PHYSICS

2018

Trial Examination

(2 hours 30 minutes)

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	16	16	110
			Total 130

(Note: Use the formula/data sheets supplied by VCAA)

SECTION A –20 Multiple-choice questions (20 marks)

Instructions for Section A
Answer **all** questions in this section.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1; an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams are **not** drawn to scale.
Take the value of g to be 9.80 N kg^{-1}.

Question 1
Consider the three fields: gravitational, electric and magnetic.
Which one of the following statements is **NOT** correct?

A. A charge particle has an electric field around it.

B. All three fields are vector quantities.

C. All gravitational fields follow the inverse square law.

D. Magnetic fields do not follow the inverse square law.

Question 2
Which one of the following statements is **NOT** correct?

A. Gravitational force exists between particles in a helium nucleus.

B. Electric force exists between some particles in a helium nucleus.

C. Magnetic force exists between some particles in a helium nucleus.

D. Nuclear force is the only force which exists between particles in a helium nucleus.

Question 3
A charged subatomic particle moves towards the surface of Earth from space.
Which one of the following statements is correct?

A. The particle moves in a straight line towards Earth.

B. The particle moves in a parabolic path towards Earth.

C. The particle spirals to a pole of Earth.

D. The particle will be deflected away from Earth.

Question 4
Which one of the following statements is correct when a positively charged particle moves towards a negatively charged particle?

A. Electric potential energy increases.

B. Electric potential energy remains constant.

C. Electric potential energy increases to infinity.

D. Electric potential energy decreases.

Question 5
Some electric and magnetic fields are considered as static or uniform.
Which one of the following statements is correct?

A. Magnetic field of a bar magnet is static.

B. Electric field around a point charge is uniform.

C. Magnetic field inside a solenoid carrying an alternating current is static.

D. Electric field in light is uniform.

Question 6
A positively charged particle exerts a force of $2.00\times10^{-2}\,\text{N}$ on a negatively charged particle. If the charge on one of the particles is halved, and the distance between the two particles is doubled, the force

A. becomes $2.50\times10^{-3}\,\text{N}$

B. becomes $0.160\,\text{N}$

C. becomes $1.25\times10^{-3}\,\text{N}$

D. remains the same

Question 7
Which one of the following statements about geostationary satellites is **NOT** correct?

A. All geostationary satellites are directly above the equator.

B. All geostationary satellites have the same force of gravity.

C. All geostationary satellites have the same orbit.

D. All geostationary satellites have the same acceleration.

Question 8
Which one of the following statements about Earth's satellites in circular orbits is **NOT** correct when the orbital radius is **four** times the original radius?

A. The orbital period of the satellite is eight times its original value.

B. The orbital speed of the satellite is halved of its original value.

C. The acceleration of the satellite is one sixteenth of its original value.

D. The kinetic energy of the satellite is halved of its original value.

Use the following information to answer Questions 9 and 10

A teacher measures the mass (in kg) of each of three students.
The measurements are: $52.3 \pm 0.1,\ 49.5 \pm 0.5,\ 50.0 \pm 0.2$

Question 9
The difference (in kg) between the largest mass and the smallest mass is

A. 2.8 ± 0.6

B. 2.8 ± 0.4

C. 2.8 ± 0.3

D. 2.8 ± 0.25

Question 10
The average mass (in kg) of the three students is

A. 50.6 ± 0.8

B. 50.6 ± 0.3

C. 50.6 ± 0.27

D. 50.6 ± 0.2

Question 11
Dispersion of sunlight is caused by

A. deflection of sunlight at the interface of two different media

B. diffraction of sunlight at the interface of two different media

C. refraction of sunlight at the interface of two different media

D. reflection of sunlight at the interface of two different media

Use the following information to answer Questions 12 and 13

Imagine a spacecraft at velocity $0.8c$ travelling past Earth and then Mars. An observer in the spacecraft, an observer on Earth and an observer on Mars measure the time of travel between Earth and Mars to be T_S, T_E and T_M, and the distance between Earth and Mars to be D_S, D_E and D_M, respectively.

Question 12
Which one of the following statements about the time of travel between Earth and Mars is correct?

A. $T_S > T_E$

B. $T_M > T_S$

C. $T_M > T_E$

D. $T_E = T_S$

Question 13
Which one of the following statements is correct about the distance between Earth and Mars is correct?

A. $D_S > D_E$

B. $D_M > D_S$

C. $D_M > D_E$

D. $D_E = D_S$

Question 14
A 1-kg particle and a 2-kg particle are projected at the same speed at the same time from the same point above the ground.
The 1-kg particle is projected horizontally and the other is projected at $60°$ above the horizontal.
Both particles travel in the same vertical plane. Ignore air resistance in this question.
Which one of the following statements is correct?

A. Both particles hit the ground at the same speed.

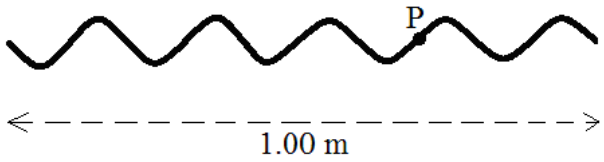
B. Both particles hit the ground at the same time.

C. Both particles hit the ground at the same point.

D. Both particles travel the same distance.

Use the following information to answer Questions 15 and 16

A standing wave is generated in a stretched elastic cord. The following diagram shows the appearance of the cord at a particular moment. The standing wave has a period of 0.50 s. A dot labeled as P is marked on the cord.



Question 15
At the moment shown in the diagram above, dot P is

A. motionless

B. moving forwards

C. moving upwards

D. moving downwards

Question 16
The speed (in m s^{-1}) of a travelling wave in the same stretched elastic cord is

A. 0.00

B. 0.20

C. 0.40

D. 2.00

Question 17
When the input of a step-up transformer is connected to a 12 V battery, the output voltage of the transformer is

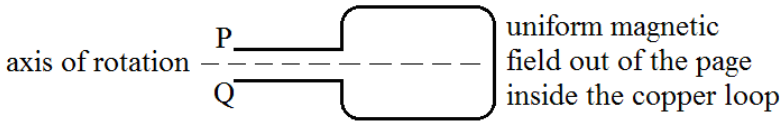
A. less than 12 V

B. greater than 12 V

C. the same as the input voltage, i.e. 12 V

D. 0 V

Question 18
A loop of copper wire is rotated in a magnetic field from an orientation of maximum flux as shown below.



Which one of the following statements is correct?

A. When the loop is rotated clockwise, the induced current flows in the loop from P to Q.

B. When the loop is rotated anticlockwise, the induced current flows in the loop from P to Q.

C. The induced current flows in the loop from Q to P.

D. Insufficient information is given to determine the flow direction of the induced current.

Question 19
Consider you have the necessary apparatus to investigate the speed of light in different media.
Which one of the following statements is **NOT** correct?

A. Frequency of light is a controlled variable.

B. Wavelength is a dependent variable.

C. Medium is an independent variable.

D. Speed of light is a dependent variable.

Question 20
A light pattern appears on a screen when a monochromatic light beam passes through a narrow opening.
Consider the four variables: (I) wavelength of light (II) width of the opening (III) distance between opening and screen (IV) medium in which the light travels.

The width of the pattern is affected by

A. all four variables

B. (I), (II) and (III) only

C. (I), (II) and (IV) only

D. (I) and (II) only

SECTION B

Instructions for Section B
Answer **all** questions in this section.
Where an answer box is provided, write your final answer in the box.
If an answer box 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 diagrams are **not** drawn to scale.
Take the value of g to be 9.80 N kg^{-1}.

Question 1
A 0.800-kg ball is dropped from a height of 2.58 m. It hits the floor and bounces off the floor vertically. It reaches a height of 1.80 m. The average net force on the ball is 1.80×10^2 N while it is in contact with the floor.

a. The net force consists of the weight of the ball and the reaction of the floor on the ball.
Calculate the average reaction force of the floor on the ball.

2 marks

N

b. Calculate the speed of the ball just before it hits the floor. 2 marks

m s^{-1}

c. Calculate the magnitude of the change in momentum of the ball while it is in contact with the floor.

3 marks

kg m s^{-1}

d. Calculate the time the ball is in contact with the floor. 2 marks

s

Question 2
A student performs a circular motion experiment. A small object attached to a cord is made to move in a circle of radius 1.0 m. It circles 10 times in 8.0 s. The other end of the cord pulls a spring balance which measures the pulling force (tension in the cord).
Assume that the circular motion is uniform, and the small object and the cord are on a horizontal plane.

a. Calculate the speed of the small object while it is in circular motion. 2 marks

	$m\ s^{-1}$

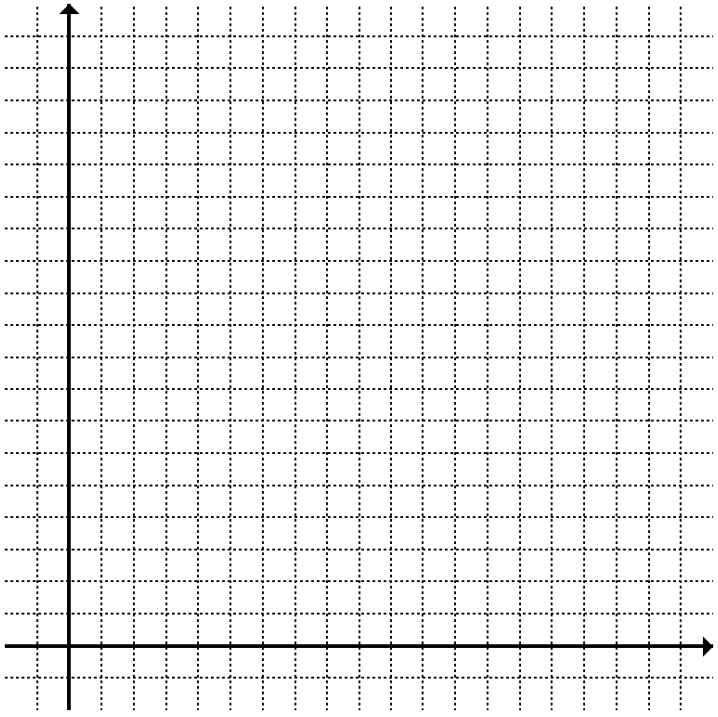
b. Calculate the acceleration of the small object. 2 marks

	$m\ s^{-2}$

c. The student obtains the following set of data.

Speed $v \pm 0.1$ ($m\ s^{-1}$)	6.6	6.9	7.2	7.9	8.8
Force $F \pm 0.5$ (N)	10.6	11.6	12.6	15.2	19.1

Plot a graph of the data including uncertainties, showing Force F as the dependent variable.
Draw a line/curve of best fit. 3 marks



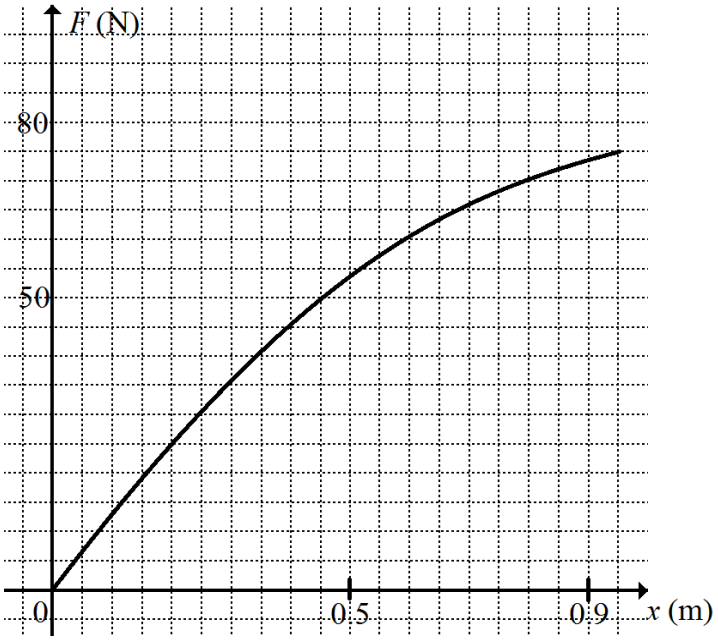
d. The data points appear to line up. Explain why it is false to suggest a linear relationship between F and v.

2 marks

e. Analyse the data carefully to find a more suitable relationship between F and v. 2 marks

Question 3

A horizontal strip of stretched rubber is fastened at both ends.
It is pulled back at the midpoint. Force F newtons is required to pull (extend) the strip by x metres.
The force-extension graph is shown below.



The rubber strip is pulled back by 0.80 metres and it is used to catapult a 0.50 kg mass to slide on a horizontal floor. The 0.50-kg mass travels 5.8 m after leaving the rubber strip before it comes to a stop.

a. Use the graph to estimate the amount of work required to stretch the rubber strip by 0.80 m. 3 marks

J

b. Assuming the work done in stretching the rubber strip can be fully recovered and changed to kinetic energy of the 0.50 kg mass after leaving the strip, find the initial speed of the sliding mass after leaving the rubber strip.

2 marks

	$m\ s^{-1}$

c. Find the force of friction between the sliding mass and the floor. 2 marks

	N

d. Determine the coefficient of sliding friction between the mass and the horizontal floor. 2 marks

Question 4

Imagine two spacecrafts A and B passing each other at a speed of 0.18 times the speed of light.
A person in spacecraft B says her spacecraft is 60.0 m long and spacecraft A is 61.5 m long.

a. What does a person in spacecraft A measure the length of his spacecraft? 2 marks

	m

b. What does a person in spacecraft A measure the length of spacecraft B? 2 marks

	m

Question 5

A particle is accelerated from $0.25c$ to $0.50c$.

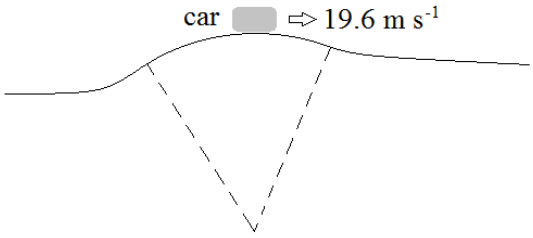
a. Calculate the percentage increase in the mass of the particle. 2 marks

	%

b. Determine the value of the ratio $\dfrac{\text{kinetic energy of the particle at } 0.50c}{\text{kinetic energy of the particle at } 0.25c}$. 2 marks

Question 6

A car with a driver has a total mass of 1200 kg. It travels along an uphill road and moves at 19.6 m s^{-1} at the crest of the road. The diagram shows the car at the road crest. The section between the two dotted lines is circular. Ignore air resistance.



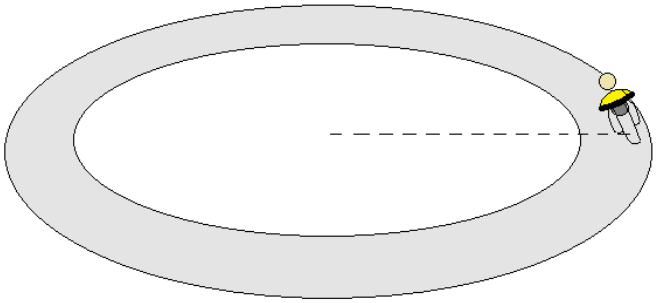
a. Calculate the radius of the circular section for the driver to feel weightless. 3 marks

	m

b. Describe the subsequent motion/path of the car beyond the crest. 2 marks

Question 7

A person riding a motorcycle (total mass 450 kg) travels at uniform speed of 20.0 m s^{-1} safely on a horizontal non-banked circular road of 30.0 m radius.



a. Determine the total reaction force of the road on the motorcycle. 3 marks

N

b. Determine the leaning angle of the motorcycle with the vertical. 2 marks

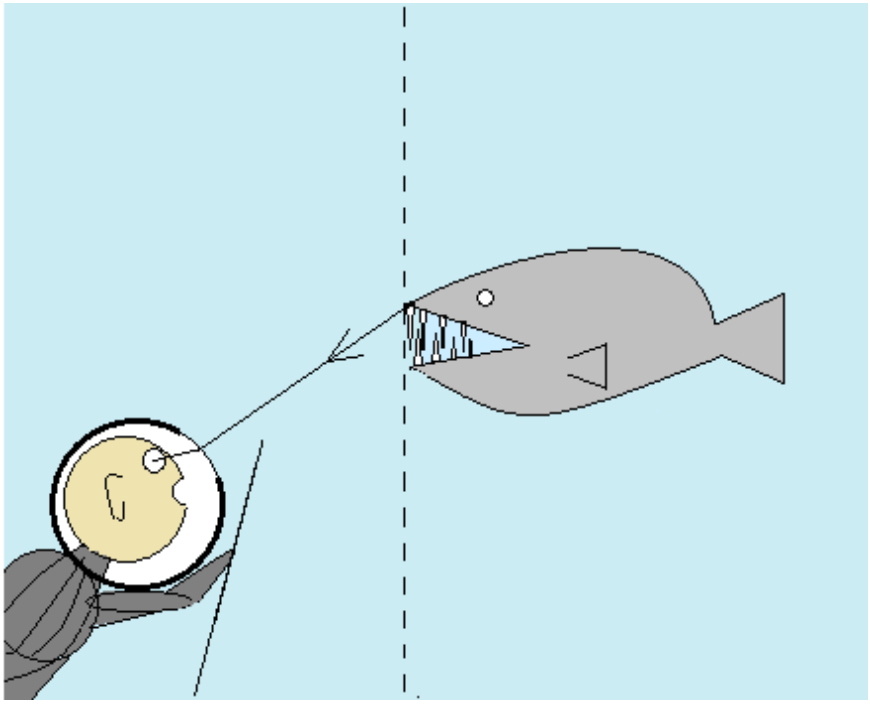
degrees

c. State and explain the effect on the leaning angle of carrying a passenger if the motorcycle travels safely at the same speed of 20.0 m s^{-1}.

2 marks

Question 8

A diver has an air filled spherical enclosure with a small thin glass window around his head. A light ray from the tip of the fish mouth to the diver's eyes is shown in the following diagram. The refractive index of the water relative to the air inside the enclosure is 1.33.



a. With the help of the light ray shown on the diagram accurately locate the image of the tip of the fish mouth by marking a clear solid dot on the dotted line.

2 marks

b. The light ray makes a 10° angle with the normal at the outside surface of the enclosure.
Calculate the angle the light ray makes with the normal when it enters the enclosure through the small window.

2 marks

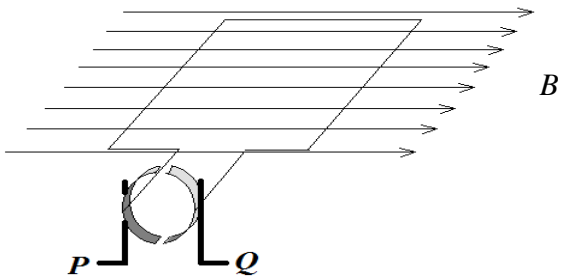
degrees

c. The diver cannot see the fish if the light ray makes an angle greater than $\theta°$ with the normal at the outside surface of the glass window when the fish is at a different location.
Determine the value of θ.

2 marks

Question 9

A simple d c motor is used as a generator. It is turned clockwise mechanically **at uniform speed**.
The time for 10 turns is 5.0 s.
The diagram shows the rotating wire loop in a uniform magnetic field B at $t = 0$.
Terminal Q in the diagram is at ground potential, i.e. 0 volt.

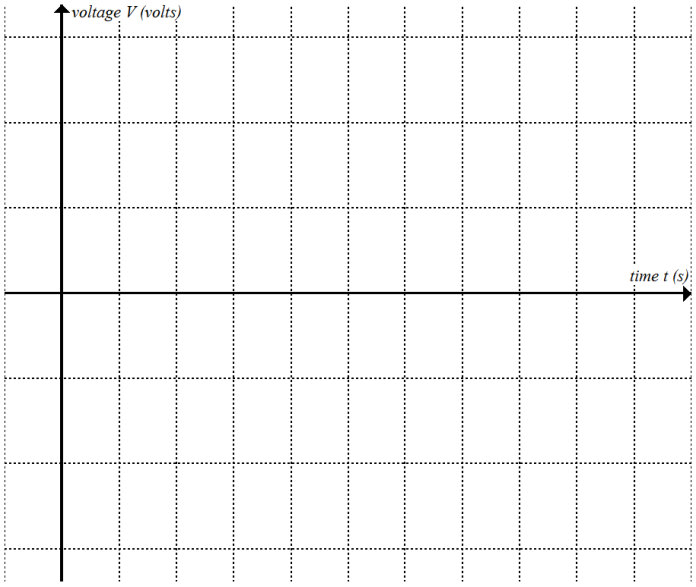


a. The rms voltage of the generator is $\sqrt{2}$ volts. Calculate the peak voltage of the generator. 2 marks

V

b. Draw a voltage-time graph for the potential at terminal P relative to the potential at terminal Q in the first second.

3 marks



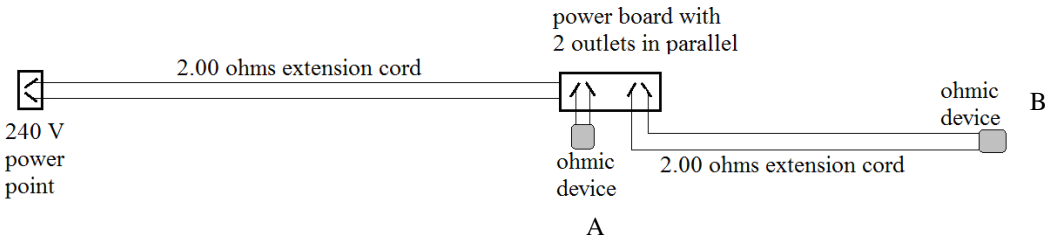
c. If a heater of 5.0Ω resistance is connected to terminals P and Q, calculate the amount of heat generated in the first second.

2 marks

J

Question 10

Two identical extension cords (2.00Ω each) are used to connect two identical ohmic devices (60.0Ω each). The circuit is connected to a household power point of 240 V.



a. Calculate the total resistance of the circuit. 3 marks

Ω

b. Calculate the current in the extension cord between the power point and the power board. 2 marks

A

c. Calculate the voltage at one of the outlets of the power board. 2 marks

V

d. Calculate the voltage drop in the extension cord between the power board and ohmic device B. 3 marks

V

Question 11
A 152-kg satellite moves in circular orbit around Earth. The radius of the orbit is r metres, the speed of the satellite is v m s^{-1}, and the period of the satellite is T seconds.

a. Determine the value and unit of $v^2 \times r$. 2 marks

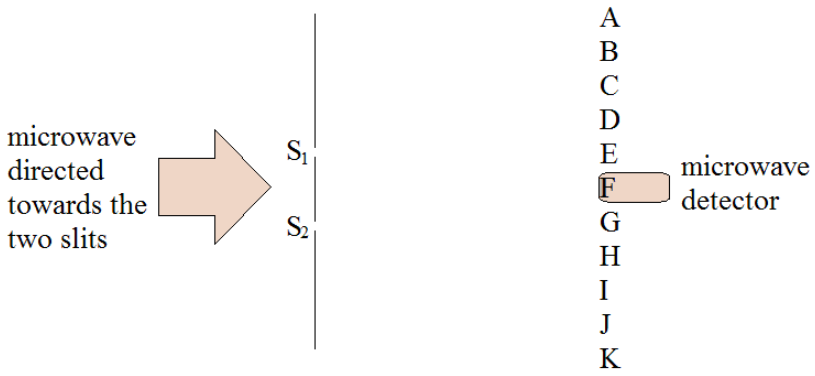
b. Determine the value and unit of $v^3 \times T$. 3 marks

Question 12
A person at the spectator stand watches a racing car approaching and departing at high speed.
Describe the sound from the racing car heard by the person. Your answer should include the frequency of the sound heard and the frequency of the source, the speed and wavelength of the sound.

4 marks

Question 13

Microwave of 3.0×10^{10} Hz passes through two parallel slits which are 6.0 cm apart. The slits produce two in phase sources of circular microwaves due to diffraction. A microwave detector is placed 0.50 m directly in front of the two slits. It is then moved sideways to measure the strength of the microwave at different positions.
The following diagram shows the aerial view of the setup.
Strong microwave is detected at positions B, D, F, H and J, relatively weaker microwave at A, C, E, G, I and K.



a. The two slits have the same width w. Give an estimate of the upper limit of w. 2 marks

m

b. Calculate the difference between distances S_1B and S_2B. 2 marks

m

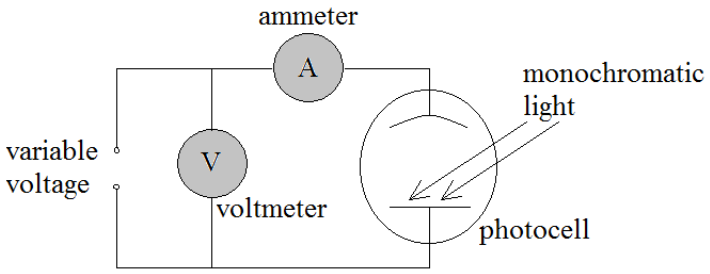
c. Calculate the difference between distances S_1K and S_2K. 2 marks

m

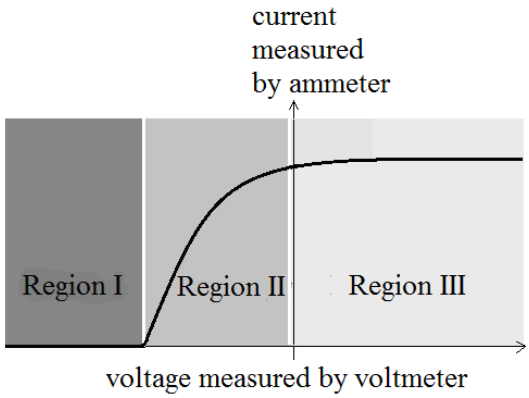
d. Describe two ways to increase the distance between positions of strong and weak microwave. 2 marks

Question 14

The following diagram shows the setup to investigate the photoelectric effect for certain light intensity and frequency.



The data from a photoelectric effect experiment is displayed in the following graph. The graph is divided into three regions.

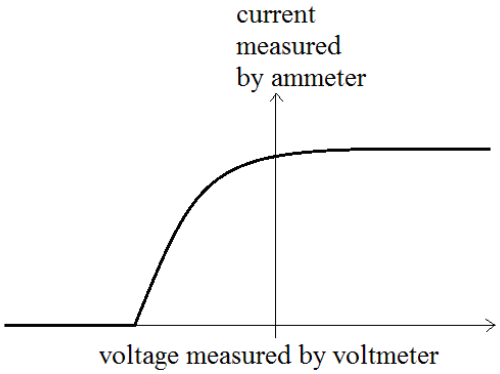


a. Explain the cause of the shape of the graph in each region in terms of the energy of the photoelectrons and applied voltage.

3 marks

b. Draw on the diagram below a possible graph of the data if the monochromatic light is changed to one of **lower intensity** but at **higher frequency**. The original graph is shown in the diagram for comparison.

2 marks



Question 15
Light from the sun is unpolarised.

a. Use the wave model of electromagnetic radiation to explain the difference between unpolarised light and polarised light.

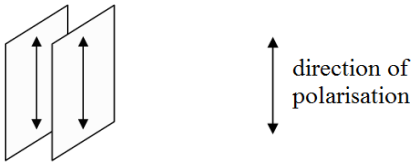
2 marks

b. Explain the polarisation of visible light by a polarising sheet. 2 marks

c. Estimate the maximum value of the ratio $\frac{\text{intensity of light after passing through a polarising sheet}}{\text{intensity of light before passing through a polarising sheet}}$.

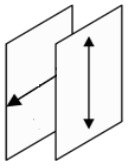
1 mark

d. Light from the sun passes through two clear polarising sheets as shown below.



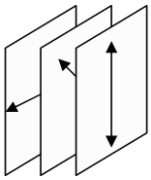
Estimate the maximum value of the ratio $\frac{\text{intensity of light after passing through}}{\text{intensity of light before passing through}}$. 1 mark

e. Light from the sun passes through the same clear polarising sheets as shown below with one of them rotated by $90°$.



Estimate the approximate value of the ratio $\frac{\text{intensity of light after passing through}}{\text{intensity of light before passing through}}$. 1 mark

f. A third polarising sheet is inserted between the two in part e as shown in the following diagram.
Light from the sun passes through the three polarising sheets.



Estimate the maximum value of the ratio $\frac{\text{intensity of light after passing through}}{\text{intensity of light before passing through}}$. 2 marks

Question 16
Electrons were ejected from a sodium surface when illuminated by light of wavelength 410 nm. The maximum kinetic energy of the ejected electrons was 0.75 eV.

a. Determine the momentum of a photon in the light used. 2 marks

kg m s^{-1}

b. Determine the maximum magnitude of the momentum of the ejected electrons. 3 marks

kg m s^{-1}

c. Determine the work function of sodium. 2 marks

J

End of examination