1) (10pts) Gold, which has a mass of 19.32 g for each cubic centimeter of volume, is the most ductile metal and can be pressed into a thin leaf or drawn out into a long fiber.

   a) (7) If a sample of gold, with a mass of 32.00 grams, is pressed into a leaf of 2.000 µm thickness, what is the area of the leaf in square meters (m²)?

   b) (3) If, instead, the gold is drawn out into a cylindrical fiber of radius 2.200 µm, what is the length of the fiber (in meters)?
2) (25 pts) You are trailing an unmarked police car by 30 m. Both your car and the police car are traveling at 105 km/hr. The police officer begins braking suddenly at 5.0 m/s², but you don’t notice his brake lights until 2.4 seconds later. Then, after 2.4 seconds, you begin braking at 5.0 m/s².

   a) (10 pts) What is the separation between the 2 cars when you begin braking (after 2.4 s)?

   b) (3 pts) What is the cop’s velocity when you begin braking?

   c) (12 pts) What is your speed when you hit the police car?
3) (20 pts) Two vectors are given by

\[ \vec{a} = 3.2\hat{i} - 2.0\hat{j} + 1.5\hat{k} \]
\[ \vec{b} = -2.4\hat{i} + 1.3\hat{j} + 3.3\hat{k} \]

In unit vector notation, find

a) (4 pts) \( \vec{a} + \vec{b} \)

b) (6 pts) \( \vec{a} - \vec{b} \)

c) (10 pts) A third vector, \( \vec{c} \), such that \( \vec{a} - 2\vec{b} + 2\vec{c} = 0 \)
4) (15 pts) Two beetles run across flat sand, starting at the same point. Beetle 1 runs 0.25 m due North, then 0.3 m in a direction 25° West of due North. Beetle 2 also makes two runs. The first is 1.5 m in a direction 15° South of due East. What must be the magnitude and direction of its second run if it is to end up at the new location of Beetle 1?
5) (30 pts) The position of a particle moving along an x-axis is given by
\[ x = 8 + 3t^3 - 10t^2, \]
where x is in meters and t is in seconds. Determine

a) (2 pts) The position when \( t = 2.0 \) s

\[ x = 8 + 3(2)^3 - 10(2)^2 = \]

b) (4 pts) The velocity when \( t = 2.0 \) s

\[ v(t) = \frac{dx}{dt} = 9t^2 - 20t \\
v(2) = 9(2)^2 - 20(2) = \]

c) (4 pts) The acceleration when \( t = 2.0 \) s

\[ a(t) = \frac{dv}{dt} = 18t - 20 \\
a(2) = 18(2) - 20 = \]

d) (5 pts) What is the minimum (negative) coordinate reached by the particle?

\[ x(t) = 8 + 3t^3 - 10t^2 = \]

e) (3 pts) At what time did it reach this minimum coordinate?

\[ \]

f) (3 pts) What is the acceleration of the particle at the instant the particle is not moving?

\[ a(t) = 18t - 20 \\
a(t) = 18t - 20 = \]

i) (5 pts) Determine the average velocity of the particle between \( t = 0 \) and 3 seconds.

\[ v(t) = 9t^2 - 20t \\
\text{Average velocity} = \frac{v(3) - v(0)}{3-0} = \]

f) (4 pts) Attached are plots of the position function. Show how you would graphically determine the answers to parts b and d.