Math 5: Music and Sound. Some midterm practise questions

You will be provided with the equations on the back sheet but no others

There are other formulae
The first two questions in HW5 are good review too.

1. compare the Pythagorean semitone 256/243 to the equal-tempered version.
2. compute the frequency of C8 the highest note on the piano.
3. How many major thirds should fit in an octave? A just-tuned major third is 5:4. Find the frequency error in cents in constructing an octave using this interval. How is this resolved in music practice?
4. What is the 'missing fundamental' illusion?
5. What is the amplitude and phase of the signal $\sqrt{3}\sin(500\pi t) + \cos(500\pi t)$?
6. An orchestra radiates 10 W acoustic power in all directions. Find the intensity in dB at a distance 20 meters. How much power would your ear with area 5 $\text{cm}^2 = 0.0005\ \text{m}^2$ collect at this distance?
7. Two drummers hit notes one every 0.3 s and the other every 1.6 s (this is actually a syncopated rhythm similar to rhumba clave). They start together. What is the period of their joint sound?
8. What 'strike note' will you perceive if a bell has partials 210, 230, 991, 1320, 1649, 1984, 5775 Hz?
9. Compare the dissonance of the pair of periodic signals at frequencies 400 and 600 Hz to the pair at 400 and 750 Hz, using our usual rule (within 10% but not within 15 Hz). Assume partials are only relevant up to 2400 Hz. What are these two musical intervals? (give error from equal-tempered intervals)
10. Explain the following terms (to someone not in this course)
    (a) Fourier series
    (b) intensity
    (c) wavelength
    (d) partial
11. How fast would a police car need to be traveling so that as they drove away from you their siren was a perfect forth lower than its pitch when stationary?
12. Draw a spacetime diagram illustrating how we measured the speed of sound outside using echoes.
13. Explain how the *phon* measure of loudness differs from the decibel. If your ear is more sensitive at 4000 Hz than at 1000 Hz, is the phons greater or less than the dB at 4000 Hz?
14. What is the Shepard's tones illusion, how does it work, and what does it prove about our perception of pitch?

Useful information

$$\omega = 2\pi f$$

$$c = f\lambda$$

$$\text{dB} = 10\log_{10}\frac{I}{10^{-12}\text{W/m}^2}$$

$$Q = \pi\frac{\tau}{T}$$

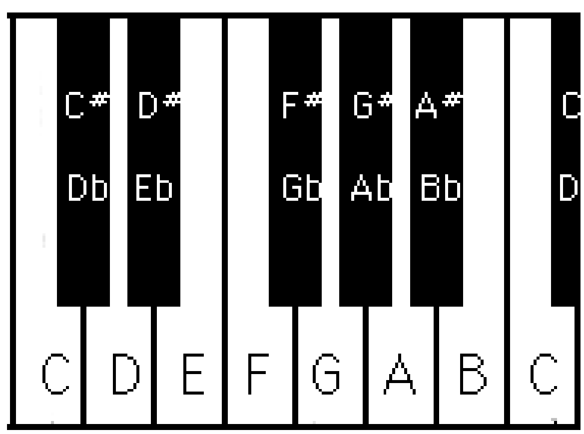
$$\frac{f_{obs}}{f} = \frac{1}{1 - v/c} \quad \text{or} \quad 1 + v/c$$

$$\sin(a+b) = \sin a\cos b + \cos a\sin b$$

$$\sin a + \sin b = 2\cos(\frac{a-b}{2})\sin(\frac{a+b}{2})$$

Intervals by number of semitones:

1. minor second
2. whole tone (major second)
3. minor third
4. major third
5. perfect fourth
6. tritone (augmented fourth)
7. perfect fifth
8. minor sixth
9. major sixth
10. minor seventh
11. major seventh
12. octave



The standard musical pitch A4 is 440 Hz

You can use the speed of sound as 340 m/s.