SPH4U

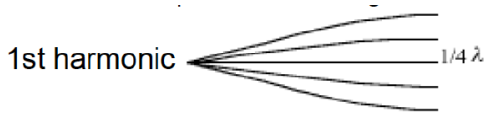
Near Space Culminating Project

This project constitutes 10% of the overall grade for the course. You are to prepare a typed document. For clarification of the evaluation see the rubric at the end of this document for details.

PART 1: Concepts and Calculations

1. The total mechanical energy in a system is given by $E_{Total} = E_K + E_g$ where E_g is gravitational potential energy and E_K is bulk kinetic energy. From the Law of Conservation of Energy we would expect the system to have the same total energy when the balloon is on the ground as it has at its apex if we ignore air resistance. Describe the "system" in this case and explain the source of the gravitational potential energy before the flight when the balloon is on the ground.

2. Radio waves are used to track the balloon while in flight. These waves can be received by an antenna if the antenna resonates with the specific frequency sent. Like sound, when electrical waves at a defined frequency hit the end of an antenna they are reflected backwards and form a standing wave in the antenna.



The electrical waves created on and received by antennas have a fixed wavelength. If the length of the antenna is compatible, it will resonate. The free end of an antenna acts like an open circuit. Voltage drop is maximum across an open circuit and zero across a short circuit. Hence the end of an antenna forms an anti-node or area of maximum voltage or e-field strength. A node is a point which has zero e-field. The distance between an anti-node and node is a quarter of a wavelength.

If the APRS frequency in North America is 144.39 MHz, determine the length of the $\lambda/4$ antenna.

3. Radio waves are electromagnetic waves that travel at the speed of light. Calculate how long it takes to receive a radio transmission at earth's surface if it is transmitted from…
a. The ISS
b. The Moon
c. Mars at its closest distance to Earth

4. Explain how helium atoms are created in the core of a star. What is the source of helium on Earth? Other than balloons, what is helium used for on Earth? Explain why we are undergoing a global helium shortage. Explain how helium is created artificially on Earth.

5. Describe one change, innovation, experiment or improvement that could be made on a future mission, and a strategy or plan for implementation of your idea.

PART 2 - Data Analysis

Using data from the payload sensors, cameras or the APRS system (aprs.fi) provide an analysis of one aspect of the flight. The purpose of your analysis and implications for future missions should be discussed. Your analysis could include a graph, known formulas from class and individual research, diagrams, images, explanations, formal definitions and calculations. Your report must include a complete and thorough description of each step in the analysis and all relevant physics concepts, and any implications this may have on future missions. You are to include references in APA format for all research sources.

Some ideas of possible analyses are:

- Image analysis to determine the altitude of the camera
- Calculation of altitude from pressure data
- Temperature/pressure/altitude analysis
- Use compass data to examine altitude/rotation/acceleration
- Orientation/Altitude/Temperature and solar panel effectiveness
- Using accelerometer data to generate acceleration-time, velocity-time and distance-time analysis

Project Proposal:

Each student is to submit a proposal that includes a paragraph describing the analysis, the set of data or image that will be used, and at least three sources of scientific information on the topic listed in APA format. Select a topic early and speak to the teacher as soon as possible as no duplicate analyses will be allowed.

Task	Performance Level					Mark
Q1 – description of concept is thorough and uses subject specific terminology	<1	1	2	3	4	
Q2, Q3 – calculations complete, correct and demonstrate proper notation	<1	1	2	3	4	
Q4 – description of concept is thorough, uses terminology, images and diagrams	<1	1	2	3	4	
Q5 – proposal is thoroughly described, feasible and applicable to physics	<1	1	2	3	4	
Data - Project Proposal is feasible, interesting and thoroughly described	<1	1	2	3	4	
Data – purpose and implications of analysis are clearly described	<1	1	2	3	4	
Data – data presented in a curated format	<1	1	2	3	4	
Data – graphical analysis or calculation is thorough, correct and complete	<1	1	2	3	4	
Data – discussion of relevant physics concepts is thorough, correct and complete	<1	1	2	3	4	
Data – research sources are reputable, relevant and correctly referenced/cited	<1	1	2	3	4	
				MARK (OUT OF 100):		

Below Level 1 – 4 Level 1 – 5 - 6 Level 2 – 6 - 7 Level 3 – 7 - 8 Level 4 – 8 – 10