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# ***PHYSICS***

## ***2019***

### ***Trial Examination***

***(2 hours 30 minutes)***

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	20	20	20
B	20	20	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  $9.80 \text{ N kg}^{-1}$ .

### Question 1

Consider the three fields: gravitational, electric and magnetic.

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

- A. All three fields can be approximately uniform in a relatively small region.
- B. All three fields are vector quantities.
- C. All three fields follow the inverse square law.
- D. All three fields can be static.

### Question 2

Consider two point charges at certain distance apart.

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

- A. The force between the two charges can be attractive or repulsive.
- B. The force between the two charges remains the same if the distance and one of the charges are doubled.
- C. The force experienced by a third point charge varies with its position from the two charges.
- D. A third point charge will either move towards one of the two charges or away from both charges.

### Question 3

A neutral (no charge) particle moves in space near Earth but outside the Earth's atmosphere.

Which one of the following statements **CANNOT** be correct?

- A. The particle is in freefall if it moves in a straight line towards the centre of Earth.
- B. The particle is in freefall if it moves in a curved path towards Earth.
- C. The particle is in freefall if it moves in a curved path away from Earth.
- D. The particle is in freefall if it moves in a straight line past Earth.

#### Question 4

Which one of the following statements is correct when a positively charged particle moves away from another positively charged particle?

- A. Electric potential energy increases.
- B. Electric potential energy increases to infinity.
- C. Electric potential energy remains constant.
- D. Electric potential energy decreases to zero.

#### Question 5

Point P is 0.25 m east of a bar magnet. The south pole of the bar magnet is facing eastward, and at point P the magnitude of its magnetic field equals the magnitude of Earth's magnetic field of  $B$  tesla.

The net magnetic field at point P is approximately  
(Select one of the following alternatives)

- A.  $2B$  tesla NE
- B.  $1.4B$  tesla SE
- C.  $2B$  tesla SW
- D.  $1.4B$  tesla NW

#### Question 6

A carriage moves along a circular track of a rollercoaster in a vertical plane. The carriage is upright at the highest point of the track. Which one of the following statements describes an **impossible** situation?

- A. All riders in the carriage feel weightless.
- B. All riders in the carriage experience an upward reaction force.
- C. All riders in the carriage experience a downward reaction force.
- D. All riders in the carriage have zero acceleration.

#### Question 7

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

- A. All geostationary satellites have the same speed.
- B. All geostationary satellites have the same period.
- C. All geostationary satellites have the same kinetic energy.
- D. All geostationary satellites have the same acceleration towards the centre of Earth.

**Question 8**

A particle with mass  $m$  and charge  $q$  is placed between two parallel metal plates. The two plates have a potential difference  $V$  and are separated by a distance  $d$ . The force of gravity on the particle is negligible. Which one of the following statements is **NOT** correct?

- A. The acceleration of the particle is proportional to  $qV$ .
- B. The acceleration of the particle is proportional to  $\frac{q}{m}$ .
- C. The acceleration of the particle is proportional to  $md$ .
- D. The acceleration of the particle is proportional to  $\frac{V}{d}$ .

**Question 9**

A student measures the length of a rectangle as 2.3 cm with a ruler (graduated in cm) and the width as 5.5 mm with another ruler (graduated in mm). Taking precision into consideration the perimeter of the rectangle is (Select one of the following alternatives)

- A. 5.6 cm
- B. 57 mm
- C. 5.70 cm
- D. 58 mm

**Question 10**

Imagine a spacecraft travelling at constant velocity  $0.8c$  past Earth and then Mars. An observer in the spacecraft measures the time of travel between Earth and Mars to be  $T$ , and the distance between Earth and Mars to be  $D$ .



Which one of the following statements about  $T$  and  $D$  is correct?

- A.  $T$  is the proper time interval and  $D$  is the contracted distance
- B.  $T$  is the proper time interval and  $D$  is the proper distance
- C.  $T$  is the dilated time interval and  $D$  is the contracted distance
- D.  $T$  is the dilated time interval and  $D$  is the proper distance

**Question 11**

A rectangular loop moves at constant velocity completely inside a uniform magnetic field. The induced current in the loop  
(Select one of the following alternatives)

- A. is in the clockwise direction
- B. is in the anticlockwise direction
- C. is zero
- D. cannot be determined without more information

**Question 12**

Polarisation of light demonstrates  
(Select one of the following alternatives)

- A. the particle nature of light
- B. the wave nature of light
- C. the wave-particle dual nature of light
- D. that matter has wave nature

**Question 13**

The speed of sound is  $344.5 \text{ m s}^{-1}$ . A compression of a sound wave of constant frequency passes point P. Another compression of the same sound wave passes point P one second later. The frequency (Hz) of the sound wave is  
(Select one of the following alternatives)

- A. 108.7
- B. 60.5
- C. 55.3
- D. 50.0

**Question 14**

A 1-kg particle is projected horizontally and a 2-kg particle is projected at  $60^\circ$  above the horizontal. Both particles are projected at the same speed at the same time from the same point above the ground. 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 with the same kinetic energy.
- C. Both particles hit the ground at the same angle.
- D. Both particles hit the ground at the same time.

**Question 15**

A ray of light of a particular frequency enters a transparent substance of absolute refractive index  $n_s$  from air of absolute refractive index  $n_a = 1.000$ .

Select one of the following alternatives, the speed of the light in the transparent substance is proportional to

- A.  $n_s$
- B.  $n_a$
- C. the angle of the refracted ray with the normal
- D. the wavelength of the light

**Question 16**

Which one of the following statements best explains/describes the resonance of sound?

- A. Resonance is the interference of two travelling sound waves
- B. Resonance occurs whenever a sound wave enters a closed pipe of air
- C. Resonance occurs if a standing wave is formed by the superposition of a travelling sound wave and its reflection
- D. Resonance cannot occur when a sound wave enters an open pipe of air

**Question 17**

The input of a transformer is connected to a power source.

While the input voltage decreases uniformly from 12 V to  $-12$  V, which one of the following statements is the best description of the output voltage of the transformer?

- A. The output increases uniformly from 0 V to 24 V
- B. The output decreases uniformly from 24 V to 0 V
- C. The output is approximately constant
- D. The output is constant at  $-12$  V and then constant at 12 V, or vice versa

**Question 18**

A student placed a sample on an electronic scale and took five readings in grams. The readings were 2.51, 2.62, 2.45, 2.58 and 2.41.

Which one of the following results in grams should be recorded as the mass of the sample?

- A.  $2.514 \pm 0.106$
- B.  $2.514 \pm 0.104$
- C.  $2.51 \pm 0.11$
- D.  $2.5 \pm 0.1$

**Question 19**

A photocurrent of  $0.80 \mu\text{A}$  is measured in a photoelectric effect experiment using light of a fixed frequency.

Which one of the following values for the number of photons absorbed in one second causing the emission of photoelectrons is the most appropriate?

- A.  $1.0 \times 10^6$
- B.  $2.0 \times 10^9$
- C.  $5.0 \times 10^{12}$
- D.  $8.0 \times 10^{15}$

**Question 20**

A particle of mass  $m$  moves at a speed of  $0.9c$ , where  $c$  is the speed of light.

Which one of the following values best represent the kinetic energy of the electron?

- A.  $0.405mc^2$
- B.  $1.294mc^2$
- C.  $2.162mc^2$
- D.  $3.162mc^2$

## 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.

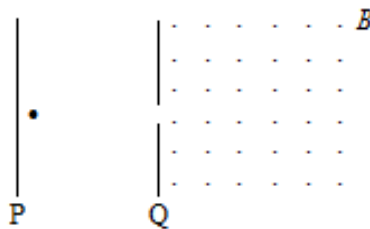
In questions where more than one mark is available, appropriate working **must** be shown.

Unless otherwise indicated, the diagrams are **not** drawn to scale.

Take the value of  $g$  to be  $9.80 \text{ N kg}^{-1}$ .

### Question 1

Two parallel metal plates P and Q are 5.0 cm apart. The electric potential difference between P and Q is 250 V. An electron starts from rest and accelerates from P to Q. Plate Q has a hole in the middle to allow the electron to pass through into a uniform magnetic field  $B$  of 0.010 T perpendicular to the motion of the electron and directed out of the page (refer to the following diagram).



- a. Calculate the force of gravity and the electric force on the electron between the two parallel plates P and Q. Compare the magnitudes of the two forces and comment on the path of the electron.

3 marks

N	N
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- b. Calculate the kinetic energy of the electron when it passes through the hole in Plate Q.

2 marks

J
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c. Calculate the magnetic force on the electron once it enters the magnetic field  $B$ .

2 marks

N

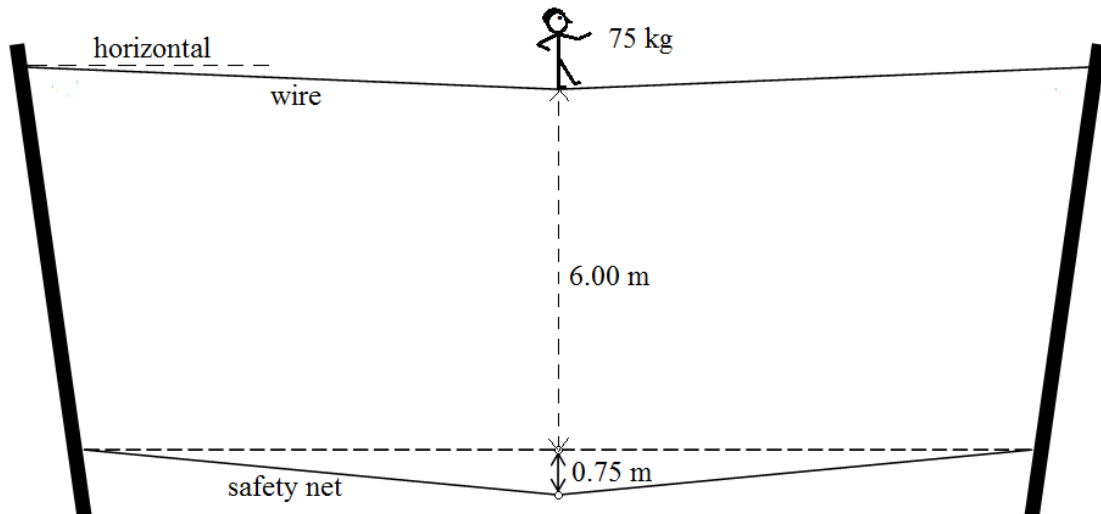
d. Describe the motion of the electron in the magnetic field  $B$  in terms of its path, speed and acceleration.

3 marks

$m\ s^{-1}$        $m\ s^{-2}$

### Question 2

While in the middle of the wire, a 75 kg circus clown causes it to make a  $5^\circ$  angle to the horizontal at both ends.



a. Calculate the tension in the wire.

2 marks

N

b. The clown falls 6.00 m to the safety net, depressing the net by 0.75 m. Assume the net is elastic (i.e. it follows Hooke's law) calculate the amount of elastic potential energy in the net when it is depressed by 0.75 m.

2 marks

c. Calculate the force required to depress the net by 1 m.

2 marks

d. Calculate the maximum force exerted by the net on the clown.

2 marks

e. Describe the subsequent motion of the clown if the net is truly elastic.

1 mark

### Question 3

A spacecraft travels past the moon of planet Earth towards Earth at a speed of  $v \text{ m s}^{-1}$ .

The half lives of a sample of a particular radioisotope carried inside the spacecraft are determined by an astronaut inside the spacecraft and by a scientist on Earth. They are 4.0 s by the astronaut and 5.0 s by the scientist.

- a. Calculate the value of the ratio  $\frac{v}{c}$  where  $c \text{ m s}^{-1}$  is the speed of light. 2 marks

- b. The distance from planet Earth to its moon is  $3.80 \times 10^8 \text{ m}$  measured by the scientist. What is the distance from the moon to planet Earth measured by the astronaut?

2 marks

- c. Find the time measured by the astronaut to travel from the moon to planet Earth. 2 marks

**Question 4**

A tennis ball moves in a parabolic path under gravity. It has a velocity of  $25.0 \text{ m s}^{-1}$  at  $60^\circ$  angle with the vertical just before it hits the ground.

- a. Determine the minimum speed of the tennis ball while it is in flight.

2 marks

$\text{m s}^{-1}$

- b. Determine the maximum height of the tennis ball above the ground.

2 marks

m

**Question 5**

An electron travels at 99% of the speed of light.

- a. Find the mass of the electron travelling at 99% of the speed of light.

1 mark

kg

- b. Find the sum of rest energy and kinetic energy of the electron travelling at 99% of the speed of light.

2 marks

J

**Question 6**

An Earth satellite is placed in a circular orbit where  $g = 0.22 \text{ N kg}^{-1}$ .

a. Calculate the altitude of the satellite.

2 marks

b. Calculate the period of the satellite.

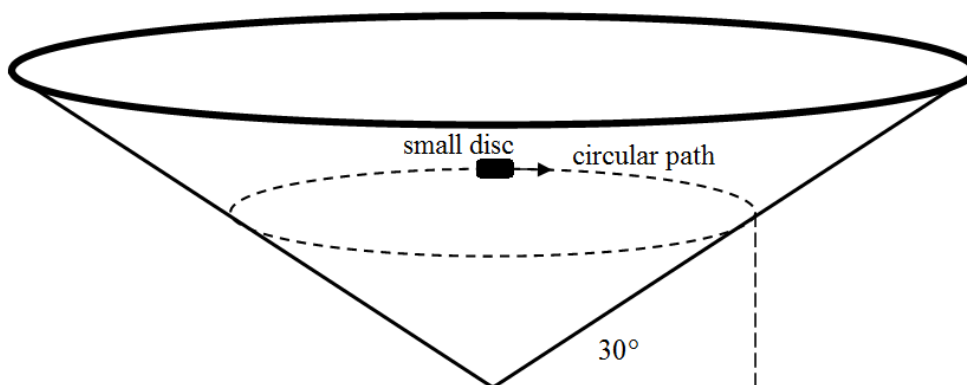
2 marks

c. Estimate the increase in gravitational potential energy for each kilogram of the satellite when its altitude is increased by 1 km.

2 marks

**Question 7**

A small disc slides in a horizontal circular path on the inside wall of a conical structure. The inside wall is icy and there is no friction between the disc and the wall. The circular path has a radius of 5.00 metres.



a. Calculate the speed of the disc.

2 marks

b. Calculate the change in the height of the disc above the ground if its speed is changed to 6.00 m s<sup>-1</sup>.

2 marks

**Question 8**

A stretched wire is 0.48 m long.

One of the resonant frequencies of the stretched wire is 150 Hz. The next higher resonant frequency is 200 Hz.

a. Calculate the wavelength of the 150 Hz frequency.

2 marks

b. Determine the wave speed of a 175 Hz transverse wave travelling in the stretched wire.

2 marks

c. The 150 Hz vibration of the stretched wire produces a sound wave in the air. Estimate the wavelength of the sound wave produced.

1 mark

**Question 9**

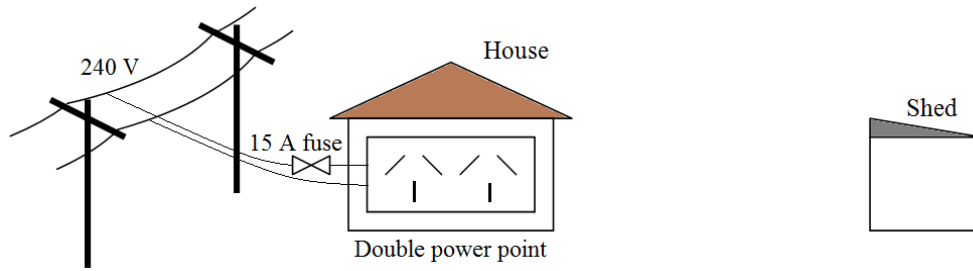
If you are in a car travelling at high speed towards the sounding siren of a stationary police car, the siren sounds at higher pitch than when you are at rest next to the police car.

Explain this effect in terms of sound speed and frequency

3 marks

### Question 10

The power point inside a house has a 15 amp fuse.



- a. Discuss with calculations the effect if any on the 15 amp fuse when two 2.20 kW kettles are connected to the double power point (a power point with two outlets).

3 marks

A power tool has a specified voltage range of 220 - 240 V and is rated maximum 3.00 kW at 240 V.

Assume that the resistance of the power tool is constant.

The total resistance per metre of an extension cord is  $0.025 \Omega$ .

The resident wants to operate the power tool in the shed by the extension cord connected to an outlet of the double power point in the house.

- b. Determine whether the power tool is operational if the shed is 50 m from the house. Show calculations.

3 marks



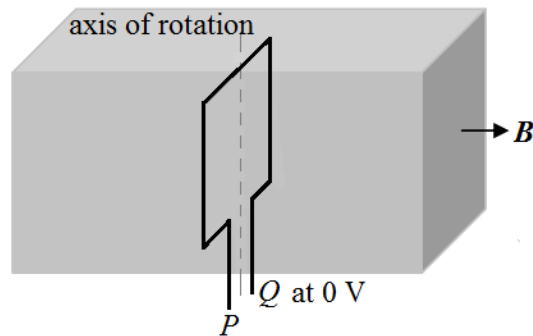
### Question 11

A rectangular coil consists of **50 turns** of insulated copper wire.

The coil has a height of 10.0 cm and a width of 6.0 cm.

It is placed in a uniform magnetic field  $B$  of  $4.0 \times 10^{-5}$  T .

Terminal  $Q$  is at 0 V.



- a. Calculate the magnetic flux through the coil.

1 mark

- b. Determine the torque on the coil about the axis of rotation if a 0.50 A current flows from  $P$  to  $Q$  and magnetic field  $B$  is perpendicular to the enclosed area of the coil as shown in the diagram.

1 mark

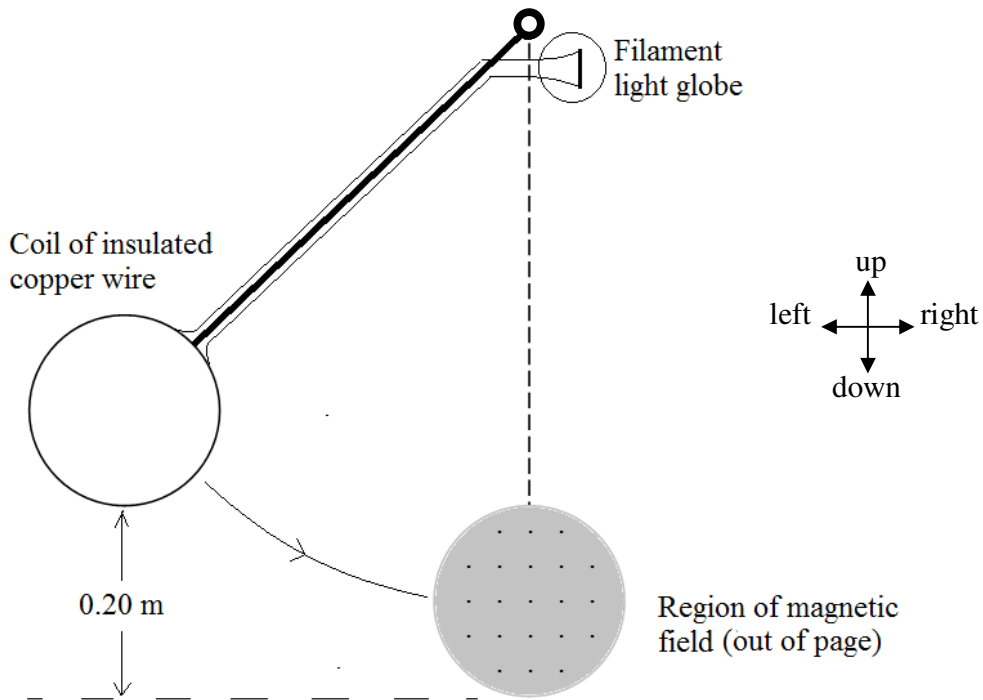
Now the coil is in uniform rotation about the axis at a frequency of 5.0 Hz .

- c. Calculate the average signed (+ or -) potential relative to terminal  $Q$  induced at terminal  $P$  after 0.050 s from the position shown in the diagram.

4 marks

**Question 12**

The pendulum bob is a coil of wire of mass 0.50 kg. The diagram shows its initial position. The coil has enough turns to light up the filament globe when it swings pass the region of magnetic field. Ignore air resistance and friction in this question. The mass of the pendulum arm is insignificant.



a. Describe and explain the subsequent motion of the pendulum bob qualitatively. In your discussion include forces when the pendulum bob enters or leaves the region of magnetic field, and the height reached when it swings to the other side.

3 marks

b. Determine the total amount of electrical energy dissipated in the light globe.

2 marks

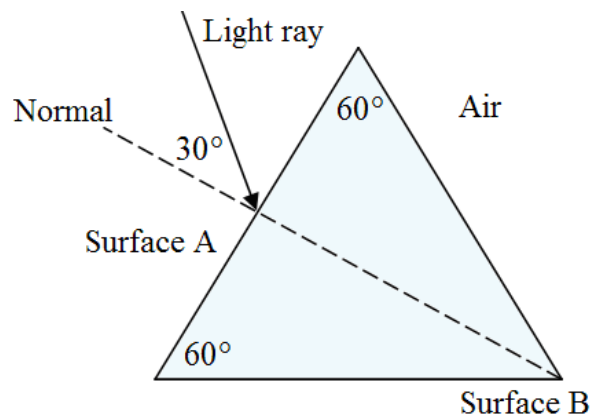
**Question 13**

A light ray has blue and red components.

The ray is directed to a triangular prism at  $30^\circ$  angle with the normal to Surface A of the prism.

The absolute refractive index of the prism is 1.514 for the red component, and 1.528 for the blue component.

Assume that the absolute refractive index of air is 1.00.



- a. Calculate the angles of refraction for the red and blue components.

2 marks

Red	Blue
-----	------

- b. On the diagram above accurately sketch and label the red (r) and blue (b) components to Surface B.

1 mark

- c. Calculate the critical angles for total internal reflection for both components.

2 marks

Red	Blue
-----	------

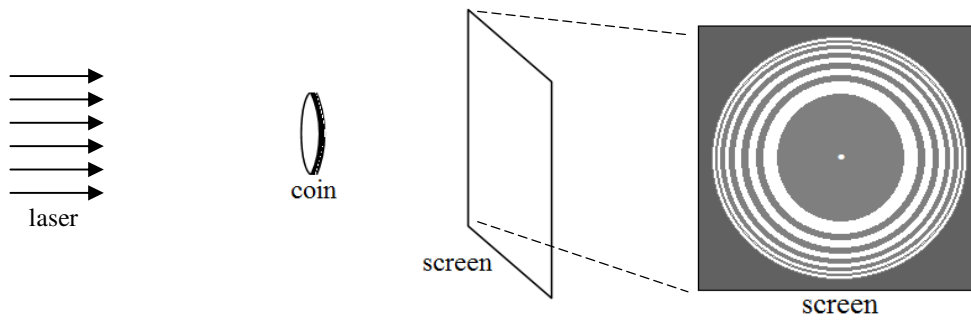
- d. On the same diagram above extend (sketch accurately and label) the two components beyond Surface B.

2 marks



### Question 15

In the following experiment the shadow cast by a coin using a laser as a source of light appears on the screen. There is a bright spot at the centre of the shadow, and there are also bright and dark fringes beyond the shadow.



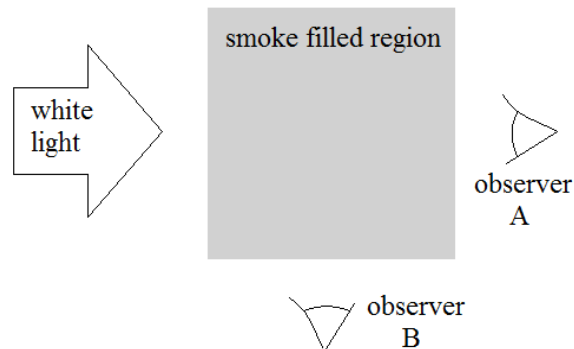
Explain clearly the appearance of the bright spot at the centre of the shadow, and the formation of the bright and dark fringes beyond the shadow.

3 marks

### Question 16

Given data: The size of smoke particles is in the range  $0.1 \times 10^{-6}$  to  $1.0 \times 10^{-6}$  m.

Wavelength of visible light has a range  $0.4 \times 10^{-6}$  to  $0.7 \times 10^{-6}$  m.

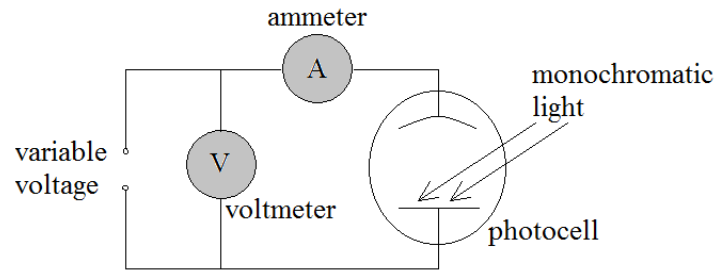


Describe and explain the observation of each observer in terms of light colours.

3 marks

**Question 17**

The following diagram shows a setup to investigate the photoelectric effect for certain light intensities and wavelengths.

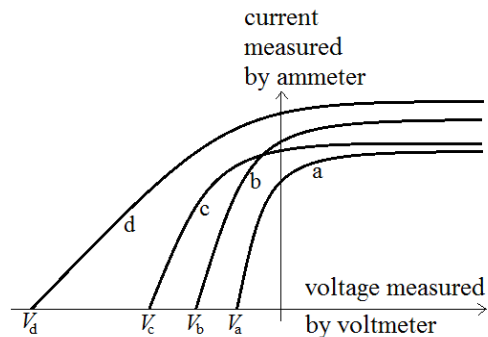


a. The two important properties of a light wave are its intensity and its frequency (or wavelength). What does the wave model of light predict about the number of emitted electrons and the kinetic energy of the electrons when the intensity and frequency of the light wave are varied?

2 marks

Four monochromatic lights labeled as a, b, c and d of different wavelengths and intensities are directed at the same photocell. Voltage is varied and current is measured. The results are recorded and graphed below.

Light x	Wavelength $\lambda_x$ (nm)	Voltage $ V_x $ (V)
a	700	0.500
b	650	0.637
c	600	0.796
d	410	1.755



b. Calculate the photon energy of the monochromatic light labeled as d, and the maximum speed of the emitted electrons.

3 marks

eV	$\text{m s}^{-1}$
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c. Are the results in the table consistent? Explain with calculations.

2 marks

d. There is a wavelength below which emission of photoelectrons occurs. Determine that wavelength.

2 marks

m
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**Question 18**

Heisenberg's uncertainty principle is stated mathematically as  $\Delta p_x \Delta x \geq \frac{h}{4\pi}$ .

Explain how diffraction from a single slit experiment can be used to illustrate the principle.

2 marks

**Question 19**

Interpret the interference pattern (bright and dark fringes) produced when very dim light (one photon at a time) is used in a double slit experiment.

2 marks

**Question 20**

A load is suspended by a supported spring when two students, A and B, investigate the relationship between the mass  $M$  of a load and the period  $T$  of oscillation of the load.

Four other factors involved in this investigation are air resistance  $r$ , mass of the spring  $m$ , elastic constant  $k$  of the spring and gravity  $g$ .

The spring extends further by 0.015 m for each additional 0.05 kg.

The spring can be extended up to 0.30 m before losing its elasticity.

a. Identify the controlled, dependent and independent variables in this investigation. 2 marks

b. Suggest a way to minimise the effect of (i) air resistance and (ii) the mass of the spring on the investigation. 2 marks

The results of the investigation by the two capable students are tabulated together as shown below.

Student	Mass of load (kg)	Time for 20 oscillations (s)	Period (s)
A	0.100	$7.7 \pm 0.4$	0.385
A	0.150	$10.1 \pm 0.4$	0.505
A	0.200	$11.6 \pm 0.4$	0.580
B	0.250	$13.0 \pm 0.5$	0.650
B	0.300	$14.5 \pm 0.5$	0.725
B	0.350	$15.4 \pm 0.5$	0.770

Note: The time for 20 oscillations is measured with a stopwatch and it is the average value of 5 repeated measurements for the same load.

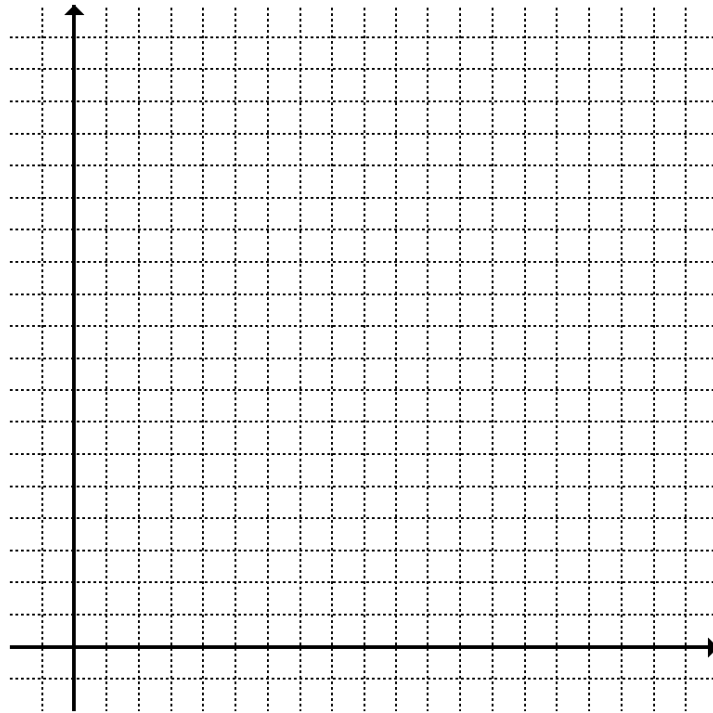
c. The calculated values in the last column of the table above are not quite correct with respect to accuracy. Enter the correct values including uncertainties for the periods in the following table. 2 marks

Student	Mass of load (kg)	Time for 20 oscillations (s)	Period (s)
A	0.100	$7.7 \pm 0.4$	
A	0.150	$10.1 \pm 0.4$	
A	0.200	$11.6 \pm 0.4$	
B	0.250	$13.0 \pm 0.5$	
B	0.300	$14.5 \pm 0.5$	
B	0.350	$15.4 \pm 0.5$	



d. Analyse the results and determine the relationship between  $M$  (mass of load) and  $T$  (period of oscillation). The use of the grid below is optional.

3 marks



e. Suggest a way to improve the investigation so that the relationship between  $M$  and  $T$  can be ascertained for the spring. This question is not about accuracy and human errors.

2 marks

**End of examination**