LMC Lachlan Macquarie College

2020 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used

Total marks:
100

Section I – 20 marks (pages x–xx)

- Attempt Questions 1–20
- Allow about 35 minutes for this section

Section II – 80 marks (pages xx–xx)

- Attempt Questions 21–xx
- Allow about 2 hours and 25 minutes for this section

Section I

20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

1 A conductor of length 12.0 cm carries a current of 40 mA in a magnetic field of strength 0.50 T and makes an angle of 45^0 with the field. The force experienced on the conductor is:

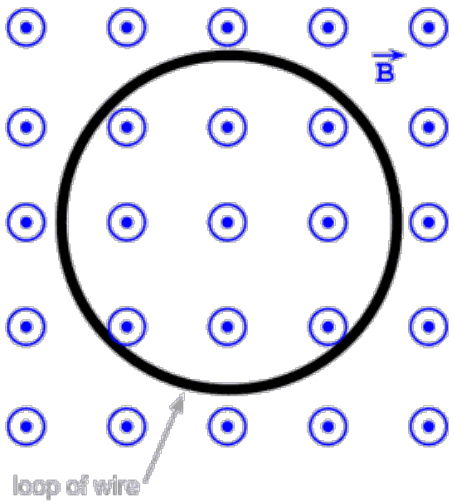
A) 1.7 N
B) 2.4 N
C) 1.7×10^{-3} N
D) 2.4×10^{-3} N

2 A projectile is fired from ground level at an angle of elevation of 50 degrees. It lands 200 metres away after 2.4 seconds.

What was the initial velocity of the projectile?

A) 83 ms^{-1}
B) 99 ms^{-1}
C) 109 ms^{-1}
D) 130 ms^{-1}

3 Calculate the magnetic flux of the situation in the diagram below if the radius of the circle is 8 cm:



B = 2 T

A) 0.02 Wb
B) 0.04 Wb
C) 0.5 Wb
D) 200 Wb

4 Hubble's astronomical observations provided evidence which supported the Big Bang Theory. What did Hubble observe?

A) Galactic Red Shift
B) Galactic Blue Shift
C) Abundance of light elements
D) Microwave Background Radiation

5 Tomas is looking through the window of his hotel at the ocean. The hotel window is polarised and he is wearing a pair of sunglasses that are also polarised but at an axis 45° from that of the window. Given the light entering the window has an intensity of I_o, what is the intensity of the light as seen by Tomas?

A) 0.25 I_o
B) 0.45 I_o
C) 0.50 I_o
D) 0.75 I_o

6 A car is travelling at constant speed on a circular track.

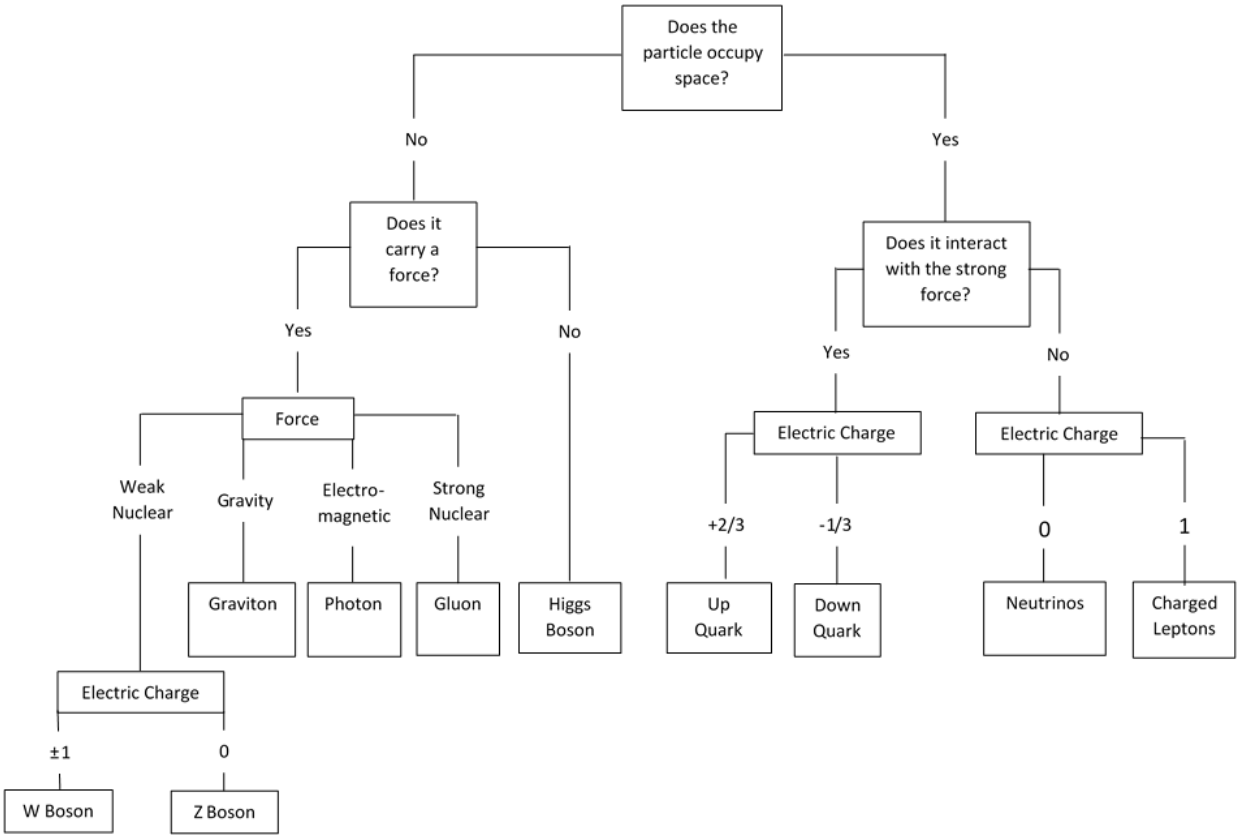
Which of the following correctly describes the acceleration of the car?

	Magnitude	**Direction**
A)	is constant	is constant
B)	is constant	changes
C)	changes	is constant
D)	changes	changes

7 Scientists send an expedition to a comet that is travelling at 90% of the speed of light. According to the scientists on Earth, the expedition members are experiencing:

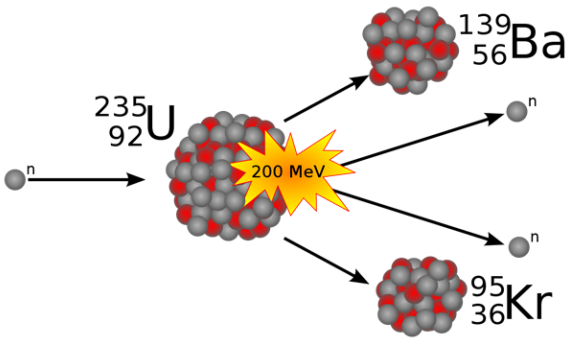
	Time	Mass	Size
A)	Moving slower	Decreasing	Decreasing
B)	Moving faster	Increasing	Increasing
C)	Moving slower	Increasing	Increasing
D)	Moving faster	Decreasing	Decreasing

8 Use the flowchart below to identify a particle which doesn't take up space, carries the weak nuclear force and has no electric charge.



A) Photon
B) Z Boson
C) Graviton
D) W Boson

9 Identify the type of nuclear reaction shown in the diagram below.

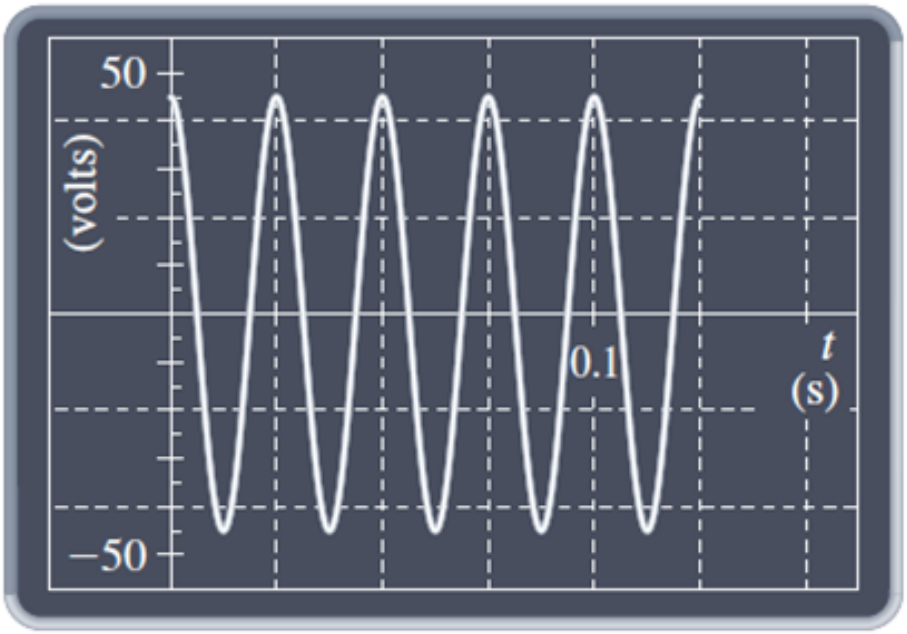


A) Beta Decay
B) Alpha Decay
C) Fusion Reaction
D) Fission Reaction

10 How much work is done on an electron being accelerated between two charged plates with a voltage drop of 20 V?

A) 8.0×10^{-19} J
B) 3.2×10^{-18} J
C) 6.4×10^{-18} J
D) 8.0×10^{-17} J

11 The image below shows an oscilloscope reading of an electric generator. The frequency is:



A) 4 Hz
B) 8 Hz
C) 20 Hz
D) 40 Hz

12 JJ Thomson's charge-to-mass ratio experiment required both Magnetic and Electric Deflecting Coils to solve the equation,

$$\frac{q}{m} = \frac{v}{Br}$$

Use the table below to match the type of field with the equation it satisfies in order to find the charge-to-mass ratio.

	Electric Field	Magnetic Field
A)	$F_E = qE$	$F_B = qvB$
B)	$E = \frac{V}{d}$	$F_c = \frac{mv^2}{r}$
C)	$E = \frac{V}{d}$	$F_B = qvB$
D)	$F_E = qE$	$F_c = \frac{mv^2}{r}$

13 Two satellites (Gemini and Aries) are in circular orbits around the Earth.

Aries is R metres from the centre of the Earth and has an orbital velocity of V.

Gemini is 2R metres from the centre of the Earth. What is Gemini's orbital velocity?

A) V/2
B) 2 x V
C) V/1.4
D) 1.4 x V

14 A scientist while calibrating a spectrometer attached to a telescope records the

observed Hydrogen α line in the Balmer series with a wavelength of 656.28 nm. Later a star is observed and its spectrum analysed and the Hydrogen α line in this spectra is recorded as 680 nm. Which of the following is true?

A) The star is blue-shifted and moving towards us
B) The star is red-shifted and is moving towards us
C) The star is red-shifted and is moving away from us
D) The star is blue-shifted and is moving away from us

15 Ultraviolet light with a wavelength of $2x10^{16}$ Hz falls on a material which then emits photons with an energy of 3.98eV. What was the material? Assume Planck's constant is 4.14×10^{-15} eV.

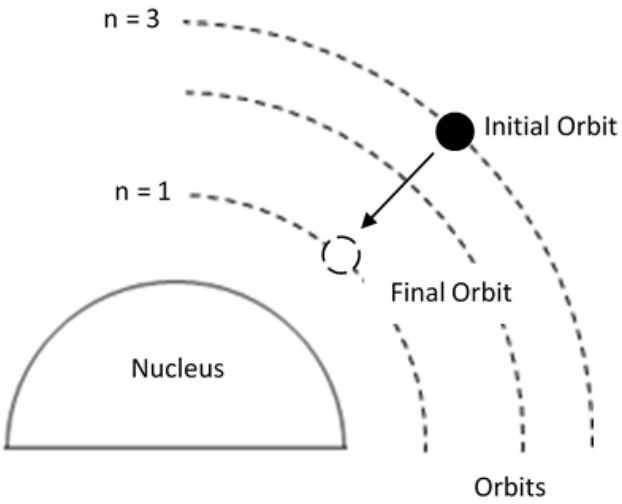
A) Zn with a work function 4.3
B) Cu with a work function 4.7
C) Ni with a work function 5.01
D) Se with a work function 3.11

16 Two satellites are in circular orbits around the Earth, at the same altitude. Pisces weighs M kg. Libra weighs 2M Kg. They are joined to each other by a cable.

If the cable is disconnected, how will that affect the satellites?

	Altitude	**Kinetic Energy**
A)	No change	No change
B)	No change	Increases for Libra, decreases for Pisces
C)	Decreases for Libra, increases for Pisces	No change
D)	Increases for Libra, decreases for Pisces	Increases for Libra, decreases for Pisces

17 An electron, in a Hydrogen atom, undergoes the following change in orbit.



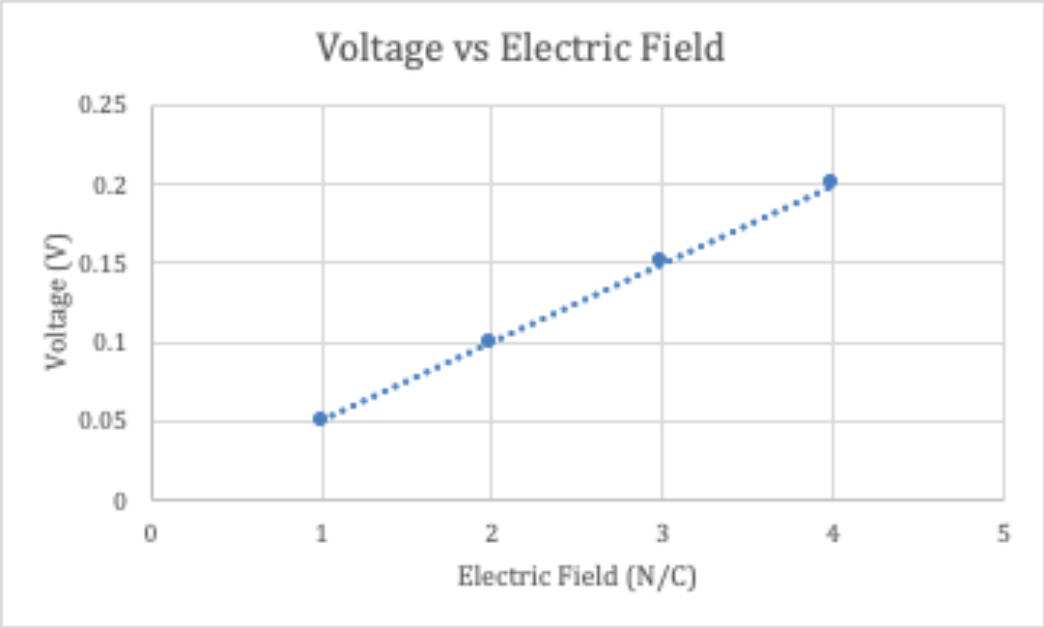
Calculate the wavelength of the photon released by this change.

A) - 975 Gm^{-1}
B) -103 nm
C) 103 nm
D) 975 Gm^{-1}

18 Calculate the speed of a photon with a frequency of $5x10^{14}$ Hz and a wavelength of 600nm.

A) 2.8×10^8 m s^{-1}
B) 2.9×10^8 m s^{-1}
C) 3.0×10^8 m s^{-1}
D) 2.72×10^9 m s^{-1}

19 Use the graph provided to determine the distance between two charged plates in a uniform electric field.

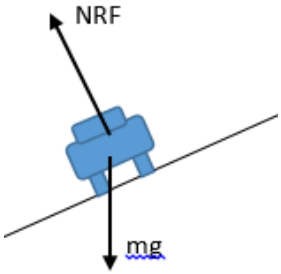


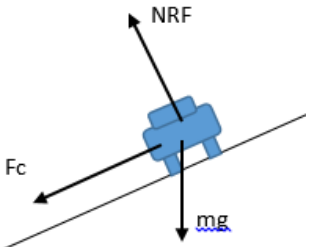
A) 0.25 m
B) 0.50 m
C) 2.50 cm
D) 5.00 cm

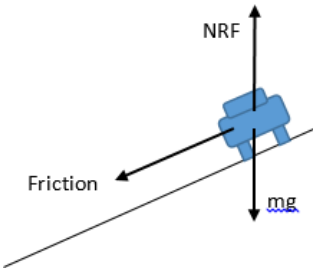
20 A car is travelling along a banked circular track.

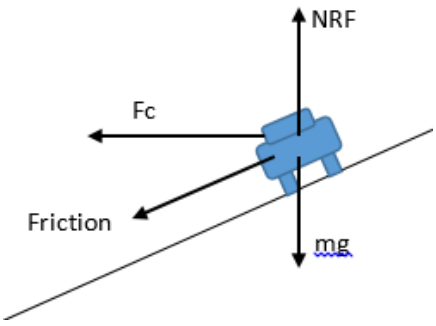
The height of the car above the ground stays constant.

Which of the following correctly shows forces acting on the car?

A)


B)


C)


D)


2020 TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Centre Number

Physics

Section II Answer Booklet

Student Number

80 marks
Attempt Questions 21–xx
Allow about 2 hours and 25 minutes for this section

Instructions	• Write your Centre Number and Student Number at the top of this page • Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response. • Show all relevant working in questions involving calculations.

Please turn over

Question 21 (4 marks)

A ray of white light hits a glass with an incidence of 60 degrees to the normal. Upon refraction the light splits into colours which include a red and blue ray. If the blue ray is travelling with a speed of 1.9×10^8 ms^{-1} and the red is travelling at 1.95×10^8 ms^{-1} calculate the angular separation between the red and blue ray.

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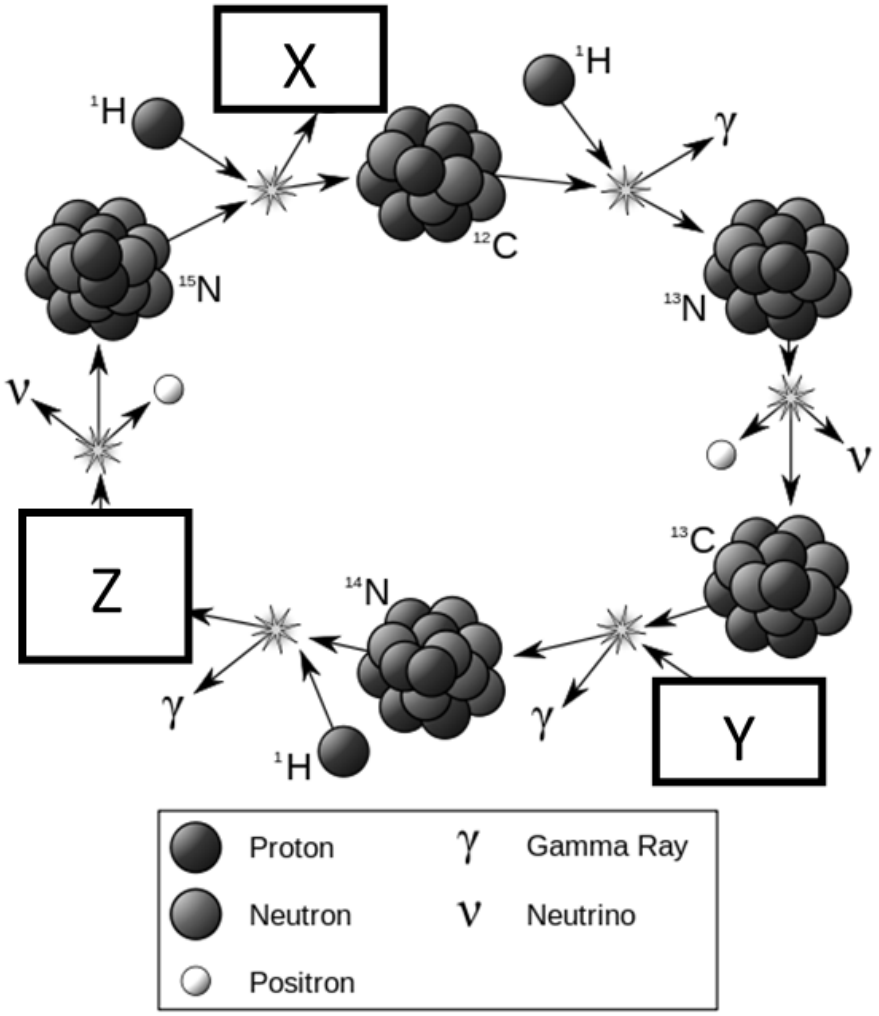
Question 22 (6 marks)

Below is a diagram of the CNO (Carbon-Nitrogen-Oxygen) cycle.



(a) Write the full name OR annotated symbol of the missing isotopes from each box: 3

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(b) Given the values below, calculate the energy of the gamma ray "γ" emitted by the fusion of a Carbon-12 with a Hydrogen-1 to produce a Nitrogen-13 atom. 3

Particle	Mass (amu)
Carbon-12	12.010
Hydrogen-1	1.008
Nitrogen-13	13.006

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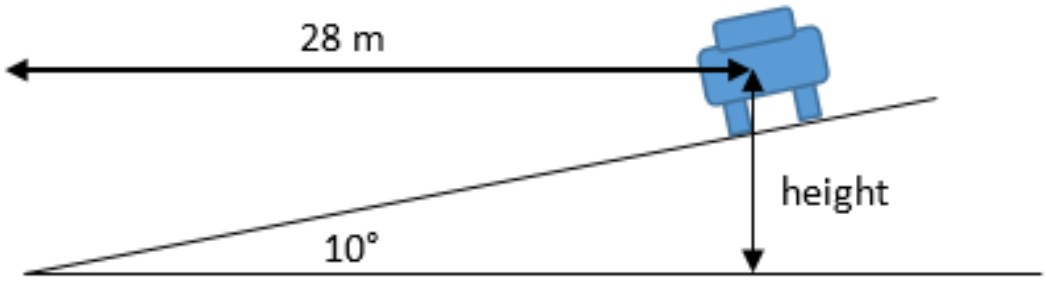
Question 23 (4 marks)

Consider a banked circular track angled at 10°.
A car weighing 1,800 Kg is moving around the track at 20 m/s at a radius of 28 metres.
There are two frictional forces to consider:



- The friction between the tyres and the track that acts as the driving force (in the direction of motion).
- The friction between the tyres and the track that prevents the car moving up or down the track (perpendicular to the direction of motion). The coefficient of friction for this is 1.4.

Is it possible for the car to maintain its current height on the track at that speed? 4
Justify your answer using appropriate calculations.

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Question 24 (2 marks)

An astronomer recorded Hydrogen spectral data from a star. She noticed the spectral lines she recorded for this star were shifted downwards by 30 angstroms and were broader than expected. Explain what caused these 2 observations.

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Question 25 (9 marks)

Energy transformations occur when a DC motor is working. Analyse the components and operation of the DC motor. Explain the physics involved during the starting and running of the motor. 9

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Question 26 (3 marks)

Explain why a geostationary satellite must be above the earth's equator, travelling from west to east, at an altitude of approximately 36,000 km. 3

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Question 27 (2 marks)

Identify 2 key concepts from Maxwell's electromagnetic theory of light.

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Question 28 (3 marks)

(a) In a replication of Young's double slit experiment interference fringes are formed on a screen. Explain the effect on the spacing between interference fringes if the separation between the slits was increased. 2

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(b) State one important change that would occur to the pattern on the screen if one of the slits was covered. 1

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Question 29 (7 marks)

Light from a laser is shone onto a diffraction grating with 30 micrometer spacings. An interference pattern appears on a wall 10m away from the diffraction grating, with 17.45cm spacings between the antinodes. Calculate the power of the laser and identify its colour based on the table below:

Colour	Wavelength (nm)
Red	635 - 700
Yellow	560 - 590
Green	520 - 559
Blue	450 - 490

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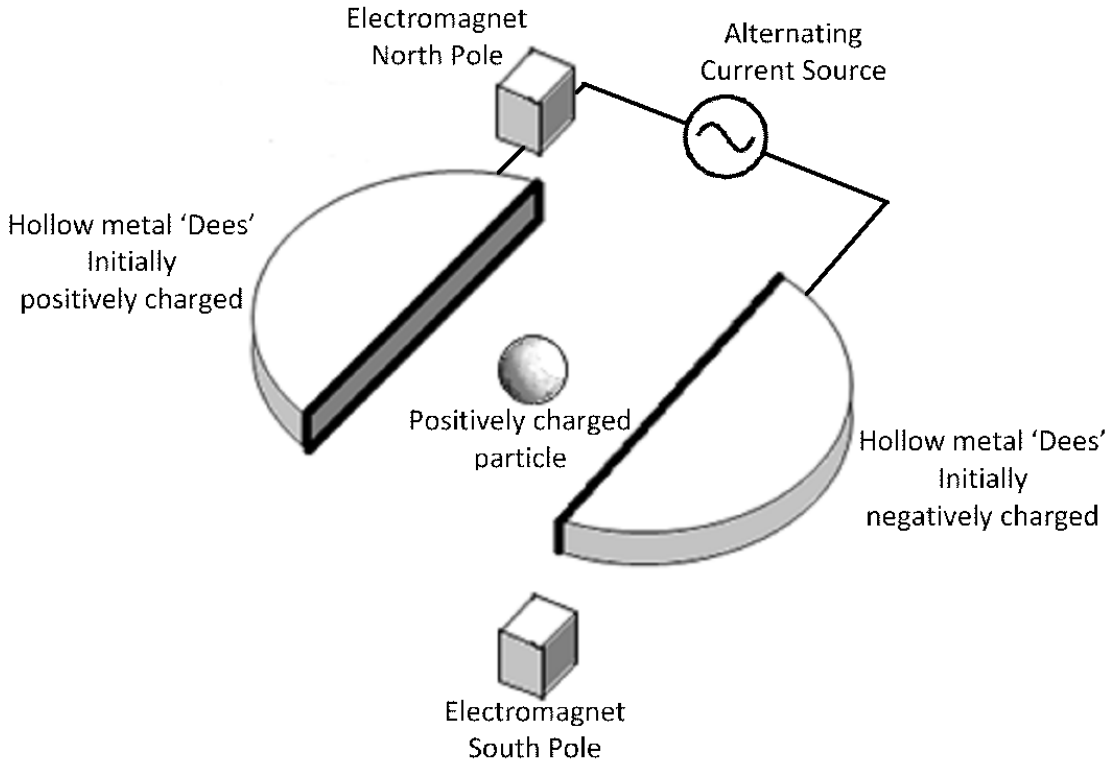
Question 30 (8 marks)

Below is a diagram of a cyclotron particle accelerator. A positively charged particle is placed in the centre of the cyclotron with some small initial velocity. The particle is moving so that it is in the same horizontal plain as the electric field from the dees and is perpendicular to the magnetic field from the electromagnets.



(a) Identify the forces each labelled component would exert on the particle at the moment illustrated in the diagram. 3

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(b) Outline the net motion the particle would undergo if the strength of the magnetic field was gradually increased and the current were allowed to alternate. 3

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Question 31 (4 marks)

Design an experiment to find the angle of elevation that gives a projectile maximum horizontal range. In your response, refer to dependent, independent and controlled variables and how you can ensure reliability and validity. 4

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Question 32 (2 marks)

Briefly describe an experimental observation which can be used as evidence to support Huygens' principle of wave propagation in diffraction.

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Question 33 (3 marks)

Upon completing his experiment to measure the charge to measure the charge-to-mass ratio of cathode ray particles, J. J. Thomson concluded that they were a part of all atoms. 3

Outline the experimental steps and observations Thomson made to arrive at this conclusion and assess the validity of his conclusion based on this evidence.

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Question 34 (3 marks)

The formula for escape velocity is 3

$$v_{esc} = \sqrt{\frac{2GM}{r}}$$

Explain how this formula is derived.

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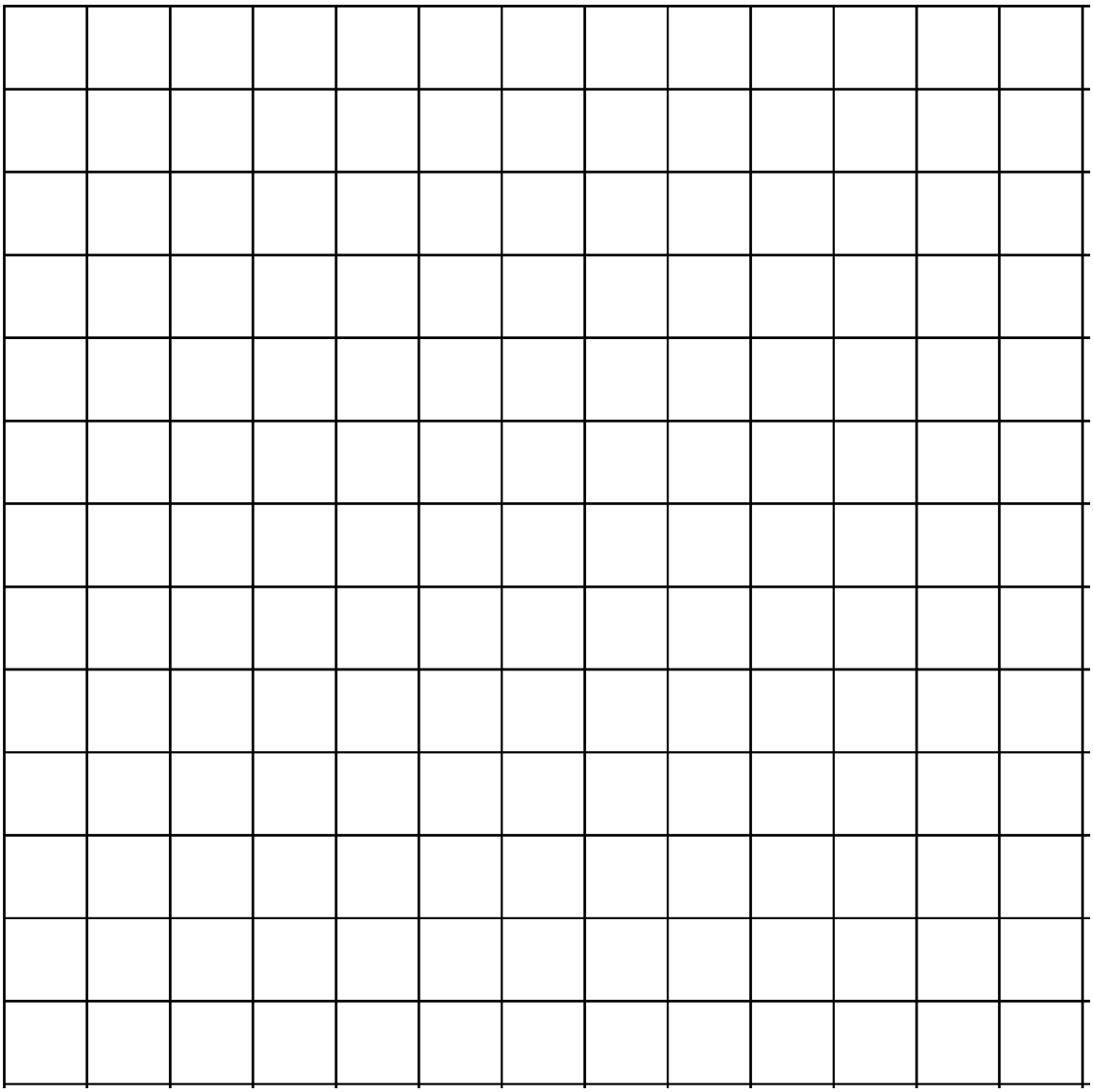
Question 35 (6 marks)

The motion of a projectile was tracked. The results were recorded in the following table.

Time (s)	Horizontal displacement (m)	Height above ground (m)
0	0	35
1	15	51
2	30	58
3	45	55
4	60	42
5	75	19

(a) Use the data to produce a graph of height vs horizontal displacement. 3



(b) Use your graph to estimate the horizontal displacement when the projectile's velocity was a minimum. 1

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(b) Explain why the shape of the graph is a parabola. 2

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Question 36 (6 marks)

(a) A student wishes to charge their iPhone and plugs the charging cord into the wall power point which delivers an input voltage of 240 V. The transformer within the charger converts this to an output voltage of 6 V. The iPhone charges with an output current of 1 A. Determine the input current. 2

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(b) Use a diagram in the space provided below to model the transformer from part (a) above. 2

(c) Explain how transformers are designed to maximise efficiency and minimise energy losses. 2

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Question 37 (3 marks)

Analyse Schrodinger's contributions to the development of the current model of the atom. 3

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Question 38 (7 marks)

Draw the eddy currents formed in each situation on the diagrams below.

(a) i) A metal sheet moving through a magnetic field. 2

ii) Magnetic field applied to a spinning disk. 2

(b) Outline the physics principles involved in one application of eddy currents. 3

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Marking Guidelines

Section I
Multiple-choice Answer Key

Question	Answer
1	C
2	D
3	B
4	A
5	C
6	B
7	B
8	B
9	D
10	B
11	D
12	A
13	C
14	A
15	A
16	A
17	C
18	C
19	D
20	A

Section II

Q21 (4 marks)

Criteria	Marks
Correctly calculates all of: - Angle of refraction for the blue ray - Angle of refraction for the red ray - Angular separation between the rays.	4
Correctly calculates any 2 of: - Angle of refraction for the blue ray - Angle of refraction for the red ray - Angular separation between the rays.	3
Correctly calculates one of: - Angle of refraction for the blue ray - Angle of refraction for the red ray - Angular separation between the rays.	2
Provides some relevant information	1

Sample Answer

Sin red/sin 60 = $1.95 \times 10^8 ms^{-1}$ / $3.0 \times 10^8 ms^{-1}$ = 34.26 degrees.

Sin blue / sin 60 = $1.9 \times 10^8 ms^{-1}$ / $3.0 \times 10^8 ms^{-1}$ = 33.26 degrees

Angular separation = 1 degree.

Q22 a) (3 marks)

Criteria	Marks
· Correctly identifies all of the isotopes.	3
· Correctly identifies some of the isotopes OR · Correctly identifies all of the atoms but does not include the mass numbers.	2
· Correctly identifies some of the atoms but does not include the mass numbers.	1

Sample Answer

X: Helium-4 (^4He)

Y: Hydrogen-1 (^1H)

Z: Oxygen-15 (^{15}O)

Q22 b) (3 marks)

Criteria	Marks
· Correctly calculates the energy of the gamma ray.	3
· Provides some relevant steps.	2
· Provides some relevant information.	1

Sample Answer

Total mass of Reactants = 12.01 + 1.008

= 13.018 amu

Mass defect = Mass Products – Mass of Reactants

= 13.006 – 13.018

= -0.012 amu

Mass defect in Kg = $-0.012 \times 1.66 \times 10^{-27}$

= -1.99×10^{-29} Kg

Energy (J) = mc^2

= $-1.99 \times 10^{-29} \times (3 \times 10^{8})^2$

= -1.79×10^{-12} J

Energy (eV) = $-1.79 \times 10^{-12} \times 6.242 \times 10^{18}$

= -11200000 eV

Energy (MeV) = 11.2 MeV released from reaction as a Gamma Ray.

Q23 (4 marks)

Criteria	Marks
Provides a thorough justification with correct, relevant calculations	4
Provides a justification with substantially correct calculations	3
Shows understanding of the relationship between the velocity of the car and friction	2
Shows limited understanding of the problem	1

Sample answer
Ignoring friction, the net force on the car is mg tan(Θ) = 3.1 kN = Centripetal force = mv^2/r
This gives a speed of 6.96 m/s.
For the car to travel faster, there must be a frictional force down the slope.
To travel at 20 m/s, Fc = mv^2/r = 25.7 kN
This means the frictional force required is (25.7 – 3.1) kN = 22.6 kN
Friction down the slope = 1.4 x mg cos(Θ) = 24.3 kN
The horizontal component of this 24.3 kN x cos(10) =23.9 kN
This is greater than the frictional force needed so the car can maintain that height.

Q24 (2 marks)

Criteria	Marks
Correctly explains the rotational and net movement of the star leading to these observations.	2
Provides some relevant information	1

Sample Answer
The star is rapidly rotating, leading to spectral line broadening. The star is also moving towards us, leading to a reduction in the observed wavelength, also known as blue-shift.

Q 25 (9 marks)

Criteria	Marks
● Energy transformations explained during the start up and running of the motor ● Motor effect explained using components of motor ● Fully labelled diagram of motor and its components provided ● Quantitative relationships of motor effect explained using F=BIlsin@ ● Relative directions of F, I and B explained using RH push rule ● Torque explained ● Function and importance of split ring commutator explained ● Back emf explained in terms of Faraday's and Lenz's law during start up and running ● Importance of back emf explained and related to energy transformations and law of conservation of energy	9
● Energy transformations explained during the start up and running of the motor ● Motor effect explained using components of motor ● Fully labelled diagram of motor and its components provided ● Plus 5 items from above	8
● Energy transformations explained during the start up and running of the motor ● Motor effect explained using components of motor ● Fully labelled diagram of motor and its components provided ● Plus 4 items from above	7
● Energy transformations explained during the start up and running of the motor ● Motor effect explained using components of motor ● Fully labelled diagram of motor and its components provided ● Plus 3 items from above	6
● Energy transformations explained during the start up and running of the motor ● Motor effect explained using components of motor ● Labelled diagram of motor and its components provided ● Plus 2 items from above	5
● Energy transformations explained during the start up and running of the motor ● Motor effect explained using components of motor ● Labelled diagram of motor and its components provided ● Plus 1 item from above	4
● Energy transformations explained during the start up and running of the motor ● Motor effect explained using components of motor ● Diagram of motor and its components provided	3
● Energy transformations explained during the start up and running of the motor ● Motor effect explained using components of motor	2

• Provides some relevant information	1

Sample Answer

When the motor starts up, electrical energy from the power source is converted into mechanical energy due to the motor effect, resulting in motion of the armature. This continues as the power source provides supply emf / voltage to the rotor. Once the motion continues, however, there is a conductor moving in a magnetic field resulting in the generation of current (Faraday's law). This generated current is back emf and flows against supply emf (Lenz's law). Hence, mechanical energy is transformed into electrical energy. Back emf causes reduced overall voltage and current in accordance with energy conservation laws.

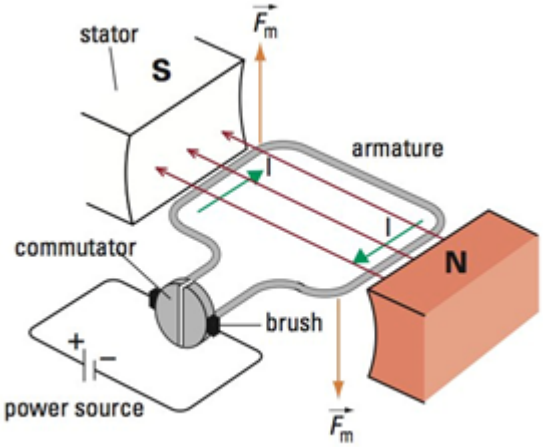


Figure 12.28 A simple DC motor

Source:Stackexchange

The electrical energy, or current, flows through the conducting coil. When this is placed into a magnetic field, each arm of the current carrying coil experiences a force (motor effect) causing the coil to rotate. The magnitude of this force is proportional to the strength of the magnetic field and the amount of current (The maximum force is experienced when the direction of current flow is perpendicular to the magnetic field. The torque remains relatively constant and in one direction because every 180 degrees of rotation the current reverses direction as does the magnetic field. So the motor effect keeps the motor rotating.

The force experienced by each arm of the coil is perpendicular to the magnetic field when the current flows perpendicular to the magnetic field; the directions of force, magnetic field and current being in accordance to the right hand push rule.

The split ring in the commutator causes the current in the loop to reverse direction each half rotation (180 degrees). This reverses the direction of the force in each arm of the coil and keeps the coil rotating in one direction.

The coil is free to rotate in a magnetic field. When current flows the coil experiences a torque due to magnetic field causing a rotating motion.

Q26 (3 marks)

Criteria	Marks
Provides a thorough explanation for all three features	3
Provides an explanation for two features	2
Shows limited understanding of geostationary satellites	1

Sample answer

The altitude must be such that the satellite takes 24 hours to orbit the Earth. In Kepler's equation,

$R^3 / T^2 = GM/4\pi^2$

T is the period (in seconds) and r is the distance to the Earth's centre (in metres)

The satellite must always be above the same point on the Earth's surface. The satellite must also orbit around the centre of the Earth. Thus it must be above the equator, not to the south or north of the equator.

The satellite must move from west to east, i.e. in the same direction that the Earth is spinning, for the satellite to stay above the Earth's surface.

Q27 (2 marks)

Criteria	Marks
Correctly identify 2 key concepts from Maxwell's theory of electromagnetism.	2
Provides some relevant information	1

Sample Answer
2 key concepts from Maxwell's electromagnetic theory of light are:

- ***Light waves are a combination of electric and magnetic fields travelling perpendicular to one another.***
- ***Light waves must travel at a constant velocity.***

Q28 a) (2 marks)

Criteria	Marks
Correctly identifies that the spacing between the interference patterns decreases. Provides an explanation with reference to the diffraction equation $d\sin\theta=m\lambda$	2
Provides some relevant information	1

Sample Answer
As the separation between the slits in the diffraction grating is increased the spacing between the nodes in the interference pattern will decrease. This is because of the inverse relationship between 'd' and 'm' in the equation $d\sin\theta=m\lambda$.

Q28 b) (1 mark)

Criteria	Marks
Correctly describes the change in pattern which occurs.	1

Sample Answer
The number of maxima and minima will decrease and each maxima will become wider.

Q29 (7 marks)

Criteria	Marks
Correctly calculates all of: - Angle of diffraction - Wavelength of laser - Frequency of laser - Energy of laser AND identifies the colour as Green.	7
Correctly calculates 4 of: - Angle of diffraction - Wavelength of laser - Frequency of laser - Energy of laser OR Correctly calculates 3 steps AND identifies the colour as Green.	6
Correctly calculates 3 of: - Angle of diffraction - Wavelength of laser - Frequency of laser - Energy of laser OR Correctly calculates 2 steps AND identifies the colour as Green.	5
Correctly calculates 2 of: - Angle of diffraction - Wavelength of laser - Frequency of laser - Energy of laser	4
Correctly calculates 1 of: - Angle of diffraction - Wavelength of laser - Frequency of laser - Energy of laser AND identifies the colour as Green.	3

Correctly calculates 1 of: - Angle of diffraction - Wavelength of laser - Frequency of laser - Energy of laser OR identifies the colour as Green.	2
Provides some relevant information	1

Sample Answer

1. Calculate angle:

Tanθ = 17.45/1000
θ=1 degree

2. Calculate wavelength

d sinθ=mλ
30 x10^(-6) sin1=1 x λ
λ=523 x10^(-9) m

3. Calculate Frequency

v=f λ
3.0 x10^(8)=f x 523 x10^(-9)
f=5.73 x 10^14 Hz

4. Calculate Energy

E=hf
E= 6.626 x 10^(-34) x 5.73 x 10^14
E= 3.80 x 10^(-19) J

5. Identifies Colour

Based on the answer in '2.' and the table, the colour of the laser is Green.

Q30 a (3 marks)

Criteria	**Marks**
· Correctly identifies the forces exerted on the particle from the electromagnet and the two Dees.	3
Answer correctly identifies the forces exerted on the particle from any 2 of the following: · Electromagnet · Initially positive Dee · Initially negative Dee	2
· Provides some relevant information.	1

Sample Answer

The electromagnet would provide a deflective magnetic force on the positively charged particle. The initially positive Dee would provide a repulsive force, while the initially negative Dee would provide an attractive force.

Q30 b (3 marks)

Criteria	Marks
· Correctly outlines the net motion of the particle.	3
Answer correctly outlines any 2 of the following: · The spiralling shape. · The anticlockwise direction. · The increasing size of the curves in the spiral.	2
· Provides some relevant information.	1

Sample Answer

The positively charged particle would begin spiralling anticlockwise in increasingly larger radii as the strength of the electromagnet increases and the current alternates.

Q30 c (2 marks)

Criteria	Marks
· Proposes a method to test if the particle is a fundamental particle. · Outlines an expected result or observation which indicates if the particle is fundamental or not.	2
· Proposes a method to test if the particle is a fundamental particle. OR · Outlines an expected result or observation which indicates if the particle is fundamental or not.	1

Sample Answer

The cyclotron could be used to collide the positive particle with a target. If the products of this collision are smaller particles than the accelerated positive particle it would suggest that the accelerated positive particle isn't a fundamental particle.

Q31 4 marks

Criteria	Marks
Method is valid, includes repetition and data processing, and attempts to address the issue of constant initial velocity. Dependent, independent and controlled variables are addressed	4
Provides a substantially correct method AND shows understanding of validity, reliability and the variables	3
Provides a partially correct method AND shows limited understanding of validity, reliability and the variables	2
Shows limited understanding of the problem through comments on variables OR by providing a partial method	1

Sample answer

Method:

Get a projectile shooter*. Adjust and measure the angle of elevation with a protractor, starting at 20 degrees. Fire the projectile. Note how far away the projectile landed. (A grid marked on the ground, and a video recording of each shot is recommended). Repeat three more times for that angle. Repeat for other angles, increasing by 10 degrees each time. Results should be graphed (range vs angle) and extra angles measured near the angle that gives maximum range.

The independent variable is the angle of elevation, the horizontal range is the dependent variable. Controlled variables include the initial velocity and the type of projectile.

Reliability is enhanced by repeating measurements several times (at least 3) and taking average ranges for each angle used.

Validity requires that the angle of elevation is increased until a maximum range is reached and then further larger angles are checked to ensure a decrease in horizontal range is observed. Most importantly, the initial velocity must be kept constant.

****The projectile shooter could be a compressed spring in a cylinder, shooting a marble.***

Q32 (2 marks)

Criteria	Marks
Correctly describes an experimental observation which demonstrates Huygens' principle of wave propagation.	2
Provides some relevant information	1

Sample Answer
As a plane wave strikes an opening in a barrier, a circular wave propagates out from the opposite side of the opening. This observation is evidence of Huygens' description of wavefronts being a collection of points which can generate wavelets, the new circular wave being the product of these wavelets.

Q33 (3 marks)

Criteria	Marks
· Outlines an experimental step and observation leading to the conclusion. · Provides a statement assessing the validity of the conclusion.	3
Answer gives any 2 of the following: · Outlines an experimental step leading to the conclusion. · Outlines an observation leading to the conclusion. · Provides a statement assessing the validity of the conclusion.	2
· Provides some relevant information.	1

Sample Answer:
In this experiment, Thomson measured the charge-to-mass ratio of cathode ray particles emitted from cathodes made of different metals. He observed that the charge-to-mass ratio of the cathode ray particles was constant regardless of the type of metal used. The consistent results obtained, regardless of the material from which the cathode ray particle was emitted, demonstrates that Thomson's conclusion was extremely valid based on the evidence he collected.

Q34 (3 marks)

Criteria	Marks
Shows understanding of the energy equivalence AND provides correct derivation	3
Shows understanding of the energy equivalence OR provides correct derivation	2
Shows limited understanding of the problem	1

Sample answer

For the projectile to escape the Earth's gravitational field, it must have enough kinetic energy to match its gravitational potential energy at the Earth's surface.

½ mv^2 = GMm/r

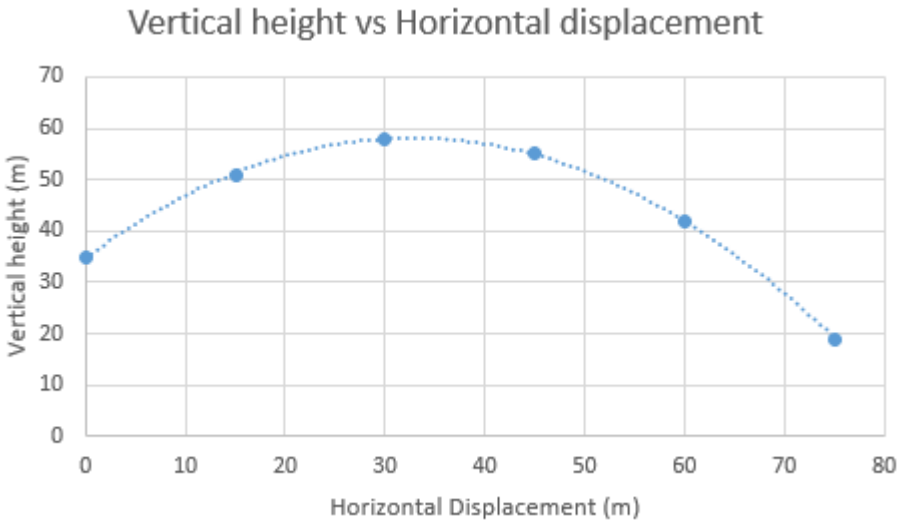
v^2 = 2GM/r

$$v_{esc} = \sqrt{\frac{2GM}{r}}$$

Q35 a) 3 marks

Criteria	Marks
Provides a substantially correct line graph with appropriate labels, titles, scales and correctly plotted points	3
Provides a partially correct graph	2
Demonstrates some relevant understanding of graphing	1

Sample answer



35 b) 1 mark

Criteria	Marks
Correct answer (within reasonable range)	1

Sample answer

Minimum velocity is at its highest point. Horizontal displacement approximately 32-34 m.

35 c) 2 marks

Criteria	Marks
Provides a correct explanation	2
Provides a partial explanation	1

Sample answer

Y = vertical displacement depends on t^2. ($s=ut + 1.2at^2$)
X = horizontal displacement depends on t. ($s=ut$)
If $Y=at^2$ and $X=bt$ then $Y/a = X^2/b^2$ which is a parabola.

Q36 a) (2 marks)

Criteria	Marks
Correct answer provided with correct units	2
Appropriate calculation attempted	1

Sample answer

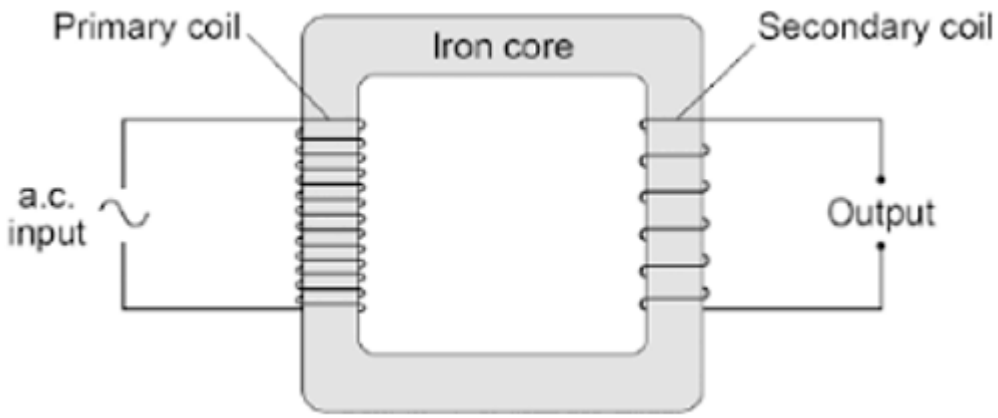
$$V_p I_p = V_s I_s$$

$$I_p = \frac{V_s I_s}{V_p} = \frac{(6\ V)(1\ A)}{(240\ V)} = 0.025\ A = 25\ mA$$

Q36 b) (2 marks)

Criteria	Marks
Fully labelled diagram of a step down transformer provided	2
Diagram of a transformer provided	1

Sample answer



Q36 c) (2 marks)

Criteria	Marks

Explanation includes how flux linkage is increased to maximise efficiency AND how eddy currents are minimised to minimise energy losses as heat	2
Explanation includes how flux linkage is increased OR how eddy currents are minimised	1

Sample answer

Transformers are designed so that both the primary and secondary coils are wound around the same iron core together. In addition, the shape of iron core is designed so that both the primary and secondary coils are in close proximity to one another. This maximises flux linkage, ensuring that the maximum change in flux from the primary coil allows maximum current to be induced in the secondary coil in accordance with Faraday's law. The iron core of the transformer is laminated (in layers of iron and insulating material) to minimise the size of eddy currents in the iron core. Without laminations in the core, large eddy currents, a consequence of electromagnetic induction, cause the transformer to lose excessive amounts of heat energy which reduces efficiency. Minimising the size of eddy currents reduces energy losses as heat.

Q37 (3 marks)

Criteria	**Marks**
· Correctly analyses two or more of Schrodinger's contributions to the development of the current model of the atom.	3
· Correctly analyses one of Schrodinger's contributions to the development of the current model of the atom.	2
· Provides some relevant information.	1

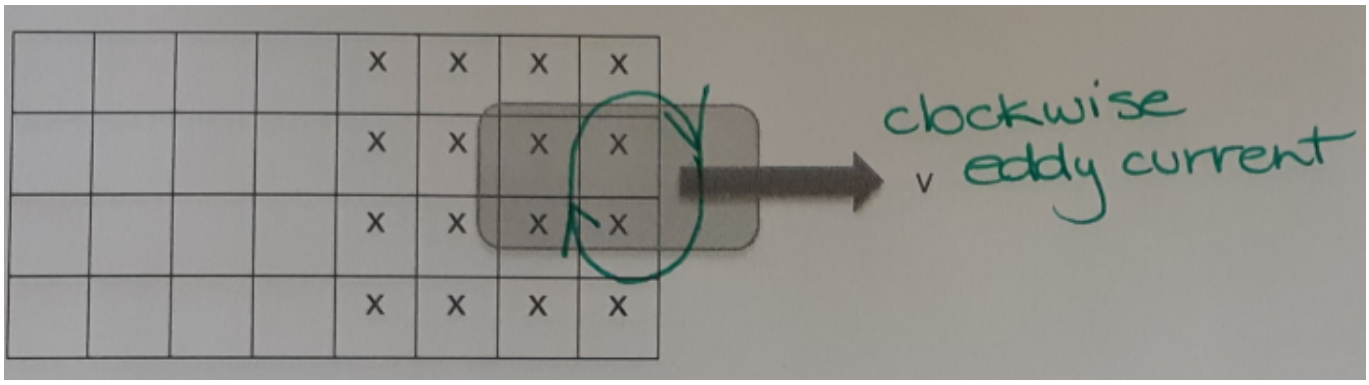
Sample Answer

Schroginder created an equation which was able to accurately predict the electron binding energy of any atom. Furthermore, an extension of this equation can be used to model the distribution of electrons around the nucleus of an atom. These two contributions led to the further development of the current, quantum mechanical model of the atom.

Q38 a) (i) (2 marks)

Criteria	**Marks**
Closed eddy current loop drawn in clockwise direction at interface of magnetic field	2
Closed eddy current loop drawn	1

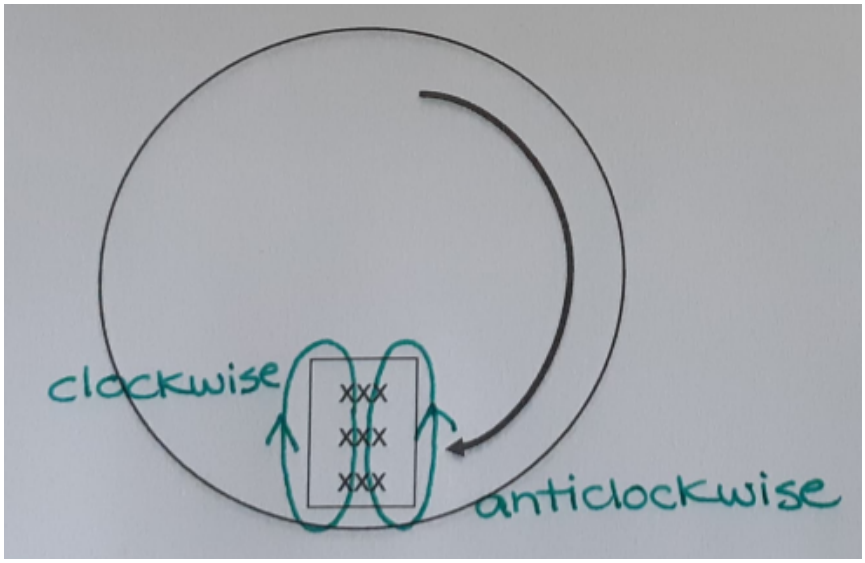
Sample Answer



Q38 a) (ii) (2 marks)

Criteria	Marks
Closed eddy current loop drawn in anticlockwise direction as disc enters magnetic field AND Closed eddy current loop drawn in clockwise direction as disc exits magnetic field	2
Closed eddy current loops drawn at points of entry into and exit out of magnetic field	1

Sample Answer



Q38 b) (3 marks)

Criteria	Marks
● An appropriate application is clearly identified ● Physics principles are outlined thoroughly, including how the conservation of energy applies	3
● An appropriate application is identified ● Physics principles are outlined	2
● An application is linked with a physics principle	1

Sample Answer

Magnetic braking uses a strong source of magnetic field (provided by electromagnets). The electromagnets are placed on either side of a spinning metal disc. The metal disk is a part of a rotating axle on a vehicle such as a train or car. As an area of the disc comes towards the electromagnets, eddy currents are induced, in accordance to Faraday's law, due to the change in flux through the disc. These eddy currents flow in such a direction such that the magnetic field they generate opposes the magnetic field from the electromagnets in accordance with Lenz's law which is a consequence of the law of conservation of energy. This interaction causes the disc to slow down and a braking effect occurs.