€ 0,10

Biophysical Concepts in HMS; Monday 21/10/2013, 8.45-11.45

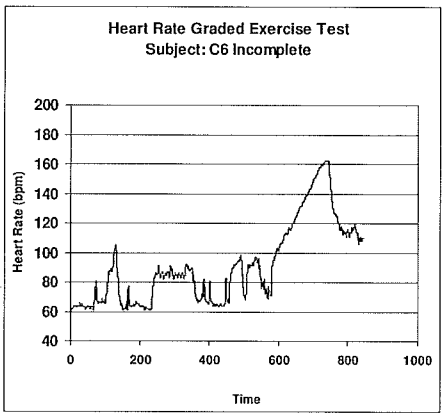
4 questions; all questions are equally weighted; for weighting of sub-questions, see indications in brackets

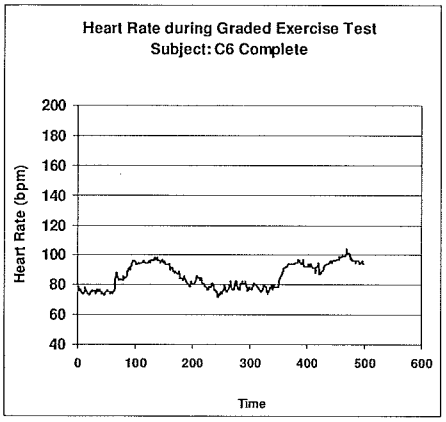
Please, answer question 3 on a separate sheet. Write your name and student number on both sheets.

1. Exercise intensity is an important parameter in exercise physiology that can be estimated in several ways.

a) Discuss the pros and cons of estimating exercise intensity using an objective method (heart rate monitors) versus a subjective method (Rating of Perceived Exertion) (4 pts).

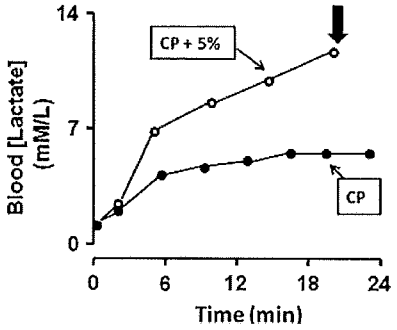
b) Below are heart rate recordings of 2 individuals with a C6 spinal cord injury (SCI) during an exercise test. First a warm up, followed by 2 submaximal blocks at constant power output (PO), followed by continuously increasing PO until exhaustion. Discuss possible explanations for the differences between the 2 recordings. (3 pts)





c) Discuss whether heart rate recordings can be used in individuals with SCI to estimate exercise intensity. (3 pts)

2. According to Jones et al. (2010), the Critical Power (CP) concept constitutes a practical framework in which to explore mechanisms of fatigue and help resolve crucial questions regarding the plasticity of exercise performance and muscular systems physiology.



a) Describe the CP model using the graph above. Also discuss what the thick vertical arrow could point at. (3 pts)

b) The CP model as described in Morton (2006) is based on several assumptions. One of the assumptions is "Aerobic power is available at its limiting rate CP the moment exercise begins and remains so right up until the end of exercise.". Discuss why this assumption is not fully correct (2 pts)

c) Using the figure below, describe how Wilkie (as described by Morton) tried to correct for this assumption (3 pts)

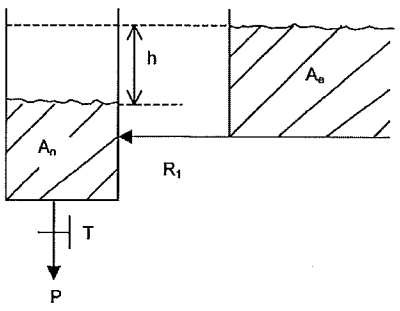


Fig. 3 Wilkie's correction to the CP hydraulic model

d) The Critical Torque is a concept related to the CP. Describe the 2 methods to determine the Critical Torque (as described in Burnley 2009) (2 pts).

3. In contact sports, external, mechanical perturbations of an athlete's trunk often occur due to contact with an opponent. This may lead to loss of balance and may limit the athlete's performance in the game, e.g., losing the ball to the opponent. Therefore, it is decided to develop a test to assess the ability of athletes to deal with this type of perturbations. The test consists of the application of short force impulse applied at the shoulder in the left-right direction, while the subject is initially standing upright. Orientation of the trunk in the frontal plane due to this perturbation is measured.

To obtain some insight in what such a test might show, a model simulating the trunk as an inverted pendulum supported by two springs is created. The springs simulate the effect of muscles on the left and right side of the trunk. Hence, the mechanical properties of the spine are ignored.

a) Explain why ignoring the mechanical properties of the spine can be justified. (3 pts)

b) Describe the response of the model to an impulse perturbation as described above. If you use a drawing, make sure that you explain this in text and provide clear axis labels. (3 pts)

c) Describe or draw how the response of the pendulum changes when spring stiffness is increased. If you use a drawing, make sure that you explain this in text and provide clear axis labels. (3 pts)

The springs in the model cause a moment, which counteracts the effect of the perturbation. The moment provided by the springs depends on their moment arm, the spring stiffness and the kinematic state of the pendulum.

d) Which state variable determines the resistance provided by the springs? (1 point)

In a more sophisticated version of the model, dampers are added in parallel to the springs.

e) Describe or draw how the response of the pendulum after an impulse perturbation is different from that when no damping is present. If you use a drawing, make sure that you explain this in text and provide clear axis labels. (3 pts)

f) Which state variable of the pendulum determines the resistance provided by the dampers? (1 point)

Considering the real test, an athlete who is being tested could increase co-contraction of muscles on both left and right side of the trunk to better counteract the effect of the perturbation.

g) Explain why a higher level of co-contraction would help to limit the effect of the perturbation. (3 pts)

h) What other general type of control mechanism could the athlete use in addition to or instead of increasing co-contraction? In your answer, indicate the main biological structures involved and describe their role in the control. (3 pts)

i) To obtain information on the use of the second type of control mechanism, what measurements would you add to the measurement of trunk movement? Motivate your answer. (3 pts)

j) Based on literature, how do you expect that results in the results of the perturbation test differ between athletes with and without low-back pain? What is the most likely cause of the different response in athletes with low-back pain? Motivate your answers. (3 pts)

Changes in trunk orientation are measured from 0-100 ms after the perturbation (i.e. 0-100 ms after initial contact with the athletes shoulder) .

k) Do you expect a difference in the changes in trunk orientation after the perturbation when the athlete closes his or her eyes? If so, what is this difference? If not, why not? Motivate your answer. (3 pts)