In an electrocardiograph (ECG), electrical signals from the heart are measured.

1. **(12 points each; 84 points total)** Discuss as quantitatively as possible, the following aspects of an ECG. Diagrams and equations may be appropriate for some of the questions.

(a) What is the physical origin of the ECG?
(b) Sketch a representative ECG waveform, and identify key parts of the waveform.
(c) What are key issues on electrodes and leads for use in the ECG?
(d) What are representative amplitudes and frequency content of the ECG waveform?
(e) What characteristics should the amplifier for measurement of the ECG have?
(f) What type of filtering should be done on the ECG waveform?
(g) What are some methods for reducing electrical noise in the ECG?

2. **(16 points)** Sketch the waveform of inspiration impedance vs. time for the transchest leads. What is the physical origin of the inspiration impedance?