

FALL 2009 — MA 227-6B — TEST 1
SEPTEMBER 21, 2009

Name: _____

1. PART I

There are 6 problems in Part 1, each worth 4 points. Place your answer on the line to the right of the question. Only your answer on the answer line will be graded.

- (1) Find the cross product of the vectors $\langle 4, 2, 1 \rangle$ and $\langle 2, 0, 1 \rangle$.

- (2) Find the dot product of the vectors $\langle -1, 3, 2 \rangle$ and $\langle 2, 1, 3 \rangle$.

- (3) Bruno's position is given by $\vec{r}(t) = \langle 3t + t^2, 2t - t^2 \rangle$. At what time is at the point $\langle 18, -3 \rangle$.

- (4) Find a vector function representing the line (a parametrization of the line) passing through the point with coordinates $(2, 2, 3)$ in the direction of $\langle 2, 0, 1 \rangle$.

- (5) Find the derivative of the vector function $\langle \sin(t), t^3, \cos(2t) \rangle$.

- (6) Find the indefinite integral $\int (-3e^{t\vec{i}} - 8t^3\vec{k}) dt$.

2. PART II

There are 2 problems in Part 2, each worth 18 points. On Part 2 problems partial credit is awarded where appropriate. Your solution must include enough detail to justify any conclusions you reach in answering the question. If you need to add assumptions in order to proceed, make the assumptions after explaining why they are reasonable.

- (1) Newton's second law of motion states the the acceleration \vec{a} of a body of mass m is given by $\vec{F} = m\vec{a}$ when the force \vec{F} acts on the body. A ball is thrown from a tower of height h with an initial velocity \vec{v}_0 . Find the vectors of acceleration, velocity, and position. State your reasons for each formula. Now assume that $h = 20\text{m}$, $|\vec{v}_0| = 10\sqrt{3}\text{m/s}$ and if the ball is thrown under an angle of 60° with the horizontal and answer the following question. Use 10m/s^2 for the gravitational acceleration.
 - (a) How far from the tower will the ball touch ground?
 - (b) Find the ball's speed at impact.

- (2) A strand of the DNA molecule has the shape of a helix or spiral. We want to estimate the length of piece of it. A parametrization of a helix is given by

$$\vec{r}(t) = \langle a \cos(t), a \sin(t), bt \rangle.$$

The radius of a DNA strand is 10\AA angstroms and it rises 34\AA during a complete turn of the helix. Compute the length of one full turn of the strand. Do not try to find a decimal expression for your answer.

Not that it matters, but $1\text{\AA}=10^{-10}\text{m}$. It is named for the Swedish physicist Anders Jonas Ångström.