Name: ______________________________

VIP ID: ______________________________

- Write your name and your VIP ID in the space provided above.
- The test has nine (9) pages, including this one, and the formula sheet attached at the end.
- You have 150 minutes to complete this test.
- Each problem is worth 10 points.
- Enter your answer in the box(es) provided.
- You must show sufficient work to justify all answers unless otherwise stated in the problem. Correct answers with inconsistent work may not be given credit.
- No books, notes or calculators may be used on this test.

Page	**Max**	**Points**
2	10	
3	20	
4	20	
5	20	
6	10	
7	10	
8	10	
Total	100	

Problem 1. Let $\boldsymbol{u} = 6\boldsymbol{i} - \boldsymbol{j} + \boldsymbol{k}$, $\boldsymbol{v} = -12\boldsymbol{i} + 2\boldsymbol{j} - 2\boldsymbol{k}$, $\boldsymbol{w} = \boldsymbol{j} - 6\boldsymbol{k}$.

(a) (4 pts) Which of those vectors are perpendicular?

(b) (4 pts) Which of those vectors are parallel?

(c) (2 pts) What is the volume of the parallelepiped determined by $\boldsymbol{u}, \boldsymbol{v}$ and $\boldsymbol{w}$?

$V =$

Problem 2 (10 pts)**.** Find an equation of the plane determined by the intersecting lines

$$L_1 : \begin{cases} x & = -1 + t \\ y & = 2 + 3t \\ z & = 1 - 4t \end{cases} \qquad L_2 : \begin{cases} x & = 1 - 4s \\ y & = 1 + 2s \\ z & = 2 - 2s \end{cases}$$

plane: $\boxed{}$

Problem 3 (10 pts)**.** Find the distance from the point $(0, 6, 0)$ to the plane $4x + 7y + 4z = 32$.

$d = \boxed{}$

Problem 4 (10 pts)**.** Find the following limit, or prove that it does not exist:

$$\lim_{(x,y)\to(0,0)} \frac{2x}{x^2+x+y^2}$$

$$\lim_{(x,y)\to(0,0)} \frac{2x}{x^2+x+y^2} = \boxed{}$$

Problem 5 (10 pts)**.** Find the line integral of $f(x,y,z) = x+y+z$ over the straight-line segment from $(2,3,1)$ to $(1,-1,-1)$.

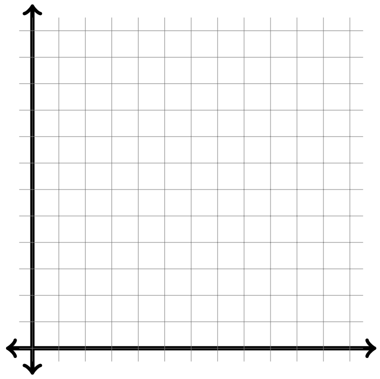
$$\int_C f\,ds = \boxed{}$$

Problem 6 (10 pts)**.** Find the curvature $\kappa(t)$ of the vector function $\boldsymbol{r}(t) = \frac{t^5}{5}\boldsymbol{i} + \frac{t^2}{2}\boldsymbol{j}$, $t > 0$.

$\kappa(t) =$ $\boxed{}$

Problem 7 (10 pts)**.** Find all the local maxima, local minima, and saddle points of the function $fx, y) = x^3 + y^3 + 3x^2 - 9y^2 - 1$.

Problem 8 (10 pts)**.** Find the absolute maximum and minimum (both location and value) of the function $f(x, y) = 7x^2 + 8y^2$ on the closed triangular region bounded by the lines $x = 0$, $y = 0$, $y + 2x = 2$ in the first quadrant. Sketch the region.

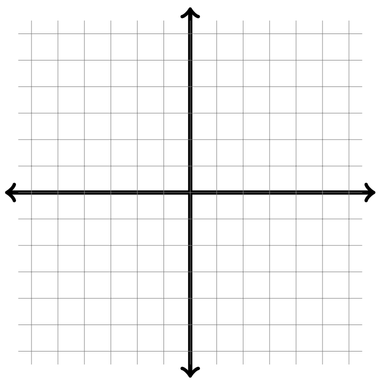


Maximum:

Minimum:

Problem 9 (10 pts)**.** Given the integral below: Sketch the domain of integration, change the integral into an equivalent polar integral, and evaluate the polar integral.

$$\int_{-1}^{0}\int_{-\sqrt{1-x^2}}^{0} \frac{6}{1+\sqrt{x^2+y^2}}\,dy\,dx$$



$$\int_{-1}^{0}\int_{-\sqrt{1-x^2}}^{0} \frac{6}{1+\sqrt{x^2+y^2}}\,dy\,dx = \boxed{} = \boxed{}$$

Problem 10 (10 pts)**.** We want to find the volume of the solid cut from the thick-walled cylinder $1 \le x^2 + y^2 \le 6$ by the cones $z = \pm\sqrt{4x^2 + 4y^2}$. Sketch that solid, find an integral expression that computes its volume (double or triple integral, your choice), and evaluate that integral to obtain that volume.

$$V = \iint_D f(x, y)dA = \iiint_R dV = \boxed{}$$