1) An object of weight $W$ is three times denser than water. It is hung from a vertical spring force scale and lowered into water. When the object is fully submerged, the reading on the scale is:
   A) $\frac{1}{3}W$  
   B) $\frac{1}{2}W$  
   C) $\frac{2}{3}W$  
   D) $W$

2) A traveling wave is described by the equation $y(x,t) = 3 \sin(-2x - 240t)$ in SI units. This represents a wave traveling in the
   A) negative $x$ direction at 120 m/s  
   B) negative $x$ direction at 480 m/s  
   C) positive $x$ direction at 120 m/s  
   D) positive $x$ direction at 80 m/s

3) Two identical loudspeakers are fed by the same signal that generates sound of wavelength $\lambda$. What is the minimum distance $L$ greater than zero such that the speakers can be separated such that the sound is the loudest it can get at a distance of $\frac{1}{4}L$ from one speaker toward the other?
   A) $\frac{1}{2}\lambda$  
   B) $\lambda$  
   C) $\frac{3}{4}\lambda$  
   D) $2\lambda$

4) You are flying a glider due east at $\frac{1}{5}$ the speed of sound. Another glider is flying 37° west of north at $\frac{1}{6}$ the speed of sound. Just as that glider crosses in front of you, the pilot honks his horn, which you hear with frequency $F$. What is the actual frequency of sound emitted by the horn?
   A) $\frac{8}{9}F$  
   B) $\frac{3}{4}F$  
   C) $\frac{25}{36}F$  
   D) $\frac{8}{11}F$

5) A brick that has a temperature 90°C is dropped into an insulated container filled with water that has a temperature 10°C. The brick and the water have the same mass, but the specific heat of the brick is twice that of the water. After thermal equilibrium is reached, the magnitude of the brick's temperature change was ________ the magnitude of the water’s temperature change.
   A) greater than  
   B) equal to  
   C) less than  
   D) unknown compared to

6) An well-insulated house has a single window with thermal conductivity $C$, width $B$, height $D$ and thickness $X$. Its heating system pumps thermal energy into the house at rate $Z$. The temperature outside is $T_{out}$. The temperature difference maintained between the inside and the outside of the house is:
   A) $\frac{ZDB}{CX} + T_{out}$  
   B) $\frac{ZX}{CBD}$  
   C) $\frac{CBD}{ZX}$  
   D) $\frac{CBD}{ZX} - T_{out}$

7) Of the four steps in the thermodynamic cycle shown in the figure on right for a gas, which one is the best candidate for an isothermal process?
   A) $1 \Rightarrow 2$  
   B) $2 \Rightarrow 3$  
   C) $3 \Rightarrow 4$  
   D) $4 \Rightarrow 1$

8) A heat engine operates between the temperatures of two water reservoirs. One reservoir is ice-liquid and the other is steam-liquid. What is a good approximate value for the maximum possible efficiency of this engine?
   A) 0.50  
   B) 0.25  
   C) 0.75  
   D) 1.0

9) An ideal gas initially in state A undergoes a sequence of processes described in the $P$-$V$ graph at the right that returns it to its original state A. What is the total amount of heat energy that flows into the gas during the entire process $A \Rightarrow B \Rightarrow C \Rightarrow A$?
   A) $-6 \text{ J}$  
   B) $-12 \text{ J}$  
   C) $12 \text{ J}$  
   D) $0 \text{ J}$