PHYSICS

IB1

Examination

Paper 1

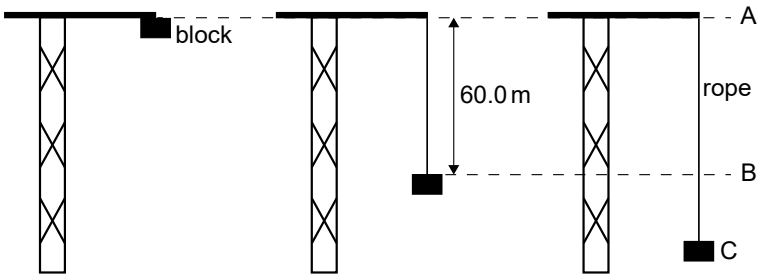
Wednesday 31th of March 2021

Name : *Lia*

9 problems Total: / 62 marks

Problem 1 *[12 marks]*

An elastic climbing rope is tested by fixing one end of the rope to the top of a crane.
The other end of the rope is connected to a block which is initially at position A.
The block is released from rest. The mass of the rope is negligible.



The unextended length of the rope is 60.0 m. From position A to position B, the block falls freely.

(a) At position B the rope starts to extend. Calculate the speed of the block at position B. [2]

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(b) At position C the speed of the block reaches zero. The time taken for the block to fall between B and C is 0.759 s. The mass of the block is 80.0 kg.

(i) Determine the magnitude of the average resultant force acting on the block between B and C. [2]

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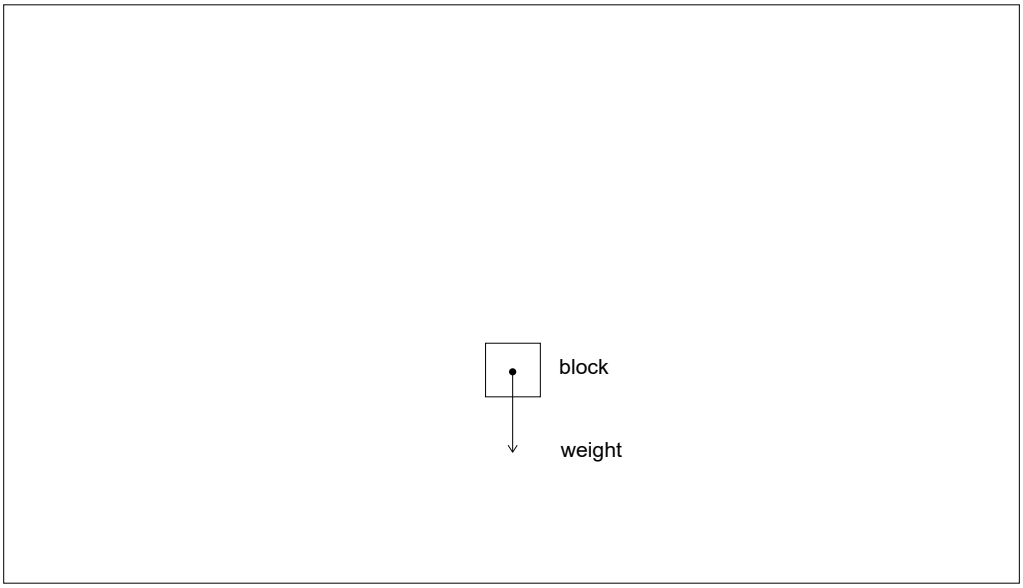
(ii) Sketch on the diagram the average resultant force acting on the block between B and C. The arrow on the diagram represents the weight of the block. [2]



(iii) Calculate the magnitude of the average force exerted by the rope on the block between B and C. [2]

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(c) For the rope and block, describe the energy changes that take place

(i) between A and B. [1]

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(ii) between B and C. [1]

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(d) The length reached by the rope at C is 77.4 m. Suggest how energy considerations could be used to determine the elastic constant of the rope. [2]

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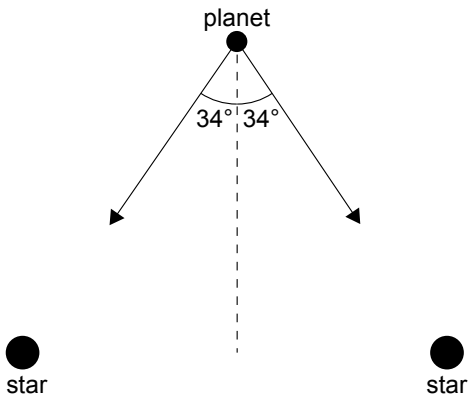
Problem 2 *[5 marks]*

The two arrows in the diagram show the gravitational field strength vectors at the position of a planet due to each of two stars of equal mass *M*.



Each star has mass $M = 2.0 \times 10^{30}$ kg. The planet is at a distance of 6.0×10^{11} m from each star.

(a) Show that the gravitational field strength at the position of the planet due to **one** of the stars is $g = 3.7 \times 10^{-4}\,\text{N kg}^{-1}$. [1]

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(b) Calculate the magnitude of the resultant gravitational field strength at the position of the planet. [2]

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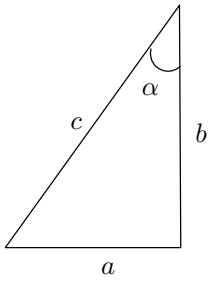
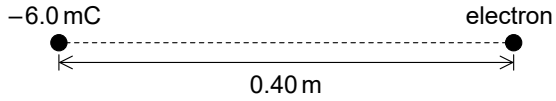
some help :



$\frac{b}{c} = \cos(\alpha)$

Problem 3 *[5 marks]*

An electron is placed at a distance of 0.40 m from a fixed point charge of –6.0 mC.



(a) Show that the electric field strength due to the point charge at the position of the electron is $3.4 \times 10^8\,\mathrm{N\,C^{-1}}$. [2]

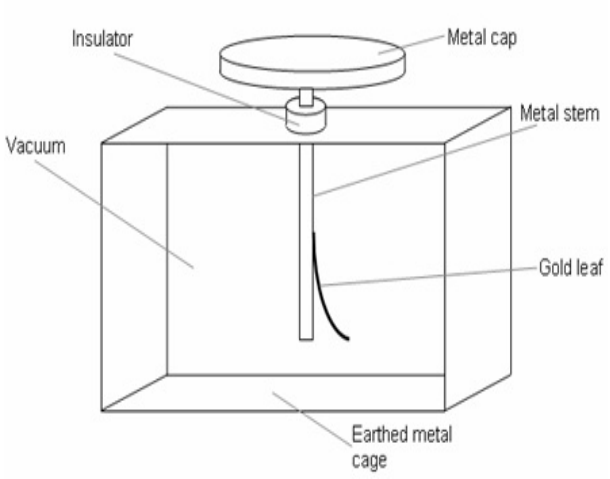
(b) (i) Calculate the magnitude of the initial acceleration of the electron.

(ii) Do you expect this acceleration to be constant ?

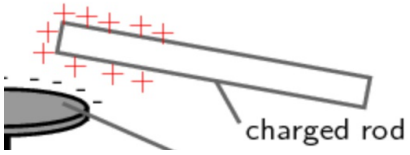
Problem 4 *[5 marks]*

An electroscop is made of a box (cage) in *insulator*. One gold leaf suspended from a metal stem in a vacuumed glass jar and connected to a metal cap, as shown in the picture below.

When no charge is present the metal leaves hang loosely downward.



1) Explain what happen to the gold if an rod with a positive charge is brought near the electroscope, *without touching* the metal cap.



cap

2) Explain what happen to the gold if the rod with a positive charge is brought very close to the electroscope, and touches the metal cap.

Problem 5 *[5 marks]*

In a simple model of the hydrogen atom, an electron orbits the proton. Both electron and proton are regarded as point charges. The orbital radius of the electron is 5.0×10^{-11} m.

a) Show that the magnitude of the electric force between the electron and the proton is

9.3×10^{-8}N.

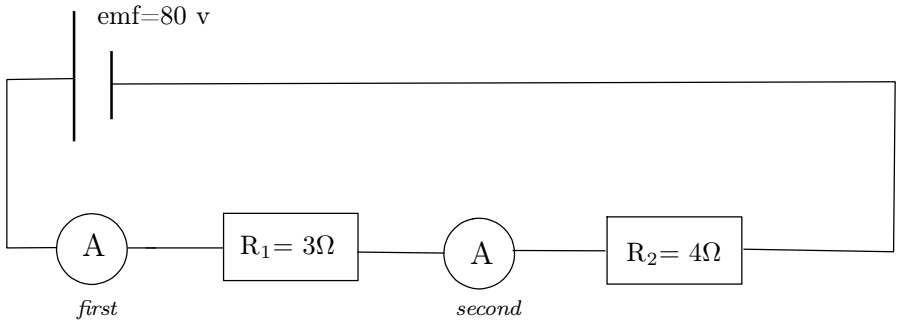
b) Explain why the motion or the electron is circular

c) Find the speed of the electron

d) Deduce that the kinetic energy of the electron is 2.3 % 10–18 J.

Problem 6 *[5 marks]*

Let us consider the following situation



1) Describe how the two resistors are disposed.

2) The first anmeter measures 10A, what measures the second anmeter ?

3) Give a definition of *emf* and a definition of i*nternal resistance*.

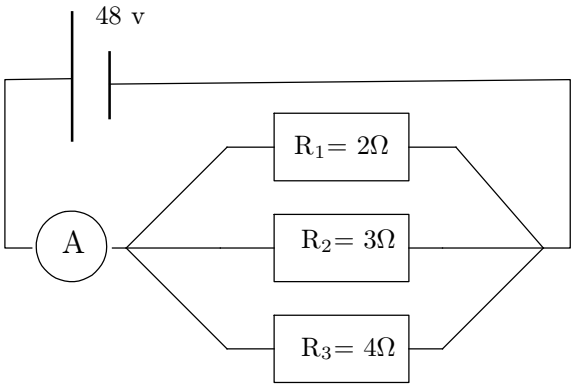
4) Find the value of the internal resistance of the cell.

Problem 7 *[12 marks]*

1) Show the direction of the current

2) Show the direction of the displacement of the electrons

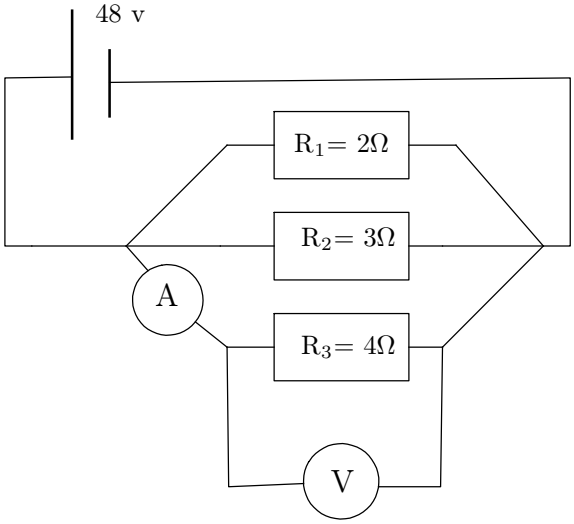
3) What will measure the ammeter ?



4) What will measure the ammeter if we move it like shown in the second picture ?

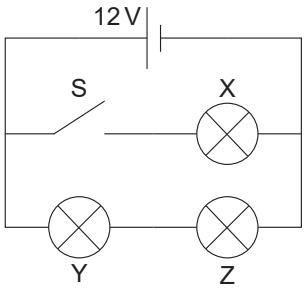
5) What is the *tension* measured by the voltemeter ?

6) What is the *power* transformed by the resistor R_3 ?



Problem 8 *[6 marks]*

Three identical light bulbs, X, Y and Z, each of resistance 4.0 Ω are connected to a cell of emf 12 V. The cell has negligible internal resistance.



(a) The switch S is initially open. Calculate the total power dissipated in the circuit. [2]

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(b) The switch is now closed.

(i) State, without calculation, why the current in the cell will increase. [1]

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(ii) Deduce the ratio $\frac{\text{power dissipated in Y with S open}}{\text{power dissipated in Y with S closed}}$. [2]

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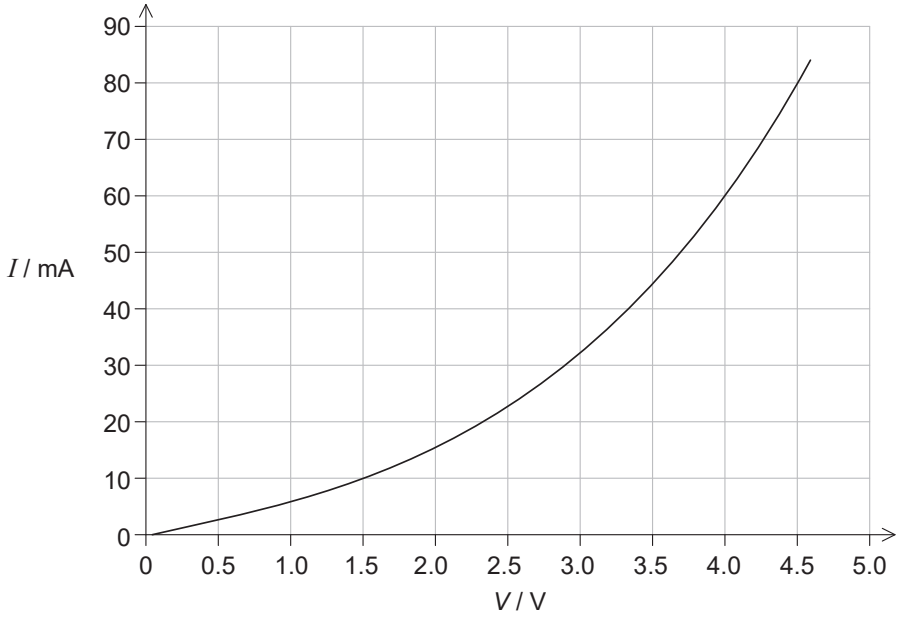
Problem 9 *[7 marks]*

The graph shows how current *I* varies with potential difference *V* across a component X.



(a) According to this graph

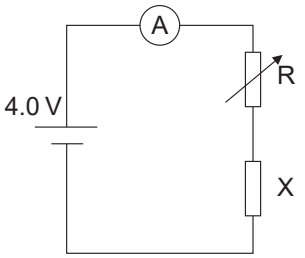
i) What is the currant (I) when the tension (V) is 4V ?

ii) Using the relation V=RI, show that when V=4V, the resistance of the resistor X is 66.7Ω

iii) Estimate the voltage (V) when the current (I) is 10mA ?

iv) Using the relation V=RI, estimate the resistance of the resistor when the current (I) is 10mA ?

(b) Component X and a cell of negligible internal resistance are placed in a circuit.
A variable resistor R is connected in series with component X. The ammeter reads 20 mA.



(i) Determine the resistance of the variable resistor. [3]