ENAE 483/788D CREW SYSTEMS SPECIALTY PROBLEMS – FALL, 2020

(1) Calculate the decompression R-values for each of the following transitions

(a) From Earth sea level (14.7 psi, 21% O_2) to a lunar habitat (10.2 psi, 34% O_2)

$$R = \frac{pp_{N_2\ start}}{P_{final}} = \frac{0.79(14.7)}{10.2} = \boxed{1.139}$$

Note that it doesn't actually matter what the N_2 partial pressure is after the decompression, the degree of supersaturation of N_2 in the blood stream is strictly based on the prior ppN_2 and the final total pressure.

(b) From a lunar habitat (10.2 psi, 34% O_2) to a Shuttle-type pressure suit (4.3 psi, 100% O_2)

$$R = \frac{pp_{N_2\ start}}{P_{final}} = \frac{0.66(10.2)}{4.3} = \boxed{1.566}$$

(c) From a habitat at Earth sea level pressure (14.7 psi, 21% O_2) to an Russian Orlan pressure suit at Stage I (6.7 psi, 100% O_2)

$$R = \frac{pp_{N_2\ start}}{P_{final}} = \frac{0.79(14.7)}{6.7} = \boxed{1.733}$$

(d) From a habitat at Earth sea level pressure (14.7 psi, 21% O_2) to an Russian Orlan pressure suit at Stage II (5.8 psi, 100% O_2)

$$R = \frac{pp_{N_2\ start}}{P_{final}} = \frac{0.79(14.7)}{5.8} = \boxed{2.002}$$

(e) From a habitat at Earth sea level pressure (14.7 psi, 21% O_2) to an "zero pre-breathe" pressure suit (8.3 psi, 100% O_2)

$$R = \frac{pp_{N_2\ start}}{P_{final}} = \frac{0.79(14.7)}{8.3} = \boxed{1.399}$$

(2) You would like to generate 0.5 Earth gravity (4.9 m/sec^2) in the transit habitat for the trip to and from Mars.

(a) If the crew can tolerate 3 rpm, what is the required radius of the spinning habitat?

$$\omega = (3\ rpm)\frac{2\pi\ rad/rev}{60\ sec/min} = 0.3142\ rad/sec$$

$$a_{centripetal} = \omega^2 r \Longrightarrow r = \frac{a_{centripetal}}{\omega^2} = \frac{4.9}{0.3142^2} = \boxed{49.63\text{ m}}$$

(b) The habitat has two decks, 2.5 m apart. If the system is designed to provide 0.5 Earth gravity at the floor of the upper deck, what is the gravity at the floor of the lower deck?

$$a_{centripetal} = \omega^2 r = 0.3142^2(49.63 + 2.5) = \boxed{5.146\text{ m/sec}^2}$$