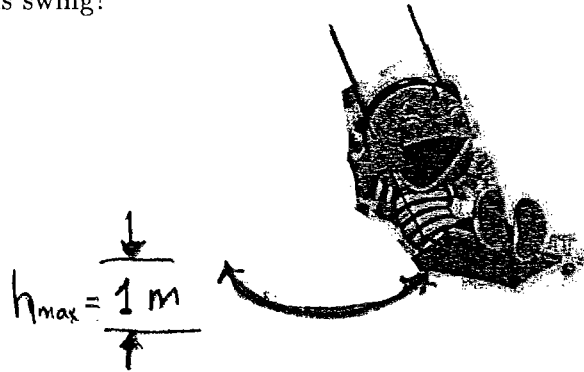


1. In a universe where the speed of light is only 50 km/hr, a football player scores an apparently game-winning touchdown just as the final gun is fired. The coach of the opposing team demands that Albert Einstein, who is moonlighting as the referee, review the play on instant replay. The replay from a camera on the football field shows that the pass was completed before the gun was fired, while the replay from a camera on the Goodyear Blimp, flying overhead at a speed of 40 km/hr, shows the gun being fired before the ball was caught. Could both replays be correct? Explain.
2. How much mass is converted into energy in a 1000 Megawatt nuclear power plant during one year of operation? (1 Megawatt = 1 million watts = 10^6 watts = 10^6 joules/sec)
3. The Sun's mass is 2×10^{30} kg and its total power output is 4×10^{26} Watts. a) What fraction of the Sun's mass is converted to energy each second? b) each year?
4. What type of star would you guess to be cooler, *red* giants or *white* dwarfs? Why?
5. When paper burns, the flame is orange. When natural gas burns the flame is blue. What does this tell us about the differences in temperature between a burning paper and burning natural gas?
6. When soldiers use infrared-sensitive glasses during nighttime battles, what infrared light are they looking for?

7. A 15 kg child plays on a swing has a natural frequency of 0.3Hz. She swings with an amplitude such that her maximum vertical displacement is 1 m.

a) What is the quantum of energy for this swing?

b) What is her total energy?



c) What is the value of her quantum number n for her motion?

8. Consider the previous problem except now imagine that the child lives in a universe where Planck's constant is $h = 100 \text{ Js}$ (as opposed to its value in our universe of $h = 6.6 \times 10^{-34} \text{ Js}$).

a) What would her quantum of energy be?

b) What would the quantum number n of her motion be?

c) Describe what the girl's motion on the swing would look in the this $h = 100 \text{ Js}$ universe.

9. Even though people studied the laws of nature throughout history, quantum effects were not realized until the twentieth century. Why were they so easy to overlook?