

National Exams Dec. 2017

98-Ind-B5, Ergonomics

3 hours duration

Instructions:

- ◆ There are eight (8) pages to this exam with three parts and a total of five (5) questions. You must answer a total of 4 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 is 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

<i>Question Number</i>	<i>Total Possible</i>	<i>Grade</i>
Part A: General – mandatory		
1.	40 marks	
2.	40 marks	
Part B: <u>Choose 1</u> question to answer from questions 3 or 4. Do not answer both questions		
3.	20 marks	
4.	20 marks	
Total	100 marks	

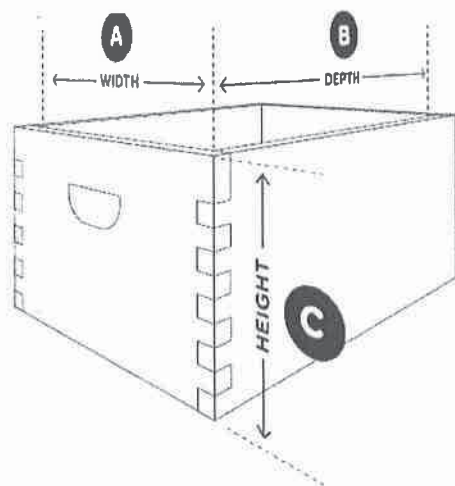
Part A: Mandatory

- 0 marks] 1. You have been asked to carry out a human factors assessment for a printing shop that prints posters, business cards, small signs and other small print jobs for students on a university campus. They also provide photocopying and binding services. The shop uses student workers who work part-time and must learn on the job. There are a variety of different control interfaces for all of the equipment (a variety of buttons and displays). A customer can either email a file for printing or can bring in a request in person.
- a) [10 marks] If an error is possible, someone will make it (D. Norman, 1985). Explain the possible sources of error and the general types of errors that the human operators could make. What recommendations would you make to the manager to mitigate each different type of error?
 - b) [15 marks] How would you go about measuring error? Design a study that would allow you to understand the impact of error on worker performance, workload and efficiency, and costs to the business. Ensure that you identify timeline, human resources required, tasks, and anticipated outcomes.
 - c) [15 marks] You have been asked by the print shop manager to design an online training system that employees could access. You want to base this design on the ergonomic principles of minimizing human error for the variety of tasks in the print shop. Describe your design and provide at least one drawing showing your ideas.

40 marks] 2. You have been asked to carry out a human factors assessment for a beekeeping operation. In this operation, the beekeeper must carry out inspection and cleaning tasks for the bee hives which are located on the ground, outside on farms or in backyards of the beekeeper. The hives are made up of boxes with 8 removable frames inserted in them (see Figure 2). Boxes can be stacked on top of each other with the lower box (called a brood box) containing the queen bee and eggs that she has laid. The eggs are laid inside each honeycomb on the frames inside the box. The upper box(es) contain the honey that is used to feed the baby bees and that is extracted by the beekeeper to process into honey for human consumption. The dimensions of the box can be found in Figure 1.

The inspection process involves checking the brood box for the health of the queen and the eggs. In order to carry out this inspection, the top boxes containing the honey must be removed from the hive in order to access the frames in the lowest box. A box full of honey weighs about 25 kg. Each frame is removed and the beekeeper inspects the eggs to ensure they are in good health (specific pattern on the frame and that there are eggs/larvae inside each honeycomb, see Figure 3). As seen in Figure 3, frames are covered with bees as they are removed from the brood box. In addition, a frame full of eggs weighs about 2 kg.

Beekeepers complain of eye strain, lower back pain, sore joints, and overheating.



Measurements are for standard Langstroth boxes

	INTERNAL MEASUREMENTS		
	A	B	C
8 frame box	310mm 12 3/16"	465mm 18 5/16"	245mm 9 5/8"
10 frame box	362mm 14 1/4"	465mm 18 5/16"	245mm 9 5/8"

Figure 1: Dimensions of a beehive box

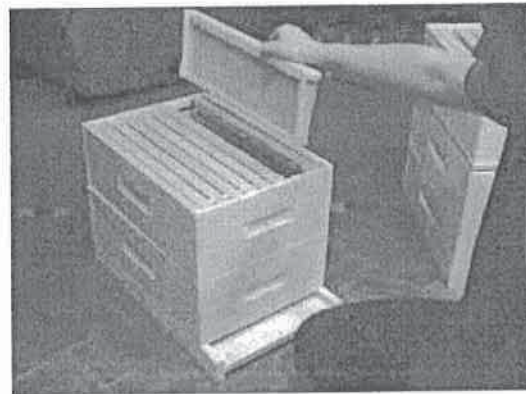


Figure 2: Frames inside a hive box.



Figure 3: A frame from a brood box.

- a) [12 marks] Describe the human factors process/approach that you would take to investigate the causes of the complaints in the work environment for beekeepers.
- b) [10 marks] What elements of this work environment would you want to examine/measure and why?
- c) [6 marks] What human factors/ergonomic standards would you use to evaluate your measures of this environment and why?
- d) [12 marks] Use the NIOSH lifting tables to determine the recommended weight limit for a bee box. State all of your assumptions

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

20 marks] 3. You have been asked by the municipal government to assess the mental workload experienced by taxi drivers in a large metropolitan area. To drive a taxi safely and efficiently, taxi drivers must attend to driving tasks (e.g., monitoring road conditions, car, pedestrian and bicycle traffic, and the audio/visual display of Global Positioning System (GPS) location finder), monitor the taxi radio from central dispatch for relevant calls, manage a cell phone, and communicate with passengers.

- a) [8 marks] Define mental workload and outline two possible ways of measuring it for this industry?
- b) [12 marks] Compare and contrast the two methods you have selected. Which method would you recommend and why? How could measuring mental workload affect government policy?

- 20 marks] 4. There are standard limits and times associated with exposure to sound over a work shift according to the Ontario Ministry of Labour (see Table 1).

Steady Sound Level (dBA)	Duration
82	16 hours
85	8 hours
88	4 hours
91	2 hours
94	1 hours
97	30 minutes
100	15 minutes
103	7.5 minutes
106	3.75 minutes
109	1.88 minutes
112	0.94 minutes
115	28.12 econds

- a) [10 marks] A worker is exposed to a steady sound level of 94 dBA for 30 minutes, 85 dBA for 6 and a half hours, 82 for 1-hour (lunch and breaks), and 97 dBA for 15 minutes. What is the total noise dose for that worker? Does this noise exposure exceed the maximum daily exposure? Explain.

Noise dose equation from the Ontario Ministry of Labour:

$$(C_1/T_1 + C_2/T_2 + \dots C_n/T_n) \times 100 = \% \text{ of exposure limit}$$

C = total duration of exposure at a specific noise level, and

T = total duration of exposure permitted at that level (Refer to “Table of Equivalent Noise Exposures” above)

- b) [10 marks] Why are these sound limits put in place by government regulators? Explain four different methods/measures to protect workers hearing.

NIOSH Work Practices Guide to Manual Handling Formula Multipliers

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

- $RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM$
- 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.
- $LI = \text{Load weight} / \text{Recommended Weight Limit} = L / RWL$ 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 P = .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