

No of pages ..... 5  
No. of questions ..... 6  
Total marks ..... 100

**THE UNIVERSITY OF ADELAIDE**

**DEPARTMENT OF MECHANICAL ENGINEERING**

3017: ENGINEERING AND THE ENVIRONMENT

EXAMINATION FOR THE DEGREE OF BE

SEMESTER 1, 2002

Duration: 3 hours + 10 minutes

Allocate the first 10 minutes to reading the paper

[The use of notes, textbooks and calculating devices is permitted in the examination room.]

Attempt **ALL SIX** questions

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1. The State Pollution Control Authority advises the Bright Corporation that it has 60 days to apply for a permit to discharge manufacturing wastes into a body of water. In order to convince the authority that it will meet the environmental standards, the corporation employs Jack, an engineer, to perform consulting engineering services and submit a detailed report. After completing the studies, Jack concludes that the discharge from the plant will violate environmental standards and that the corrective action will be very costly to the Bright Corporation. Jack verbally notifies the company, which terminates its contract with Jack with full payment for the services performed. It instructs Jack not to render a written report to the corporation. A short time later, Jack learns that the authority has called a public hearing where the Bright Corporation has presented data to support its view that the present plant discharge meets minimum standards.
- (a) After learning of the hearing, is Jack obliged to report the violation of environmental standards to the authority? Refer to the IEAust Code of Ethics. [5 marks]
- (b) Does Jack have any residual obligation to the Bright Corporation that would stand in the way of doing so? [3 marks]
- (c) Is there any additional information that you feel Jack needs before he reports the violation? [2 marks]
2. There is a low-frequency resonance instability in a furnace and as an engineer, you need to track down its source. You are also interested in the acoustic power generated at higher frequencies. The molecular weight of the exhaust gases is 0.035 kg/mole, the ratio of specific heats is 1.4, the pressure in the furnace is atmospheric and the temperature in the furnace is 1600°C.
- (a) Calculate the speed of sound in the furnace [5 marks]
- (b) Calculate the density of the gas in the furnace [5 marks]
- (c) Calculate the wavelength of sound corresponding the frequency of instability if this frequency is 40 Hz. Comment on what one of the furnace dimensions might be to produce this resonance instability. [Hint: treat it like a closed end tube with the resonance being the lowest tube resonance.] [5 marks]

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2. (Cont.)

- (d) If the average sound pressure level measured in the furnace at distances further from the wall than half a wavelength is 120 dB in the 500 Hz octave band, what is the sound power level in watts generated by the burner in this frequency band? Assume that the furnace is a cylinder of 4 m diameter and assume an average Sabine sound absorption coefficient for the internal surfaces of the furnace of 0.02 in the 500 Hz band. State any other assumptions you make.

[10 marks]

- (e) If a second burner with a sound power level of twice the original burner were added to the furnace (and the original burner remained as well), what would be the resulting reverberant field sound level in the furnace and away from the furnace walls in the 500 Hz octave band.

[5 marks]

3. The sound levels measured in octave bands in an office space are listed in the table below.

Octave band centre frequency (Hz)	63	125	250	500	1k	2k	4k	8k
$L_p$	55	49	43	37	33	33	32	30

- (a) Using the set of curves attached to this exam paper, determine the NCB number of the noise.

[5 marks]

- (b) Does the noise sound rumbly or hissy? Explain how you arrived at your answer.

[5 marks]

4. A residence is located adjacent to a tertiary oil recovery operation that operates 24 hours/day and the vibration levels measured on the floor of the house are listed in the table below. Assume that the vibration levels at all other frequencies are negligible.

1/3 octave band centre frequency (Hz)	2	2.5
a ( $m/s^2$ ) in vertical direction	0.04	0.08
a ( $m/s^2$ ) in lateral direction	0.05	0.1

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4. (Cont.)

- (a) Calculate the weighted root sum of squares (rss) acceleration ( $\text{m/s}^2$ ) for a person standing on the floor.

[5 marks]

- (b) Calculate the estimated vibration dose value if the facility operates 24 hours per day. What is the probability that the resident would complain?

[5 marks]

5. (a) Discuss the four ways in which industrial wastewater discharges intended for treatment can be minimised: water reuse, byproduct recovery, plant maintenance and separation of waste flows. Provide examples for your answers.

(7 marks)

- (b) Briefly describe the three different phases of sedimentation: discrete, flocculent and zone sedimentation.

(6 marks)

- (c) Briefly describe the conditions required for effective removal of oil from wastewater and describe three methods of oil removal. Provide sketches to assist in your description.

(7 marks)

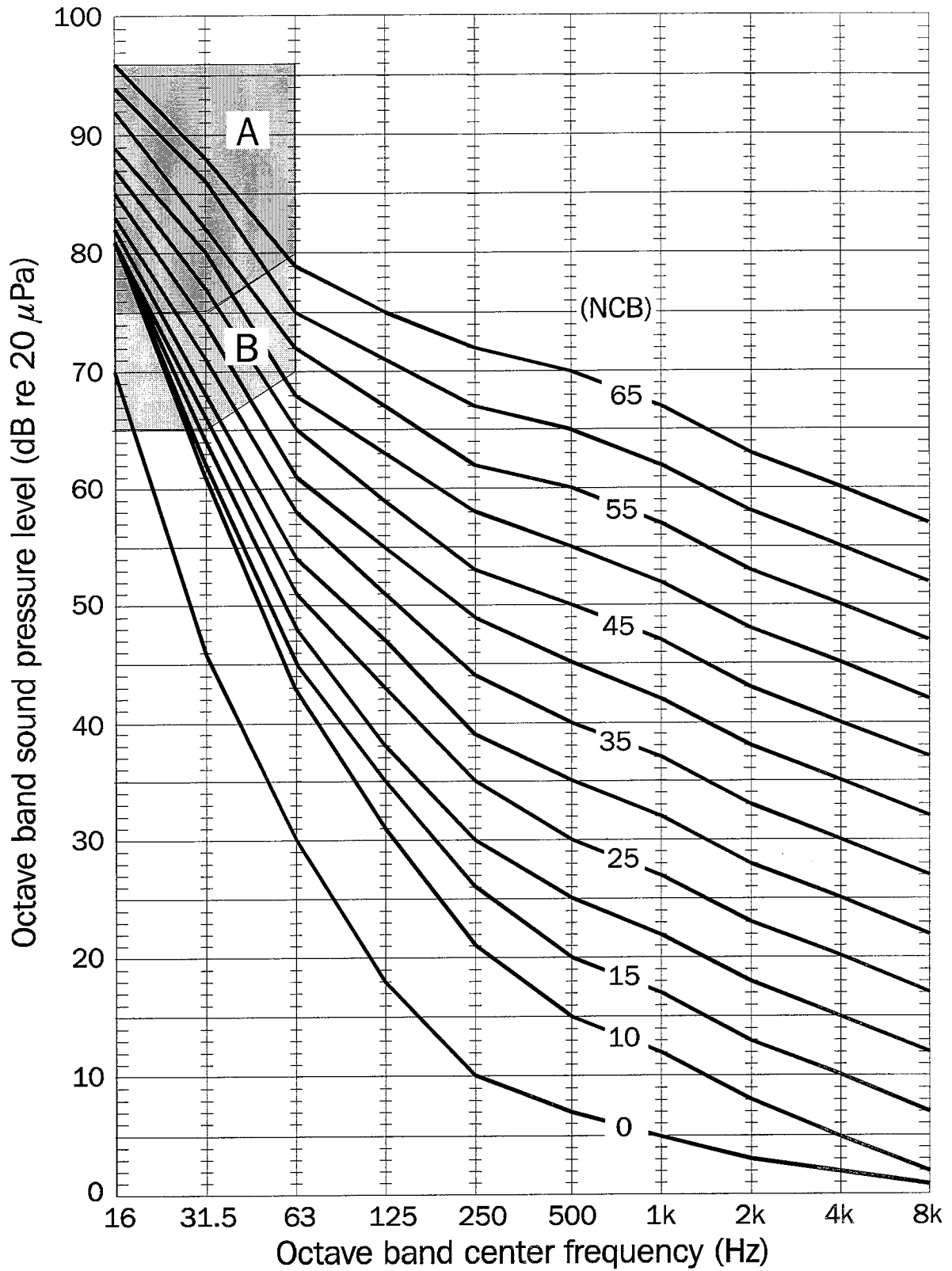
6. A stage in a ceramics manufacturer process involves the cutting of ceramic rods into lengths. The dust produced from this has a density of  $2700 \text{ kg/m}^3$  and a size distribution shown in the table below. The combined temperature of the dust and air is  $385^\circ\text{C}$  and its flow rate at STP is  $1170 \text{ m}^3/\text{hr}$ . The ceramic material is deemed to be chemically inert at these conditions.

Particle Size ( $\mu\text{m}$ )	1	5	15	40	80	150
Weight percentage less than	5	14	38	59	79	98

The company wishes to develop a system to provide a highly efficient and cost-effective dust extraction and clean up, and has asked you to evaluate the effectiveness of a cyclone. Geometric constraints mean that you are limited to just one cyclone.

- (a) Calculate the predicted efficiency of a single cyclone based on the Stairmand design procedure; [8 marks]
- (b) Discuss the accuracy of your calculations [8 marks]
- (c) What are the greatest health issues with the above system? [5 marks]
- (d) What modifications to the above system would you recommend? [3 marks]

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