Year 1 Assessed Problems

Semester 2

Assessed Problems 2

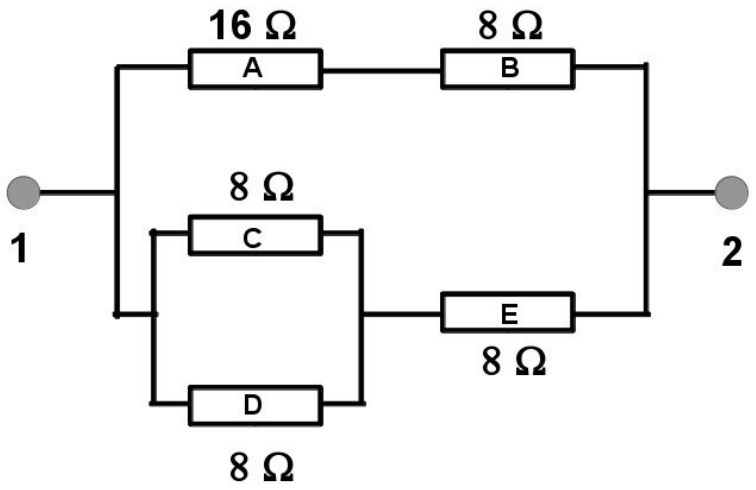
SOLUTIONS TO BE SUBMITTED ON CANVAS BY

Wednesday 5th February 2025

at 17:00

ELECTRIC CIRCUITS, Problem Sheet 1

1. Using the electric circuit schematic given below:
   (a) Find the equivalent resistance between points 1 and 2.
   (b) If the potential drop between (1) and (2) is 16 V, find the current through each resistor.
   (c) Calculate the power dissipated in each of the resistors in the circuit.



Continuous Assessment I

Continuous Assessment for Chaos is centred around two analogue exam questions which can be found on canvas.

1. The energy of an oscillator is

$$E = \frac{1}{2}\left[\frac{dx}{dt}\right]^2 + \frac{1}{8}\left(x^2 - 1\right)^2$$

and is conserved. Determine the equations of motion. **[5]**

2. Find the two types of small-scale oscillations and provide the lowest order representation for the trajectory of these oscillations, including the time dependence. **[5]**

Maths for Physicists 1B Assessed Problem 1

The function $f(x, y) = x^2 - y^2$ where $x = u \sec v$ and $y = u \tan v$.

(a) Evaluate the partial derivatives $\frac{\partial f}{\partial x}$, $\frac{\partial f}{\partial y}$, $\frac{\partial x}{\partial u}$, $\frac{\partial x}{\partial v}$, $\frac{\partial y}{\partial u}$, $\frac{\partial y}{\partial v}$, and write the results in terms of u and v. **[3]**

(b) By direct evaluation of both sides of each equation, prove that

$$\frac{\partial f}{\partial u} = \frac{\partial f}{\partial x}\frac{\partial x}{\partial u} + \frac{\partial f}{\partial y}\frac{\partial y}{\partial u} \quad \text{and} \quad \frac{\partial f}{\partial v} = \frac{\partial f}{\partial x}\frac{\partial x}{\partial v} + \frac{\partial f}{\partial y}\frac{\partial y}{\partial v}. \quad \textbf{[7]}$$

Classical Mechanics and Special Relativity 2
Assessed Problem 1

(a) A muon lives for 2×10^{-6} s before decaying, as measured in its rest frame. The muon is created in the upper atmosphere and moves towards the Earth at a speed of 0.99c. From the point of view of an observer on Earth, how far does the muon travel before it decays?

(b) GPS satellites use precise clocks to locate where they are relative to Earth. A satellite in orbit moves at 10,000 km/h relative to the Earth's surface.

- By how much time per day would a failure to take the effects of special relativity into account make the clock incorrect?
- How far would the satellite travel in this time as measured by an observer on the Earth?