9.1 Wave Interference p. 419 #1, 2

* Read 9.1 to be able to explain noise cancelling earphones

#1.

a)

Waves in phase

will give you constructive interference. In fact: you will get supercrest and supertrough

#2. Out of phase

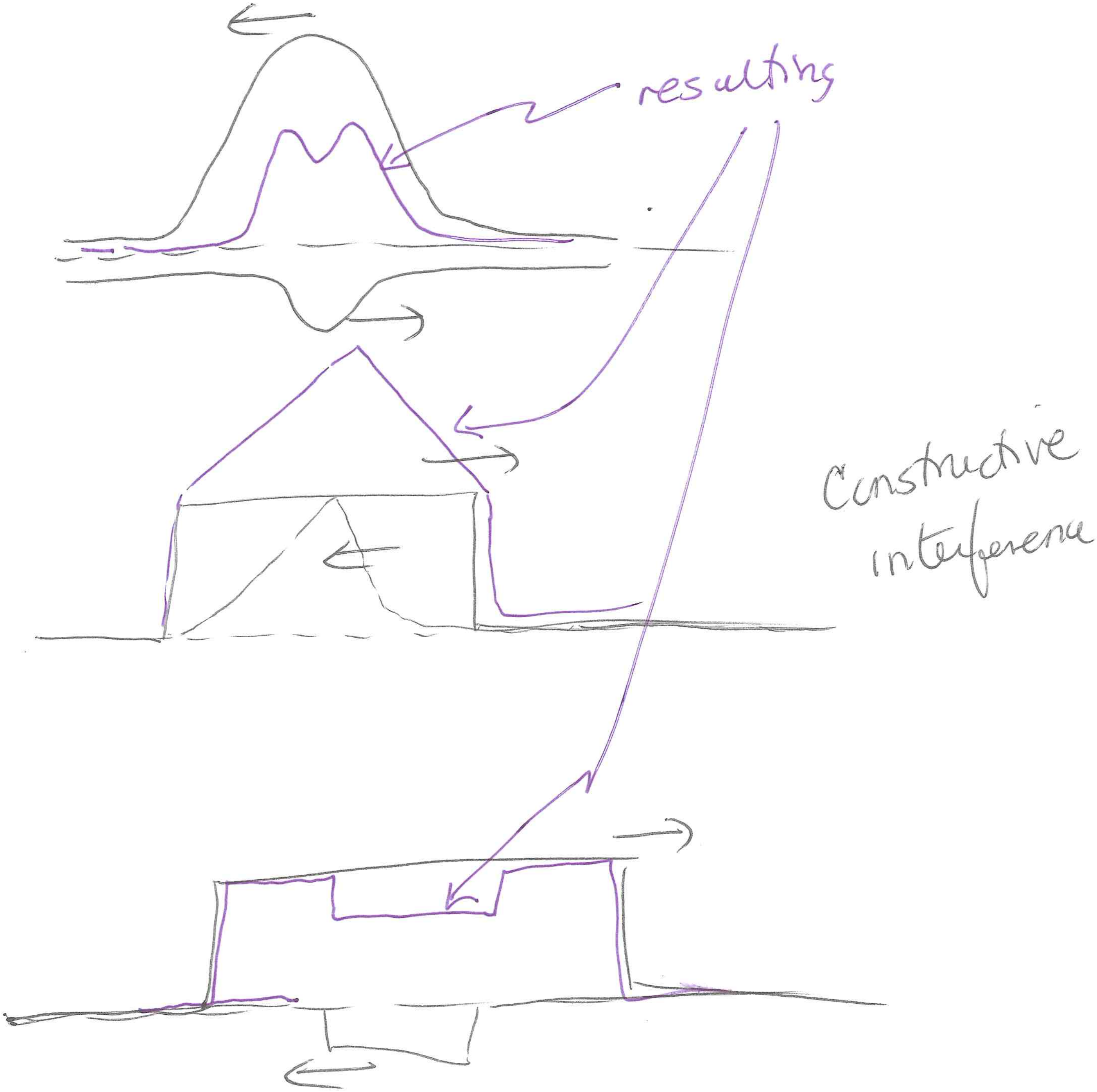
b)

constructive interference

destructive interference

You will get areas of constructive and destructive interference.

2.



* If I give you 2 waves, be able to draw in resulting wave.

p.394 #1,2,3
Mach speed

#1. speed of sound = 344 m/s
speed of object = $910 \frac{km}{h} \times \frac{1000 m}{1 km} \times \frac{1 h}{3600 s} = 253 m/s$

$M = \frac{253 m/s}{344 m/s} = 0.74$

Flying at Mach 0.74

#2 M = 0.93
speed sound = 320 m/s   speed object = ?

$M = \frac{\text{speed object}}{\text{speed sound}}$ ∴ speed object = speed sound × Mach

= 320 m/s × 0.93
= 297.6
= 300 m/s

* Be able to convert to km/h if asked *

#3

M = 0.81
speed plane = 850 km/h
speed sound = ?

speed sound = $\frac{\text{speed object}}{M} = \frac{850 km/h}{0.81}$

= 1049
= 1000 km/h

9.2 Standing Wave Math

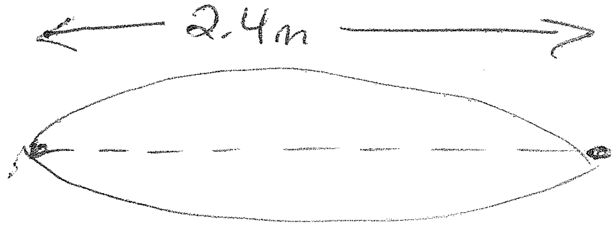
p. 426
1, 4, 5, 6, 7

(1) Be able to define & include a diagram if asked.

(4) Conditions for a standing wave

- wave travels along a medium & reflects back
- frequency of wave & length of wave is such that the resultant wave appears stationary.

(5)



f_0 (1st harmonic)

$v_{wave} = 450$ m/s

$f_{wave} = ?$

(1) length (m) = length (λ)

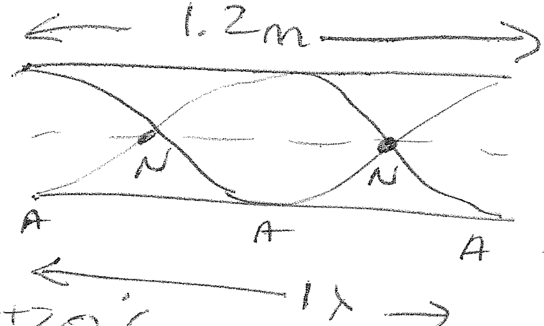
$2.4\text{m} = \frac{1}{2}\lambda$

$\underline{4.8\text{m} = \lambda}$

(2) $v = f\lambda$

$\therefore f = \frac{v}{\lambda} = \frac{450 \text{ m/s}}{4.8 \text{ m}} = \underline{94 \text{ Hz}}$

(6)



f_1 (2ND harmonic)

T = +20°C

freq = ?

→ Length = length

→ $v_{sound} = 331.4 + (0.606)T$

→ $v = f\lambda$

$1.2m = 1\lambda$

$\therefore \lambda = 1.2m$

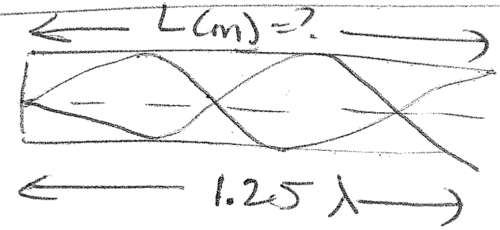
$v_{sound} = 331.4 + (0.606)(+20)$

$= 344 \ m/s$

$v = f\lambda \quad \therefore \quad f = \frac{v}{\lambda} = \frac{344 \ m/s}{1.2 \ m} = 286 \ \frac{1}{s}$

$= 290 \ Hz$

(7)



f_2 (3RD harmonic)

T = 25°C

$f_{wave} = 340 \ Hz$

$v_{sound} = 331.4 + (0.606)T$

$= 331.4 + (0.606)(25)$

$= 347 \ m/s$

→ $v = f\lambda$

$\lambda = \frac{v}{f} = \frac{347 \ m/s}{340 \ Hz} = 1.02_m$

L = L

length (m) $= 1.25\lambda$

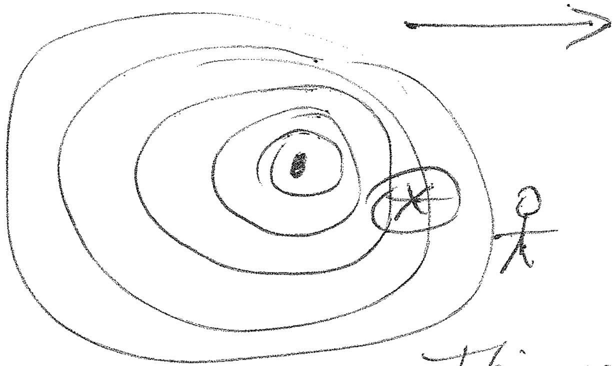
$= 1.25(1.02)$

$= 1.3 \ M$

Doppler

p. 435
2, 3, (4), 5

(2) A diagram along with words is best here



As a source moves, it will move towards sound waves already emitted (*).
This effectively squishes the waves closer together for an observer.
The speed the waves travel remain constant ∴ waves closer together result in <u>higher</u> frequency.

(3) $f_o = 300$ Hz
$v = -25$ m/s * <u>negative</u> speed if <u>towards</u>
$T = 15°C$
$f_{obs} = ?$ assume $V_{detector} = 0$ m/s

Find V_{sound} then use Doppler formula

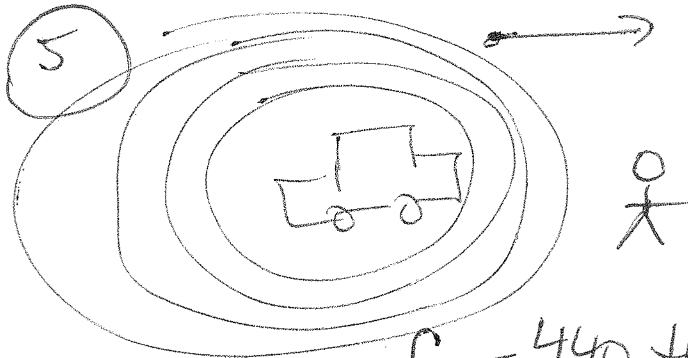
$V_{sound} = 331.4 + (0.606)(T)$
$= 331.4 + (0.606)(15)$
$= \underline{340 \text{ m/s}}$

$$f_{ob} = \left(\frac{V_{sound} + V_{detect}}{V_{sound} + V_{source}}\right) f_o$$

$$= \left(\frac{340 + 0}{340 + (-25)}\right) 300$$

$= 320$ Hz

(5)



$V_{source} = -90 \frac{km}{h} \times \frac{1000\,m}{1\,km} \times \frac{1\,h}{3600\,s} =$

$= -25\,m/s$ approach

$= +25\,m/s$ pass

assume $v_{detector} = 0\,m/s$

$f_o = 440\,Hz$ $T = 0°C$

$f_{obs} = ?$

$v_{sound} = 331.4\,m/s$ (no adjustment needed. $(0.606)(0°C) = 0$!)

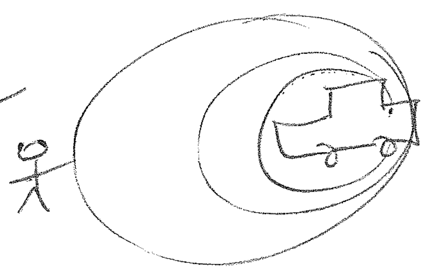
Approach

$$f_{obs} = \left(\frac{V_{sound} + V_{det.}}{V_{sound} + V_{source}} \right) f_o$$

$$= \left(\frac{331.4 + 0}{331.4 + (-25)} \right) 440 = 475.9$$

$= 480\,Hz$ (a ↑ freq and ↑ note) ✓

Pass



$$f_{obs} = \left(\frac{331.4 + 0}{331.4 + 25} \right) 440$$

* only difference

$f_{obs} = 410\,Hz$ (back of book is wrong!)