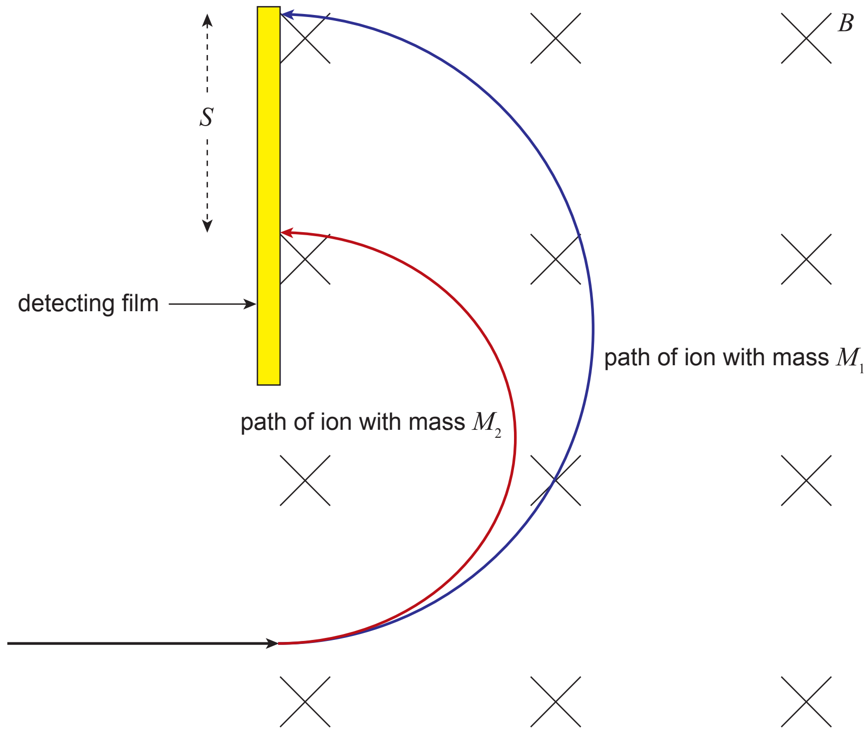
____ (3 marks)

12. The diagram below shows the paths of two identically charged isotopes of an element. The two isotopes enter a magnetic field at $90°$, with the same speed v.



Show that the separation S of the isotopes on the detecting film is given by

$$S = \frac{2v(M_1 - M_2)}{qB}$$

where:

- M_1 and M_2 are the masses of the two isotopes
- q is the charge of each isotope
- B is the magnitude of the magnetic field.

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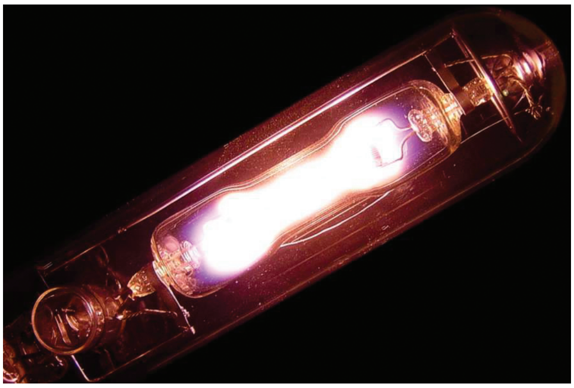
____ (2 marks)

13. The helium lamp shown below is a monochromatic light source:



Source: www.lamptech.co.uk

(a) (i) State what is meant by 'monochromatic' light.

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____ (1 mark)

(ii) Explain why light from the helium lamp is not coherent.

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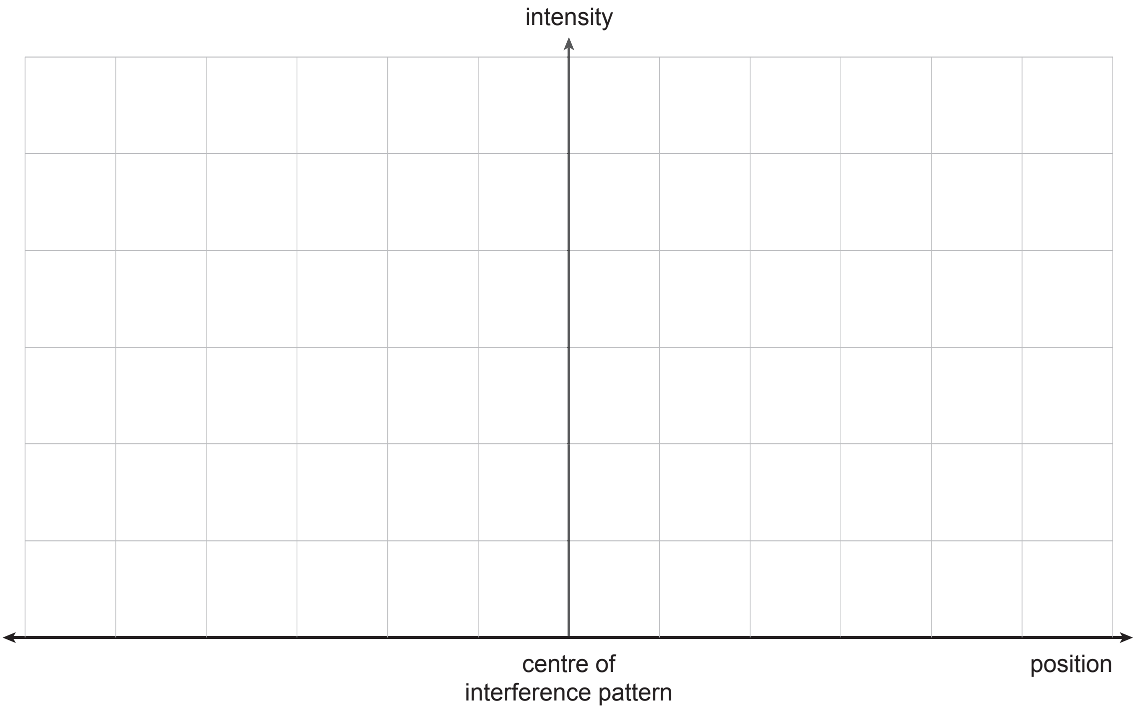
____ (2 marks)

(b) In a two-slit experiment, light from a helium lamp passes through a single slit before illuminating the double slits. The single slit is equidistant from the double slits. The interference pattern produced is viewed on a screen.

(i) *On the axes below*, sketch a graph showing the intensity distribution of the interference pattern.



(2 marks)

(ii) Explain the fringe at the centre of the pattern in terms of interference.

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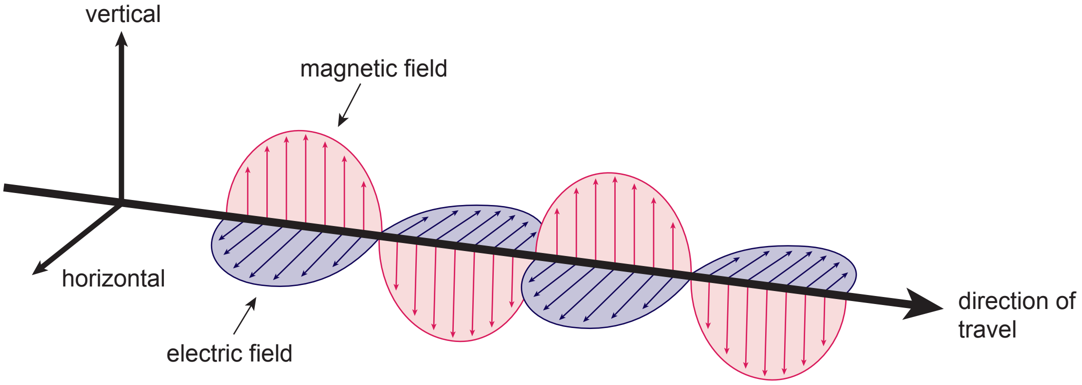
____ (2 marks)

14. The diagram below shows an electromagnetic wave, with a wavelength of $1.32\,\mathrm{m}$, carrying a digital television signal:



(a) State the plane of polarisation of the electromagnetic wave shown.

____ (1 mark)

(b) Calculate the frequency of the electromagnetic wave.

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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. 4(c) continued).

Government of South Australia

SACE
Board of SA

External Examination 2011

2011 PHYSICS

SACE REGISTRATION NUMBER			
SEQ	FIGURES	CHECK LETTER	BIN

PHYSICS

QUESTION BOOKLET

2

18 pages, 11 questions

Wednesday 2 November: 9 a.m.

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)

(75 marks)

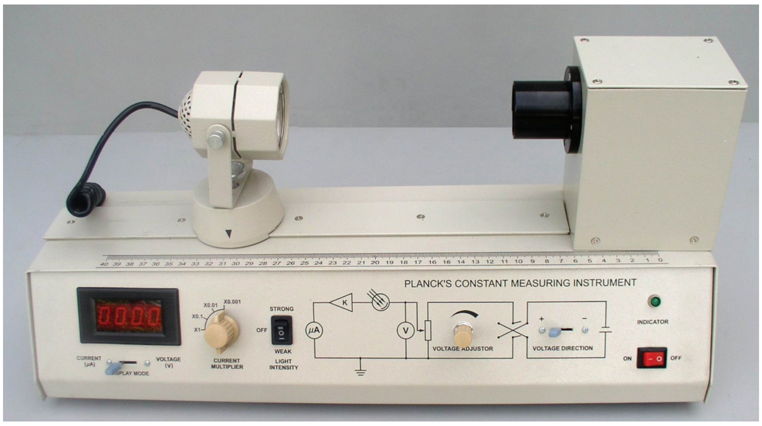
15. Explain, with the aid of a diagram, the speckle effect in terms of interference.

(3 marks)

16. The instrument shown in the photograph below contains a photoelectric cell and a sensitive ammeter. The potential difference is adjusted to give an ammeter reading of zero.

The work function of the metal in the photoelectric cell is 3.6×10^{-19} J.

Photons of energy $E = 8.62 \times 10^{-19}$ J are directed onto the photoelectric cell.



Source: SES Instruments website, www.sestechno.com

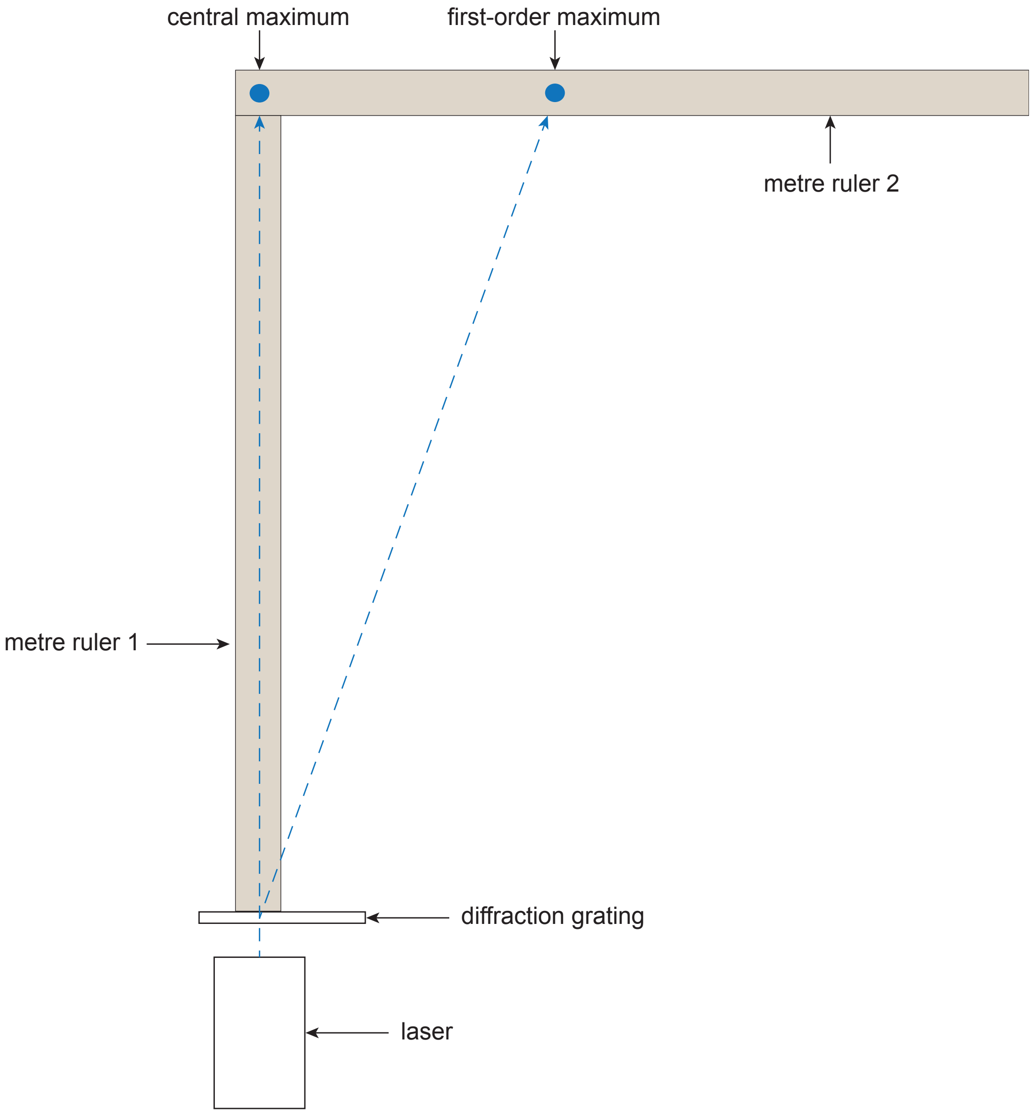
(a) Determine the stopping voltage.

(3 marks)

(b) State the effect, if any, that increasing the intensity of the incident light would have on the stopping voltage. Explain your answer.

(3 marks)

17. A teacher asks the students in a class to conduct an experiment to determine the wavelength of a helium–cadmium laser. Working in groups, the students use a diffraction grating with 300 lines per millimetre and two metre rulers, as shown in the diagram below:



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

(a) State one requirement for the safe handling of a laser.

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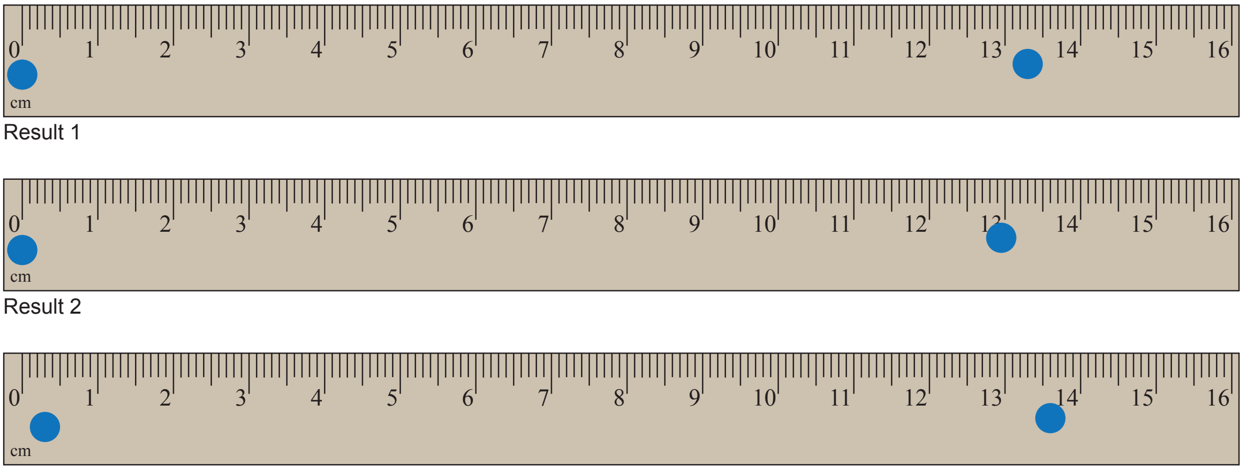
____ (1 mark)

Each group of students conducts the experiment three times. The results obtained by one of the groups are shown in the diagram below. The images indicate the positions of the central and first-order maxima seen on metre ruler 2.



Result 1

Result 2

Result 3

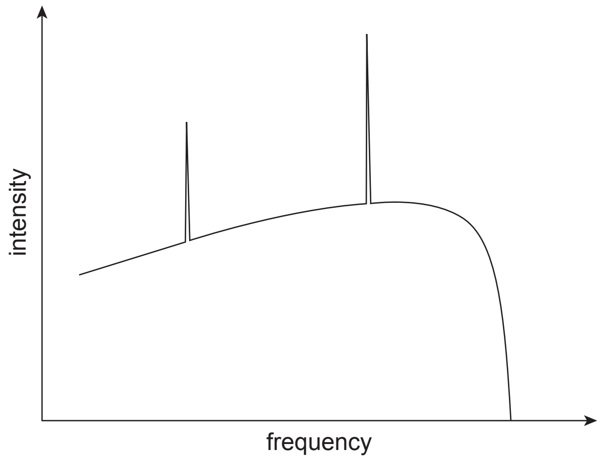
(b) Construct a table of results for the images shown in the diagram above.

(3 marks)

(c) Using the results from your table above, determine the wavelength of the helium–cadmium laser.

(5 marks)

18. (a) The graph below shows a typical spectrum produced by an X-ray tube:



Explain the continuous range of frequencies and the maximum frequency in the spectrum of the X-rays.

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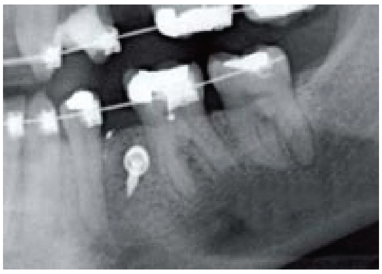
____ (3 marks)

(b) The image of a dental X-ray (right) shows teeth, metal braces, a metal screw, and a section of jawbone.



Source: www.bangkokdentalhospital.com

(i) State what is meant by the 'attenuation of X-rays'.

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____ (1 mark)

(ii) Explain the different attenuations of X-rays shown in the image.

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____ (2 marks)

19. In an experiment to show that slow-moving electrons exhibit wave behaviour, a beam of electrons with an associated wavelength of 1.67×10^{-10} m is incident on a lattice of nickel atoms. The spacing between the atoms in the nickel is 2.15×10^{-10} m.

The electrons are diffracted when they reflect off the top layer of atoms in the lattice.

(a) Determine the speed of the electrons.

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____ (3 marks)

(b) Determine the angle of the first-order maxima for the diffracted electrons.

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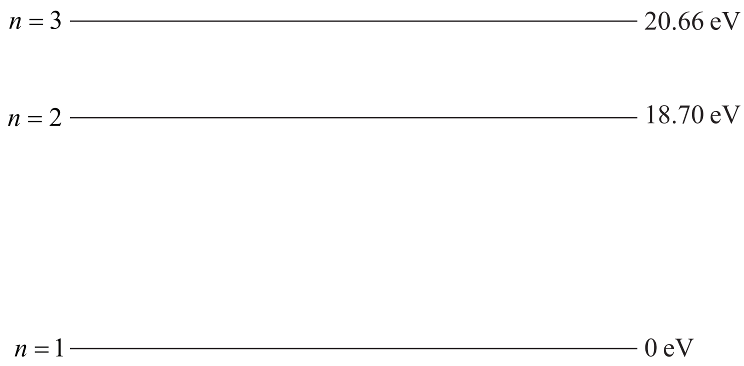
____ (3 marks)

20. Neon atoms are contained in a helium–neon laser.

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



The transition from the $n = 3$ level to the $n = 2$ level produces red $633\,\text{nm}$ photons as a result of stimulated emission. The transition from the $n = 2$ level to the $n = 1$ level produces photons as a result of spontaneous emission.

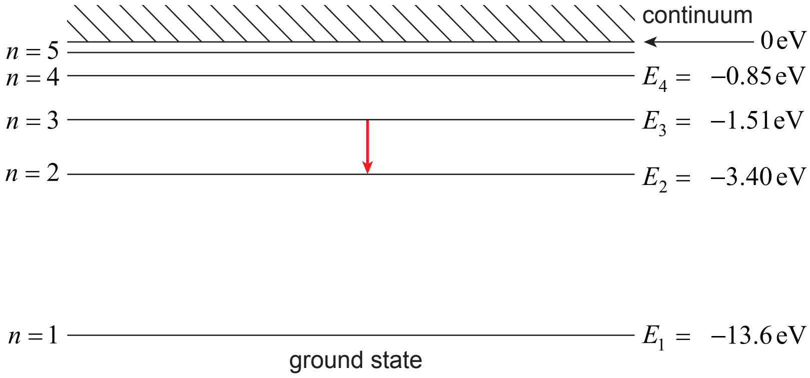
(a) Explain the difference between spontaneous emission and stimulated emission.

(3 marks)

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

(2 marks)

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



(a) One transition that produces photons is shown in the diagram above.

(i) Calculate the frequency f_1 of the photons produced in this transition.

(3 marks)

(ii) *On the diagram above*, draw a transition that produces photons of a frequency lower than f_1. (1 mark)

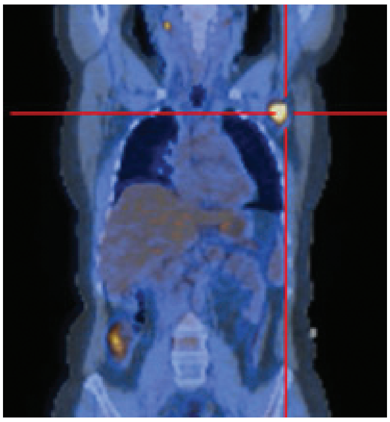
(b) Explain how the line emission spectrum of hydrogen provides evidence for the existence of states with discrete energies in hydrogen atoms.

(3 marks)

22. The photograph (right) shows an image from a positron emission tomography (PET) scanner. Before they go into the PET scanner, patients at the Royal Adelaide Hospital are given a chemical that contains a fluorine radioisotope. The radioisotope is made in Melbourne, added to the chemical, and then immediately flown to Adelaide.

For a PET scan to be effective, the activity of the radioisotope must stay above a certain level.

The half-life of the fluorine radioisotope is 110 minutes.



Source: Tennessee Oncology website, www.tnoncology.com

(a) State the meaning of 'the activity of the radioisotope'.

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____ (1 mark)

(b) Calculate the time taken for the fluorine radioisotope to decay to one-sixteenth of its original activity.

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____ (2 marks)

(c) Hospitals in America can make the same fluorine radioisotope.

State why it would not be possible for the Royal Adelaide Hospital to use a fluorine radioisotope that had travelled from America.

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____ (1 mark)

23. Boron–neutron capture therapy is a radiotherapy treatment for cancer. Boron is absorbed by cancer cells in the body and then exposed to neutrons, producing a nuclear reaction in which alpha particles are released. The alpha particles can kill the cancer cells.

(a) Explain why alpha particles are more effective than beta particles at killing cancer cells.

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____ (2 marks)

(b) Explain why alpha particles affect only the cell in which they are released.

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____ (2 marks)

24. An artificially produced isotope of californium $\left({}^{252}_{98}\mathrm{Cf}\right)$ can undergo spontaneous fission, as shown in the following reaction:

$$ {}^{252}_{98}\mathrm{Cf} \longrightarrow {}^{140}_{54}\mathrm{Xe} + {}^{108}_{44}\mathrm{Ru} + 4\,{}^{1}_{0}\mathrm{n} $$

(a) Explain the spontaneous fission in terms of the different forces acting inside a ${}^{252}_{98}\mathrm{Cf}$ nucleus.

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____ (3 marks)

(b) The masses of the particles involved in the reaction are shown in the table below:

Particle	Mass
${}^{252}_{98}\mathrm{Cf}$	4.1859×10^{-25} kg
${}^{140}_{54}\mathrm{Xe}$	2.3235×10^{-25} kg
${}^{108}_{44}\mathrm{Ru}$	1.7919×10^{-25} kg
${}^{1}_{0}\mathrm{n}$	1.6749×10^{-27} kg

Calculate the amount of energy released in the spontaneous fission reaction.

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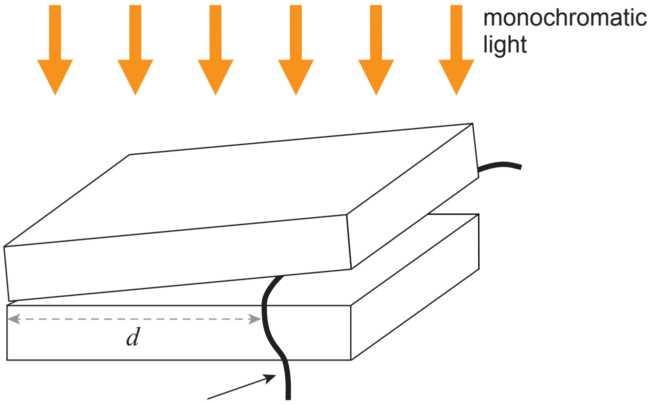
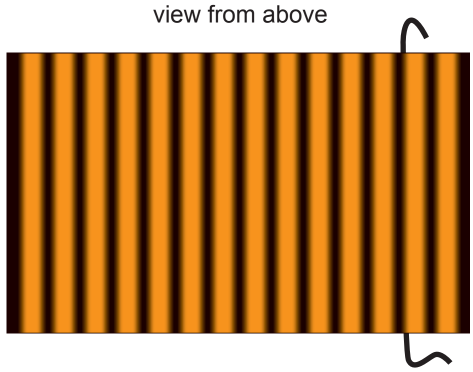
____ (4 marks)

25. One method of determining the thickness of a human hair is to use it to create a wedge of air between two flat glass slabs. When the wedge of air is illuminated from above by monochromatic light, a series of bright and dark fringes can be seen. These fringes result from the interference between rays of light that travel different distances through the wedge of air.





[*These diagrams are not drawn to scale.*]

The hair is placed at a distance d from the point where the two glass slabs touch, and five students count the number of bright fringes per centimetre. The process is repeated a number of times, with the value of d varied each time.

The results of the data collection are shown in the table below:

d (cm)	Number of Bright Fringes per Centimetre				
	Student 1	Student 2	Student 3	Student 4	Student 5
4.0	100	99	102	103	106
5.0	82	82	84	83	79
6.0	67	70	67	71	65
7.0	60	62	58	58	57
8.0	50	51	51	49	53

(a) State one benefit of using data collected by five students.

____

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____ (1 mark)

The number of bright fringes is averaged, as shown in the table below:

d (cm)	Average Number of Bright Fringes per Centimetre	W (m)
4.0	102	
5.0	82	
6.0	68	
7.0	59	
8.0	51	

W is the average distance between bright fringes, measured in metres. It can be calculated using the following equation:

$$W = \frac{1}{\text{number of bright fringes per metre}}$$

(b) Complete the table above by calculating each value of W. (2 marks)

(c) (i) State which one of d and W should be plotted on the horizontal axis of a graph of the data in the table above.

Give a reason for your answer.

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___ (2 marks)

(ii) *On page 15*, plot a graph of the data. Include a line of best fit. (6 marks)

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

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___ (2 marks)

(e) W and d are linked by the equation:

$$W = \frac{\lambda}{2t} d$$

where t is the thickness of the hair used in the experiment.

The monochromatic light used by the students has a wavelength of $589\,\mathrm{nm}$.

Using the gradient of your line of best fit from part (d), determine the thickness of the hair.

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____ (3 marks)

(f) *On your graph on page 15*, draw and clearly label a possible line of best fit that would have been obtained if the students had used a thicker hair in the experiment.

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 2 of Section A. Make sure to label each answer carefully (e.g. 18(b)(ii) continued).

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External Examination 2011

2011 PHYSICS

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PHYSICS

QUESTION BOOKLET

3

8 pages, 2 questions

Wednesday 2 November: 9 a.m.

Section B

Write your answers to Section B in this question booklet.

SECTION B (Questions 26 and 27)

(32 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 16 marks.
- Question 27, on pages 6 and 7, is worth 16 marks.

In answering these questions, you should:

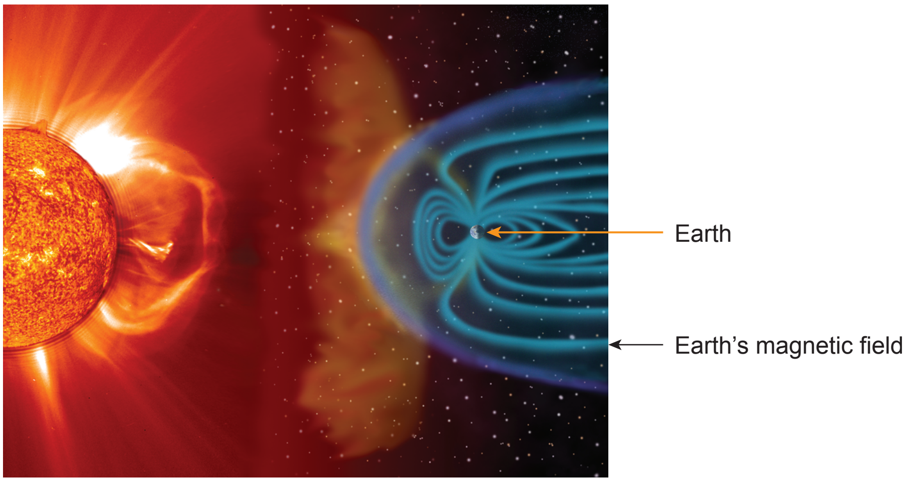
- communicate your knowledge clearly and concisely
- use physics terms correctly
- present information in an organised and logical sequence
- include only information that is related to the question.

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

26. The electrostatic force on an electron is responsible for the electron's circular orbit around a nucleus. On a much larger scale, the gravitational force on a communication satellite is responsible for the satellite's circular orbit around the Earth.

- Describe the similarities between these electrostatic and gravitational forces.
- Describe and explain *one feature* of the orbit of a geostationary satellite. (16 marks)

27. Some of the energy that is converted in the interior of the Sun is released as a stream of charged particles. The illustration below shows a sudden release of energy from the Sun. The Earth's magnetic field provides protection from this stream of charged particles.



Source: http://sohowww.nascom.nasa.gov

- Explain the energy conversion process that takes place in the interior of the Sun.
- Explain how the Earth's magnetic field can change the velocity of charged particles that flow from the Sun. (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 2011

ACKNOWLEDGMENT

The photograph for Question 2(d) on page 7 of Booklet 1 is © Hupeng/Dreamstime.com.

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