Please print the information in the table below with clear, legible dark lettering. Your writing has to be readable by a computer. Your email address should be very clear and readable too. Work on your own. No notes, books, calculators, or electronic devices.

**TOTAL POSSIBLE POINTS: 10 Pts**
Multiple choice: circle ONE correct answer. Use scrap paper for calculations.

(Q1) Consider a cubic crystal of side length $x$ and volume $V = x^3$. If the volume is increasing at the rate of 3 mm$^3$ per month, and the crystal remains a cube, at what rate is its side length changing (in mm/month) when its volume is 8 mm$^3$?

(A) $3^{1/3}$, (B) $\frac{3^{1/3}}{8}$, (C) $\frac{9}{64}$, (D) $\frac{1}{64}$, (E) $\frac{1}{4}$.

(Q2) The human population on Earth doubles roughly once every 50 years. If there are 7.5 billion people on Earth now, in how many years will there be 30 billion?

(A) $7.5e^{50t}$ years (B) $7.5e^{t/50}$ years (C) $\frac{7.5}{30}e^{\ln(2)/50}$ years (D) 75 years (E) 100 years

(Q3) Consider the function $y = ax^b$. When I graph $\ln(y)$ versus $\ln(x)$, I see a line with slope $3/4$ and vertical intercept 1. This tells me that

(A) $a = 1, b = 3/4$ (B) $a = 3/4, b = 1$ (C) $a = e, b = 3/4$ (D) $a = 3/4, b = e$ (E) $a = 1, b = e^{3/4}$.

(Q4) Which function is a solution to the differential equation $\frac{dh}{dt} = -k\sqrt{h}$ with $h(0) = h_0$?

(A) $h(t) = (\sqrt{h_0} - \frac{1}{2}kt)^2$
(B) $h(t) = (\sqrt{h_0} - kt)^2$
(C) $h(t) = h_0e^{-kt}$
(D) $h(t) = (1 - e^{-kt})$
(E) None of the above

(Q5) Which of the following differential equations has unstable steady states at $y = \pm 1$ and a stable steady state at $y = 0$? (Hint: consider sketching the state-space diagrams).

(A) $\frac{dy}{dt} = -2(y^3 - y)$
(B) $\frac{dy}{dt} = y^3 - y$
(C) $\frac{dy}{dt} = y(1 - y)^2$
(D) $\frac{dy}{dt} = y^4 - y^2$
(E) None of the above