KINCOPPAL – ROSE BAY
SCHOOL OF THE SACRED HEART

Student Number

2023 Year 12 Assessment Task 4 – Trial

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
- A data sheet, formulae sheet and Periodic Table are provided at the back of this paper

Total marks: 100

Section I – 20 marks (pages 2 – 10)

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

Section II – 80 marks (pages 11– 29)

- Attempt Questions 21-34
- Allow about 2 hours and 25 minutes for this section

Section I

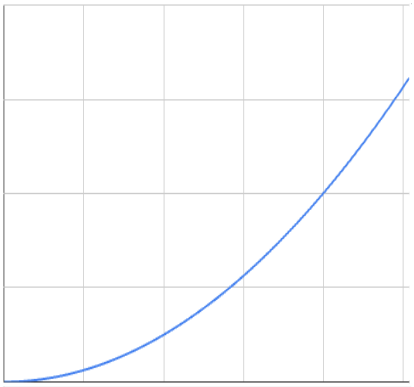
20 marks
Attempt Questions 1-20
Allow about 35 minutes for this section.

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

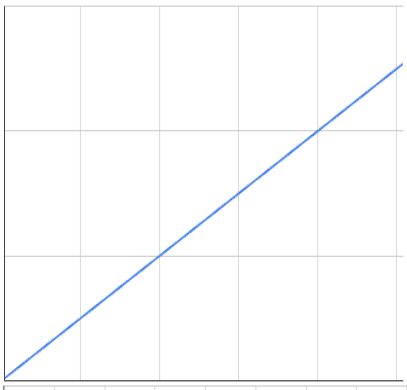
1 Light, sound, gravitation, electrostatics, and many other physical principles all follow an inverse-square law.

Which of the following graphs depicts this relationship?

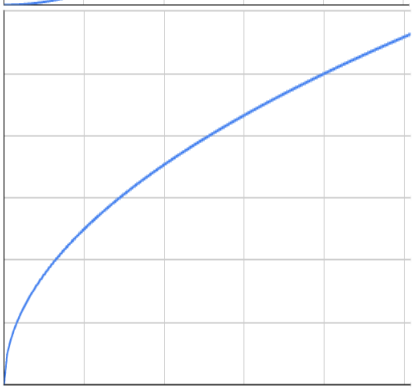
(a)



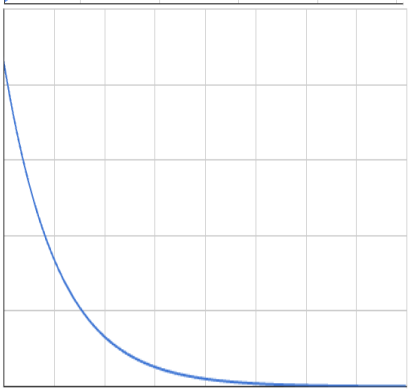
(b)



(c)



(d)



2 If two projectiles are launched at the same initial velocity but at different launch angles, which projectile will reach its maximum height first?

(a) The projectile launched at a smaller angle

(b) The projectile launched at a larger angle

(c) Both projectiles will reach maximum height at the same time

(d) It depends on the mass of the projectiles

3 Why do transformers only use AC voltage?

(a) DC voltage is too dangerous to use with transformers.

(b) AC voltage is easier to generate than DC voltage.

(c) The magnetic field in the transformer needs to be constantly changing to induce a current in the secondary coil.

(d) AC voltage is more efficient than DC voltage for transferring energy between coils.

4 A transformer used to step down the voltage of an AC power source from 240 V to 12 V has an input current of 10 A. If the primary coil has 300 turns, how many turns are in the secondary coil?

(a) 15

(b) 20

(c) 24

(d) 40

5 The table shows the energy levels in a hydrogen atom.

Energy level	Energy of electron (J)
n=1	0
n=2	1.63×10^{-18}
n=3	1.94×10^{-18}
n=4	2.04×10^{-18}

An electron in the n=4 level transitions to the n=3 level.

How does the energy change as the electrons moves between levels?

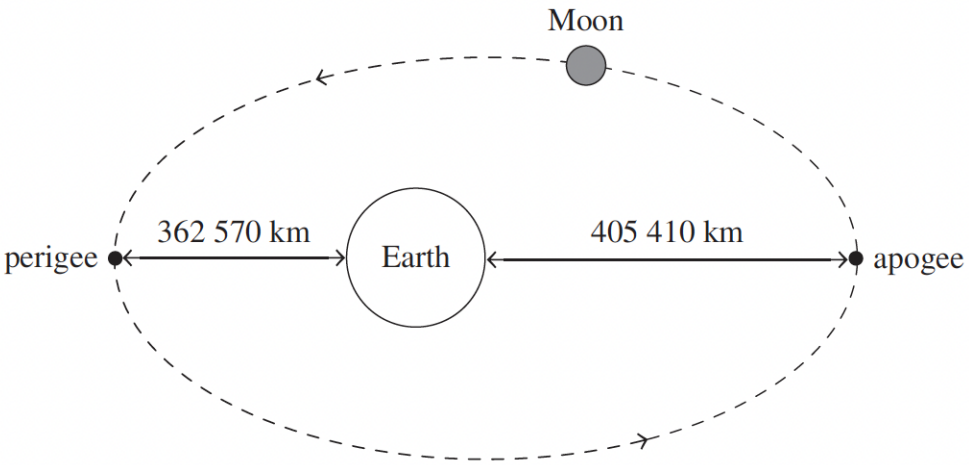
(a) 1.00×10^{-19} J absorbed

(b) 1.00×10^{-19} J emitted

(c) 2.04×10^{-18} J absorbed

(d) 2.04×10^{-18} J emitted

6 The diagram shows the perigee and apogee of the Moon – two points in the Moon's elliptical orbit around Earth.



Which of the following statements is correct?

(a) When the Moon reaches the apogee, its gravitational potential energy and kinetic energy will be at minimums. It will move at a low velocity.

(b) When the Moon reaches the apogee, its gravitational potential energy and kinetic energy will be at maximums. It will move at a high velocity.

(c) When the Moon reaches the perigee, its gravitational potential energy will be at a minimum and its kinetic energy will be at a maximum. It will move at a high velocity.

(d) When the Moon reaches the perigee, its gravitational potential energy and kinetic energy will be at maximums. It will move at a low velocity.

7 A student with a mass of 65 kg is asked to determine their weight while they travel in an elevator.

The elevator goes through three stages of movement:
- During stage 1, the elevator moves upwards at a constant velocity of 9.8 ms^{-1}.
- During stage 2, the elevator accelerates upwards at 5 ms^{-2}.
- During stage 3, the elevator accelerates downwards at 5 ms^{-2}.

Which row of the table identifies the student's weight during the different stages of the elevator's movement?

	Stage 1	Stage 2	Stage 3
(a)	65 kg	115kg	15kg
(b)	65 kg	15 kg	115kg
(c)	637 N	312 N	962 N
(d)	637 N	962 N	312 N

8 Two current-carrying wires are parallel to each other and separated by a distance of 0.05 m. They carry currents of 0.5 A and 0.3 A in opposite directions.

If the distance between the wires were increased to 0.1 m, the force acting on the 0.3 A wire would be

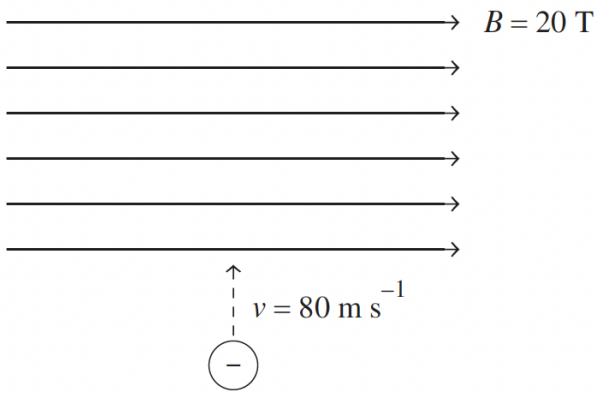
(a) a quarter of the original value.

(b) half of the original value.

(c) 0.6 of the original value.

(d) double the original value.

9 An electron travels into a uniform magnetic field as shown.



What is the force acting on the electron?

(a) 0.4×10^{-20} N up the page

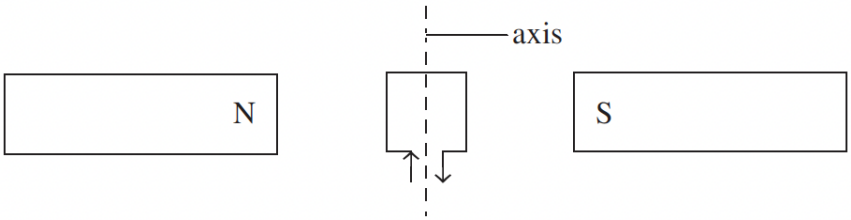
(b) 4.0×10^{-20} N out of the page

(c) 2.6×10^{-16} N out of the page

(d) 2.6×10^{-16} N into the page

DO NOT write in this area.

10 A rectangular coil has the dimensions 3.0 cm x 4.0 cm and carries a current of 15.0 mA in a uniform magnetic field of 3.0 T. The coil has 20 turns of wire and is free to rotate about the axis as shown.



If the coil is rotated by 25°, what is the torque acting on the coil?

(a) 9.79×10^{-4} Nm clockwise

(b) 9.79×10^{-4} Nm anticlockwise

(c) 4.56×10^{-4} Nm clockwise

(d) 4.56×10^{-4} Nm anticlockwise

11 A scientist finds that the frequency of incident light on a piece of metal is greater than the threshold frequency.

The scientist decides to investigate how changing the light may affect the photoelectrons emitted by the piece of metal. They apply the following two conditions as part of their investigation.

1. The intensity of the light is decreased, and the frequency is kept constant.
2. The frequency of the light is increased, and the intensity is kept constant.

The scientist records the maximum kinetic energy of the photoelectrons and the number of photoelectrons emitted under each condition and compares these results to the initial observation.

Which row of the table best describes the results of the scientist's investigation?

	Maximum kinetic energy of the photoelectrons	**Number of photoelectrons emitted**
(a)	increases under conditions 1 and 2	increases under conditions 1 and 2
(b)	increases under condition 1 and remains constant under condition 2	decreases under condition 1 and remains constant under condition 2
(c)	remains constant under condition 1 and increases under condition 2	decreases under condition 1 and remains constant under condition 2
(d)	remains constant under condition 1 and decreases under condition 2	decreases under conditions 1 and 2

12 Which of the following best explains why circular tracks are banked?

(a) To increase the centripetal force required to keep the object moving in a circle.

(b) To decrease the centripetal force required to keep the object moving in a circle.

(c) To increase the gravitational force acting on the object.

(d) To decrease the frictional force acting on the object perpendicular to the direction of motion.

13 Which of the following is a limitation of the Bohr model of the atom?

(a) It cannot explain the observed line spectra of atoms with more than one electron.

(b) It cannot account for the quantization of angular momentum in atoms.

(c) It cannot predict the correct value of the ground state energy for hydrogen.

(d) It does not consider the wave-particle duality of electrons.

14 Which statement correctly matches Malus' Law?

(a) The intensity of polarised light entering an analyser is directly proportional to the cosine squared of the angle between the polariser and the analyser.

(b) The intensity of polarised light entering an analyser is inversely proportional to the cosine squared of the angle between the polariser and the analyser.

(c) The intensity of non-polarised light entering an analyser is directly proportional to the cosine squared of the angle between the polariser and the analyser.

(d) The intensity of a non-polarised light entering an analyser is inversely proportional to the cosine squared of the angle between the polariser and the analyser.

15 Students plotted the radiation of stars against their wavelengths.

If a star has a surface temperature of 4000 K, what is the maximum wavelength of the radiation emitted by the star?

(a) 0.725×10^{-7} m

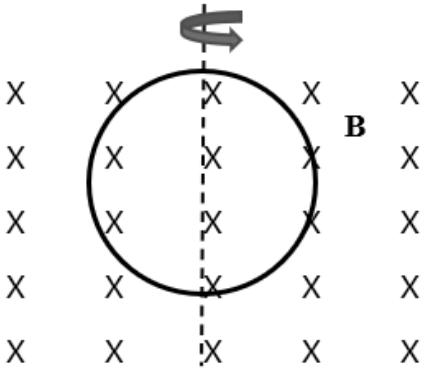
(b) 7.25×10^{-6} m

(c) 725×10^{-7} nm

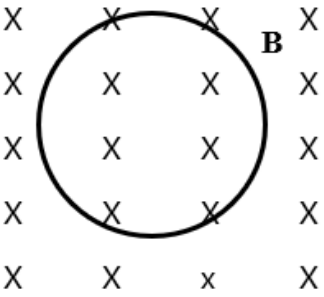
(d) 725 nm

16 In the diagrams below the loops are initially all the same size and the magnetic field B is the same.

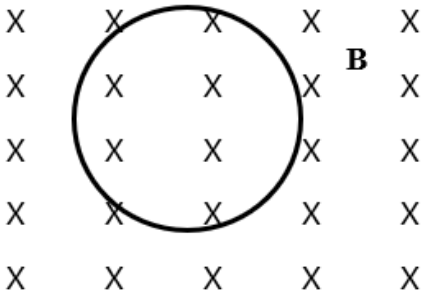
(S) The loop is rotated 90° in 2.0 s.



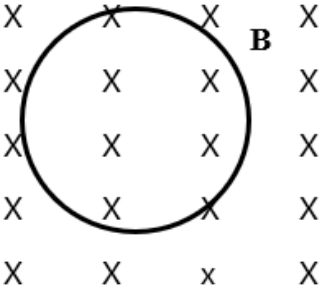
(T) The magnetic field is reduced to zero in 4.0 s.



(U) The loop's radius doubles in 2.0 s.



(V) The direction of the magnetic field is reversed in 2.0s.



In which situation would the average induced EMF around the loop be the greatest?

(a) S

(b) T

(c) U

(d) V

DO NOT write in this area.

17 In a Physics class, students conduct three experiments in which they observe various light sources through a spectroscope.

- Experiment 1 uses an incandescent lamp.
- Experiment 2 uses a sodium lamp.
- Experiment 3 uses an incandescent lamp and passed the light through sodium vapour.

Which row of the table identifies what the students would observe through the spectroscope in each experiment?

	Experiment 1	**Experiment 2**	**Experiment 3**
(a)	Continuous spectrum of colours	Two yellow lines on a dark background	Fully coloured background with two black lines
(b)	Continuous spectrum of colours	Fully coloured background with two black lines	Two yellow lines on a dark background
(c)	Two yellow lines on a dark background	Full spectrum of colours	Fully coloured background with two black lines
(d)	Fully coloured background with two black lines	Two yellow lines on a dark background	Full spectrum of colours

18 An electron is accelerated from rest in an evacuated glass tube with a voltage of 3200 V through a uniform magnetic field of 2.2×10^{-3} T at right angles to the electron's path.

What is the speed of the electron?

(a) 2.56×10^{-16} ms^{-1}

(b) 5.13×10^{-16} ms^{-1}

(c) 3.35×10^{7} ms^{-1}

(d) 1.12×10^{15} ms^{-1}

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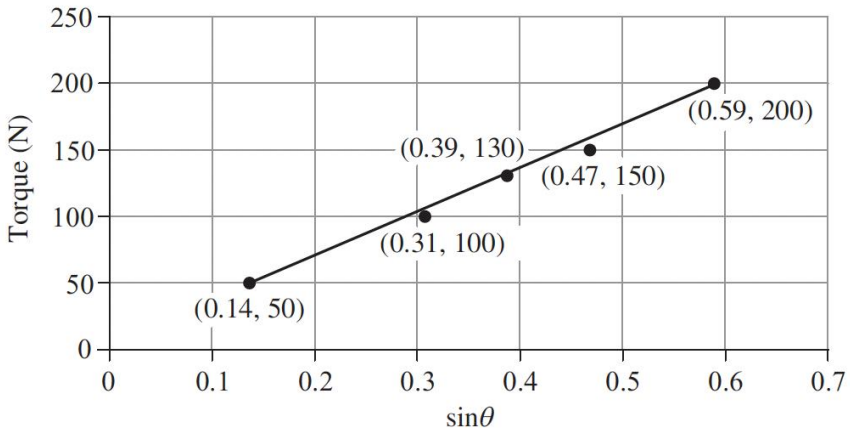
19 An engineer turns a nut by applying a constant force to a 25.00 cm spanner. They applied this force at different angles and measured the torque. The graph shows the data collected by the engineer.



What is the magnitude of the force applied to the nut?

(a) 14.8 N

(b) 84.8 N

(c) 339 N

(d) 1333 N

20 Sophie has a mass of 65.00 kg and boards a ride at an amusement park. The ride has a central structure with four 15.00 m steel arms extending from it. Each arm is attached to a steel carriage that has a mass of 550.0 kg and can carry one occupant. When the ride is activated, the arms rotate around the central structure, completing 10 full rotations per minute.

What is the magnitude of the force that the steel arm needs to apply to Sophie's carriage so that it continues to move in uniform circular motion?

(a) 6744 N

(b) 9037 N

(c) 10 116 N

(d) 363 819 N

DO NOT write in this area.

Student Number

Physics
Section II Answer Booklet

80 marks
Attempt Questions 21-33
Allow about 2 hours and 25 minutes for this section

Instructions

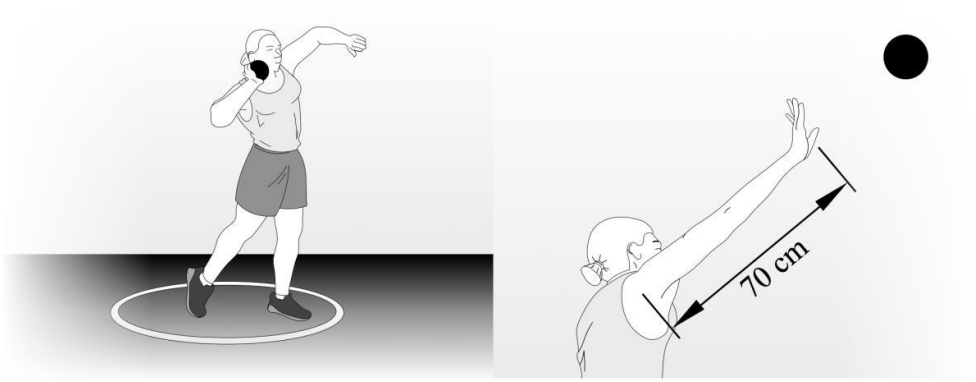
- Write your Student Number at the top of this page.
- Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
- Show all relevant working in questions involving calculations.
- Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.

DO NOT write in this area.

Please turn over

Question 21 (8 marks)

A champion shot-put thrower is competing in a competition despite having recently damaged a ligament in her knee. Because of her injury she is forced to throw the shot put from a static position. Therefore, the shotput will only be accelerated across the distance of her extended arm which is 70 cm long.



(a) During her first attempt, she applied a constant force of 431 N throughout the extension of her arm. If the 4.0 kg ball is released at 12 ms^{-1}, at what angle did she throw the ball? **4**

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(b) On her second attempt she releases the shot put at an angle of 45˚ with the same launch velocity as her first attempt in part (a). If she released it from a height of 2 m above the ground, determine the range of her throw. **4**

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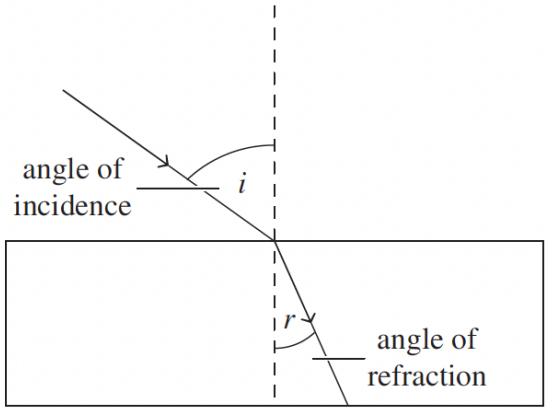
Question 22 (5 marks)

The diagram shows light moving through a glass prism. **5**



Compare how Huygens's and Newton's models would explain the movement of light through the glass prism.

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Question 23 (8 marks)

A 1300 kg car makes a turn on a circular bend of road at a speed of 80 km per hour. The bend is not banked and has a radius of 40 m.

(a) What is the magnitude of the centripetal force required for the car to make this turn? **2**

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(b) What is the magnitude of the centripetal acceleration of the car around the bend? **2**

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(c) If the bend were banked at an angle of 8°, calculate the magnitude of the centripetal force exerted by the road on the car. Support your answer with a diagram that identifies the relevant forces and vector components. **4**

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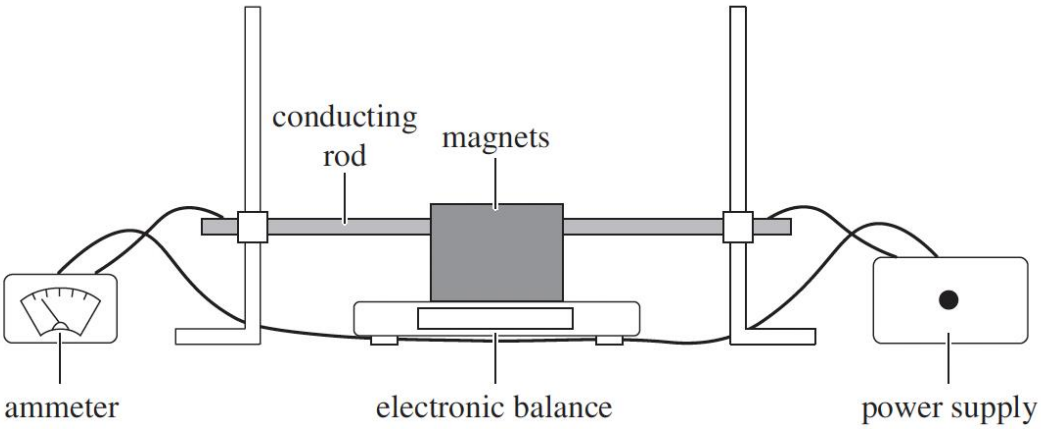
Question 24 (7 marks)

A group of students were conducting an experiment and set up a current balance. Consider the experiment shown in the diagram.



The conducting rod was positioned between two magnets. The balance was initially set at zero. When the students changed the current flowing through the apparatus, the readings on the balance changed due to the force acting up or down.

The students steadily increased the current, which was measured using the ammeter, and recorded the mass displayed on the balance. They then used the measured current and mass to calculate the force acting on the magnets. Their results are shown in the table.

Current (A)	*Mass (kg)*	*Force (N)*
1.1	-0.55×10^{-3}	5.61×10^{-4}
2.1	-1.02×10^{-3}	1.04×10^{-4}
2.9	-1.43×10^{-3}	1.46×10^{-4}
3.6	-1.86×10^{-3}	1.90×10^{-4}
4.3	-2.15×10^{-3}	2.19×10^{-4}

(a) Plot a graph of force versus current. Include a line of best fit. **3**

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(b) Identify the relationship between force and current shown in the graph from part (a) and state TWO assumptions that must be made for this relationship to exist. **2**

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(c) Calculate the gradient of the graph from part (a) and identify what the gradient represents. In your response, include any relevant equation(s). **2**

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Question 25 (8 marks)

A satellite of mass 250 kg is launched from Earth's surface and enters a uniform circular orbit at 5.0×10^5 m above Earth's surface.

(a) Calculate the orbital velocity of the satellite. **2**

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(b) Calculate the magnitude of the gravitational potential energy of the satellite. **2**

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(c) Calculate the escape velocity of the satellite from its current position in orbit. **2**

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(d) If the satellite were lifted into a higher orbit, explain why work would need to be done by the satellite's engines to change its orbital path. **2**

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Question 26 (5 marks)

A popular theme park ride is the 'giant drop'. This ride often uses large, permanent magnets under the seats on the ride as a brake. The seats are attached to cables that are used to raise the seats to the top of a tower. The seats are released and as they fall, the magnets pass the bottom section of the tower, which has copper fins that cause the seats to slow down.

A teacher demonstrates this concept to their Physics class using a bar magnet and two pipes made of different materials. They drop the magnet through a PVC pipe and record the time it takes for the magnet to hit the floor, then repeat the action with a copper pipe of the same length and diameter.

The teacher makes the following comment about the giant drop.

> 'The ride is moving quite fast, so the occupants in the seats stop quickly but smoothly. They do not feel a rough jolt. This is much better than if the ride used conventional brakes applied by an operator.'

(a) Using Lenz's law, explain the expected results of the experiment and how they relate to the giant drop. **3**

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(b) Is the teacher's comment correct? Explain your answer. **2**

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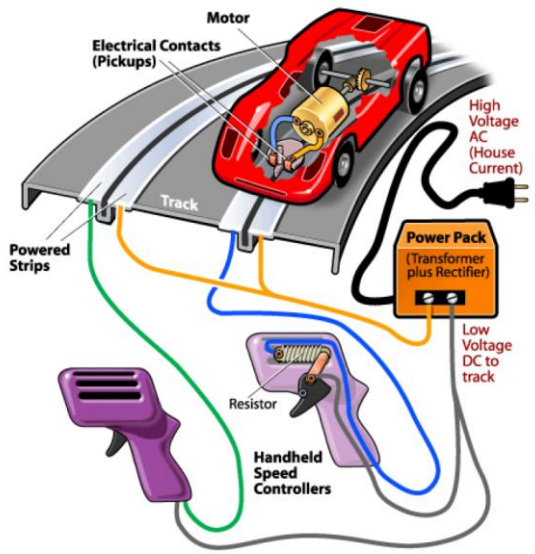
Question 27 (5 marks)

Slot cars are a fun and simple application of electric motors.

The diagram below shows a simple setup of the slot car on a circuit with an electric controller.



Source: https://commons.wikimedia.org/wiki/File:SlotcarElecCircuit.png

(a) Describe the four main components of a DC motor. **3**

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(b) Briefly analyse the functions of a DC motor as it applies to this system. Include relevant energy transformations and transfers. **2**

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(c) After running a slot car for a length of time, the slot cars heat up immensely. Explain, using physics principals, why this is the case. **2**

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Question 28 (3 marks)

Explain how discharge tubes with different gases can produce different spectra. **3**

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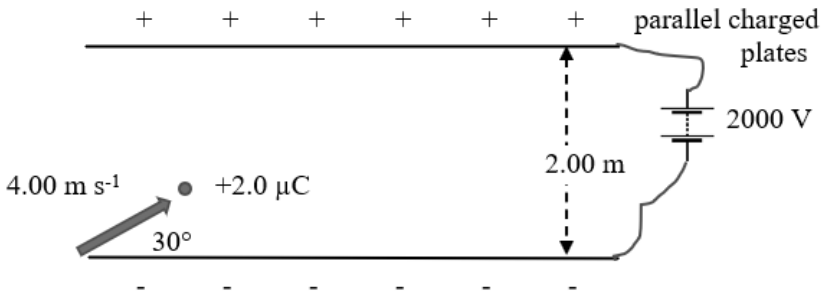
Question 29 (5 marks)

A small particle with mass 5.0 mg and a charge of +2.0 μC is shot at an angle of 30° and initial speed 4.00 ms^{-1} into a large gravity-free region between two parallel charged plates 2.0m apart, as shown below.



(a) Find the acceleration of the charged particle within the gravity-free region. **3**

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(b) How far along from its launch position will the charged particle hit the negative plate? **2**

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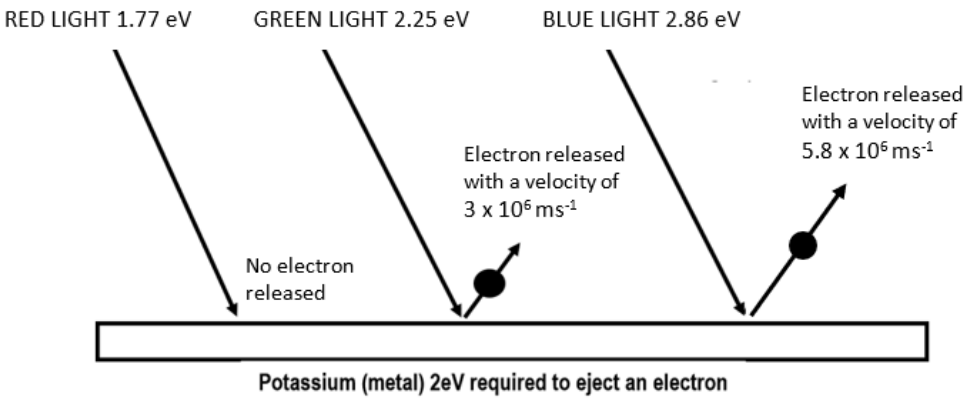
Question 30 (6 marks)

Red, green and blue light were shone on a piece of potassium metal and the results are shown in the diagram.



(a) Using the above diagram as a guide, draw a predicted result in the space below for shining 400 nm Violet light onto the potassium. On your diagram, include the velocity and energy values for any electrons which may be released. **3**

(b) Explain how this experiment is used to support quanta and photoelectric principles. **3**

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Question 31 (4 marks)

James Clerk Maxwell's contributions to classical physics were made through his description of electromagnetism in mathematical formulae. **4**

Outline the major aspects of Maxwell's contributions to electromagnetic theory at the time.

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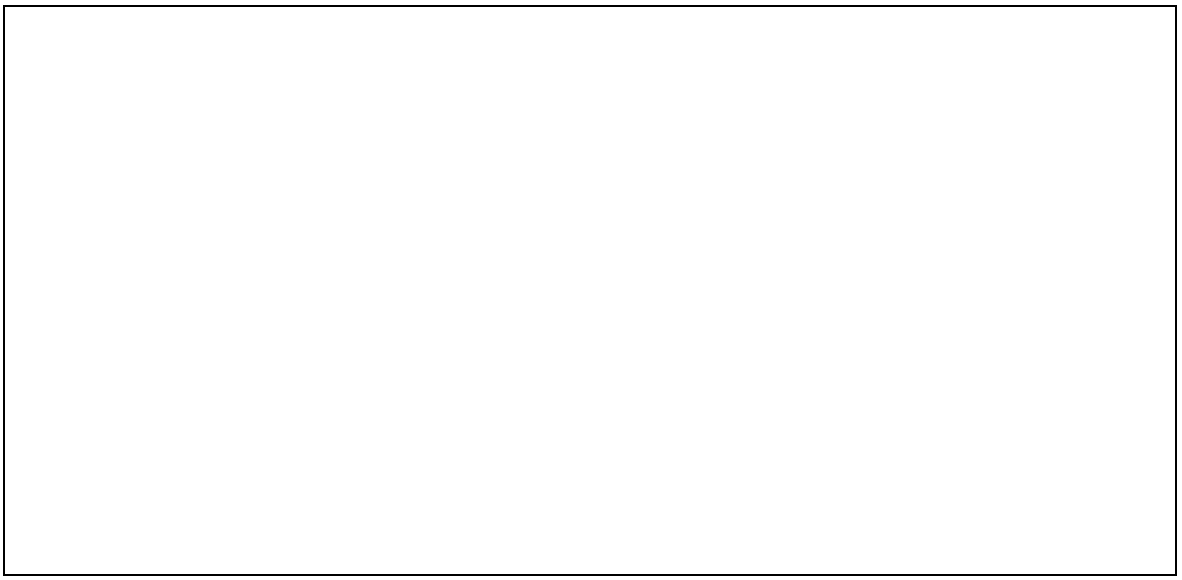
Question 32 (6 marks)

Several scientists and many experiments have contributed to the development of the current atomic model. **6**

Draw a model of the Geiger-Marsden experiment and explain how Rutherford's analysis of the results from this experiment advanced the atomic model.



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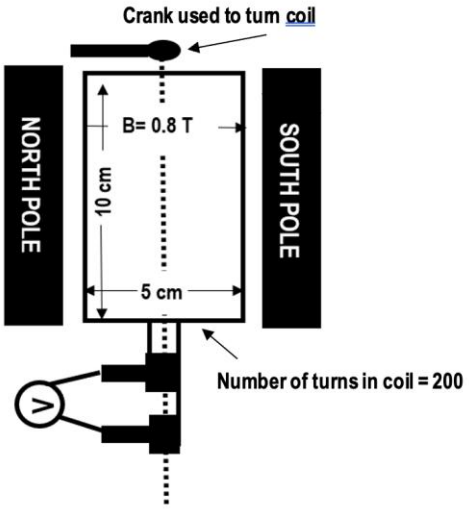
Question 33 (6 marks)

A device was constructed in a physics' laboratory and the design is shown in the diagram.



(a) Identify this device justifying your answer. **2**

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(b) Calculate the emf created in this device if the coil was spun ¼ of revolution in 18 ms. **2**

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(c) Explain how back emf causes this device to obey the law of conservation of energy. **2**

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Question 34 (4 marks)

A red laser light with a wavelength of 652 nm was used in the Young's Double Slit experiment to determine the distance from the diffraction slits (X) to screen (Z).

The experiment had a slit separation of 250 μm. The distance between the bright spot and the first order value (Y) was measured as 5 mm.

(a) Draw a diagram of this experiment. **1**

(b) Calculate the distance from the diffraction slits (X) to the screen (Z). Include an explanation of how tan θ and sin θ are used to calculate X to Z. **3**

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