When necessary, write in symbolic not decimal expansion. That is, we would say \((3+\pi)\) not 6.14. . .
Please simplify as much as you can. Show your work.

1. (Section 1.6) Suppose \(u(x, y)\) is a real-valued function defined in a domain \(D\). If
\[
\frac{\partial u}{\partial x} = 2x(1 + y) \quad \text{and} \quad \frac{\partial u}{\partial y} = x^2
\]
at all points of \(D\), show that \(u(x, y) = x^2(1 + y) + c\) for some constant \(c\).

2. (Section 1.6) Which of the following sets are bounded? Give reasons and sketch them.
   a) \(2 < \Re z \leq 3\)   b) \(D(0, 1)\) and \(D(2, \frac{1}{2})\) together   c) \(|\Arg(z)| < 1\)

3. (Section 2.1) For each of the following, describe and sketch the range of the region, \(R\), under the map \(f(z)\).
   a) \(R = \{z \in \mathbb{C} \mid \Re(z) \geq 0\}, \quad f(z) = e^z\)
   b) \(R = \{z \in \mathbb{C} \mid 0 < \Arg(z) \leq \frac{\pi}{4}\}, \quad f(z) = \frac{1}{z}\)
   c) \(R = \{z \in \mathbb{C} \mid |z - (1 + 3i)| > 2\}, \quad f(z) = (z + \overline{z})(1 + i)\)

4. (Section 2.2) Evaluate each of the limits, if it exists, or else explain why it does not exist. The limits are always over integers, \(n\). Pictures help.
   a) \(\lim_{n \to \infty} i^n\)   b) \(\lim_{n \to \infty} \left(5 + \frac{1}{n}e^{\frac{\pi n}{6}}\right)\)   c) \(\lim_{n \to \infty} (n + (\frac{i}{3})^n)\)

5. (Section 2.2) Explain why \(\arg_{\mathbb{R}}(z)\) is not continuous at \(z = i\) but is continuous at \(z = -1\). You do no not need to make an \(\epsilon\) and \(\delta\) argument, but you can if you want to. In any case, you should probably draw a picture.