HW2 Solutions

1

The earth is in orbit around the sun so our view of the sky changes every night.

2

In class it was written $P^2 \propto a^3$ or $\frac{P_1^2}{P_2^2} = \frac{a_1^3}{a_2^3}$ whereas the textbook has $P^2 = a^3$. This is only valid for certain scenarios compared to $P^2 \propto a^3$ which is correct in general.

3

On our ideal island high tide is around midday and midnight, specifically 12:00 AM and 12:25 PM.

4

The highest tides occur when it is a Full Moon or a New Moon; they're called the spring tides. At these phases the moon is aligned with the sun such that the gravitational pull from both is at a maximum.

5

The surface flux of a black body is given by $F = \sigma T^4$. With a cube of side length $10^2 Mpc$, the surface area is $SA = 6 * (10^4 Mpc^2)$. The CMB temperature is about $2.7K$. $\sigma = 5.67 \times 10^{-8} W m^{-2} K^{-4}$. $1Mpc = 3.086 \times 10^{22} m$.

The energy lost by this volume in 1 second is then:

$$\dot{E} = F * (SA)$$

$$\dot{E} = (5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4}) * (2.7\ K)^4 * (6 * (10^4\ Mpc^2))$$

$$\dot{E} = 1.786 \times 10^{44}\ W$$

6/7

This time period is when the sun is incident on the tropical waters in the Northern Hemisphere meaning the ocean waters are at their warmest, the air above is very humid, and the pressure at the surface is low.

The latitude should be between 5° to 23.5° N. No hurricanes can occur at the equator due to the lack of the Coriolis effect and with the need for warm waters the latitude should be within the tropics (23.5° N).

For the southern hemisphere hurricane season is expected to occur during their late-summer to early-fall so Jan-Apr. It should also occur between 5° to 23.5°S.

8

For Mars $a = 2.279 \times 10^8 km$ and $e = 0.093$:

$$r_{pe} = a(1-e) = 2.067 \times 10^8 km$$

$$r_{ap} = a(1+e) = 2.492 \times 10^8 km$$

9

Astronauts aren't weightless during launch as they experience the acceleration from the rocket. Similarly on their return to Earth they feel the deceleration from the rocket/parachute so they are not weightless.

10

The US energy consumption rate is $10^{20} J/yr$, the fusion rate of hydrogen is $7 \times 10^{13} J/L$. Then we would need:

$$\frac{10^{20}\ J/yr}{7 \times 10^{13}\ J/L} \frac{1}{525600\ min/yr} = 2.72\ L/min$$

The kitchen faucet was assumed to have a rate of 1 L/min meaning the energy needs would not be met.