National Exams May 2018

17-Ind-B5, Ergonomics

3 hours duration

Instructions:

♦ There are seven (7) pages to this exam with three parts and a total of four (4) questions. You must answer a total of 3 questions (Part A which is mandatory and Part B where you chose one of two questions).
♦ The NIOSH tables are produced at the end of this exam for your use.
♦ This is an open book exam; all notes, books and non-communicating calculator are permitted.
♦ **Please use point form to answer all questions**.
♦ If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made;
♦ Any non-communicating calculator is permitted.
♦ No pagers, cellular telephones, smartphones or other communication devices are permitted in this exam.

Marking Scheme

Question Number	Total Possible	Grade
Part A: General – mandatory 1. 2.	40 marks 40 marks	
Part B: Choose 1 question to answer from questions 3 or4. Do not answer both questions		
3.	20 marks	
4.	20 marks	
Total	**100 marks**	

Part A: Mandatory

10 marks] 1. You are a consultant to an architectural firm that specializes in high end kitchen designs for homes. You have been asked to carry out a human factors assessment for a new kitchen renovation where the kitchen is to be open concept with an island in centre between the kitchen and dining room. It is possible to have plumbing and electricity to all parts of the kitchen. Different family members will use the kitchen to prepare various meals including able-bodied adults, three children ranging in ages between 8 and 13, the older child uses a manual wheelchair. The family would like to be able to work efficiently in the kitchen doing typical cooking tasks including stocking and retrieving dry and canned goods from a pantry, accessing the refrigerator, cooking with a stovetop oven, doing preparation work (e.g., chopping) on countertops, using dishes, knives utensils and cutlery, using appliances such as a toaster, microwave, coffee maker, and rice cooker, and eating at the island. They would also like to integrate smart controls where possible so that the appliances can be connected to phones and/or tablets. You have been asked to carry out a human factors analysis for this family and kitchen.

   a) [10 marks] Explain the checklist method for human factors analysis. How could this method be applied in this situation? What modifications would you make to a standard human factors checklist for this particular application?
   b) [15 marks] Other than a checklist, describe two possible human factors methods you could use to assess the various needs of the family members in carrying out possible tasks. Explain the costs and benefits of each method? Which method identified from question 1a and 1b would you recommend?
   c) [10 marks] What environmental factors would you consider in your design and why are they important?
   d) [5 marks]. What assumptions must you make when considering your possible design solutions?

[40 marks] 2. A worker unloads 20 kg bags of apples from a conveyor and loads them onto a chute from where they are dispatched. He loads for a 1.5-hour shift twice per day at a rate of 5 sacks per minute. The height of the conveyor is 60 cm and the height of the chute is 100 cm above the floor. The angle of asymmetry is 45° and the load is held 30 cm from the body. Note that the worker must place the bags of apples on the conveyor carefully so as not to damage the apples.

a) [10 marks] Calculate the RWL and LI using the NIOSH tables attached to this paper.
b) [10 marks] What are the safety issues and risk factors to the worker in this job? What anatomical structures are affected?
c) [10 marks] What human factors resolutions would you recommend to reduce each of these risks and justify why these resolutions are appropriate?
d) [10 marks] What would you recommend the worker do as other work in between shifts of loading apples? He must work 8-hours in total including two 15-minute breaks and a 45-minute lunch. Justify this other work from a human factors perspective.

Part B: Choose one question to answer from questions 3 or 4.

[20 marks] 3. A worker works at a table sorting rough diamonds into different categories according to colour and size. The diamonds are delivered in small glass dishes and are manipulated with tweezers for inspection. The luminance of the task is 400 cd/m². The workbench has a reflectance of 40% and an illuminance of 500 lx.

a) [10 marks] Is this luminance ratio appropriate for this task? Why or why not? Show your work.

b) [10 marks]? Explain what is required to ensure visual comfort for the visual demands required in this work environment. What do you recommend to improve the visual environment for this worker?

[20 marks] 4. Worker injuries

   a) [5 marks] What is carpal tunnel syndrome (CTS) and why is it a concern in human factors?

   b) [10 marks] Explain how a person suffering from carpal tunnel syndrome might be affected by the following tasks? Which task would have the greatest impact on the symptoms of CTS

      a. Rapid data entry with a keyboard

      b. Plucking a chicken

      c. Playing a piano

      d. Kneading dough

      e. Painting a ceiling

   c) [5 marks] For each task in b, what would you recommend as a job modification to alleviate the problem(s)?

NIOSH Work Practices Guide to Manual Handling Formula Multipliers

These formulas eliminate the need for you to do the detailed calculations in the formula:

- ❑ RWL = LC x HM x VM x DM x AM x FM x CM
- ❑ LC is 23kg or 51 lb.
- ❑ You still need to figure the correct values of H, V, D, A, coupling, etc. and determine the multipliers.
- ❑ LI= Load weight / Recommended Weight Limit = L / RWL Where Load Weight (L) is the object lifted (kg or lb)

Horizontal Multiplier

H in	HM	H cm	HM
≤10	1.00	≤25	1.00
11	.91	28	.89
12	.83	30	.83
13	.77	32	.78
14	.71	34	.74
15	.67	36	.69
16	.63	38	.66
17	.59	40	.63
18	.56	42	.60
19	.53	44	.57
20	.50	46	.54
21	.48	48	.52
22	.46	50	.50
23	.44	52	.48
24	.42	54	.46
25	.40	56	.45
>25	.00	58	.43
		60	.42
		63	.40
		>63	.00

Table 2
Vertical Multiplier

V in	VM	V cm	VM
0	.78	0	.78
5	.81	10	.81
10	.85	20	.84
15	.89	30	.87
20	.93	40	.90
25	.96	50	.93
30	1.00	60	.96
35	.96	70	.99
40	.93	80	.99
45	.89	90	.96
50	.85	100	.93
55	.81	110	.90
60	.78	120	.87
65	.74	130	.84
70	.70	140	.81
>70	.00	150	.78
		160	.75
		170	.72
		175	.70
		>175	.00

Table 3
Distance Multiplier

D in	DM	D cm	DM
≤10	1.00	≤25	1.00
15	.94	40	.93
20	.91	55	.90
25	.89	70	.88
30	.88	85	.87
35	.87	100	.87
40	.87	115	.86
45	.86	130	.86
50	.86	145	.85
55	.85	160	.85
60	.85	175	.85
70	.85	>175	.00
>70	.00		

Table 4
Asymmetric Multiplier

A	AM
deg	
0	1.00
15	.95
30	.90
45	.86
60	.81
75	.76
90	.71
105	.66
120	.62
135	.57
>135	.00

Table 5
Frequency Multiplier Table (FM)

Frequency Lifts/min (F) ‡	Work Duration					
	≤1 Hour		>1 but ≤2 Hours		>2 but ≤8 Hours	
	V < 30†	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤0.2	1.00	1.00	.95	.95	.85	.85
0.5	.97	.97	.92	.92	.81	.81
1	.94	.94	.88	.88	.75	.75
2	.91	.91	.84	.84	.65	.65
3	.88	.88	.79	.79	.55	.55
4	.84	.84	.72	.72	.45	.45
5	.80	.80	.60	.60	.35	.35
6	.75	.75	.50	.50	.27	.27
7	.70	.70	.42	.42	.22	.22
8	.60	.60	.35	.35	.18	.18
9	.52	.52	.30	.30	.00	.15
10	.45	.45	.26	.26	.00	.13
11	.41	.41	.00	.23	.00	.00
12	.37	.37	.00	.21	.00	.00
13	.00	.34	.00	.00	.00	.00
14	.00	.31	.00	.00	.00	.00
15	.00	.28	.00	.00	.00	.00
>15	.00	.00	.00	.00	.00	.00

†Values of V are in inches. ‡For lifting less frequently than once per 5 minutes, set F = .2 lifts/minute.

Table 7
Coupling Multiplier

Coupling Type	Coupling Multiplier	
	V < 30 inches (75 cm)	V ≥ 30 inches (75 cm)
Good	1.00	1.00
Fair	0.95	1.00
Poor	0.90	0.90