ACCESS EDUCATION

STUDENT NAME:

VCE PHYSICS

Unit 3 & 4 Trial Examination 2024

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
B	15	15	100
			Total 120

- Students are permitted to bring into the exam room: pens, pencils, highlighters, erasers, sharpeners, rulers, pre-written notes (one A4) and one scientific calculator.
- Students are NOT permitted to bring into the exam room: blank sheets of paper and/or white out correction fluid/tape.
- Students are not permitted to bring into the exam a mobile phone, electronic devices or wear a smart watch.

Materials supplied

- Question and answer booklet of **32** pages
- Formula Sheet
- Answer sheet for multiple-choice questions

Instructions

- Write your student name in the space provided above on this page.
- Write your student name in the space provided on the multiple choice answer sheet.
- Unless otherwise indicated, the diagrams in this book are not drawn to scale.
- All written responses must be in English.

At the end of the examination

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

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

Disclaimer: This practice examination has been written for students of VCE Physics. This does not imply that it has been endorsed by the Victorian Curriculum and Assessment Authority (VCAA). Teachers are advised to preview and evaluate this resource before using or distributing it to students.

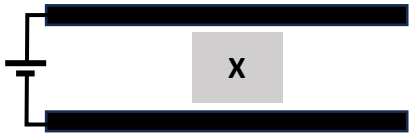
SECTION A: Multiple Choice Questions

Instructions for section A

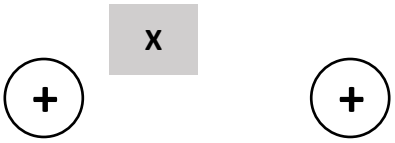
Answer all questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is correct or that best answers the question.
A correct answer scores 1; an incorrect answer scores 0.
Marks will not be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams in this book are not drawn to scale.
Take the value of g to be 9.81 m s^{-2}.

Question 1

In which of the following diagrams does region **X** represents a region in which there is a non-uniform electric field?

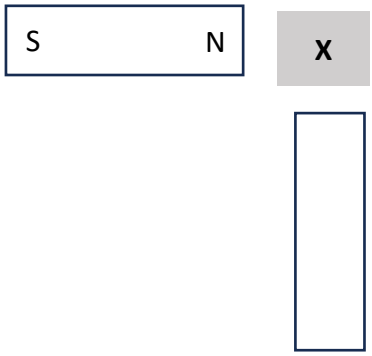


a)



b)

c)



d)

Question 2

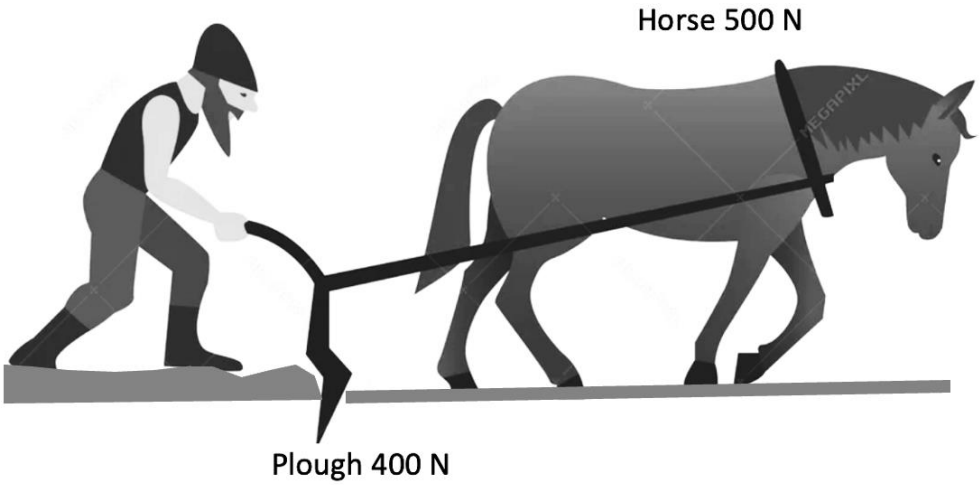


Figure 1

Figure 1 shows a horse pulling a plough. If the farmer is to maintain a constant speed under these conditions then he must apply a force of:

A) 100 N to the right

B) 0 N

C) 500 N to the left

D) 100 N to the left

Question 3

A satellite located in a stable orbit of 3630 km above the Earth's surface has a period closest to:

A) 7.65 hours

B) 5.45 hours

C) 2.75 hours

D) 1.25 hours

Question 4

A cyclist and her bike of combined mass 65 kg travelling on a flat road, approaches a 25 m radius turn. She knows the combined maximum frictional force her tyres can generate is 260 N. The fastest constant speed she can safely make the turn without changing the radius is:

A) 10 km h^{-1}

B) 16 km h^{-1}

C) 24 km h^{-1}

D) 36 km h^{-1}

The following information applies to Questions 5 and 6

A 250 kg dodgem car travelling at 4 m s^{-1} to the right collides head on with a 200 kg stationary dodgem car. After the collision the 250 kg car continues to the right at 1 m s^{-1}.

Question 5

The final velocity of the 200 kg dodgem car equals:

A) 3.75 m s^{-1} to the right

B) 3.75 m s^{-1} to the left

C) 1.25 m s^{-1} to the right

D) 1.25 m s^{-1} to the left

Question 6

In order to answer ***Question 5*** above which assumption below was made about the collision?

A) Momentum and kinetic energy are both conserved

B) Momentum is conserved but kinetic energy is not

C) Kinetic energy is conserved but momentum is not

D) Neither momentum or kinetic energy are conserved

Question 7

In a game of volleyball, when air resistance is taken into account, the theoretical parabolic path of the volley ball changes so that:

A) The maximum height is reduced but the horizontal distance is unchanged

B) The maximum height is reduced but the time of flight is unchanged

C) The maximum height is the same but the horizontal distance is unchanged

D) The maximum height and the horizontal distance are both reduced

Question 8

Select the correct option concerning field properties.

	Monopole only	Dipole only	Monopole or dipole
A)	Electric	Gravitational	Magnetic
B)	Gravitational	Electric	Magnetic
C)	Magnetic	Gravitational	Electric
D)	Gravitational	Magnetic	Electric

Question 9

The ratio of the gravitational field strength at an attude of 1 Earth radii above the Earth's surface compared to 3 Earth radii above the Earth's surface is closest to?

A) 4

B) 3

C) 2

D) 1

Question 10

Figure 2 below shows a conductor that is free to move inside a uniform magnetic field.

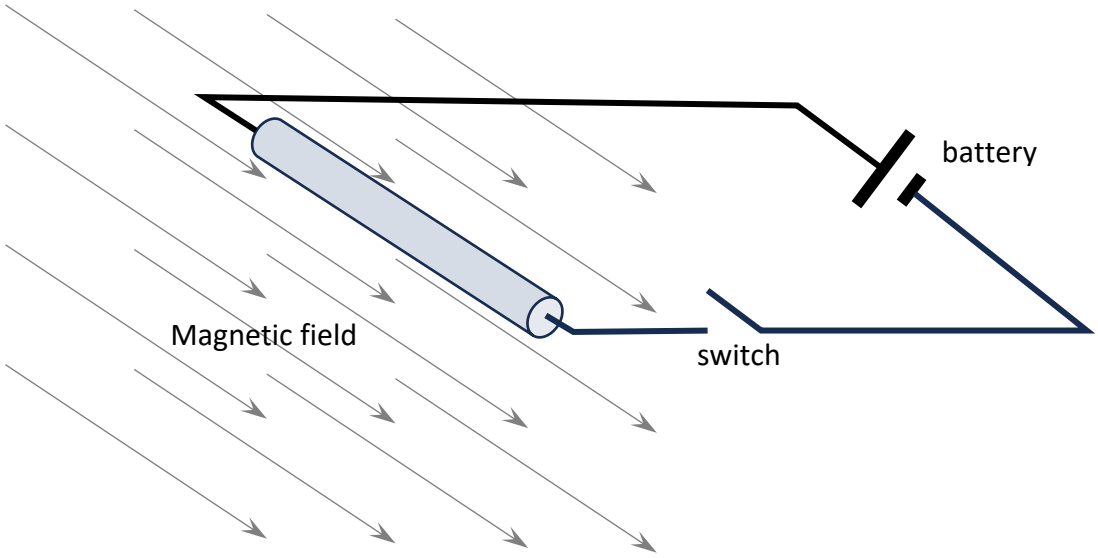


Figure 2

When the switch is closed the conductor will:

A) Move up

B) Move down

C) Move left

D) Not move

Question 11

A stone is dropped vertically from a height of 6.0 m. Its final velocity is close to what percentage of the final velocity of the same stone dropped from 12.0 m?

A) 50 %

B) 70 %

C) 75 %

D) 80 %

Question 12

An ideal transformer has 30 turns on its primary and 120 turns on its secondary. The input power supplied is 60 W at 240 V RMS. The secondary current in the transformer will be:

A) 1 A peak

B) 1.4 A peak

C) 2.4 A peak

D) 88 mA peak

Question 13

A household solar power array using photovoltaic cells requires the use of an inverter to:

A) Boost the electrical voltage up to 240 V_{RMS}

B) Convert the peak AC current to RMS

C) Convert the DC current to AC

D) Convert the negative voltage half cycles to positive half cycles

Question 14

A teacher sets up a standing wave on a vibrating string as shown in Figure 3.

Figure 3

If the end points of the standing wave shown are 3.60 m apart then the wavelength equals:

A) 3.60 m

B) 1.80 m

C) 0.90 m

D) 0.45 m

Question 15

A green laser is shone toward a pair of narrow slits. A screen behind the slits shows a clear interference pattern. When the green laser is changed to a red laser of the same intensity the interference pattern will:

A) change colour but not the pattern's spread

B) have a smaller gap between the bright regions

C) have a larger gap between the bright regions

D) have a smaller gap between bright regions but a larger gap between dark regions

Question 16

When Young directed monochromatic light through a pair of double slits, the experiment provided evidence that light behaved as a:

A) wave because it showed diffraction and diffraction is a wave property

B) wave because it showed interference and diffraction which are both wave properties

C) particle because it showed interference and diffraction which are both particle properties

D) wave because it showed interference and interference is a wave property

Question 17

A photon is absorbed as t transfers a of its energy to an electron that transitions from the – 10.4 eV energy level to the – 5.60 eV energy level. The photon's wavelength was?

A) 259 nm

B) 0.026 nm

C) 4.14×10^{-26} m

D) 239 nm

Question 18

Monochromatic light of frequency 9.66×10^{14} Hz is incident upon a metal surface which releases electrons with a maximum kinetic energy of 4.0×10^{-19} J.
The work function of the metal is:

A) 1.5 eV

B) 2.0 eV

C) 5000 eV

D) 0.24 MeV

Question 19

The Michelson-Morely experiment produced a null result which was used as evidence to support:

A) The speed of light was 3.00×10^{8} m s^{-1}

B) The existence of the (luminiferous) aether

C) Einstein's theory of special relativity

D) That length contraction occurs in only the direction of motion

Question 20

A very fast moving electron possesses 1.065×10^{-13} J of kinetic energy?
The electron's Lorentz Factor is:

A) 1.3

B) 2.3

C) 3.6

D) 4.8

END SECTION A

SECTION B: Short Answer Questions

Instructions for section B

Answer all questions in the spaces provided.
Marks will not be deducted for incorrect answers.
No marks will be awarded if more than one answer is provided for any question.
Unless otherwise indicated, the diagrams in this book are not drawn to scale.
Take the value of g to be 9.81 m s^{-2}.

Question 1 (7 marks)

A 2000 kg car is towing a 1200 kg boat at a constant speed of 108 km h^{-1} along a horizontal road (Figure 4). The resistive forces of the car and the boat can be assumed to be constant at 200 N and 300 N respectively.

Figure 4

a) Determine the magnitude of the driving force the car is producing.

2 marks

N

b) What is the tension in the towbar?

2 marks

N

The car arrives at a hill at angle of 10.0^{o} to the horizontal (Figure 5).

Figure 5

c) If the driver is to maintain the same speed (108 km h^{-1}) what driving force must the engine now produce?

3 marks

N

Question 2 (10 marks)

In the Olympic sport of Discus competitors spin in a circle before releasing a 2.0 kg discus. The aim is to throw the discus as far as possible.

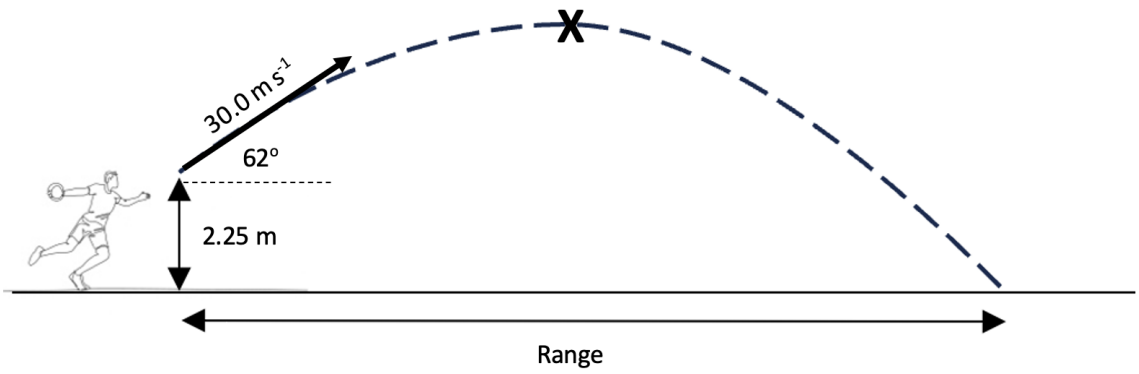


Figure 6

Figure 6 (not to scale) shows the path the discus will take in flight .

NOTE: Ignore the effect of air resistance for this question.

a) Just before the release the discus travels in a horizontal circle at 30 m s^{-1} due to a tension force of 1500 N in the throwers arm. Find the radius of the circle the discus travels?

2 marks

m

b) Point **X** on Figure 6 is at the maximum height the discus reaches during its flight. Determine the magnitude and direction of net force acting on the discus at point **X.**

2 marks

N

Direction:

c) If the flight time of the discus is 5.50 seconds, find the distance (range) the discus travels horizontally?

2 marks

m

d) Show using energy calculations that the speed of the discus when it hits the ground is close to 31 m s^{-1}.

4 marks

Question 3 (5 marks)

A 2.0 kg block travelling at 3.0 m s^{-1} to the right collides head on with a 3.0 kg block travelling at 2.0 m s^{-1} to the left. The 3.0 kg block is stationary after the collision.

a) What is the speed of the 2.0 kg block after the collision?

2 marks

m s^{-1}

b) The same situation is repeated but the blocks **do** stick together after the collision. Use Physics principles to explain and justify what changes you would expect in the 2.0 kg block's final velocity compared to part **a)**.

3 marks

Question 4 (7 marks)

A 50 g yo-yo is being swung in a vertical circle.
The radius of the circle is 20 cm.

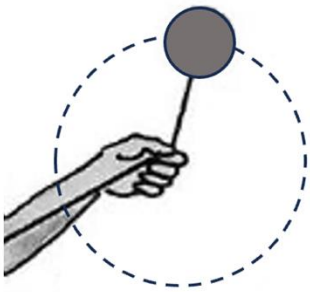


Figure 7

a) What is the minimum speed that the yo-yo can travel at the top of the loop and keep the string taut?

2 marks

m s^{-1}

b) The system can be considered to be isolated. f the yo-yo's speed at the top of the loop is 2.5 m s^{-1}:

(i) Show the yo-yo's speed at the lowest point of the loop is 3.75 m s^{-1}

3 marks

(ii) Find the maximum tension the string will experience during one complete vertical revolution.

2 marks

N

Question 5 (8 marks)

In the early part of this century the Cassini Space Probe spent over 10 years orbiting Saturn and investigating its moons. The initial orbital period about Saturn of the 2,125 kg Cassini Space Probe was 120 days. The mass of Saturn is 95 times the mass of Earth.

a) Show that the average orbital radius of the Cassini Space Probe during this initial orbit period was close to 4.7 million kilometres.

4 marks

Prior to crashing into Saturn, the Cassini Space Probe at one stage descended from a distance 1.50×10^9 km to only 1.25×10^9 km from the centre of Saturn.
(Shown in Figure 8).

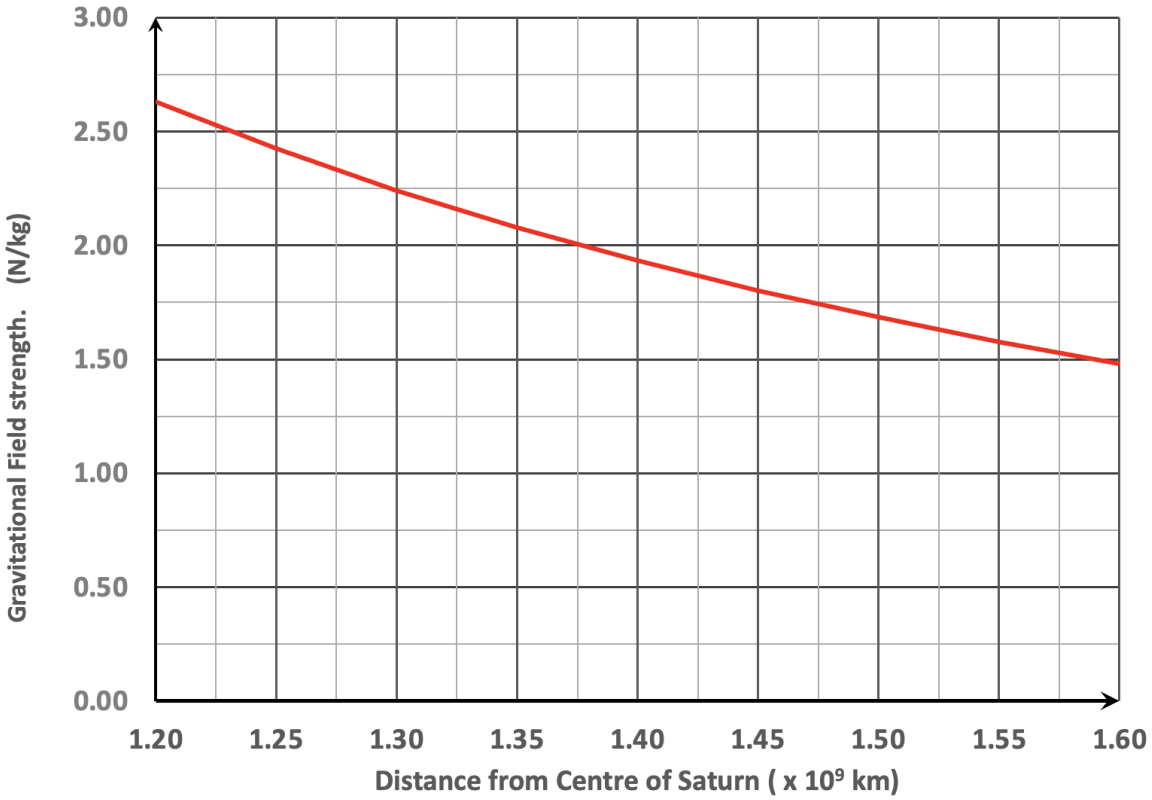


Figure 8

b) How much kinetic energy did Cassini gain during this descent?

4 marks

J

Question 6 (15 marks)

Three physics students Ari, Billi, and Ciri conducted an experiment to investigate friction. Their set-up is shown in Figure 9 below. They used a frictionless track with a uniform spring ($k = 100$ N m^{-1}) at one end to launch a 250 g cart across different surfaces and recorded the distance **CD** the cart travelled before coming to rest.

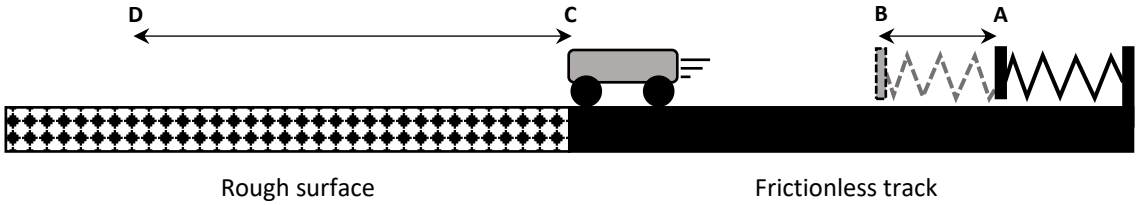


Figure 9

The spring is compressed by the cart from its natural length at position **B** to position **A** and then released. At position **C** a photogate is placed to record the cart's velocity just as it reaches the rough surface.

The distance **BA** the spring was compressed was 20 cm.

The recorded data for 3 trials is shown in the table below.

Trial Number	Velocity at **C** (m s^{-1})	Rough surface material	Stopping distance, **CD** (m)
1	3.94	carpet	1.25
2	3.96		1.20
3	3.96		1.29
4	3.94	Fake grass	2.03
5	3.95		2.10
6	3.97		2.02

a) Show that the expected speed of the cart at position **C** is 4.0 m s^{-1}.

3 marks

b) Give two reasons why the recorded speed through the photogate at position **C** is always less than the expected 4.0 m s^{-1} ?

2 marks

_____

_____

_____

_____

c) What is the average frictional force of the Fake grass on the cart?

4 marks

N

d) Identify the following variables in this experiment:

3 marks

Independent	
Dependent	
Controlled	

e) The three students make the following statements:

Billi: "All the data recorded is both accurate and precise. "
Ari: "Only the velocity data at **C** is accurate."
Ciri: "All the data is precise."

dentfy whch of these statements you agree with. Justify your response.

3 marks

Question 7 (4 marks)

An electron is travelling at 2.6×10^6 m s^{-1} towards the centre of a square 7.0 mm $\times$ 7.0 mm uniform magnetic field (B = 4.0×10^{-3} T) as shown in Figure 10.
Relativistic effects can be ignored in this question.

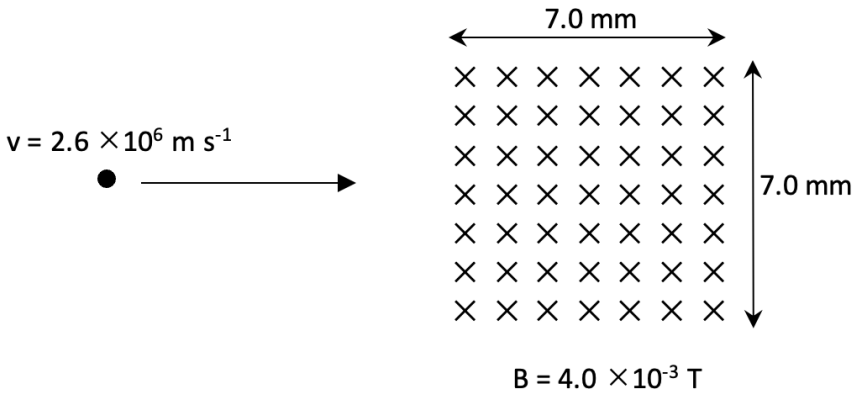


Figure 10

a) Determine the radius of the electron's path through the magnetic field.

2 marks

mm

b) Draw the path of the electron through the magnetic field.

2 marks

Question 8 (8 marks)

A simple DC motor consists of 50 turns in a single rectangular 4.0 cm $\times$ 3.0 cm loop inside a uniform 6.0 $\times$ 10^{-4} T magnetic field created by a magnet on the lefthand side and a solenoid on the righthand side (Figure 11).

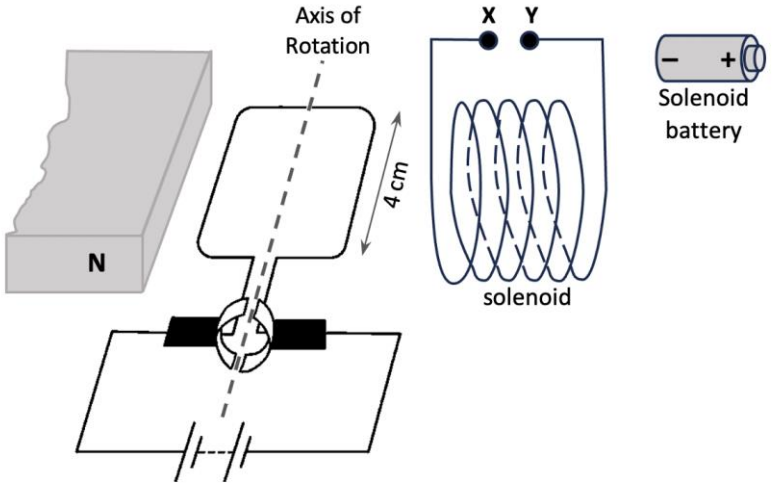


Figure 11

The solenoid is to act as the south pole of a magnet for the motor.

a) To produce the required magnet field for this motor, draw in connections between the terminals **X** and **Y** and the solenoid battery.

1 mark

b) Identify the direction the coil will turn (clockwise or anticlockwise as viewed from the split ring commutator) when the solenoid battery is correctly connected. Justify your answer.

3 marks

clockwise **anticlockwise**

c) If the maximum force on one side of the loop is 3.0×10^{-6} N what current must be flowing through the motor's battery?

2 marks

A

d) When the motor has rotated 90^{o} from the position shown, calculate the magnitude of the torque being produced.

2 marks

N m

Question 9 (10 marks)

A generator (Figure 12) is being rotated at a frequency of 5 Hz in the direction shown.
The uniform magnetic field in the region of the coil is 4.0×10^{-6} T.
The 4.0 cm $\times$ 4.0 cm coil consists of 20 turns.

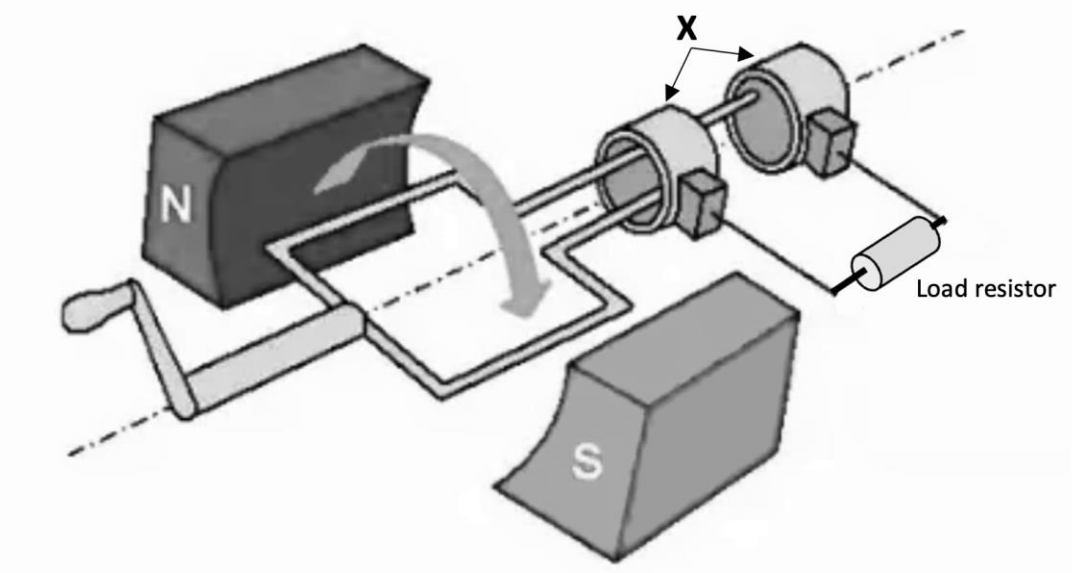


Figure 12

a) Name component X and explain its function in the operation of the generator.

4 marks

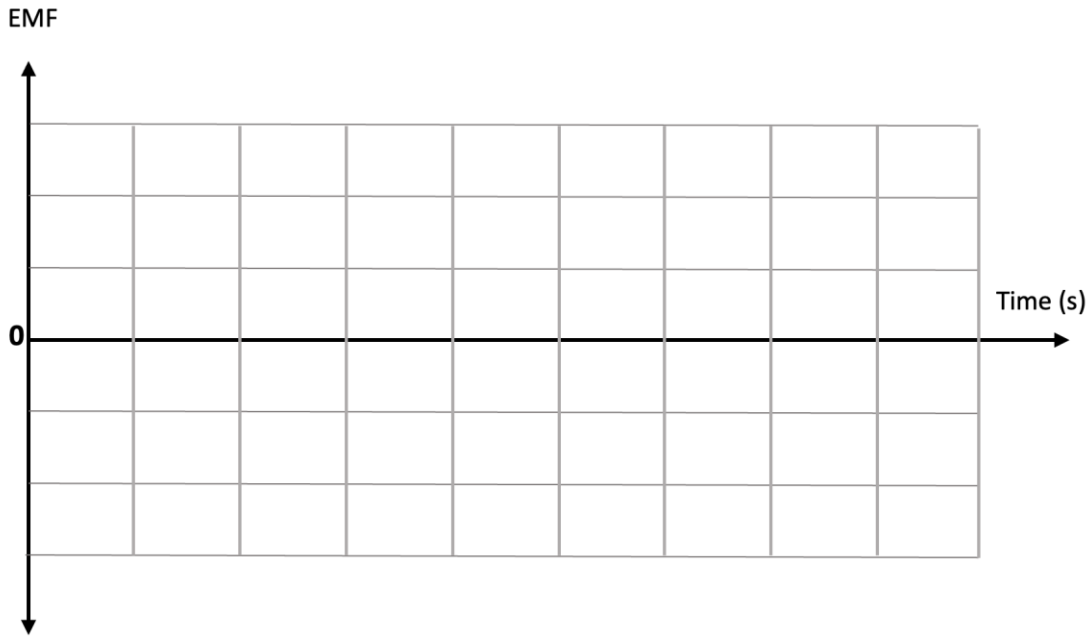
b) Calculate the average EMF generated in volts.

3 marks

V

c) From the position shown in Figure 12 draw the voltage output across the load resistor for two complete revolutions on the axes below.
Include a scale on the **horizontal axis only**.

3 marks



Question 10 (6 marks)

Aaron and Beetha are two physics students studying the nature of light. They use a 540 nm laser as a monochromatic light source and direct the beam of light at two large pinholes in a cardboard slide situated 1.5 m in front of a screen in an attempt to recreate Young's Double Slit experiment (Figure 13a). They then replace the two pinhole card with a new card that has very narrow slits only 1.75×10^{-7} m wide (Figure 13b, not to scale) and see a series of bright and dark bands.

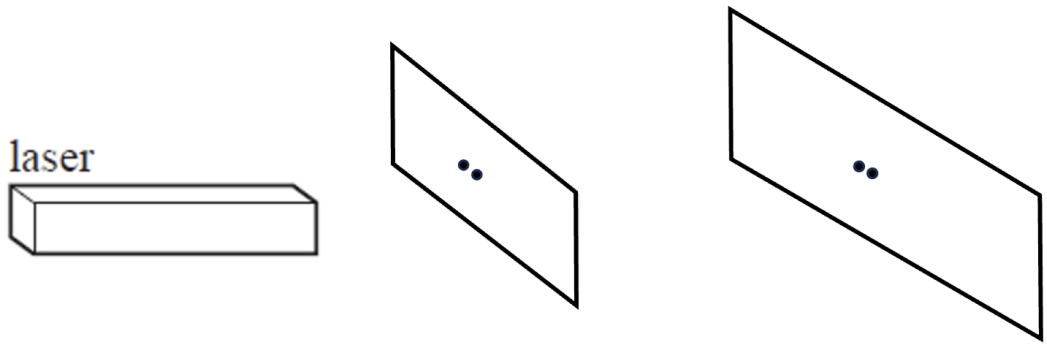


Figure 13a

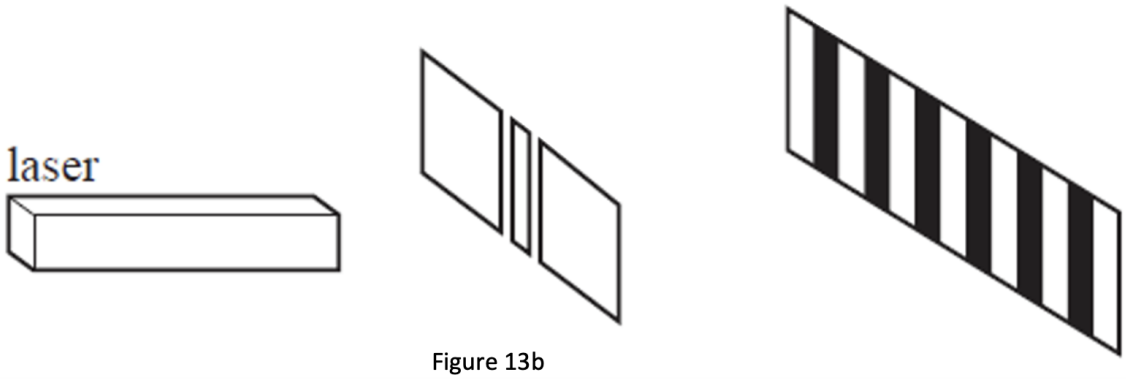


Figure 13b

a) Explain why only two bright spots are seen on the screen when the pinhole card is used but many bright and dark bands are visible when the two slit card is used.

3 marks

b) Calculate the distance on the screen from the central maxima to the 3rd dark fringe that the students would measure on ***Figure 13b*** under the conditions provided given the slit separation is 15.0×10^{-3} mm.

3 marks

mm

Question 11 (4 marks)

Provide **two** observations from the photoelectric effect and explain how each contradicts the wave theory of light.

4 marks

1.

2.

Question 12 (2 marks)

An electron transitioning between energy levels releases a photon with a wavelength of 121 nm. Use an arrow to show the electron's transistion on Figure 14 below.

2 marks

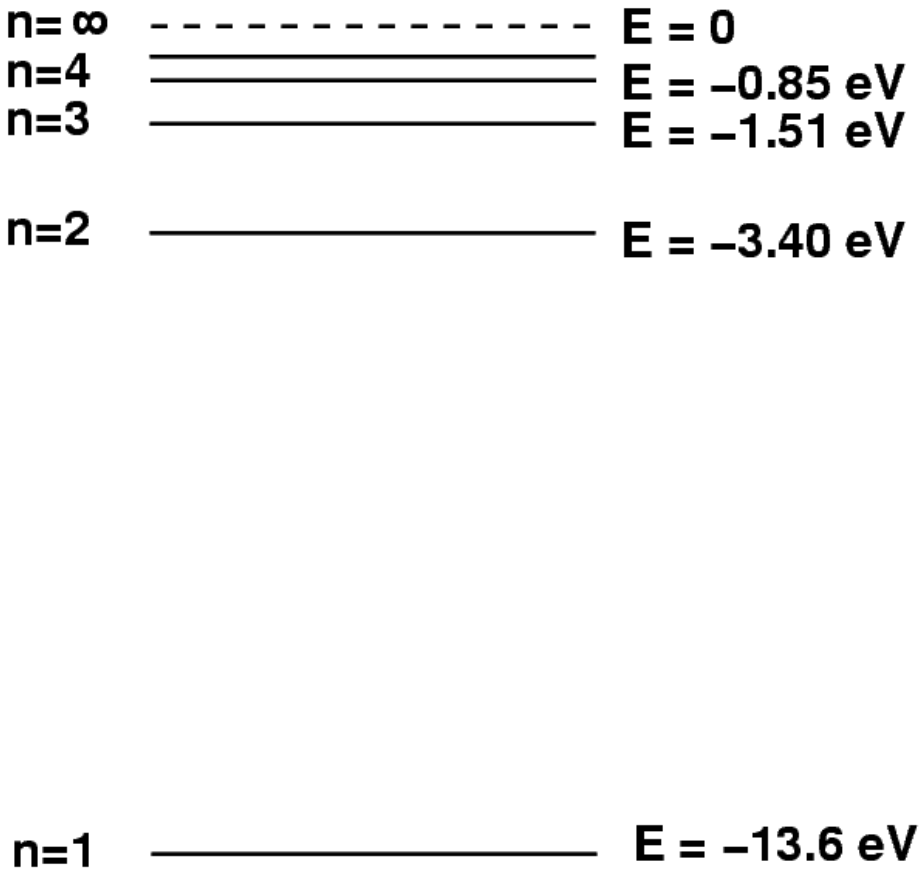


Figure 14

Question 13 (4 marks)

A 15 keV electron beam when directed at a crystalline structure produces the same diffraction pattern as when a beam of monochromatic X-rays is used.

Determine the wavelength of the X-rays used.

4 marks

nm

Question 14 (3 marks)

The absorption and emission spectra of Hydrogen are shown below in Figure 15.

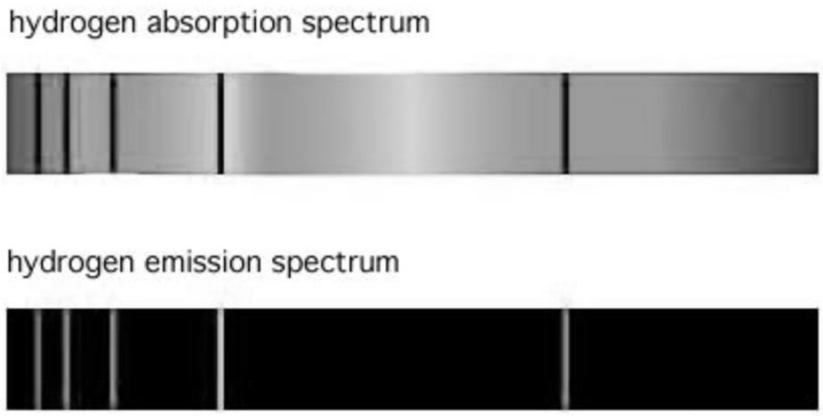


Figure 15

Explain how spectra like that shown in Figure 15 support the dual nature of matter.

3 marks

Question 15 (7 marks)

Imagine a 300 m long spaceship was able to travel at 0.80c. Proxima Centuri is a relatively close star to Earth located 4.25 light years from our Sun.

Assume that the spaceship can travel at 0.80c for the entire distance.

a) Show the Lorentz factor at this speed is close to 1.7

2 marks

b) How long would the journey take according to observers who remain on Earth?

2 marks

years

Observers on Jupiter watch the spaceship pass.

c) What length would they measure for the spacehip?

2 marks

m

d) Would proper time be recorded on the spaceship or on Earth for this journey?

1 mark

END OF TRIAL EXAMINATION