5. [7 points]

a. [3 points] Let

$$Q(t) = 7 - \sin(t^2).$$

Suppose k is a nonzero constant. Write an explicit expression for the average rate of change of Q between $t = 5$ and $t = 5 + k$.
Your answer should not involve the letter Q. Do not attempt to simplify your expression.
Draw a box around your final answer.

b. [4 points] Let

$$P(w) = 6^{\arctan(4w)}.$$

Use the limit definition of the derivative to write an explicit expression for $P'(-3)$.
Your answer should not involve the letter P. Do not attempt to evaluate or simplify the limit.
Draw a box around your final answer.

6. [11 points] Define the following functions for an airplane taking off from a certain airport.

- Let $H(t)$ be the height above sea level, in kilometers (km), of the airplane t minutes after takeoff.
- Let $T(k)$ be the temperature of the air outside the airplane, in degrees Celsius (°C), at a height of k kilometers above sea level.

The functions $H(t)$ and $T(k)$ are differentiable and invertible.

a. [2 points] Use a complete sentence to give a practical interpretation of the equation $H^{-1}(6) = 5$.

b. [3 points] Write a single equation representing the following statement in terms of the functions H, T, and/or their inverses:

The temperature of the air outside the airplane fell by 12 °C in the first five minutes after takeoff.

c. [3 points] Complete the following sentence to give a practical interpretation of the equation

$$T'(9) = -10.$$

As the plane climbs from 8.8 km above sea level to 9 km above sea level...

d. [3 points] Which of the following gives a valid interpretation of the equation $(H^{-1})'(4) = 0.5$? Write down the Roman numeral corresponding to your choice. There is only one correct answer.

i. When the plane is at a height of 4 km, the temperature of the air outside the plane will decrease by about 0.5 degrees Celsius as the plane climbs an additional kilometer.

ii. It will take approximately 30 seconds for the airplane to climb from a height of 4 km to a height of 5 km.

iii. Four minutes into its flight, the plane will increase its height by about 0.5 km in the next minute.

iv. Once the plane has reached a height of 4 km, it will take about one minute to climb an additional 0.5 km.