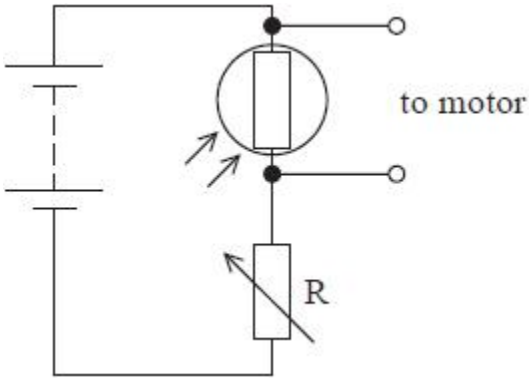
Name of the Student:_____
Max. Marks : 25 Marks **Time : 25 Minutes**

Q1.

A rain sensor is mounted on the inside of a car windscreen. When the rain sensor detects raindrops on the windscreen, a motor is switched on to operate the windscreen wipers.

A student modelled a simple infrared detector, using a light dependent resistor (LDR) in series with a variable resistor R. She connected a motor in parallel with the LDR, as shown.



(i) The intensity of the light incident on the LDR increased.

Explain what happened to the speed of the motor. Your answer should include reference to conduction electrons.

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(ii) The power supply consisted of several 1.5 V cells in series.

The student set the resistance of resistor R to 270 Ω and measured the potential difference across the motor as 5.0 V. In this situation the resistance of the LDR was 193 Ω. The motor had a very high resistance. Deduce the number of cells the student used.

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(Total for question = 7 marks)

Q2.

Our understanding of the atom has developed over time, from early models in which atoms were considered to be h**6**ard incompressible spheres, through to the nuclear model of the atom and the ladder model in which electrons exist in a discrete number of allowed energy states.

The nuclear model of the atom was established following a series of experiments in which alpha particles were directed at thin gold foil.

(i) An alpha particle approaching a gold nucleus, $^{197}_{79}\mathrm{Au}$, head-on will be brought to rest and returned along its original path.

Calculate the minimum distance between the alpha particle and the nucleus for alpha particles of energy of 5.5 MeV.

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Minimum distance = ...

(ii) It is observed that electrons, with energy of 5.5 keV, are diffracted as they pass through the thin gold foil.

Explain a conclusion about the electrons that can be made from this observation.

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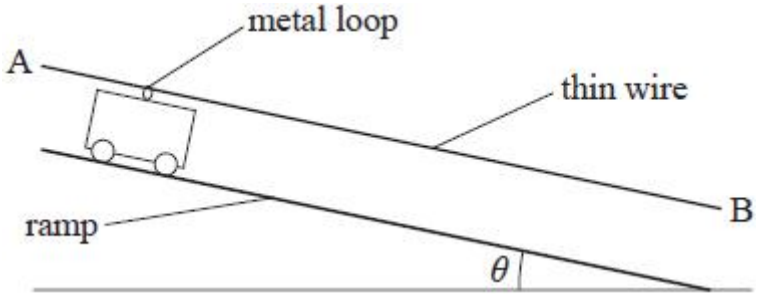
(Total for question = 7 marks)

Q3.

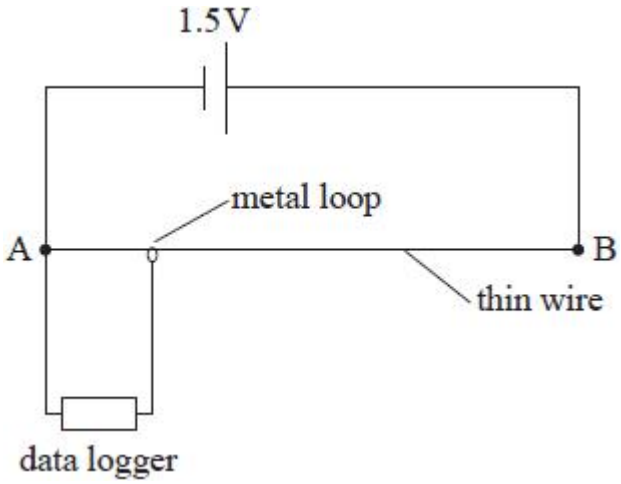
A student investigates the motion of a friction-free trolley down a ramp. On the top of the trolley there is a metal loop which makes contact with a length of thin resistance wire, AB, fixed above the ramp. The resistance wire has a uniform diameter.

The trolley accelerates down the ramp and the metal loop stays in contact with the wire along the full length of the ramp.



The student uses a protractor to measure the angle θ between the ramp and the horizontal and records a value of 4° with an uncertainty of ±1°.

(a) The two ends of the wire are connected to a 1.5 V cell. A data logger, set to measure potential difference, is connected to the metal loop and to the negative terminal of the cell.



Explain how the potential difference recorded by the data logger will vary as the loop moves along the length of the
wire AB.

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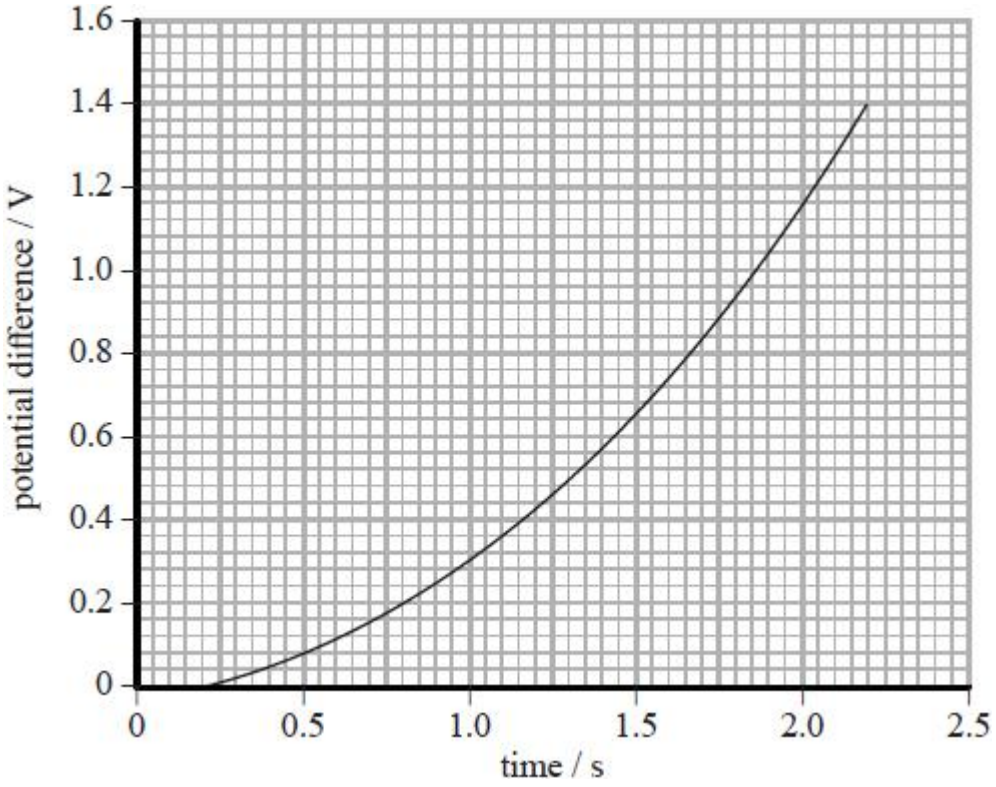
(b) The graph shows the data obtained from the data logger.



Determine the velocity of the trolley at 1.5 s.

1.5 V represents a distance of 2.00 m.

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Velocity = ...

(c) The student calculated the velocity of the trolley at 2.0 s to be 1.5 m s^{-1}.

By considering the acceleration of the trolley, determine whether the student's measurement of θ was within the uncertainty quoted.

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(Total for question = 11 marks)