Question 1. Ohm's Law and Circuits

Given:
- $R_1 = 100\,\Omega$
- $R_2 = 200\,\Omega$
- $R_3 = 300\,\Omega$
- $R_4 = 400\,\Omega$

a) Calculate the voltages at points A, B, C, and D.

b) Calculate the current flowing from the battery, and mark on the diagram the direction of the current.

c) Calculate the equivalent capacitance between points A and B.

d) You have an RC circuit with a time constant of 25 ms and it has a resistance of 1736\,\Omega. What is the value of the capacitor?
**Question 2. Electrical Energy Generation and Faraday's Law**

A rectangular one turn wire loop rotates at 248 revolutions per minute. Its length and height are 23.6 cm and 17.8 cm. A magnetic field oriented perpendicular to the axis of rotation is slowly increasing at 0.0371 T/second and started at a magnetic field strength of 0.27T at t = 0 seconds. (Assume that a cosine function can be used to describe the rotation of the loop and at t = 0 its phase angle = 0.)

a) Write down the time dependent equation for the magnetic flux of this "rotating loop – B field" electric power generator.

b) Using Faraday's Law calculate the emf generated in the loop.

c) Calculate the current flowing in the loop circuit at 3.6 seconds given that the loop resistance is 0.037Ω.

**Question 3. Relativity**

Scientists in a 173m long rocket moving past a terrestrial (ground based) laboratory at 0.995C observe subatomic particles that live for 23 ms in that laboratory.

a) What is the proper life span for these particles?

b) To the ground based observer, how long is the rocket?

This subatomic particle has a mass of $1.53 \times 10^{-30}$ Kg.

c) Calculate its rest mass energy in Joules and in eV.

d) At what speed would it have to be approaching you to have a total energy of 12 times its rest mass energy?