Physics 2C(B), 10/25/19

1. (1st Law) What are $\Delta E_{th}$, $Q$, and $W$?

2. Clickers, pt. 1

3. “Free Expansion” (theoretical ex.)

4. More clickers / prob. to work on

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1. w/ neighbor: What is Internal Energy?

   - Energy inside box.
   - We'll focus on $E_{total} = E_{int} = U$

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1st Law of Thermodynamics $\Delta E_{th} = Q + W$

- Energy transferred to box via heat
- Energy transfer to box via forces/pressures

$W = W_{on} = -W_{out}$ (system)
\[* W = - \int p \, \text{d}V \]

\[ W = -(\text{Area}) \]

\[ E_{\text{int}} = E_{\text{in}} \]

\[* (E_{\text{int}} \uparrow) \Longleftrightarrow (T \uparrow) \]

\[ (\Delta E_{\text{in}} > 0) \Longleftrightarrow (\Delta T > 0) \]

\[ \text{area} > 0, \quad W < 0 \]

\[ W_{\text{on}} = W < 0 \]
A system undergoes an isochoric process in which its internal energy increases by 20 J. Which entry in the table below is correct?

<table>
<thead>
<tr>
<th>Heat</th>
<th>Work</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) None</td>
<td>20 J done on system</td>
</tr>
<tr>
<td>B) None</td>
<td>20 J done by system</td>
</tr>
<tr>
<td>C) 20 J removed from system</td>
<td>None</td>
</tr>
<tr>
<td>D) 20 J added to system</td>
<td>None</td>
</tr>
<tr>
<td>E) 40 J added to system</td>
<td>20 J done by system</td>
</tr>
</tbody>
</table>

Take the following first-law bar chart, and sketch a possible process on a pV diagram.
The following figure shows three paths on a pV diagram along which a gas can be taken from state $a$ to state $b$. Rank the paths according to $\Delta U$ for the gas, greatest first.

- A) $1 > 2 > 3$
- B) $3 > 2 > 1$
- C) $1 = 2 = 3$
- D) Unable to tell

The following figure shows three paths on a pV diagram along which a gas can be taken from state $a$ to state $b$. Rank the paths according to $Q$ for the gas (heat added to gas), greatest first.

- A) $1 > 2 > 3$
- B) $3 > 2 > 1$
- C) $1 = 2 = 3$
- D) Unable to tell
Free Expansion

Irreversible

\[ P = nRT \]

\[ \Delta E_{\text{in}} = Q + W \]

\[ \Delta S = 0 \quad \Rightarrow \quad 0 = (\text{zero}) + (\text{zero}) \]
The figure shows two processes by which 1.0 g of Nitrogen gas moves from state 1 to state 2. The temperature of state 1 is 27 degrees C.

[let $p_i = 1.0 \text{ atm}$]

What is the net work done by the gas...

a) ... if going along the path 1 $\rightarrow$ 3 $\rightarrow$ 2?

b) ... if going along the path 1 $\rightarrow$ 4 $\rightarrow$ 2?
The figure shows two processes by which 1.0 g of Nitrogen gas moves from state 1 to state 2. The temperature of state 1 is 27 degrees C. 

\[ \text{let } p_1 = 1.0 \text{ atm} \]

What is the net work done by the gas...

a) ... if going along the path 1 \( \rightarrow \) 3 \( \rightarrow \) 2?

b) ... if going along the path 1 \( \rightarrow \) 4 \( \rightarrow \) 2?

\[
W_{by}^{1 \rightarrow 3 \rightarrow 2} = (0.5)(50 \text{ cm}^3) = 25 \times (1.81 \times 10^5 \text{ Pa}) \times (10^{-6} \text{ m}^3)
\]

\[
W_{by}^{1 \rightarrow 3 \rightarrow 2} = +2.5 \text{ Joules}
\]