1.) *Multiple Choice*  

For each statement below, circle the correct answer (TRUE or FALSE, no reasoning required).

(a) If a police car is moving away from you, you will hear its siren with a higher frequency than when the police car is at rest.  
   TRUE  
   FALSE

(b) The frequency of standing waves on a string depends on the tension in the string.  
   TRUE  
   FALSE

(c) Just like sound propagation, heat transfer via radiation requires a medium.  
   TRUE  
   FALSE

(d) At constant volume the pressure of an ideal gas is proportional to the average kinetic energy of the gas particles.  
   TRUE  
   FALSE

(e) When an ideal gas does expansion work without heat being added to it, its temperature increases.  
   TRUE  
   FALSE

(e) The heat capacity of a gas is larger when it is kept at constant pressure compared to constant volume.  
   TRUE  
   FALSE

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2.) *Standing Wave and Sound Intensity* (24 pts.)

A wire of mass 25 g and length 1.2 m with both ends fixed vibrates in its second harmonic frequency of 300 Hz.

(a) What is the propagational speed on the wire?

(b) What is the tension in the wire?

(c) If the intensity level of the emitted sound is 40 dB at 1 m distance, at which distance has the intensity level dropped to 0 dB (assume spherical propagation)?
3.) Heat Capacity

Consider 1 kg ice at 0 degrees Fahrenheit (specific heat capacities: $c_{\text{ice}}=2010 \, J/(kg \cdot K)$,
$c_{\text{water}}=4190 \, J/(kg \cdot K)$, $c_{\text{steam}}=1890 \, J/(kg \cdot K)$; latent heats: $L_f=3.34 \cdot 10^5 \, J/K$, $L_v=2.256 \cdot 10^6 \, J/K$).

(a) Calculate the energy needed to convert the ice into steam at 250°F.

(b) Equate the energy calculated in part (a) to gravitational potential energy, to calculate the height (in miles) to which the ice would have to be lifted.  

(1 mi = 1.6 km)
4.) *Kinetic Theory of Gases* 

In the following assume ideal monatomic gases.

(a) What is the root-mean-square speed of helium atoms (mass 4u) at a temperature of $T = -200^\circ C$?

(b) At which temperature do argon atoms (mass 40u) have the same root-mean-square speed than helium atoms at $T = -200^\circ C$?
5.) *Ideal Gas Equation* (24 pts.)

In an isothermal process an ideal gas expands to a final volume of $0.2 \, m^3$ at a final pressure of $5 \cdot 10^4 \, Pa$ at $T = 120^\circ C$. The initial pressure was 5 times larger than the final one.

(a) How many moles of gas are used?

(b) What is the initial volume of the gas?

(c) Sketch the $p$-$V$ diagram of the process and calculate the work that has been done by or on the gas (include the correct sign)?