2017

VCE

Physics

Trial Examination

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VICTORIAN CERTIFICATE OF EDUCATION
Year 2017

STUDENT NUMBER **Letter**

Figures									
Words									

Student Name ………………………………………………………………………………..

PHYSICS

Trial Written Examination

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
	Number of detailed studies	*Number of detailed studies to be answered*	*Number of marks*
B	17	17	110
			Total 130

Materials allowed

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (two A4 sheets) of pre-written notes (typed or handwritten) and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 45 pages. A formula sheet of 3 pages.
- Answer sheet for multiple-choice questions.
- All written responses must be in English.

Instructions

- Write your student **number** and **name** in the space provided above on the Answer Booklet and also on the Multiple Choice answer sheet, page 5.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this answer book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

	VCE PHYSICS 2017 **Trial Written Examination**

MULTIPLE-CHOICE ANSWER SHEET

Student Name ____________________________________

Student Number ____________________________________

Use a **PENCIL** for **ALL** entries. For each question, shade the box that indicates your answer.
All answers must be completed like **THIS** example. This example selects **B.**

A		C	D

Marks will **NOT** be deducted for incorrect answers.
NO MARK will be given if more than **ONE** answer is completed for any question.
If you make a mistake, **ERASE** the incorrect answer. **DO NOT** cross it out.
ONLY ONE ANSWER PER QUESTION

Question				
1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D

Question				
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D

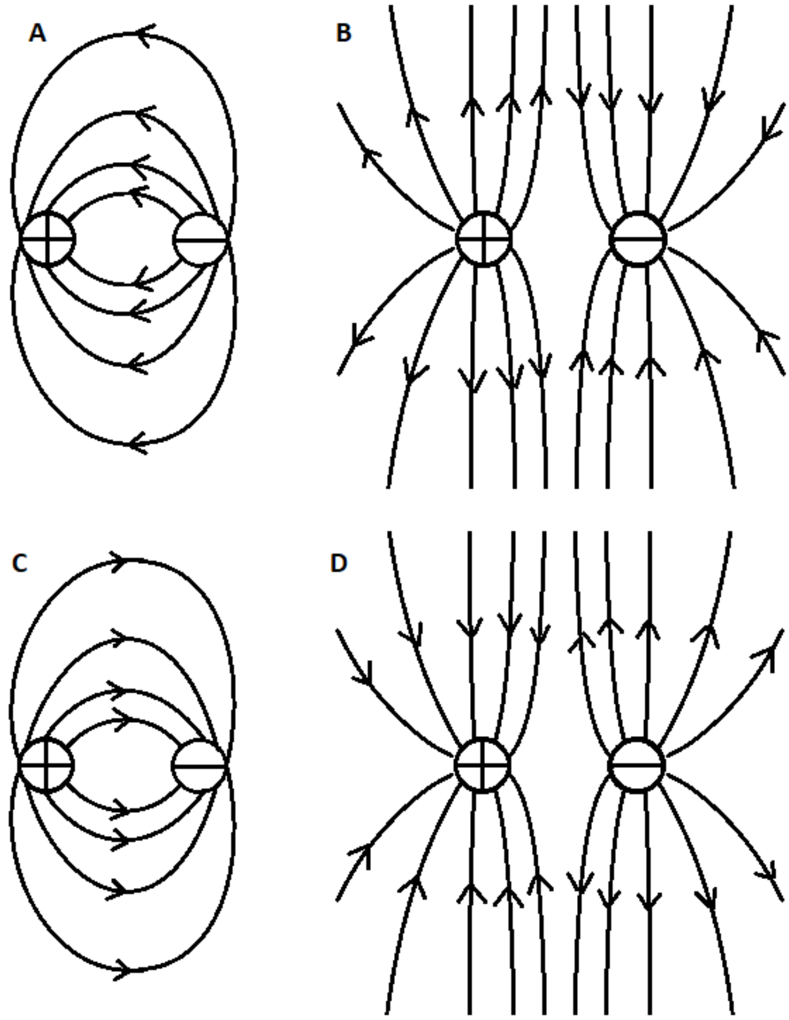
SECTION A Multiple choice questions

Answer all questions for this section in pencil on the multiple choice answer provided.
Choose the response which is clearly correct or best answers the question.
A correct answer scores 1, an error scores 0.
Marks are not deducted for incorrect answers.
No marks are given if two or more selections are made to the answers.
Unless otherwise indicated the diagrams are not drawn to scale.
The value of g is to be taken as 9.8 ms^{-1} unless otherwise stated.

Question 1

Two equal electric charges are close together. The charge on the left is positive and the charge on the right is negative.

Which diagram would best indicate the nature of the field structure produced?

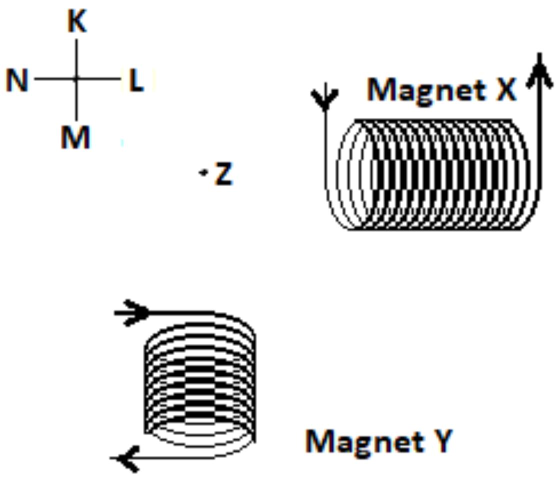


Question 2

Two electromagnets are placed as shown in **Figure 1**.
The direction of current flow in the wire coils is shown with an arrow.
Magnet X produces a stronger field than magnet Y at point Z.

Ignore the influence of the Earth's magnetic field.

Figure 1
The two magnets produce a field at point Z.
Magnet X contributes more than magnet Y.



What is the direction of the resultant field?

A between K and L
B between L and M
C between M and N
D between N and K

Question 3

Two electric charges have been placed 10 cm apart.
Charge M is + 45 μC, while charge N is – 5.0 μC.
A test charge T of + 1.0 μC is placed 5.0 cm further beyond charge N, as shown in **Figure 2.**

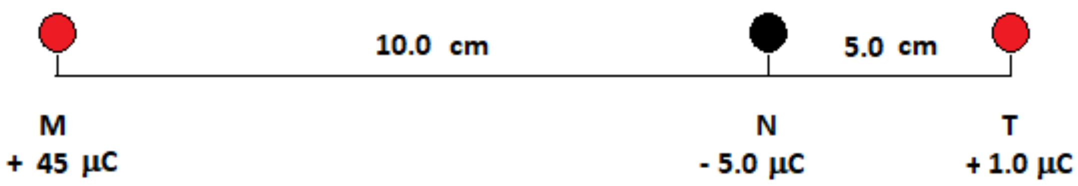


Figure 2 The charges M and N and the test probe charge T.

What is the force on the test charge T?
Take force to the right as positive.

A 36 N
B 18 N
C 0 N
D -18 N

Question 4

In an experiment to test Newton's theory of gravitation, the strength of the gravitational field was measured just above sea level. The measurement was made in a flying aircraft. A value of 9.81 m s^{-2} was found.

At 1.00×10^{4} m higher, the gravitational field was again measured. The plane flew at the same speed, same direction in the same location.

Which result would be predicted by Newton's theory of gravitation?

A 9.84 m s^{-2}
B 9.81 m s^{-2}
C 9.79 m s^{-2}
D 9.78 m s^{-2}

Question 5

When the experimenters measured the gravitational field in **Question 5,** they had to consider the role of both independent and dependent variables.

The best decision they could make regarding these variables would have been that:

A the gravitational field strength and the height were both independent variables.
B the gravitational field strength and the height were both dependent variables.
C the gravitational field strength was independent and the height was a dependent variable.
D the gravitational field strength was dependent and the height was an independent variable.

Question 6

In Question 5, there were variables which were held constant. Which was the most important variable which was to be constant?

A Location
B Temperature
C The aircraft cabin used for the measurements at sea level and at 10000 m
D The strength of the gravitational field

Question 7

An electric field and a magnetic field can both be described as dipolar.
Electric field lines are directed from positive to negative and magnetic field lines from north to south polarity.
Which statement below about these dipolar fields is correct?

A These two fields are similar in all ways.
B Electric field lines start on one charge and end on the other, unless the electric field lines are extending infinitely. Magnetic field lines pass right through the magnetic source producing them.
C The dipolar structure means that if a constant magnetic or electric field is present, then the other field will also be present.
D Magnetic fields can apply force to electric charge, but electric charge cannot apply a force to a magnet.

Question 8

Experimenters were testing the magnetic field of a powerful magnet. They had measured the strength of the field at 10.0 cm from its end surface. The strength was 8.32 T averaged over 5 trials, at the measuring point (M).

They then placed a thick disc of aluminium between the measuring point (M) and the magnet. The magnet was turned on again. The aluminium sheet was not moving. They again measured the magnetic field and found the field was 8.37 T, over 5 trials.

They are interested in whether aluminium has an effect on a magnetic field.

Figure 3 Testing for the influence of aluminium on a strong magnetic field.

If there is a difference in the magnetic field strengths, how small must the error in their measurements be? Select the largest allowable error.

A $\pm$ 0.05 T
B $\pm$ 0.03 T
C $\pm$ 0.02 T
D $\pm$ 0.01 T

Question 9

The Heisenberg uncertainty principle provides an interpretation of the single slit experiment.

This interpretation does this by:

A providing a more precise interpretation of the wave model
B showing that the similar results for waves and particles are not related
C showing that no measurement can be made with perfect accuracy.
D showing that a particle whose position in the slit is quite accurately known will have an error in the sideways momentum.

Question 10

The International Space Station orbits at between 330 and 430 km above the Earth's surface. It orbital height is raised by the use of the use of the rocket engines in the Zvezda module. It has a mass of 4.20×10^{5} kg.

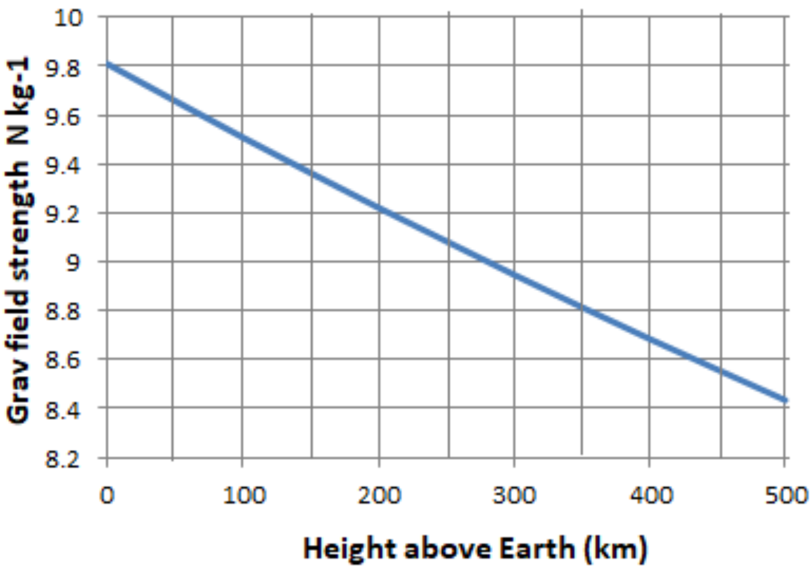


Figure 4 The graph shows the variation in the Earth's gravitational field at these heights.

How much work is done by the engines in a lift from 330 to 430 km?

A 3.61×10^{11} J
B 3.68×10^{11} J
C 3.74×10^{11} J
D 4.12×10^{11} J

Question 11
An extra-terrestrial tourist spacecraft is on a relativistic speed flypast of a small planet. The planet's primitive inhabitants made measurements of the spacecraft on the flypast, recording its width and length.

The observations were reported.

Which statement best describes the correct measurements which were made of the flypast spacecraft?

A The proper width was observed, the proper length could be calculated.
B The proper length was observed, the proper width could be calculated.
C The proper width and length were observed.
D No proper length or width was observed, both could be calculated.

Question 12
When travelling through a material, a wave can have a transverse form if the material has a sideways restoring force which will return it to its initial state, prior to the passage of energy. If this force does not exist then any waveform must be longitudinal.

At the surface, water waves are transverse, what form do water waves have below the surface?

A The sound carrying wave in water has some properties of each form.
B Sound waves do not travel through water.
C Water waves are always transverse.
D Water waves are always longitudinal.

Question 13
Beta particles are directed in a straight path into across a region of uniform magnetic field. The field has a strength of 0.055 T. The beta particles have a speed of 1.34×10^{7} m s^{-1}

What is the radius of the curved path now followed by the beta particles?

A 5.5×10^{-2} m
B 1.4×10^{-3} m
C 7.6×10^{-5} m
D 4.2×10^{-6} m

Question 14

In a tensioned string a wave is generated by a sideways deflection near one end. A travelling wave moves along the string.

How does this generate the standing wave which is generated in the string?

Figure 5 Nashville artist Lera Lynn with her guitar**.** The left hand controls the string length, the right provides the deflection to generate the sound.

https://commons.wikimedia.org/wiki/File%3ALera_Lynn_Guitar.jpg

A A sound wave, which is transverse, will always be a standing wave.

B The waveform splits initially, some energy is transferred to one, the rest to the other. This causes the nodes and anti-nodes to remain static while the energy passes to the end of the string.

C The travelling wave reaches the end and is reflected, upright. The two waves superimpose with fixed nodes and anti-nodes.

D The travelling wave reaches the end and is reflected, inverted. The two waves superimpose with fixed nodes and anti-nodes.

Question 15

Einstein presented two postulates of special relativity. It is the second, describing the speed of light which set his physics apart from earlier understandings.

Einstein's second postulate leads to the expectation that:

A Light produced by a moving source will have a different speed compared to that for a stationary source.
B Even if the source of light is moving, the light speed, frequency and wavelength will all be unchanged.
C If the source of light is moving, the frequency and wavelength remain fixed, even though the speed of light is varied.
D If the source of light is moving then the frequency and wavelength can vary but the speed of light will be the same for any observer.

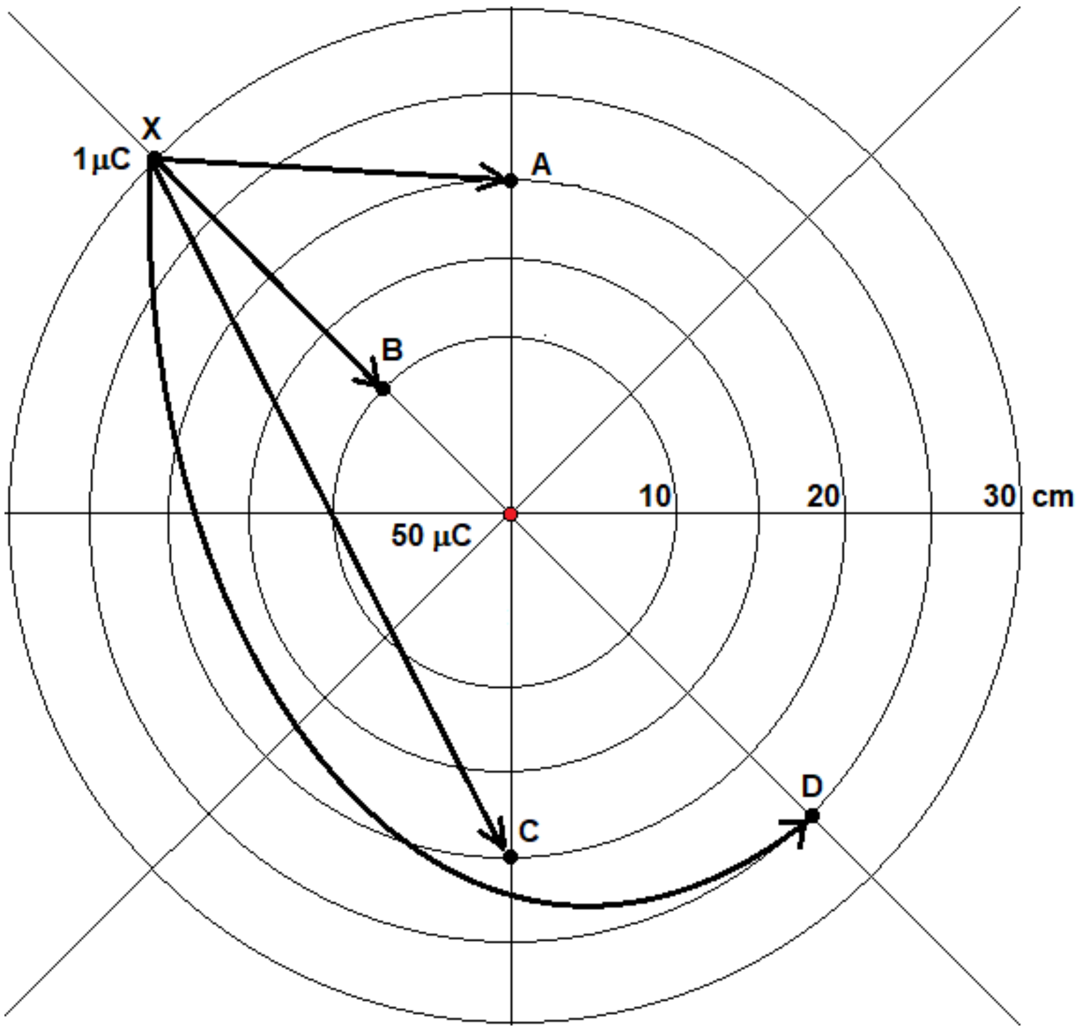
Question 16

Under which of the following situations will an electromagnetic photon not be produced.

A An electron spins in a circular path in a synchrotron.
B An electron spins in a circular path, bound in an atom.
C An electron is accelerated forward by an intense electric field.
D An electron makes a transition to a lower energy state while bound in an atom.

Question 17

A charge of -1 μC is moves from point **X** to a number of points, closer to a fixed charge of 50 μC. There are 4 different paths shown.



It moves closer to a +50 μC charge. The axis line, marked in centimetres, shows the distance from to +50 μC charge.

Select the path (A, B, C or D) which releases the greatest amount of electric potential energy.

Question 18

There are two coils. The coil on the left (A) is moving with constant velocity to the right, while the second (B) is stationary.
Coil (A) carries a constant current as shown by arrows indicating the current direction in **Figure 6.**

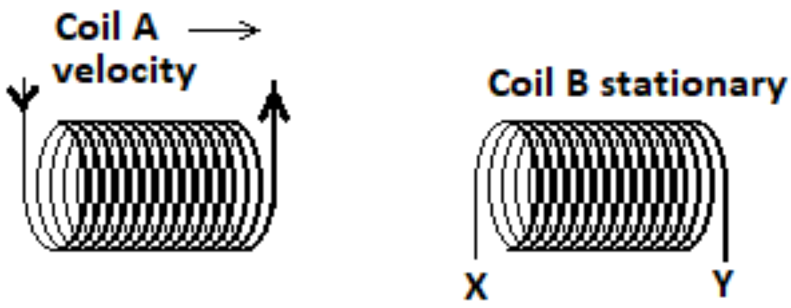


Figure 6. Coil A, carrying a constant current moves towards stationary Coil B.

What is the best description of the current flow induced in Coil B?

A There is an increasing current induced, directed from terminal X of Coil (B).
B There is an increasing current induced, directed from terminal Y of Coil (B).
C There is a constant current induced, directed from terminal X of Coil (B).
D There is a constant current induced, directed from terminal Y of Coil (B).

Question 19

A 100 cm^3 block of aluminium was immersed in water. Before immersion, its mass was recorded as 270 g, but in the water, it registers only 170 g. The water is providing some support to the aluminium.

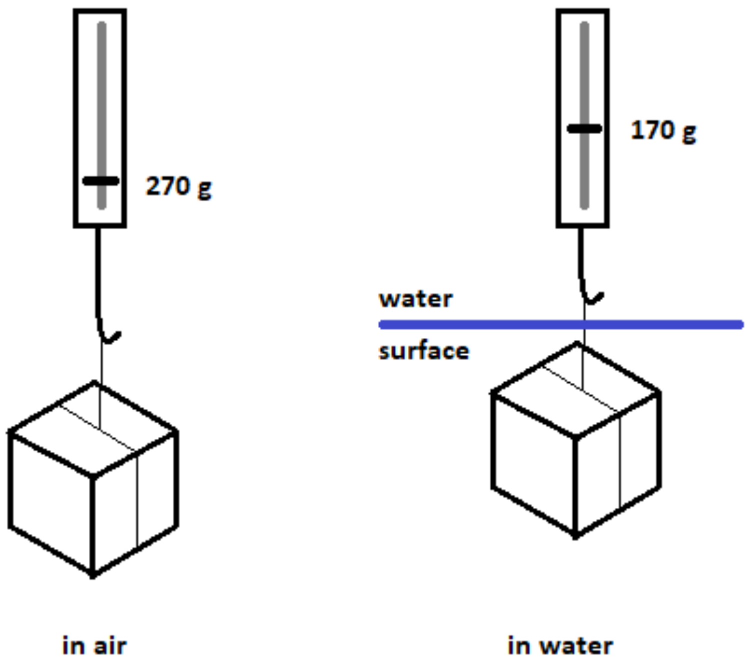


Figure 7 The aluminium cube measured on a spring balance in air and in water.

What is the size of the Third Law force, acting in response to the gravitational force exerted on the block?

A 0.98 N
B 1.67 N
C 2.65 N
D 3.63 N

Question 20

An experimental generator is producing a voltage which is being displayed on a cathode ray oscilloscope screen.

The vertical scale is 2.0 V per division.

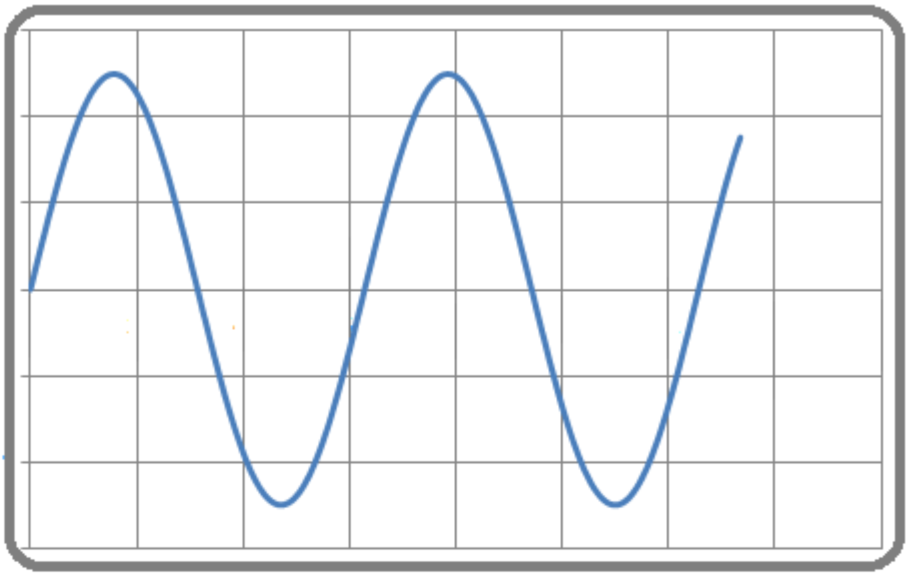


Figure 8 The oscilloscope screen showing the generated voltage

The voltage is measured from the screen and values of V_{RMS}, V_P and V_{PP} are collected.

Which are the correct values?

Answer	V_{RMS}	V_P	V_{PP}
A	5.0	10.0	5.0
B	3.5	5.0	10.0
C	5.0	3.5	7.0
D	3.5	7.0	10.0

SECTION B

Instructions for Section B

Answer all questions in the spaces provided, Write using a blue or black pen.
Where an answer box is provided, write your final answer in that box.
If an answer has a unit printed in it, give your answer in that unit.
In questions where more than one mark is available, appropriate working **must** be shown.
Unless otherwise indicated, the diagram in this book are **not** drawn to scale.
Take the value of *g* to be 9.8 m s^{-2} unless otherwise specified.

Question 1 (2 + 2 + 2 = 6 marks)

In the Winter Olympics the ski jump event involves a skier gathering speed in the upper track. At point “t” the skier leaps and rises above the ski path. In this case the angle of elevation is 15°. In a jump over a small hill, from point “t” to level ground could be 55 m horizontally and 35 m vertically.

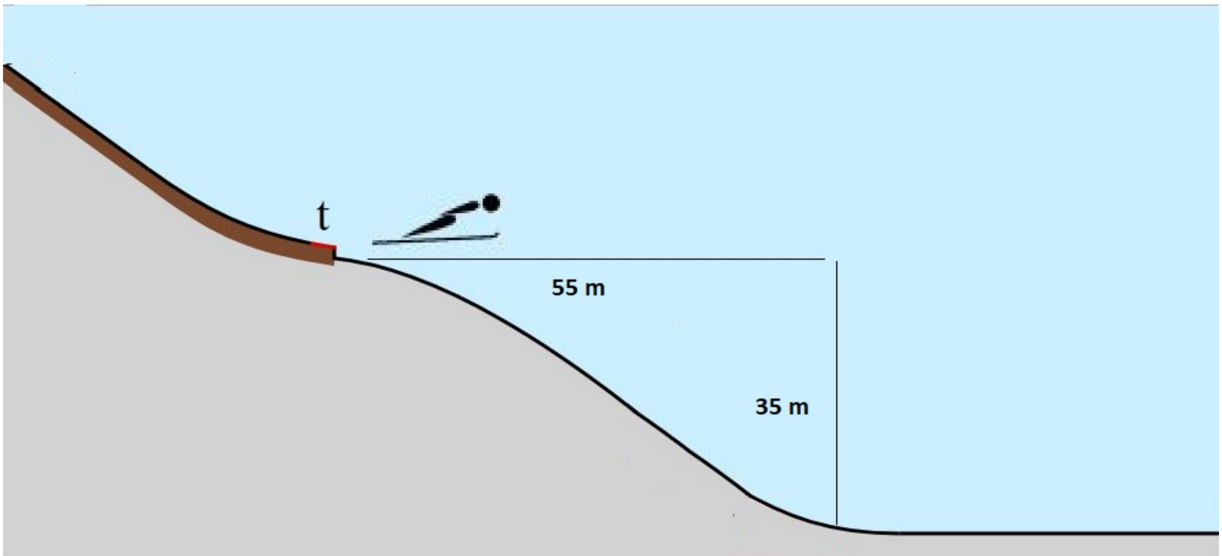


Figure 9. The ski jumper makes the jump on a small hill jump**.**
Diagram modified from Wikipedia.

The skier had a take-off speed of 28.0 m s^{-1}. Ignore air resistance in this question.

Question 1 (continued)

a How high does the skier rise above the jump height of 35.0 m?

m

b For how long will the skier be airborne?

s

c How far will the skier travel horizontally before reaching the ground?

m

Question 2 (2 + 1 + 1 + 2 = 6 marks)

Figure 10
A coin donation bin has been designed as a horizontal cone with a hole in the centre. A coin can be rolled around the conical surface, but will slow and eventually drop through the hole in the centre.

Author's photo.

The surface of the cone is very smooth. The conical path and coin are shown in **Figure 11** below.

a. On the diagram below (**Figure 11**) indicate the applied forces which act on a coin rolling smoothly in a circle around this conical surface.
Use correctly drawn vectors. (Names of the forces are not needed)

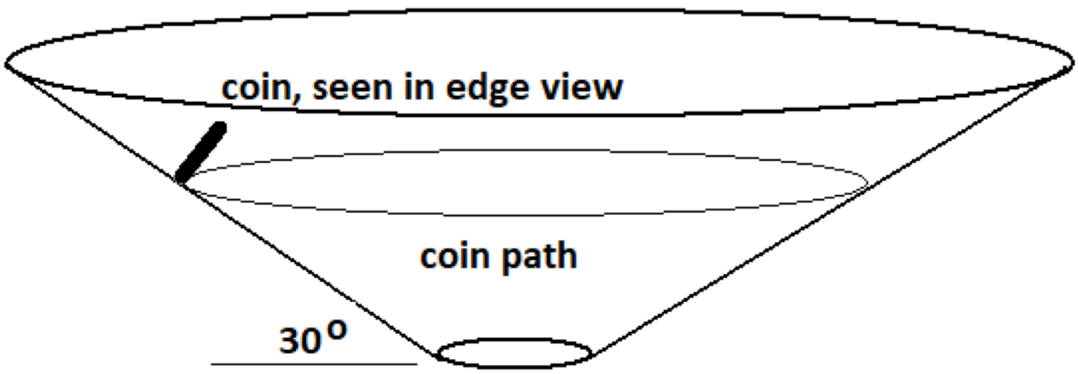
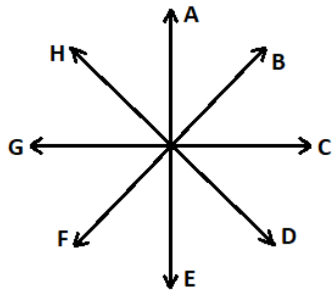


Figure 11 The coin rolling in a horizontal circle on the cone surface.

Question 2 (continued)

b. From the selection of arrows shown below, choose an arrow which shows the direction of the **net** force when the coin is in the position shown in **Figure 11** .



c. Explain your choice.

d. The cone makes an angle of 30° to the horizontal.
The 20c coin, mass 11.3 g, is rolling in a circle with a radius of 0.31 m.
What speed will it need, to continue in its circular path?

m s^{-1}

Question 3 (1 + 1 + 2 + 2 + 2 = 8 marks)

Muons are negatively charged leptons, which are formed following cosmic ray collisions in the upper atmosphere, usually at about 1.0×10^4 m high.

The speed of the muons is 0.98 c.

a Calculate the gamma (Lorentz) factor of these muons.

b At 0.98 c, and with a half survival time of 2.2 μs, how far will an Earth based observer measure for the average muon's passage through the atmosphere?

m

Question 3 (continued)

c What would a muon based observer record of this journey?
Use a calculation for the height travelled to clarify your answer.

m

d Comment on your answers above and use them to explain why so many muons reach the Earth's surface after travelling 1.0×10^{4} m. The number is much greater than would be expected in classical physics.

A muon has a rest mass of 1.88×10^{-28} kg.

e What is the kinetic energy of a muon travelling at 0.98 c?

J

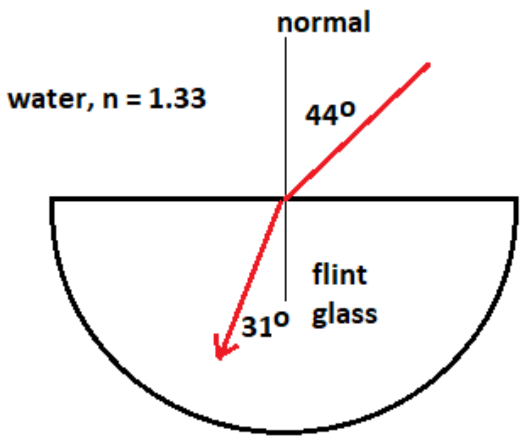
Question 4 (2 + 1 + 2 + 1 = 6 marks)

Students were conducting an experiment passing light in water into a semi-circular block of solid material.

The index of refraction of water was known to be 1.33. The block is made of a sample of flint glass.

A ray of red light is shone through the water and into the flint glass. The angles are measured from the normal to the material surfaces as shown in **Figure 12**.

Figure 12
A red light ray passes from water into flint glass.



a What is the index of refraction of the flint glass for red light?

b The experiment is repeated with blue light. What sort of change, if any, would be expected in the angle of the light passing through the flint glass?
Provide a short explanation of your answer.

Question 4 (continued)

c What is the critical angle for total internal reflection, for red light at a flint glass into water interface?

°

d What is the speed of red light in flint glass?

$m\ s^{-1}$

Question 5 (2 + 2 + 1 + 1 + 2 = 8 marks)

A coil of wire, with 50 turns was placed into a uniform magnetic field, strength 0.35 T. The square coil has a side length of 0.040 m.

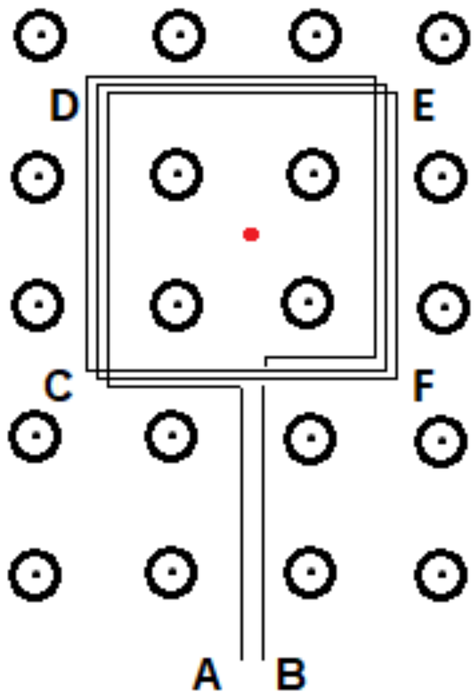


Figure 13 The coil in the uniform field.
The red point is the centre of the coil.

In the first investigation, the coil is rotated so that side EF rises up from the horizontal position shown while the side CD drops. It rotates a ¼ turn about the leads labelled AB.

This quarter turn is completed in 0.015 s.

a What is the average emf generated during this quarter turn?

V

Question 5 (continued)

b In which direction will current flow during this process?
Explain you answer, referring to electromagnetic induction.

The coil is now rotated clockwise in the uniform magnetic field. This rotation is seen horizontally about the red spot at the centre of the square.

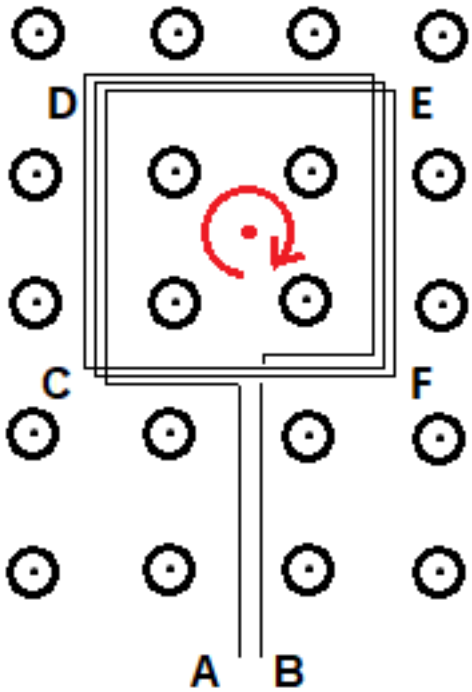
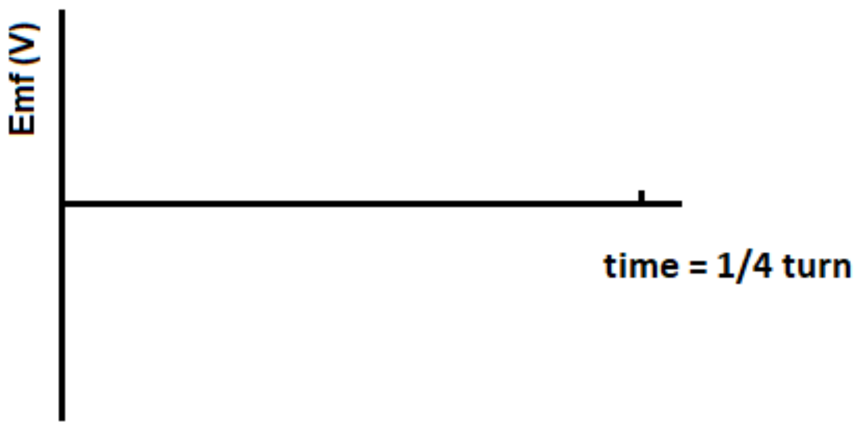


Figure 14 The clockwise rotation.

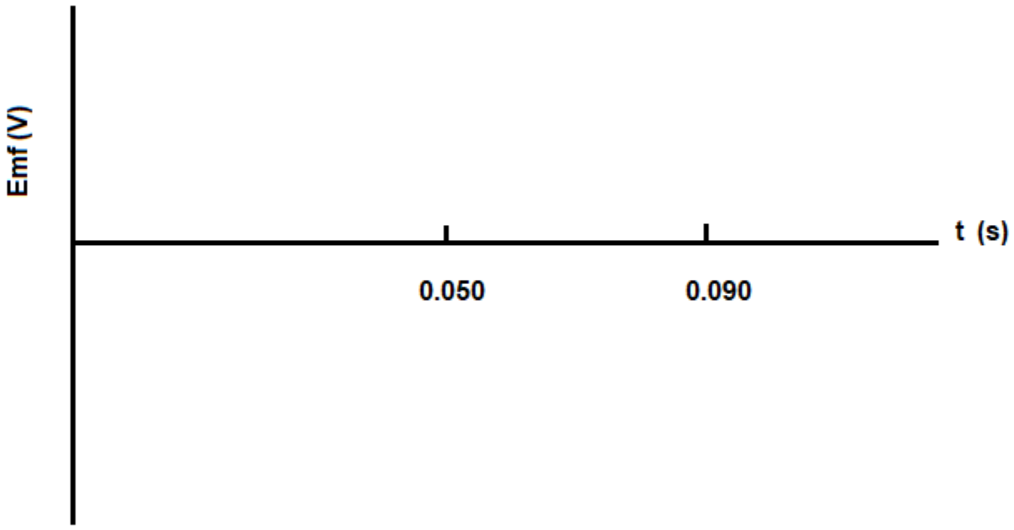
c Sketch the waveform of the voltage in the first quarter turn. Label a relevant voltage on the vertical axis.



Question 5 (continued)

In a final investigation, the coil is removed from the uniform field.
It moves with constant speed, with the side DE reaching the edge of the field at time = 0.050 s.
The other side, CF reaches the edge of the field at 0.090 s.

d Sketch the waveform of the voltage produced during this investigation on the axes below.



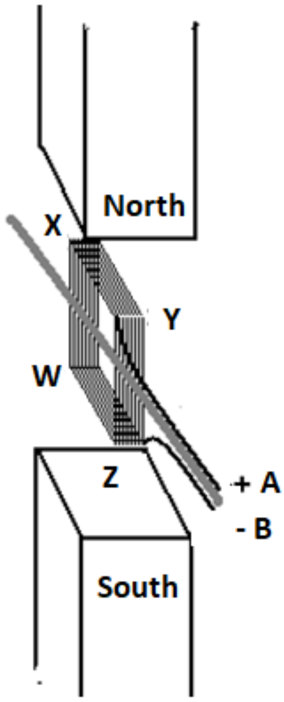
e From this investigation a practical DC generator is to be built. Which design would you start (“a”, “c” or “d”) with and what changes will need to be made to design a generator which can produce a continuous DC voltage?

Question 6 (1 + 1 +1 + 2 + 3 = 8 marks)

A DC motor has a coil of 100 turns, which is free to turn on a shaft between two poles of a permanent magnet.
Terminal A is connected to the positive voltage, terminal B to the negative.
The coil has a length WZ = 6.2 cm and width WX = 7.5 cm.
The magnetic field is 0.075 T and is uniform. The current is 0.24 A.

At the start of the experiment, the coil was vertical, aligned with the magnetic field between the poles as shown in **Figure 15**. At this stage, contact to the coil is made with a set of slip ring commutators.

Figure 15 The experimental DC motor



a. What is the direction of the force on side WZ?

____

Question 6 (continued)

b. What is the magnitude of the force on side WZ?

	N

c. What is the magnitude of the force, on side WZ, when the coil Is rotated 90° clockwise to the horizontal position?

	N

d In which position, the vertical “b” or the horizontal “c” will the motor start turning more easily? Explain your answer.

e The electrical contacts on the shaft are changed to a split ring commutator. Why will this help make an effective motor and how is the switch position of the split ring determined?

Question 7 (1 + 1 + 2 + 2 = 6 marks)

An investigation is using Young's double-slit experiment to measure the speed of light in water. Firstly the experiment was carried out in air, where the index of refraction can be taken as 1.00.

Under these conditions a fringe pattern was seen on a screen placed 1.20 m from the slits through which the light passed. The laser light source has a wavelength of 6.20×10^{-7} m. The fringe widths are spaced at 7.4 mm apart. The slit width was 0.10 mm.

A bright band at the centre of the pattern was selected and labelled "A".
A second bright band, labelled "B" was selected two fringes to the right.
A dark band next past the bright band B was labelled "C".

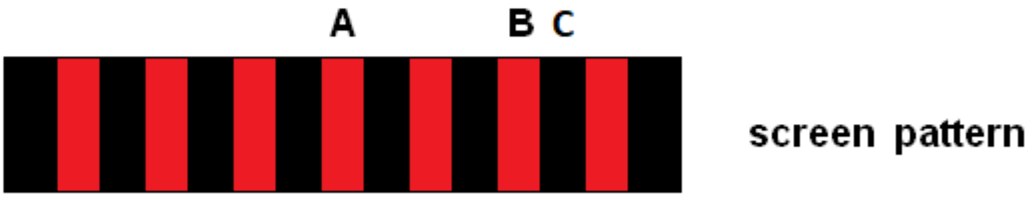


Figure 16 The pattern seen on the screen, Fringes A, B and C are labelled.

a If it is known that the band A at the centre of the pattern what is the path difference from the slits to band B?

m

b What is the path difference to the dark band C from the two slits.

m

Question 7 (continued)

c What is the significance of these bands for demonstrating the wave nature of light?

____

____

____

d The experiment is repeated in water, using the same slit width and screen distance.
The same red laser light is used.
The fringe width is 5.6 mm at 1.20 m screen distance.
What is the speed of light in water?

You **must** show your workings.

$m\ s^{-1}$

Question 8 (2 + 2 +2 +1 = 7 marks)

An investigation was made into the action of light on a metal cathode.

The apparatus used is shown in **Figure 17.**

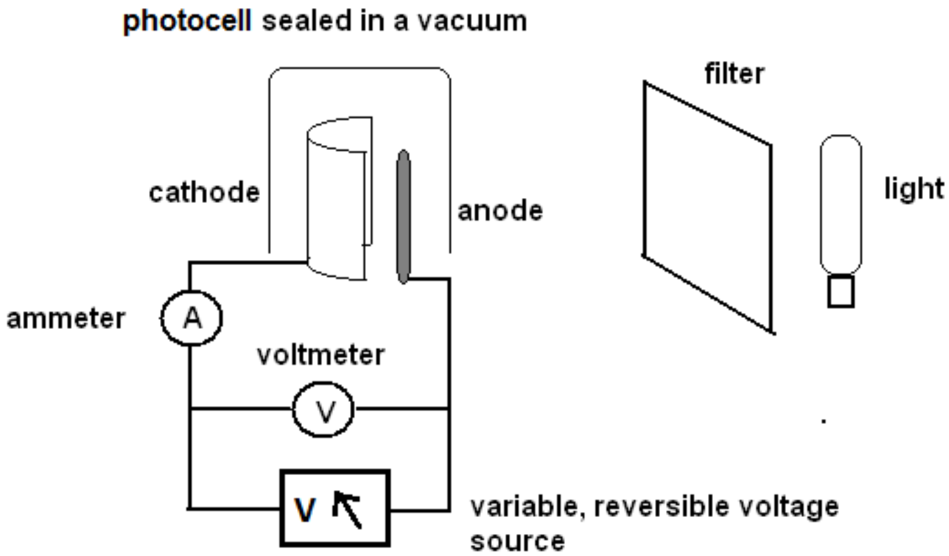


Figure 17 A light filter selects the frequencies of the light, a variable potential supply allows for the determination of the maximum kinetic energy of the freed electrons. The anode is negatively charged in this investigation.

The results obtained are shown in the graph in **Figure 18.**

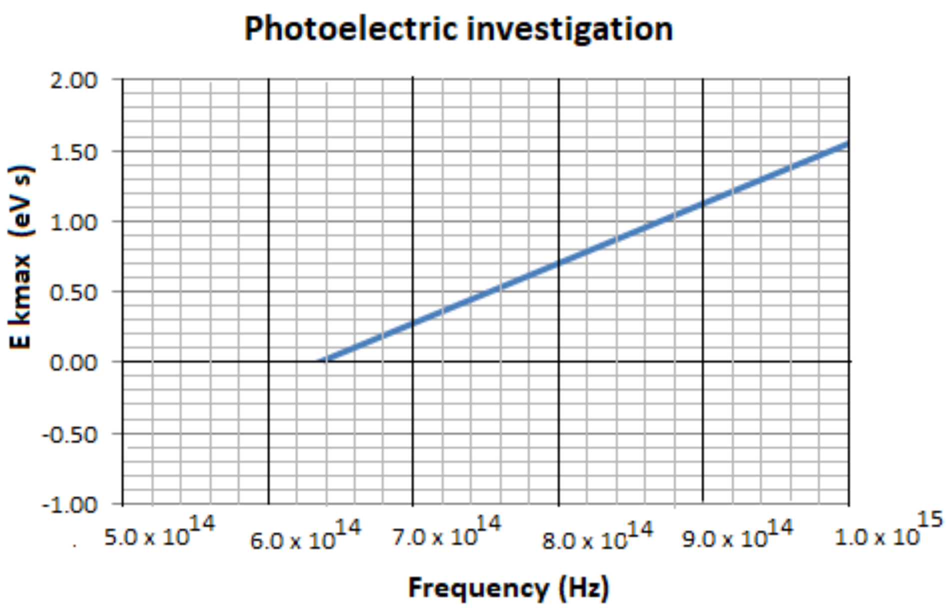


Figure 18 The maximum kinetic energy drops with decreasing frequency until no electrons are freed from the cathode.

Question 8 (continued)

In an effort to find freed electrons at still lower frequencies, the intensity of the light is significantly increased.

a Explain the expected result with brighter light if the investigation follows the wave model.

b Explain the expected result with brighter light if the investigation follows the particle model.

c Determine the gradient of the graph and explain its significance.
You must show your working.

eV s

d What is the work function of this metal, **using this data**?

eV

Question 9 (2 + 2 + 3 = 7 marks)

A set of garden lights was supplied with power from a transformer. The voltage output of the transformer is 6.00 V. There are three globes, each with a resistance of 5.00 Ω. However in the wires to the globes B and C there is significant resistance, a total of 0.40 Ω in each of the two sections.

There is no significant resistance in the wires to globe A.

The design is shown in **Figure 19.**

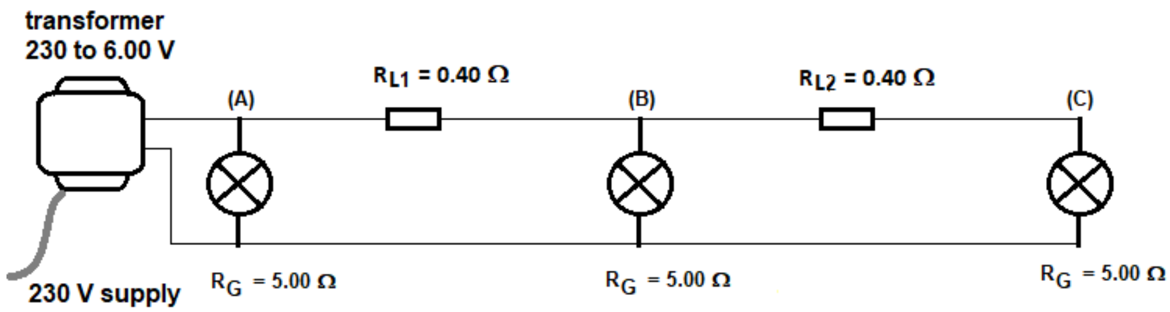


Figure 19 The garden lights with the line resistances to globes B and C.

It is noted that globes B and C are duller than globe A. The potential difference is measured across globe C and it is found to be 4.81 V.

a What potential difference must be across Globe B?

V

b What power is lost in line resistance (R_{L2}) compared to the total power delivered to R_{L2} and the globe C?

W

Question 9 (continued)

c For the safety of people digging in the garden, the supply voltage cannot be raised significantly.
Why would an increased voltage be the usual solution to this problem and what would be the best solution in this situation?

Question 10 (2 + 2 + 1 = 5 marks)

A glass ball, 24 g rolls down a ramp and strikes a second glass ball, mass 10 g.
The first ball had a velocity of 1.34 m s^{-1}, forward, immediately prior to impact.
The first ball has a speed of 0.74 m s^{-1} in the same direction, immediately after the impact.

a What is the magnitude of the velocity of the second ball immediately after impact?

m s^{-1}

Question 10 (continued)

Measurement also shows that the first ball gains a velocity of 0.025 m s^{-1} to the right immediately after impact.

b What will be the velocity of the second ball, in the sideways direction?

magnitude	direction
m s^{-1}	

c The glass balls are undamaged after the collision. However, this collision was not elastic; 21% of the kinetic energy was lost.
If energy is always conserved, where is the energy if it is no longer in a kinetic form?

Question 11 (2 + 2 + 2 + 2 = 8 marks)

In an experiment, X-ray photons are being diffracted through a crystal lattice. The photons have 15.6 keV of energy. The pattern produced is investigated. It shows a central bright spot and a series of rings surrounding it.

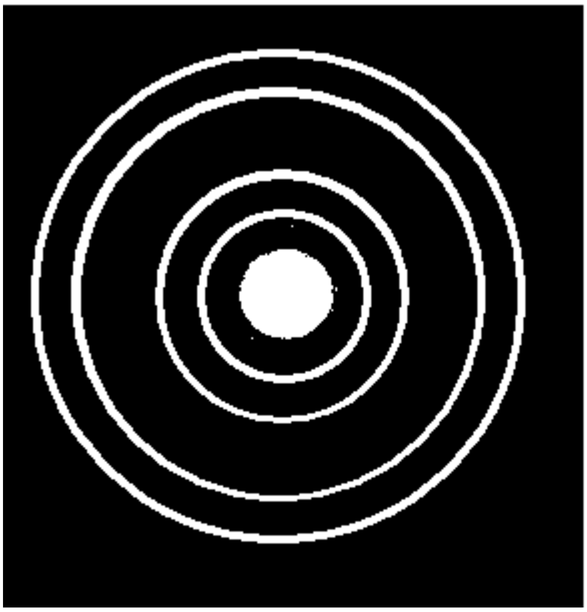


Figure 20 The diffraction ring produced by the 15.6 keV photons

a What is the wavelength of these photons?

m

b How many photons are emitted per second if the beam has a power of 0.020 W?

Question 11 (continued)

The 15.6 keV photons are replaced with photons with energy 12.3 keV.

c Explain what will be the change in the pattern?

Electrons now replace the X-ray photons. The experimenter wishes to reproduce the 15.6 keV pattern with these electrons.

d One particular measurement must be equal for the electrons and the X-rays, if this pattern is to be repeated by the electrons.
What value will this be?
Tick a unit and measurement from the options in the table on the right.

energy	J	
momentum	N s	
wavelength	m	
frequency	Hz	
speed	$m\ s^{-1}$	
power	W	

Question 12 (1 + 1 + 1 + 2 = 5 marks)

Figure 21 shows the energy levels for the excitation of the hydrogen electron.

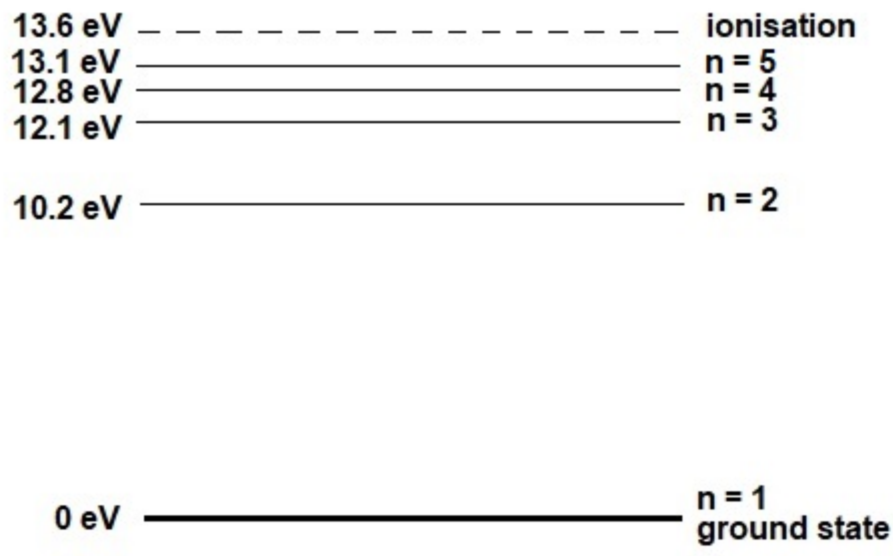


Figure 21 The energy levels for a hydrogen atom

Consider an electron which is at the 12.1 eV, n = 3 level.

a What is the lowest energy photon which this electron can absorb?

eV

b Show this transition with an arrow on **Figure 21.**

c What is the smallest energy photon which it can emit in dropping from the 12.1 eV state (n = 3) to the ground state (n = 1)?

eV

Question 12 (continued)

d Which wave properties of electrons are demonstrated by this quantisation of energy?

Question 13 (1 + 2 + 1 +2 + 1 + 2 + 1 = 10 marks)

In an experiment to study the behaviour of an extendible spring, a spring was hung securely from a laboratory stand. Masses of varying size were suspended from the lower end and the extension of the spring by different masses was recorded as shown in **Figure 22.**

When extra mass is added, the spring is allowed to gently stretch to its new equilibrium position.

The spring extended without permanent distortion.

The extension is measured from the spring end position when no force is applied.

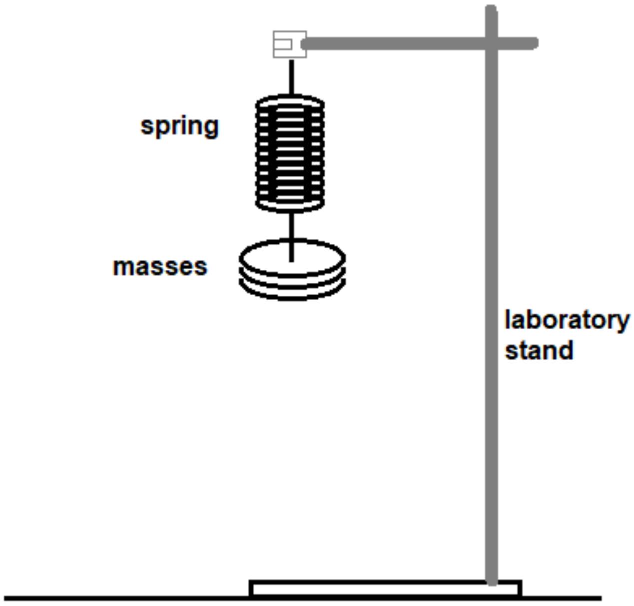


Figure 22 The spring being extended by added masses

Question 13 (continued)

The data collected is shown in **Figure 23.** The gravitational force exerted by the masses on the spring has been calculated. This force-extension data has been plotted onto the graph.

Data Point	x	F
1	0.000	0.00
2	0.015	0.49
3	0.032	0.98
4	0.042	1.47
5	0.064	1.96
6	0.075	2.45
7	0.092	2.94
8	0.104	3.43
9	0.122	3.92
10	0.136	4.41
11	0.148	4.90
12	0.169	5.39
13	0.181	5.88
14	0.192	6.37
15	0.210	6.86
16	0.217	7.35
17	0.228	7.84

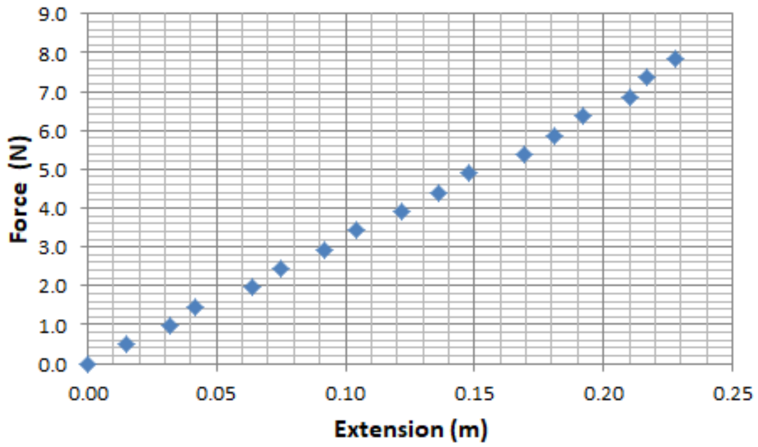


Figure 23 The data and graph from the force extending a spring.

a How is the gravitational force exerted by the masses calculated?

b On the graph, draw in a line of best fit.

c Determine the value of the spring constant from this data.

N m^{-1}

Question 13 (continued)

d What energy is stored in the spring when the extension is 0.136 m?

J

e What gravitational potential energy has the mass lost when the extension is 0.136 m? This is measured relative to the position of the base of the unextended length of the spring.

J

When the spring and mass were at equilibrium with an extension of 0.136 m, the mass of 0.450 kg was given a deflection of a further 0.040 m downwards and then allowed to oscillate freely.

f Once released, what would be the upward acceleration?
Use the correct number of significant figures in the answer.

m s^{-2}

g What is the acceleration as the mass passes the equilibrium position at 0.136 m?

m s^{-2}

Question 14 (2 + 2 = 4 marks)

A star, larger than the Sun, has a luminosity of 7.65×10^{26} W, which describes the rate of production of energy by the star's fusion processes.

In the star the fusion process follows the reactions below:

$$^1_1H + {}^1_1H \rightarrow {}^p_1H + {}^{0}_{-1}e + {}^0_0\nu$$
$$^1_1H + {}^2_1H \rightarrow {}^3_2He + \gamma$$
$$^3_2He + {}^3_2He \rightarrow {}^q_2He + 2\,{}^1_1H$$

while releasing 25 MeV of energy.

a In the reaction above, two numbers have been replaced with *p* and *q*.
What are their correct values?

p =	*q* =

b At what rate is the star losing mass in this energy production?

kg s^{-1}

Question 15 (2 + 2 + 2 + 2 = 8 marks)

Light differs from all other waves in that it can travel through a vacuum.
When travelling through a vacuum two features of the light wave can be identified as unique to electromagnetic waves and are not found in any mechanical waves.

a Which two features can be identified about such an electromagnetic wave?

1 ______________________________

2 ______________________________

Polarisation is a property of light, exhibited when passing through certain filters or crystals such as Iceland Spar. This is the crystal which some have suggested enabled Vikings to navigate the Arctic Ocean.

Figure 24
Iceland spar, possibly the Icelandic medieval sun stone used to locate the sun in the sky when obstructed from view

By ArniEin - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=12518599

http://www.physicsclassroom.com/class/light/Lesson-1/Polarization

b When light is passed through one polarisation filter and then another at right angles, there is evidence that light is a wave. How does this demonstration indicate the wave-like nature of light.

____

____

____

Question 15 (continued)

Electromagnetic radiation with a wavelength longer than that of visible light has a range of technological uses.

c Identify two of these uses.

1 ______________________________

2 ______________________________

Electromagnetic radiation with a wavelength shorter than that of visible light has a range of uses in scientific investigation.

d Identify two waves and their uses.

1 ______________________________

2 ______________________________

Question 16 (3 +1 = 4 marks)

A light emitting diode (LED) produces light. Ordinary silicon based diodes do not produce light even if the diode junction is revealed.

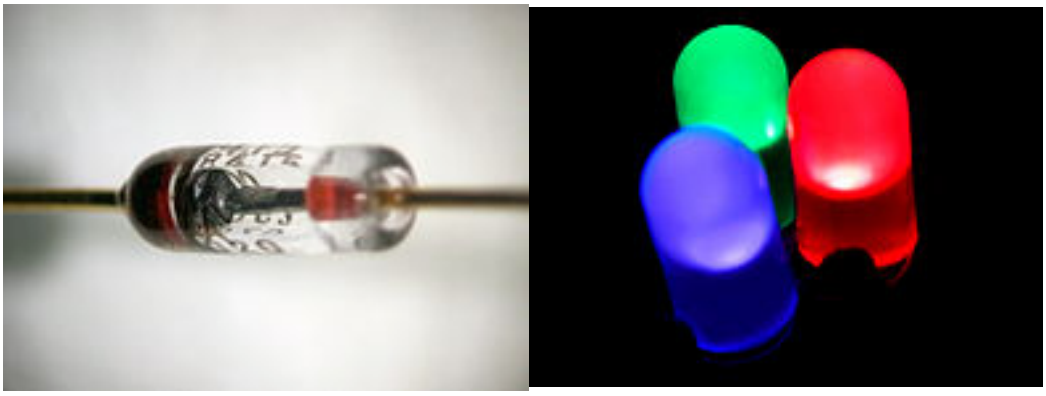


Figure 25 A glass cased silicon diode (left) emits no light, coloured LEDs (right) glow with light when conducting (left).

Close-up view of a silicon diode. The anode is at the right side; the cathode is at the left side (where it is marked with a black band). A square silicon crystal can be seen between the two leads. I, John Maushammer, took this picture Aug 2, 2006.
By The original uploader was Morcheeba at English Wikipedia - Transferred from en.wikipedia to Commons., CC BY-SA 2.5, https://commons.wikimedia.org/w/index.php?curid=2542965

Three LEDs, red, blue and green (right)
Author: PiccoloNamek

The threshold voltage of the silicon diode is 0.70 V while that of a green LED is 2.20 V.

a Use this data to explain why the silicon diode is dark, while the green one produces visible light.

b What is the source of this quantised energy released in light emitting diodes?

Question 17 (1 + 2 + 1 = 4 marks)

A CubeSat satellite is in orbit at a distance of 6.8×10^3 km from the Earth's centre. It is travelling with a speed of 7.65×10^3 m s^{-1}.

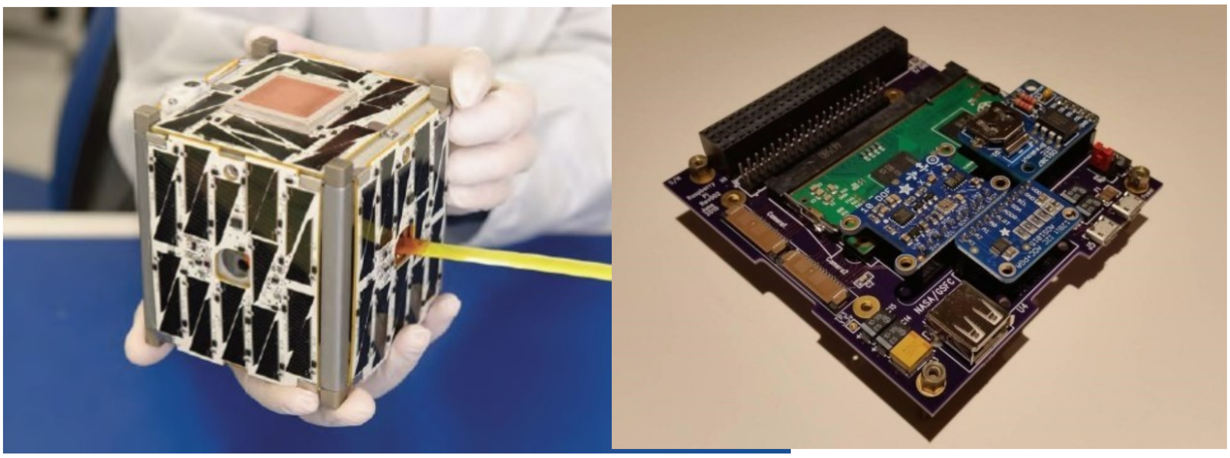


Figure 26 A CubeSat satellite and one of its the electronic circuit boards.
Photo NASA.

a What is the acceleration of the satellite?

m s^{-2}

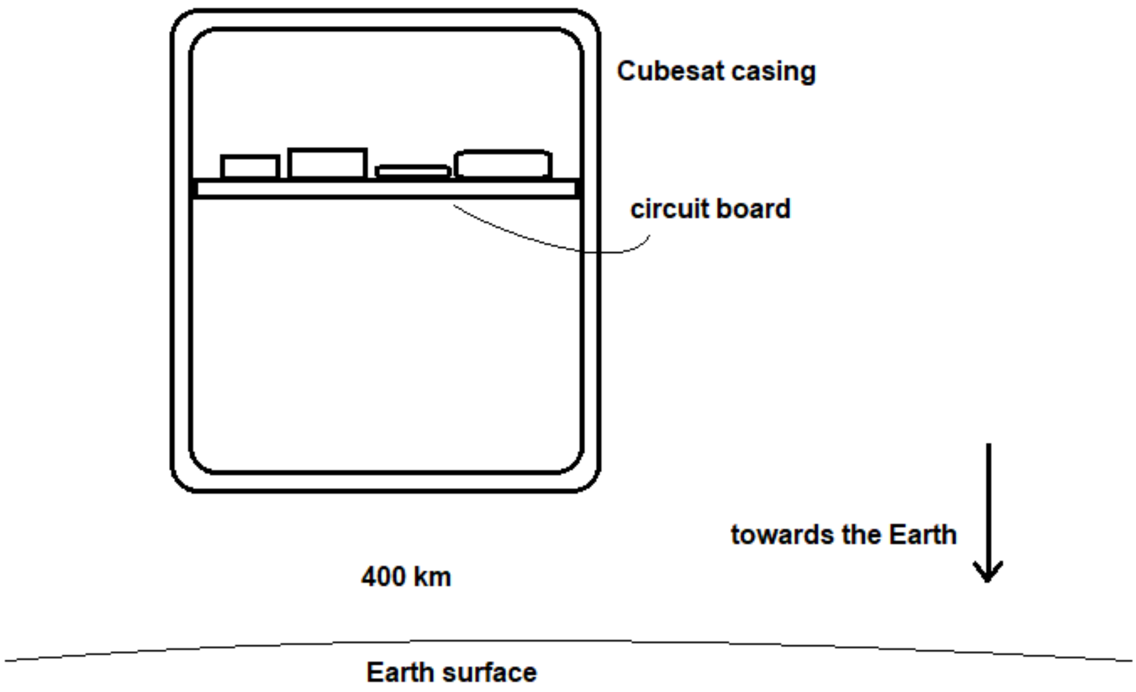
Question 17 (continued)

There are layers of electronic circuits inside the CubeSat, but they do not bend under the gravitational force of the components as they did while under construction back on the Earth's surface.

b Why is there no bending of the circuit boards in a satellite in orbit?

---

c To clarify your answer from "**b**" above, use labelled vectors on the **diagram below** to indicate the applied forces on the circuit board inside the satellite.



End of questions for the 2017 Kilbaha Year 12 Trial Physics Examination

Formula List

Motion and related energy transformations

velocity, acceleration	$v = \frac{\Delta x}{\Delta t} \quad a = \frac{\Delta v}{\Delta t}$
equations for constant acceleration	$v = u + at$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2ax$ $x = \frac{1}{2}(v + u)t$
Newton's second law	$\Sigma F = ma$
circular motion	$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$
Hooke's law	$F = -F\Delta x$
elastic potential energy	$\frac{1}{2}k\Delta x^2$
gravitational potential energy near the surface of the Earth	$mg\Delta h$
kinetic energy	$\frac{1}{2}mv^2$
Newton's law of universal gravitation	$F = G\frac{M_1 M_2}{r^2}$
gravitational field	$g = G\frac{M}{r^2}$
impulse	$F\Delta t$
momentum	$m\Delta v$
Lorentz factor	$\gamma = \frac{1}{\sqrt{(1-\frac{v^2}{c^2})}}$
time dilation	$t = t_o\, \gamma$
length contraction	$L = \frac{L_o}{\gamma}$
rest energy	$E_{rest} = E_o = mc^2$
relativistic total energy	$E_{total} = \gamma mc^2$
relativistic kinetic energy	$E_K = (\gamma - 1)mc^2$

Fields and application of field concepts

electric field between charged plates	$E = \frac{V}{d}$
energy transformations of charges in an electric field	$\frac{1}{2}mv^2 = qV$
field of a point charge	$E = \frac{kq}{r^2}$
force on an electric charge	$F = qE$
Coulomb's law	$F = \frac{kq_1q_2}{r^2}$
magnetic force on a moving charge	$F = qvB$
magnetic force on a current	$F = IlB$
radius of a charged particle in a magnetic field	$r = \frac{mv}{qB}$

Generation and transmission of electric power

voltage, power	$V = RI$, $P = VI = I^2R$
resistors in series	$R_T = R_1 + R_2$
resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
radius of a charged particle in a magnetic field	$r = \frac{mv}{qB}$
ideal transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$
AC voltage and current	$V_{RMS} = \frac{1}{\sqrt{2}} V_{Peak}$, $I_{RMS} = \frac{1}{\sqrt{2}} I_{Peak}$
electromagnetic induction	$EMF: \varepsilon = -N\frac{\Delta\Phi}{\Delta t}$, $Flux: \Phi = BA$
transmission losses	$V_{Drop} = I_{Line} R_{Line}$, $P_{Loss} = I_{Line}{}^2 R_{Line}$

Wave concepts

wave equation	$v = f\lambda$
constructive interference	$path\ difference = n\lambda$
destructive interference	$path\ difference = (n - \frac{1}{2})\lambda$
fringe spacing	$\Delta x = \frac{\lambda L}{D}$
Snell's law	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
refractive index and wave speed	$n_1 v_1 = n_2 v_2$

Nature of light and matter

photoelectric effect	$E_{K\,max} = hf - W$
photon energy	$E = hf$
photon momentum	$p = \frac{h}{\lambda}$
de Broglie wavelength	$\lambda = \frac{h}{p}$
Heisenberg's uncertainty principle	$\Delta p_x \, \Delta x \geq \frac{h}{4\pi}$

Data

acceleration due to gravity at the Earth's surface	$g = 9.8$ ms^{-2}
mass of the electron	$m_e = 9.1\times10^{-31}$ kg
charge of the electron	$e = -1.6\times10^{-19}$ C
Planck's constant	$h = 6.63\times10^{-34}$ Js, $h = 4.14\times10^{-15}$ eVs
speed of light in a vacuum	$c = 3.0\times10^{8}$ m s^{-1}
universal gravitational constant	$G = 6.67\times10^{-11}$ N m^2 kg^{-2}
Coulomb constant	$k = 9.0\times10^{9}$ N m^2 C^{-2}
mass of the Earth	$m_E = 5.98\times10^{-24}$ kg
radius of the Earth	$r_E = 6.37\times10^{6}$ m

Prefixes

p = pico = 10^{-12}	n = nano = 10^{-9}	μ = micro = 10^{-6}	m = milli = 10^{-3}
k = kilo = 10^{3}	M = mega = 10^{6}	G = giga = 10^{9}	t = tonne = 10^{3} kg

End of formula sheet for the 2017 Kilbaha VCE Physics Trial Examination

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