ORDRE DES INGÉNIEURS DU QUÉBEC

MAY 2015 SESSION

Open-book examination Calculators : only authorized models Duration : 3 hours

14-IN-B2 ERGONOMICS

1) In a laboratory, a microscope will be used by men and women. The eyepiece of the microscope is at a height of 33 cm from its base. Calculate the following dimensions <u>based on the anthropometric dimensions provided in the appended table</u>. (20 pts)
   a) The fixed height of the table on which should be placed the microscope.
   b) The minimum and maximum height of the adjustable work seat.
   c) The minimum and maximum height of the adjustable foot rest.

2) Explain why exposure to cold temperatures is a risk factor for musculoskeletal disorders (10 pts).

3) From a physiological point of view, why does static work quickly produce muscle fatigue? (10 pts)

4) You need to determine if the intensity of a given task is acceptable for a group of workers. Considering the energy expenditure associated with this task, explain the different approaches that you could use, providing details of the methods, tools or measurements that you could use. (10 pts)

5) A 35 years old and 79 Kg male worker, with an average physical condition, performs a task with an estimated energy expenditure of 0.9 li O_2/min. (10 pts)

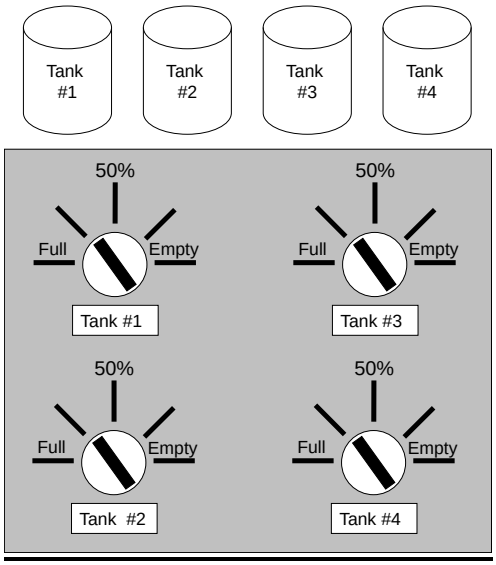
a) Is this task acceptable for an 8-hours work shift? Justify your answer.

b) Propose a work-rest cycle which would make this task acceptable for a 12-hours work shift.

6) Compare the advantages and disadvantages of manual controls versus foot controls. (10 pts)

7) Discuss the various factors that can influence the visual acuity of people in a given context. (10 pts)

8) A control panel is placed in front of four large tanks arranged as shown in the figure. Four rotary controls are used to control the liquid level in each of the four tanks. What are the design mistakes in this control panel and what compatibility principles were not respected? (10 pts)



9) A worker must handle small boxes of 10.5 Kg (without handles) every 6 minutes for 8 hours. The boxes are lifted from the ground and are placed (with a trunk rotation of 40°) on a trolley at a height of 91 cm. Significant control of the load is required at the destination. Determine the RWL for this task using the NIOSH Manual Lifting Guidelines. (10 pts)

Appendix

Anthropometric data

TABLE 1–3. Body Dimensions of U.S. Civilian Adults, Female/Male, in mm

	Percentiles			
	5th	*50th*	*95th*	*SD*
HEIGHTS				
(*f* above floor, *s* above seat)				
Stature ("height")[f]	1,527.8/1,646.9	1,629.4/1,755.8	1,737.3/1,866.5	63.6/66.8
Eye height[f]	1,415.2/1,528.2	1,516.1/1,633.9	1,621.3/1,742.9	62.5/65.7
Shoulder (acromial) height[f]	1,240.9/1,341.6	1,333.6/1,442.5	1,432.0/1,545.6	57.9/62.0
Elbow height[f]	926.3/995.2	997.9/1,072.5	1,074.0/1,152.8	44.8/48.1
Wrist height[f]	727.9/777.9	790.3/846.5	855.1/915.2	38.6/41.5
Crotch height[f]	700.2/764.4	771.4/837.2	845.8/916.4	44.1/46.2
Height (sitting)[s]	795.3/854.5	852.0/913.9	910.2/971.9	34.9/35.6
Eye height (sitting)[s]	684.6/735.0	738.7/792.0	794.3/848.0	33.2/34.2
Shoulder (acromial) height (sitting)[s]	509.1/548.5	555.5/597.8	603.6/646.3	28.6/29.6
Elbow height (sitting)[s]	175.7/184.1	220.5/230.6	264.4/273.7	26.8/27.2
Thigh height (sitting)[s]	140.4/148.6	158.9/168.2	180.2/189.9	12.1/12.6
Knee height (sitting)[f]	474.0/514.4	515.4/558.8	560.2/605.7	26.3/27.9
Popliteal height (sitting)[f]	351.3/394.6	389.4/434.1	429.4/476.3	23.7/24.9
DEPTHS				
Forward reach (to tip of thumb)	676.7/739.2	734.6/800.8	796.7/867.0	36.4/39.2
Buttock–knee distance (sitting)	542.1/569.0	588.9/616.4	639.8/667.4	29.6/29.9
Buttock–popliteal distance (sitting)	440.0/458.1	481.7/500.4	527.7/545.5	26.6/26.6
Elbow–fingertip distance	406.2/447.9	442.9/484.0	482.5/524.2	23.4/23.3
Chest depth	208.6/209.6	239.4/243.2	277.8/280.4	21.1/21.5
BREADTHS				
Forearm–forearm breadth	414.7/477.4	468.5/546.1	528.4/620.6	34.7/43.6
Hip breadth (sitting)	342.5/328.7	384.5/366.8	432.2/411.6	27.2/25.2
HEAD DIMENSIONS				
Head circumference	522.5/542.7	546.2/567.7	570.5/593.5	14.6/15.4
Head breadth	136.6/143.1	144.4/151.7	152.7/160.8	4.9/5.4
Interpupillary breadth	56.6/58.8	62.3/64.7	68.5/71.0	3.6/3.7
FOOT DIMENSIONS				
Foot length	224.4/248.8	244.4/269.7	264.6/292.0	12.2/13.1
Foot breadth	81.6/92.3	89.7/100.6	97.8/109.5	4.9/5.3
Lateral malleolus height[f]	52.3/58.4	60.6/67.1	69.7/76.4	5.3/5.5
HAND DIMENSIONS				
Circumference, metacarpal	172.5/198.5	186.2/213.8	200.3/230.3	8.5/9.7
Hand length	165.0/178.7	180.5/193.8	196.9/210.6	9.7/9.8
Hand breadth, metacarpal	73.4/83.6	79.4/90.4	85.6/97.6	3.8/4.2
Thumb breadth, interphalangeal	18.6/21.9	20.7/24.1	22.9/26.5	1.3/1.4
WEIGHT (in kg)	39.2*/57.7*	62.0/78.5	84.8*/99.3*	13.8*/12.6*

*Estimated (from Kroemer 1981).

Source: Adapted from U.S. Army data reported by Gordon et al. (1989).

Note: In this table, the entries in the 50th-percentile column are actually mean (average) values. The 5th- and 95th-percentile values are from measured, not calculated, data (except for weight). Thus, the values given may be slightly different from those obtained by subtracting 1.65 SD from the mean (50th percentile) or by adding 1.65 SD to it.

Normal law table
[z = (x – mean) / standard-deviation]

p	z	p	z	p	z	p	z
1	*-2.33*	*26*	*-0.64*	*51*	*0.03*	*76*	*0.71*
2	*-2.05*	*27*	*-0.61*	*52*	*0.05*	*77*	*0.74*
3	*-1.88*	*28*	*-0.58*	*53*	*0.08*	*78*	*0.77*
4	*-1.75*	*29*	*-0.55*	*54*	*0.10*	*79*	*0.81*
5	*-1.64*	*30*	*-0.52*	*55*	*0.13*	*80*	*0.84*
6	*-1.55*	*31*	*-0.50*	*56*	*0.15*	*81*	*0.88*
7	*-1.48*	*32*	*-0.47*	*57*	*0.18*	*82*	*0.92*
8	*-1.41*	*33*	*-0.44*	*58*	*0.20*	*83*	*0.95*
9	*-1.34*	*34*	*-0.41*	*59*	*0.23*	*84*	*0.99*
10	*-1.28*	*35*	*-0.39*	*60*	*0.25*	*85*	*1.04*
11	*-1.23*	*36*	*-0.36*	*61*	*0.28*	*86*	*1.08*
12	*-1.18*	*37*	*-0.33*	*62*	*0.31*	*87*	*1.13*
13	*-1.13*	*38*	*-0.31*	*63*	*0.33*	*88*	*1.18*
14	*-1.08*	*39*	*-0.28*	*64*	*0.36*	*89*	*1.23*
15	*-1.04*	*40*	*-0.25*	*65*	*0.39*	*90*	*1.28*
16	*-0.99*	*41*	*-0.23*	*66*	*0.41*	*91*	*1.34*
17	*-0.95*	*42*	*-0.20*	*67*	*0.44*	*92*	*1.41*
18	*-0.92*	*43*	*-0.18*	*68*	*0.47*	*93*	*1.48*
19	*-0.88*	*44*	*-0.15*	*69*	*0.50*	*94*	*1.55*
20	*-0.84*	*45*	*-0.13*	*70*	*0.52*	*95*	*1.64*
21	*-0.81*	*46*	*-0.10*	*71*	*0.55*	*96*	*1.75*
22	*-0.77*	*47*	*-0.08*	*72*	*0.58*	*97*	*1.88*
23	*-0.74*	*48*	*-0.05*	*73*	*0.61*	*98*	*2.05*
24	*-0.71*	*49*	*-0.03*	*74*	*0.64*	*99*	*2.33*
25	*-0.67*	*50*	*0*	*75*	*0.67*		