UNIVERSITY OF SWAZILAND

Faculty of Health Science

Department of Environmental Health Sciences

Final Examination 2009

Title of paper: ACOUSTICS AND HEALTH 1

Course code: EHS 569

Time allowed: 3 hours

Marks allocation: 100 Marks

Instructions:

1) Read the questions and instructions carefully
2) Answer ANY FOUR (4) questions
3) Each question is weighted 25 marks
4) Write neatly and clearly
5) Begin each question on a separate sheet of paper

This paper is not to be opened until the invigilator has granted permission

QUESTION 1

Multiple Choice: Write True or False against each letter corresponding to the following statements as they apply to acoustics.

I.

a) Noise is unwanted or damaging sound or sound which has an adverse effect on health.

b) Sound power is the force per unit area.

c) Frequency is the number of vibration cycles per second.

d) Sound with a frequency above 20 000 Hz is called infrasound.

e) At 21oC the speed of sound in water is 1470 m/s.

f) Refraction occurs when an obstacle's dimensions are larger than the wavelength of the sound.

g) Diffraction occurs when an obstacle's dimensions are of the same order or less than the wavelength of the sound

h) When hearing thresholds are measured, essentially it is a person's inability to hear pure tones that is measured.

i) The incidence of noise-induced hearing loss is directly related to total exposure time.

j) The vibration of the ossicles creates waves in the fluid of the inner ear that stimulates hair cells and thereby generating nerve impulses to the brain for interpretation.

(20 Marks)

II.

Show that the ratio of the acoustic powers of two sounds expressed in dB is equal to the difference of their power levels.

(5 marks)

QUESTION 2

a) Two sound sources are radiating sound waves of different frequencies and the individual sound pressure levels recorded are 75 and 80 dB. Determine the total sound pressure level.

(5 marks)

b) The background sound pressure level at a point is 56dB. Sound from a fan increases this to 58dB. What would be the sound pressure level due to the fan alone?

(5 marks)

c) The 1/1 octave band sound pressure levels of the noise from a garbage disposal are given below. Determine the overall noise level of the garbage disposal.

Freuency	Hz	63	125	250	500	1000	2000	4000	8000
Sound Pressure level	dB	64	83	69	56	55	50	50	49

(15 marks)

QUESTION 3

a) An established business has transferred to premises on a site 50 m from a dwelling. The pre-existing background noise level is 48 dB by day and 38 dB at night. A newly installed intermittent noise is to be rated. This source has a distinctive hiss and is on for 8 minutes in each hour, day and night.

The daytime specific noise level is to be determined over the complete daytime. The night time noise level is to be measured over a 5 minute period when the source is on and including the loudest phase. Measurement results were as followers:

Specific noise measurement (day time) = 58 dB
Specific noise measurement (night time) = 60 dB

(13 marks)

b) Describe the following terms as they apply to acoustics and health:

i) Neuro-sensory deafness

(3 marks)

ii) Conductive deafness

(3 marks)

iii) Audiometry

(3 marks)

iv) Threshold Shift

(3 marks)

QUESTION 4

a) The sound pressures of the sound propagating in a duct were measured in the indicated areas and were found to be:

$P_{rms}(1) = 3.2 \times 10^{-2}$ Pa $P_{rms}(2) = 4.0 \times 10^{-2}$ Pa

$P_{rms}(3) = 2.52 \times 10 -2$ Pa $P_{rms}(4) = 2.82 \times 10^{-2}$ Pa

The dimensions of areas 1, 2, 3 and 4 of the duct are 0.5m x 0.5m each.

1	2
3	4

Determine the acoustic sound power of the sound that is propagating in the duct.

N.B: $W = \sum_{1=1}^{4} \frac{p^{2rms(1)} S_i}{\rho C}$, where ρC = 420 RAYLS.

(7 marks)

b) A simple spherical sound source radiates sound into whole space with 5 acoustic watts of power at frequency of 700 Hz. Find the acoustic intensity and sound pressure at radial distances of 1m and 2m from the source.

(8 marks)

c) If a pure tone acoustic wave has a S.I.L of 95dB what is the peak value of acoustic pressure?

(10 marks)

QUESTION 5

(8 marks)

b) Describe the hearing process and the types of hearing loss.

(10 marks]

c) Suppose the sound pressure level of each of three individual noise sources is measured at a point such that with only the first source running, the sound power level is 89 dB, with only the second running it is 85 dB, and with only the third source running it is 83 dB. What will the sound pressure level at the point be with all three sources running concurrently?

(7 marks)

FORMULARS

1. $Cd = 0.61$ and $T = \int dt = \frac{ZA\,(H_1^{1/2} - H_2^{1/2})}{Cda\sqrt{2g}}$

2. $Q = 2/3\ Cd\ \sqrt{2g}\quad b(H_1^{3/2} - H_2^{3/2})$

3. $Y_i = Y_S/2\ (\sqrt{1+8\beta f_S^2} - 1)$

4. $F_S = V_S/\sqrt{gY_S}$

5. $(Y + V/2g) - (Y + V/2g)$

6. $\rho g y^2/2 + \rho q(V_1 - V_2) - \rho g Y_2^2/ F_X = 0$

7. $Y_G = Y_s\ \sqrt{1+2F_s^2}\ (1 - Y_S/ Y_2)$

8. $Q = AV$

9. $Q = A/n\ R^{2/3}\ S_0^{1/2}$

10. $Y_i = Y_S/2\ (\sqrt{1+8\beta f_S^2} - 1)$

11. $F_S = V_S/\sqrt{gY_S}$

12. $p_1/\rho g + v_1^2/2g = p_2/\rho g + v_2^2/2g + 0.03\ (p_1/\rho g - p_2/\rho g)$

13. $Q = 1.84BH^{3/2}\ [(1+ \alpha\ v^2/2g\ H)^{3/2} - (\alpha\ v^2/2g\ H)^{3/2}]$

14. $k=[(1+ \alpha\ v^2/2g\ H)^{3/2} - (\alpha\ v^2/2g\ H)^{3/2}]$

15. $h= (v^2/2g)(1+ A_1/A_2)^2 = v^2/2g\ (A_1/A_2 - 1)^2$

16. $W = \sum_{i=1} \frac{p^{2rms(1)} S_i}{\rho C}$, where $\rho C = 420$ RAYLS.

17. $S.I.L = 10 \log_{10} (I) + 120$

18. $L_p = 10 \log (p_1/p_0)^2$ or
$(p_1/p_0)^2 = 10^{Lp/10}$

19. $L_p(total) = 10 \log (p_{total}/p_0)^2$

20. $I = W/A$

21. $L_W = 10 \log W/W_0$

22. $Q_1 = 1.84\ BH^{3/2}$

23. $Q = Cd\ 8/15\ \sqrt{(2g)}(\tan \square/2)H^{5/2}$

24. $\Delta Q = \dfrac{-\sum h}{2\sum h/Q}$