1. (12) Obtain $dy/dx$ for: (a) $y = e^{\ln(2x)}$; (b) $y = \ln[(3x^2 + 4)^3]$; (c) $y = 5^2x^3$.

   (a) \[ \frac{dy}{dx} = 2 \]

   (b) \[ \frac{dy}{dx} = \frac{18x}{3x^2 + 4} \]

   (c) \[ \frac{dy}{dx} = 6x^2 \ln 5 \cdot 5^x^3 \]

2. (8) The ideal gas law reads $PV = nRT$, where $P$ is the pressure, $V$ the volume, $n$ the number of moles, $R$ the gas constant, and $T$ the absolute temperature.

   (a) Express $P$ as a function of $V$, $n$, and $T$.

   \[ P = \frac{nRT}{V} \]

   (b) What are the independent and dependent variables here?

   \[ \text{independent: } n, T, V \quad ; \quad \text{dependent: } P \]

   (c) Give a general (formal) definition of $dP$; then evaluate all the partial derivatives to make this expression specific.

   \[ dP = \left( \frac{\partial P}{\partial n} \right)_T d_n + \left( \frac{\partial P}{\partial T} \right)_n d_T + \left( \frac{\partial P}{\partial V} \right)_n d_V \]

   \[ = \frac{RT}{V} d_n + \frac{nR}{V} d_T - \frac{nRT}{V^2} d_V \]

3. (6) In problem 11, you had to use the chain rule to obtain the partials $(\partial f/\partial x)_t$ and $(\partial f/\partial t)_x$, when $f$ was defined as $f(x+ct)$. Suppose now that $f = f(u)$, with $u = x^2 + 3t$. Obtain $(\partial f/\partial x)_t$, $(\partial^2 f/\partial x^2)_t$, and $(\partial f/\partial t)_x$. [Express these in terms of $f'(u)$ and $f''(u)$.]

   \[ \left( \frac{\partial f}{\partial x} \right)_t = 2x f'(u) \]

   \[ \left( \frac{\partial^2 f}{\partial x^2} \right)_t = 2 f'(u) + 4x^2 f''(u) \]

   \[ \left( \frac{\partial f}{\partial t} \right)_x = 3 f'(u) \]