1. A container contains \( n \) moles of an ideal diatomic gas at temperature \( T_1 \). The gas slowly expands against a piston and heat is added in such a way that the state of the gas follows a straight line on a \( pV \)-diagram as shown. When it reaches the final state 2, both the pressure and volume have been doubled. Express all your answers below in terms of \( n, T_1 \), and the gas constant \( R \).

   a) What is the final temperature of the gas? (1 point)

   b) How much work was done by the gas in the expansion from state 1 to state 2? (2 points)

   c) What is the change in internal energy of the gas in this process? (2 points)

   d) How much heat was added to the gas in this process? (2 points)

Rewrite and sign the Honor Pledge: *I pledge my honor that I have not violated the Honor Code during this examination.*
2. Consider helium gas which has a molar mass \( M = 0.004 \text{ kg mole}^{-1} \). If you want to make a sample of helium hot enough that its root mean square speed is the escape velocity from the Earth at the Earth’s surface, what would its temperature be? (3 points)

Ignore any ionization of the helium. You may find it useful to remember that the acceleration of gravity is \( g = 9.8 \text{ m s}^{-2} \); the radius of the Earth is \( r_E = 6.4 \times 10^6 \text{ m} \); and the gas constant is \( R = 8.3 \text{ J mole}^{-1} \text{ K}^{-1} \).