Name: _____

- **READ THE FOLLOWING DIRECTIONS!**
- **Do NOT open the exam until instructed to do so.**
- You have until 10:50am to complete this exam. When you are told to stop writing, do it or you will lose all points on the page you write on.
- You may not communicate with other students during this test.
- No written materials of any kind are allowed. No scratch paper is allowed except as given by the proctors.
- No phones, calculators, or any other electronic devices are allowed for any reason, including checking the time (a simple wristwatch is fine).
- Any case of cheating will be taken extremely seriously.
- Show all your work and explain your answers.
- Before turning in your exam, check to make certain you've answered all the questions.

Question:	1	2	3	4	5	Total
Points:	20	25	15	20	20	100
Score:						

1. Consider the planes $3x - y + 2z = 4$ and $2x - 2y + z = 6$.

   (a) (5 points) Explain why, at a glance, you know these planes are not parallel.

   (b) (8 points) Find a vector that is parallel to both planes.

   (c) (7 points) Give an equation for the line that is the intersection of the two planes.

2. Suppose a particle moves in the plane, with position $(t^2, 2t^3)$ at time t.

(a) (3 points) Find the velocity at time $t = 1$.

(b) (3 points) Find the acceleration at time $t = 1$.

(c) (7 points) Find the tangential component of acceleration at time $t = 1$.

(d) (7 points) Find the normal component of acceleration at time $t = 1$.

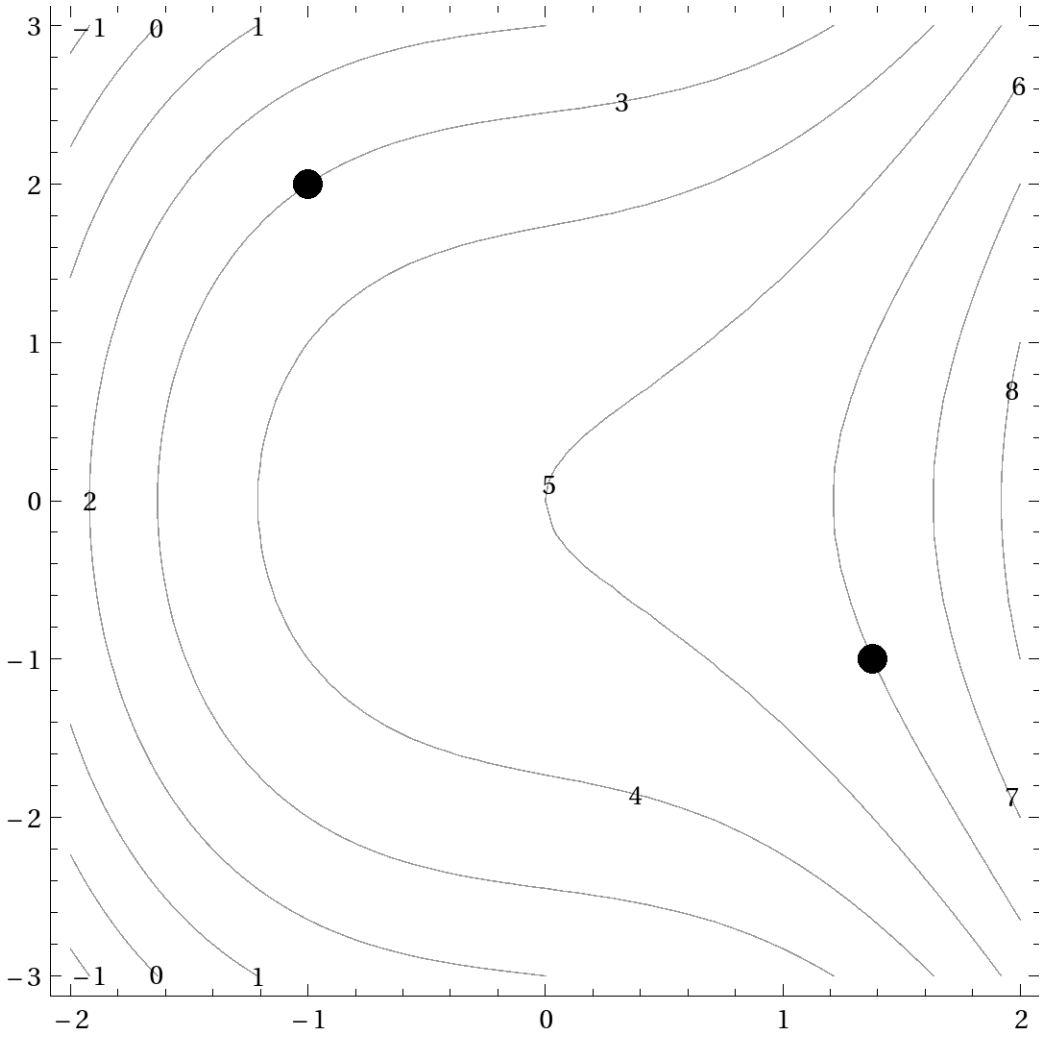
(e) (5 points) What do the above tell you about how the speed of the particle is changing at $t = 1$?

3. (15 points) By switching the order of integration, compute

$$\int_0^4 \int_{\sqrt{x}}^2 \frac{3}{4+y^3}\, dy\, dx.$$

4. (20 points) Find the maximum and minimum values of $f(x, y) = x^2 + 9y^2$ on the disk $x^2 + y^2 \leq 4$. Hint: consider the interior of the disk and its boundary (the circle) separately. Then sketch the region together with the level curves for f corresponding to your maximum and minimum.

5. Below is a plot of several level curves of a function $f(x, y)$ inside the rectangle R.



(a) (15 points) At each of the two indicated points, sketch in the gradient vectors.

(b) (5 points) Which of the following intervals does $\iint_R f(x, y)\, dx\, dy$ fall into? Explain how you know.

$(-\infty, -120)$ $(-120, -80)$ $(-80, -40)$ $(-40, 0)$ $(0, 40)$ $(40, 80)$ $(80, 120)$ $(120, \infty)$

Scratch Paper - you may remove this if you find it convenient

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