Problems
Chapter 1

1.2-1   Determine expected work performance times for work at the following rates:

        100
        200
        300
        400 N·m/sec

1.2-2   Using Riegel's endurance equation, calculate the expected distance men over 40 would run for the performance times determined in question 1.2-1.

1.2-3   For the work rates of question 1.2-1, what are the expected limitations to exercise for each of the exercise rates?

1.2-4   Use the Riegel equation to calculate the endurance time for running a distance of 10 km. State all assumptions.

1.2-5   Working at a rate of 300 W will likely result in what type of exercise limitation? What if the work rate were 200 W instead?

1.2-6   Men engaging in competitive Nordic skiing have average speed times given by what equation?

1.3-1   What are the expected relative contributions of aerobic and anaerobic processes for the work rates of question 1.2-1?

1.3-2   Estimate the oxygen requirement for each of the work rates in question 1.2-1.

1.3-4   Johnny is at the gym performing squats. He is doing this exercise at 90% of maximal torque. How long can he maintain the weight on his back before he must drop it?

1.3-5   A mad scientist is performing an experiment while a poor graduate student runs on a treadmill at a constant speed. The scientist wants to determine the equilibrium heartbeat, but he only takes one measurement 10 sec after running begins. What is the expected error of measurement?

1.3-6   Calculate the endurance times for the work rates in problem 1.2-1.

1.3-8   If a subject performs by walking on a treadmill at 100 N·m/sec for over 90 minutes, what would be the expected reason for stopping?

1.3-10   Calculate the energy equivalence of the oxygen consumption calculated in question 1.2-4. State all assumptions. Compare with values from Table 5.2.22, page 399.

1.3-11   Oxygen uptake increases exponentially with a time constant of about 49 sec. If a resting person suddenly increases her exercise level to an oxygen requirement of 3×10^{-5} m^3/sec, and maintains that level for 300 sec, what is the oxygen deficit incurred?

1.3-12   Why is the replenishment of an oxygen deficit at the end of exercise always larger than the original oxygen deficit incurred?

1.3-13   What is the anaerobic threshold? Why is it difficult to determine precisely?

1.3-14   How does oxygen uptake vary with exercise work rate?

1.3-15   A constant level of exercise is maintained for 480 sec. What fraction of the maximum oxygen uptake is represented by that work rate?

1.3-16   Explain the energy relationship in muscles as exercise begins. What is the source of the energy, is metabolism aerobic or nonaerobic, and what is the consequence of this metabolism?

1.3-17   What are the total oxidative energy stores and how much energy is typically generated from each?

1.3-18   How is oxygen consumption related mathematically to rate of work?

1.3-19   Define maximum oxygen uptake.

1.3-20   Why is Excess Postexercise Oxygen Consumption greater than the oxygen deficit?

1.3-21   How does maximum oxygen uptake compare between arm-only and leg-only exercise?

1.3-22   What is the maximum oxygen uptake expected for you? How much is the potential gain if you were to train intensely?

1.3-23   What is the meaning of the anaerobic threshold?

1.3-24   Explain peak and decline in exhaled CO_2 concentration with time in the Skinner and McLellan scheme of exercise.

1.3-25   Explain what happens in Margaria's hydraulic model of exercise with an exercise level greater than that corresponding to maximum oxygen uptake.

1.3-26   A person works at a rate of 250 N·m/sec. How long would you expect her to work at that rate?

1.3-27   Look up the energy expenditure of cleaning windows in Table 5.2.22. Predict how long you could work at that job.

1.3-28   Compare the expected distribution of fast-twitch and slow-twitch muscle fibers in a long-distance runner and a sprinter.

1.4-1   Study Figure 1.4.1. Notice that heart rate becomes steady at about 300 sec but increases thereafter. Why?

1.4-2   How does heart rate change in response to a prolonged exercise session?

1.4-3   Graded exercise tests usually progress by holding a given level of work rate for a certain length of time and then increasing the work rate suddenly and holding it constant again for a while. The test thus progresses in a stepwise fashion. Calculate the minimum amounts of time at each step needed to assure less than 5% error in the following parameters: heart rate, respiratory rate, oxygen uptake, and body temperature.

1.4-4   Rank from fastest to slowest the responses at the beginning of exercise in body temperature, heart rate, oxygen consumption, and respiration.

1.7-1   A man runs at a steady rate in the aerobic range for 1/2 hr then rests for 1/2 hr. Sketch the heart rate, oxygen uptake, and thermal load for the 1 hr period.

1.7-2   Steve Austin III, a very average astronaut, has just landed on Mars. He needs to lift an object that requires him to use about 200 N·m/sec of work. Houston has calculated that he needs about 3 min to do this task on Mars. What would be Steve's maximum oxygen uptake? How many liters of oxygen will he consume during 1.75 min to three min? If the work rate is constant at 200 N·m/sec and he was forced to continue, what will be his expected voluntary performance end time, final heart rate, and final exhalation time average? If he were ordered to wear a rectal probe by his grandfather Steve Austin I, what would be his core temperature at termination of this 200 N·m/sec work?

1.7-3   What is the expected value of endurance time for exercise if the minute ventilation is 3.5 L/min?

Problems
Chapter 2

2.2.2-1 The forearm is used to lift a load of 10 N. Would you expect the force produced by the forearm muscle to be less than, equal to, or greater than the lifted load?

2.2.2-2 Of what advantage is the class 3 lever in muscular work?

2.2.2-3 People who hurt their legs often walk leaning to the hurt side. This should be expected to put more of their body weight on that side. Why then, do they walk in this way?

2.2.2-4 The astronaut, Steve Austin III, while returning from Mars, crashes the space ship and loses his right arm and two legs. The Biomedical industry has the technology to rebuild him for less than a million dollars. In fact, with the cost of technology being significantly cheap, all the various components can be purchased for less than 200,000 dollars. The doctor who will rebuild the muscles and bones needs to know the description of the various classes of levers because he has lost the instruction manual. Help him out.

2.2.3-1 If you run at a rate of 7.6 m/sec and then perform a high jump, what is the estimate of your jumping height?

2.2.3-2 For the length of your leg, what is the speed of most effortless walking?

2.2.3-3 You are the engineer in charge of tuning the track for an indoor track meet. You expect the running speeds to be about 1.8 m/sec (15 mi/hr). What is the banking angle of the turns?

2.2.3-4 The Olympic Committee has proposed an exhibition event for the Olympic games: the Walking High Jump. High jumpers replace their traditional running start with a standard walking approach. Estimate the maximum theoretical jump height for a competitor with a 1.2-meter leg length.

2.2.3-5 A grad student fractures both the tibia and fibula of the right leg falling down a flight of stairs while rushing to get to the Santa Fe Cafe before the end of Happy Hour. One week later, at Happy Hour, the student offers to buy the next round if you can determine how much extra energy is expended due to the use of crutches rather than walking. The crutches are 130 cm in length, the student's legs are 90 cm long and a nominal step length is 75 cm. Make any needed assumptions.

2.2.3-6 A high jumper runs at 7m/s. An unusual high 50% of the energy is lost in friction. The rest is used to gain height. Compute this height.

2.2.3-7 Calculate your walking speed.

2.3-1 Assuming a muscular efficiency of 20%, specify a meal to provide enough energy to walk 25 km.

2.3-2 How long would a 630 N person have to run in order to work off an apple, a cup of green beans and a boiled egg? How long would they have to cycle? Recline? How long would it take this same person to work off a T-bone steak, a 120 mL cup of peas, and 1 L of ice cream? Cycling? Reclining? Graph the differences.

2.3-3 You are very hungry. You go to a fast food restaurant and eat five hamburgers!!!! Suddenly, after having eaten all that food, you decide to run your bike until all that energy is transformed into positive work! How long do you have to ride your bike to do so?

2.4.1-1 Why is walking so inefficient? What can be done to increase the efficiency of locomotion?

2.4.2-1   What is the consequence of walking at a different rate than the optimum?

2.4.2-2   Compare open-loop and closed-loop (feedback) control. Under what circumstances is each used in walking?

2.5.2-1   If you measured your peak force developed during a dynamic lifting strength test to be 570 N, what would be your maximum expected repetitive lifted load?

2.5.2-2   If a woman were to work for UPS in the loading area, what is the maximum load she could constantly lift during her work shift? What is this value for a man? How do these values compare?

2.6-1   If you were performing static work of the elbow that required 15 N·m of muscle torque at 90-degree joint angle, what would be your predicted time to exhaustion? What minimum rest time would you recommend?

2.6-2   At what value of $\dot{V}_{O_2}/\dot{V}_{O_2\,max}$ are the predicted endurance time and rest time equal?

Supplement 3.10

Problems
Chapter 3

3.2.1-1   Calculate the percentage hemoglobin saturation for a temperature of $37^{\circ}C$, pH of 7.40, pCO_2 of 5300 N/m^2 and pO_2 of 13.0 kN/m^2. If the temperature changes to $38^{\circ}C$, what is the hemoglobin saturation?

3.2.1-2   If blood pH falls to 7.2, what is the ratio of bicarbonate to carbonic acid concentrations?

3.2.1-3   What is the volume of circulating blood in yourself?

3.2.1-4   If the percentage of oxygen in your lungs is 14%, what is the volume of oxygen dissolved in your blood? What is the volume of oxygen carried by your hemoglobin?

3.2.1-5   Estimate values of the consistency coefficient and flow behavior index for blood with 60% hematocrit at $37^{\circ}C$.

3.2.1-6   Human blood is characterized as (Newtonian, pseudoplastic, dilatent, Bingham plastic). How would various factors influence the viscosity of blood during prolonged exercise?

3.2.1-7   What are normal values for:

   a.   hematocrit
   b. O_2 partial pressure
   c. CO_2 partial pressure
   d.   pH

   of human blood?

3.2.1-8   Conditions in working muscle tend to make more oxygen available than would otherwise be expected based on the standard oxygen saturation curve for hemoglobin. What conditions are especially important?

3.2.1-9   What is the bicarbonate buffering equation for the blood?

3.2.1-10   Human blood contains many long-chain molecules in suspension. What type of non-Newtonian fluid would you expect it to be? Compare the viscosity of blood in the center and at the blood vessel wall.

3.2.1-11   Calculate the amount of oxygen dissolved in the pulmonary venous blood if the percentage of oxygen in the alveolus is 9%.

3.2.1-12   Referring to Table 3.2.1, how much oxygen and carbon dioxide are probably in the blood? In what forms are they?

3.2.1-13   Indicate which parts of equation 3.2.3 are important in what parts of the body.

3.2.1-14   Calculate percent oxygen saturation of hemoglobin for a pO_2 of 100 mm Hg. Indicate how conditions in the working muscles would change this percentage.

3.2.1-15   Estimate the additional blood pressure required to maintain blood flow after doping with additional red blood cells.

3.2.1-16   A group of aliens has been conducting a study of the human body. They have concluded that it would last longer if it ran 10 deg C cooler. If the total quantity of hemoglobin were changed to allow the same oxygen carrying capacity at this new body temperature, what change in blood volume would be required?

3.2.1-17   Estimate values of consistency coefficient and flow behavior index for blood with 60% hematocrit at 37 deg C.

3.2.1-18   Explain the effect of carbon dioxide, pH, and temperature on hemoglobin dissociation and how it differs during rest and exercise.

3.2.2-1   In what part of the body is vascular resistance the greatest?

3.2.2-2   Why does muscular activity prevent blood pooling in the legs?

3.2.2-3   Estimate the vascular resistance of the aorta, capillary bed, and left ventricle.

3.2.2-4   Calculate the pressure drop in the brain using the data in Table 3.2.3 and Equation 3.2.12. Does the answer make sense? Why or why not?

3.2.2-5   Calculate normal blood flow through the following organs for rest and exercise conditions:

	Rest	Exercise
Lungs		
Gastrointestinal tract		
Heart		
Kidneys		
Bone		

Brain
Skin
Muscle

3.2.3-1 State Starling's Law of the Heart.

3.2.3-2 According to the Law of Laplace, high pressures inside spheres can result in low wall shear stresses depending on what two geometrical parameters?

3.2.3-3 Compare resting heart rates for rats, dogs, and camels.

3.2.3-4 The body is cooled to hypothermic conditions during open-heart surgery. Is the work of the heart more, the same, or less during these conditions? What factors contribute to or answer?

3.2.3-5 Calculate the oxygen uptake by the heart muscle for an adult human with an oxygen consumption of 4.17 x 10^{-6} m^3/sec. Partition this value into contributions toward blood potential energy (pressure), kinetic energy (velocity), and waste.

3.2.3-6 Estimate flow resistances of the blood vessels listed in Table 3.2.6.

3.2.3-7 Estimate systolic and diastolic blood pressures for males and females 100 years of age.

3.2.3-8 Estimate the average tensile stress in the wall of the heart ventricle.

3.2.3-9 What is preload? What is afterload?

3.2.3-10 Estimate your blood volume and resting cardiac output. How long on average does it take for your blood to complete a loop through the cardiovascular system?

3.2.3-11 Develop prediction equations for stroke volume, heart rate, and cardiac output as functions of $(\dot{V}_{O_2} / \dot{V}_{O_2 max})$.

3.2.3-12 What is the predicted maximum heart rate for you?

3.2.3-13 Develop prediction equations for systolic, diastolic, and mean blood pressure as functions of age. Use these equations to predict what your blood pressures will be when you reach age 100.

3.2.3-14 What is your expected maximum oxygen consumption?

3.2.3-15   If a person 25 years old has a resting heart rate of 65 beats/min and exercises at 70% of $\dot{V}_{O_2\,max}$, what is the expected exercise heart rate?

3.2.3-16   A 29-year-old male has a stroke volume of 122 ml and a total peripheral resistance of 19 mm Hg/L/s when exercising vigorously. Estimate his mean arterial blood pressure at maximal heart rate.

3.2.3-17   An exceptional 26-year-old male long distance runner decides to play some football instead. How long will he be able to play?

3.2.3-18   Calculate the VO_2 max and HR max of a 65-year-old female. Give an estimate of her stroke volume.

3.3.1-1   Formulate a mathematical expression for firing rate of a carotid baroreceptor as a function of arterial pressure and rate of change of arterial pressure. Be sure to estimate numerical values of all parameters.

3.3.1-2   What are the two autonomous nervous systems that innervate the heart, and what is the effect of each?

3.3.1-3   Define inotropic and chronotropic effects.

3.3.1-4   Diagram the blood pressure control system.

3.3.1-5   Calculate the Total Peripheral Resistance of the systemic blood flow system at rest and during exercise. Estimate the additional blood pressure required to maintain blood flow after blood doping with additional red blood cells.

3.3.1-6   Where are the blood pressure sensors important for cardiovascular control located? What determines the firing rate of a carotid baroreceptor? Why is this important?

3.3.1-7   Explain the roles of central regulation and autoregulation in cardiovascular control.

3.3.1-8   Formulate a mathematical expression for systemic arterial pressure as a function of carotid sinus pressure and rate of change of carotid sinus pressure.

3.3.2-1   List humoral (chemical) cardiovascular regulators and their effects.

3.3.4-1   Compare the duration of systole at 20% $\dot{V}_{O_2\,max}$ and 70% $\dot{V}_{O_2\,max}$.

3.3.5-1   Before Steve's tragic loss of limbs, the space ship's heating system malfunctioned and caused the temperature in the ship to rise.   After

admitting to Houston that he wished he had read this book, Steve hesitantly asks Houston what is the cardiovascular response to excessive heat. Houston has no idea. With panic, Austin pleads for someone to answer his question: "What happens to the cardiovascular system when a person suffers from excessive heat?" What happens to the cardiovascular system when the heater unit on the space ship breaks down?

3.4.1-1 What representative values of resistance and compliance are encountered by the left ventricle as it pumps blood into the aorta?

3.4.1-2 Construct a model that adds an atrium to Robinson's Ventricle Model. Give mathematical equations that describe the model.

3.4.4-1 Calculate the inertance of the blood as it leaves the left ventricle.

3.4.4-2 Estimate stored elastic work (E_1), contractile energy (E_2), external work (E_3), and systolic contraction penalty (E_4), for a resting heart, according to Livnat and Yamashiro. How do these terms differ in exercise?

3.4.5-1 Calculate our expected heart rate response to an impulse load of 300 W using the Fujihara model.

3.4.5-2 Using the Givoni and Goldman model, calculate equilibrium heart rate for a person exercising with an energy expenditure of 250 W. The person wears clothing with a thermal conductance of 8 N·m/(m^2·sec·^{o}C) in an environment of 27^oC and a partial pressure of water vapor of 5300 N/m^2. State all assumptions.

3.4.5-3 Plot the heart rate with time after the beginning of exercise.

How would the answer for question 3.4.5-2 be modified for unacclimatized individuals?

3.4.5-5 Calculate expected heart rate 1 minute after beginning work at a constant 350 N·m/sec after rest.

3.4.5-6 Calculate expected heart rate 30 minutes after beginning work at a constant 350 N·m/sec after rest, neglecting heat effects.

3.4.5-7 Why model exercise responses?

4.2.1-1 How much surface area is there for gas exchange in the average lung?

4.2.1-2 About how many generations of airways are there in the respiratory system?

4.2.1-3 What is the purpose of lung surfactant?

4.2.1-4 Plasma CO_2 is given as 0.0262 m^3 CO_2/m^3 blood. How many moles/m^3 does this represent?

4.2.1-5 What is surfactant? What would happen without the presence of surfactant? Include visuals.

4.2.2-1 Identify the names of the following lung volumes:

      a.   the volume of gas in the lung at the end of inspiration.
      b.   the volume of gas in the lung at rest with the glottis open.
      c.   the smallest volume of gas in the lung.
      d.   the volume inspired during a breath.
      e.   the volume of gas that doesn't take part in gas exchange.

4.2.2-2 Explain the difference between ventilation and perfusion. Why should they be matched? Under what conditions are they not matched?

4.2.2-3 A person exhales 0.56 L of air. How much air would this be if measured at ambient conditions?

4.2.2-4 Explain how closely end-tidal air concentrations are to those of blood returning from the lung.

4.2.2-5 Explain how you would measure respiratory dead volume in a sitting subject.

4.2.2-6 Rank the following according to pH changes from rest to exercise:

      a.   cerebrospinal fluid
      b.   extracellular fluid in working muscles
      c.   blood in vena cava
      d.   blood in pulmonary vein

4.2.2-7 If minute volume is 30 x 10^{-5} m^3/sec, respiration rate is 0.3/sec, and dead volume is 1.8 x 10^{-4} m^3, what is the alveolar ventilation rate?

4.2.2-8 Calculate the diffusion coefficients for oxygen, carbon dioxide, and water vapor in alveolar air.

4.2.2-9 If minute ventilation is 10 L/min, respiration rate is 20 breaths/minute, end-tidal CO_2 is 4.5%, and mixed exhaled CO_2 is 3.3%, what is the dead volume?

4.2.2-10 Room air at 20°C, 50% RH and atmospheric pressure, is inspired at a rate of 50 L/min. At what rate would it be expired?

4.2.2-11 How much faster will carbon dioxide diffuse at body temperature compared to ambient temperature?

4.2.2-12 Calculate the carbon dioxide content of the blood, including plasma CO_2 and red blood cell CO_2, in the working muscles, where pH $\approx$ 7.0, temperature $\approx$ 40°C, and p CO_2 $\approx$ 5500 N/m^2. Estimate the fraction of this carbon dioxide in carbamino and bicarbonate form.

4.2.2-13 In the expired air you measure 15.8% O_2 and 4.5% CO_2. What is the respiratory exchange ratio?

4.2.2-14 If Functional Residual Capacity (FRC) is 2.5 L, Residual Volume (RV) is 1.2 L, Tidal Volume (V_T) is 0.5 L, and Vital Capacity (VC) is 4.8 L, what is the Expiratory Reserve Volume at rest?

4.2.2-15 Explain how end-tidal air pCO$_2$ and pO$_2$ are related to pulmonary venous pCO$_2$ and pO$_2$

4.2.2-16 What is the oxygen requirement to metabolize a daily intake of: 85 g carbohydrate, 40 g fat, and 45 g protein?

4.2.2-17 Estimate the amount of dead volume in the respiratory system at rest and during exercise.

4.2.3-1 Using the respiratory system model diagrammed in Figure 4.2.14 and the values given in Table 4.2.15, determine values for the R and C in Figure 4.2.15.

4.2.3-2 Calculate the Reynolds number for the respiratory bronchioles and a minute volume of 65 L/min. Is the flow laminar or turbulent?

4.2.3-3 If breathing is sinusoidal, and respiratory mechanics can be approximated by a resistance and capacity similar to Figure 4.2.15, what is the respiratory work rate if inspiration begins at FRC?

4.2.3-4 Redraw the schematic diagram of the respiratory system in Figure 4.2.14 and label each element with its typical value.

4.2.3-5 Calculate entrance lengths for airways of generations 0,1,2,3,4,10,20 at a respiratory flow rate of about 0.003 m^3/sec. Compare entrance lengths to actual lengths.

4.2.3-6 How soon after constant rate exercise begins can minute volume measurements be made with assurance that the error compared to steady state is no more than 2%?

4.2.3-7 Determine Rohrer coefficient values for the pressure-flow relations of equations 4.2.76 and 4.2.77.

4.2.3-8 Estimate minimum and maximum alveolar, pleural, and respiratory muscle pressures during rest and during moderate exercise.

4.2.3-9 Calculate the amounts of respiratory work in all four diagrams of Figure 4.2.26.

4.2.3-10 Why does airway resistance during exhalation differ from inhalation resistance?

4.2.3-11 Estimate the time constant and explain its meaning.

4.3.1-1 List humoral factors important in respiratory control.

4.3.1-2 What is the most important sensed chemical in the:

      1.   aortic arch
      2.   carotid sinus
      3.   medulla oblongata

4.3.1-3 There are three chemoreceptive sites involved in the control of respiration. Give the locations for at least two of them.

4.3.2-1 Given a tidal volume of 1.8 L, what is the minimum amount of time required for exhalation? Show all work and indicate all assumptions.

4.3.4-1 For the conditions of question 4.2.2-9, 500 mL dead volume is added to the respiratory circuit. How much increase in minute volume is expected?

4.3.4-2 How does respiratory control depend on: a) oxygen content of alveolar air, b) carbon dioxide content of alveolar air, c) carbon dioxide produced by the working muscles?

4.3.4-3 List the two apparent control criteria for respiration.

4.3.4-4 What evidence is there that blood oxygen levels are not critical for respiratory control?

4.3.4-5 What is the difference in respiratory response between inhaled CO_2 and metabolic CO_2?

4.3.4-6 Explain the respiratory response to exercise while breathing through a tube. What happens to blood pCO_2?

4.3.4-7 A person at rest has an oxygen uptake of 0.5×10^{-5} m^3/sec and a respiratory exchange ratio of 0.8. The person breathes into and from a paper bag initially containing 0.1 m^3 of fresh air. Plot expected minute volume for this person over the course of 5 minutes.

4.3.4-8 Calculate the optimum breathing rate to minimize average aspiratory power if flow rate occurs as a rectangular wave form. Calculate average inspiratory power at one-half and twice the optimum frequency to check that the optimum breathing rate is truly the point where minimum power occurs.

4.3.4-9 Describe what is meant by a "dog-leg" or "hockey-stick" respiratory response.

4.3.4-10 Name four respiratory parameters that appear to be optimized during exercise.

4.3.4-11 What kind of experiment would you conduct to demonstrate that metabolic CO_2 is completely removed by respiration but inhaled CO_2 was not?

4.3.4-12 What are the respiratory effects of exercising above the anaerobic threshold?

4.3.4-13 Estimate the energy expenditure, O_2 consumption, respiratory minute volume, tidal volume, and the respiratory period for the following activities. A. Sleeping B. Doing Homework C. Playing Volleyball D. Skiing

4.3.4-14 Derive an expression relating pulmonary ventilation to oxygen uptake for an average man.

4.5.4-1 Summarize (one or two paragraphs) one of the respiratory models given in Chapter 4.

5.1.1-1 List the modes of heat transfer from the human body.

5.2.1-1 Trace the heat loss paths from the body to the external environment.

5.2.1-2 Calculate your skin surface area.

5.2.1-3 If you were walking inside at a rate of 1.1 m/sec while wearing a minimal amount of clothing, how much heat would you lose by convection?

5.2.1-4 For the conditions of the previous question, calculate the respiratory convection heat loss.

5.2.1-5 Estimate convective heat loss from a nude person seated in a private room at 22^oC.

5.2.2-1 If the effective thickness for skin thermal resistance is 5 mm in males and 7 mm in females, estimate the total thermal resistance for sking conduction for yourself.

5.2.2-2 Calculate the total thermal resistance for the clothing you wear.

5.2.2-3 Estimate the convective heat loss from a fully clothed person seated in the same room.

5.2.2-4 A man (183 cm tall, 756 N) wearing briefs, shorts, and running shoes is jogging at 1.5 m/sec on a beautiful 30^oC day. Estimate the total convective heat loss.

5.2.3-1 Would it be better for a person living outside in a hot, dry, sunny climate to dress in lightweight or heavy clothing? Why?

5.2.3-2 Calculate the value of the radiation coefficient for skin in an ambient temperature of 25^oC.

5.2.3-3 Name the various sources of radiant heat.

5.2.3-4 Estimate the radiant heat loss from the person in question 5.2-19.

5.2.3-5 What is the solar heat load on a person walking from Khartoum to Cairo?

5.2.4-1 The Lewis number establishes a relationship between what two modes of heat transfer?

5.2.4-2 Estimate the value for the heat transfer coefficient for evaporation for a walking person.

5.2.5-1 Define BMR and SDA.

5.2.5-2 Calculate your theoretical basal metabolic rate.

5.2.5-3 Use the energy expenditure for dancing, and predict: rate of oxygen consumption, respiratory minute volume, heart rate, and rate of heat produced.

5.2.5-4 Estimate your body surface area, basal metabolic rate, and mean skin temperature.

5.2.5-5 Develop an equation relating gross muscular efficiency for bicycling to work rate. Relate gross efficiency to cycling speed.

5.2.5-6 Steve used to weigh about 700 N before the accident, but due to government cutbacks, super light replacement materials could not be used and now he weighs 860 N. His bionic arm weighs 14.4 N

and each bionic leg weighs 111 N. Assuming that the bionic components have no insulative or conductive properties or heat sources, would his theoretical Basal Metabolic Rate change? If he were to become an astronaut again what would be his oxygen consumption at room temperature inside the spaceship when resting with clothing?

5.3.3-1   List the thermoregulatory responses to acute heat stress.

5.3.7-1   Draw a diagram of the thermoregulatory system and identify on this diagram in what structures the various functions reside.

5.3.7-2   What is the most amazing aspect of thermoregulation?

5.4.1-1   Use the Gagge model to estimate blood flow rate, sweat rate, and skin temperature for a 70 kg person walking on a treadmill in a room at $25^{o}C$, five minutes after the start of walking.

5.5.3-1 Fill in the following table:

Work Classification Parameter	Rest	Light	Moderate	Heavy	Very Heavy
$(\dot{V}_{O_2} / \dot{V}_{O_2 \max})$	9	20	70	90	100
Oxygen Consumption (L/min)					3.2
Performance Time (min)					
Muscular Efficiency (%)	0	5	18	20	20
Physical Work Rate (Watts)					
Carbon Dioxide Production (L/min)					
Respiratory Exchange Ratio					
Blood Lactic Acid (m mol/L)					
Heartrate (beats/min)					
Stroke Volume (mL)					
Cardiac Output (L/min)					
Systolic Pressure (mmHg)					
Diastolic Pressure (mmHg)					
Blood Partial Pressure for:					
CO_2 (mm Hg)					
O_2 (mm Hg)					
Arterial Hemoglobin Saturation (%)					
Cardiac Work Rate (watts)					
Aerobic Fraction (%)					
Total Peripheral Resistance (mm $Hg \cdot min / L$)					