Wave Worksheet #5: Assume the speed of sound in air is 343 m/s unless otherwise noted.

1. The speed of sound, like all waves, depends on the ___medium___ through which it travels. Sound travels fastest in ___solids___ (solids, liquids, gases) and slowest in ___gases___.

2. The speed of sound in air depends on the ___temperature___ of the air. At 0°C, the speed of sound in air is ___331___ m/s. For every degree above 0°C, the speed ___inc___ by 0.6 m/s. For every degree below 0oC, the speed___dec___by 0.6 m/s.
   The equation is:
   v_{sound} =___331___m/s + 0.6 ___T___

3. What is the speed of sound at 35°C? ___352m/s___
4. What is the speed of sound at -20°C? ___319 m/s___

5. Other than the velocity/temperature equation, there are two important equation involving the speed of sound:

V=___f___ x ___λ___	V= $\frac{d}{t}$

   Rearrange one equation to solve for: f = ___V/λ___ ; λ=___V/f___
   Rearrange the other to solve for: d = ___Vt___ ; t = ___d/V___

6. A 320 Hz tuning fork will produce a wave of what wavelength in air at 22°C? $V_s = 344$ m/s **λ = 1.1 m**

7. We see a bolt of lightning and 4 s later we hear the thunderclap. If the speed of sound in air is 343m/s, how far away is the lightning? $V = d/t$ $d = V \cdot t = 343(4) =$ **1372 m**

8. How many seconds will it take an echo to reach your ears if you yell toward a mountain 82 m away on a day when the air temperature is 0°C? $d = 164$ m $V_s = 331$ m/s $V = d/t$ **t = 0.5 sec**

9. You look up and see a helicopter pass directly overhead. 3.10s later you hear the sound of the engine. If the air temperature is 23.0°C, how high was the helicopter flying?
   $V_s = 331 + 0.6(23) = 345$ m/s $V = d/t$ $d = Vt =$ **1069 m**

10. Navy ships use sonar (sound navigation and ranging) to detect submarines. A sound pulse sent by the ship reflects off the submarine. If the submarine is 2.2 km away from the ship, and the speed of sound in seawater is 1400 m/s, how long will it take the sound pulse to travel out and back?
    $d = 4.4$ km $V = d/t$ $t = d/V = \frac{4400\text{ m}}{1400\text{ m/s}} =$ **3.14 sec**

11. A person is listening with his ear against the rail for an oncoming train. When the train is 1.65 km away, how long will it take him to hear the sound of the whistle? (The speed of sound in steel is ~~5200 m/s.~~)
    $d = 1650$ m $V = d/t$ $t = d/V = 1650/5200 =$ **0.317 sec**
    How long would it take his friend who is standing nearby to hear the same whistle if the air temperature is 0°C?
    $V_s = 331$ m/s $t = d/V = 1650/331 =$ **4.98 sec**

12. If a ship captain sounds a foghorn toward an iceberg and hears the echo 4.6 s later, how far away is the iceberg? (air temperature is -10 °C) Think about this one. If you make a mistake, the ship could run into the iceberg!!!
    $V_s = 331 + 0.6(-10) = 325$ m/s $V = \frac{d}{t}$ $d = Vt = 325(4.6) = 1495$ m

    but dist = $\frac{1}{2}(1495) =$ **747.5 m**