1. (10 points) Find the maximum value of the function

$$f(x, y) = 3x^2 - 6x + 3y^2 - 12y + 17$$

subject to the constraint $x^2 + y^2 = 5$.

A. 2

B. 32

C. 62

D. 92

E. 122

2. (10 points) Compute the area of one leaf of the graph of the polar function

$$r = \sin(3\theta).$$

(Recall that $\sin^2(\theta) = \frac{1-\cos(2\theta)}{2}$)

A. $\pi/12$

B. $1/12$

C. $2\pi/3$

D. $2/3$

E. $\pi/3$

3. (10 points) Find the volume of the solid bounded by the surfaces $z = \sqrt{x^2 + y^2}$ and $z = 2$.

A. 2π

B. $8\pi/3$

C. $10\pi/3$

D. 4π

E. $14\pi/3$

4. (10 points) Compute

$$\int_0^{\sqrt{2}} \int_x^{\sqrt{4-x^2}} \int_0^{\sqrt{4-x^2-y^2}} \sqrt{x^2+y^2+z^2}\, dz\, dy\, dx.$$

A. $\pi/4$

B. $\pi/2$

C. π

D. 2π

E. 4π

5. (10 points) Suppose a room has temperature

$$T(x, y, z) = x^2 \cos z + xze^y$$

at a point (x, y, z) in the room. Find the unit vector which gives the direction in which T increases most rapidly at the point $(1, 0, 0)$.

6. (10 points) Classify all critical points of the function

$$f(x, y) = 2x^2 + 2yx^2 - y^2.$$

7. (10 points) Let D be the region bounded by the curves $y = \sqrt{x}$ and $y = x/2$. Write down (but do not evaluate) **two** iterated integrals with **different** orders of integration that can be used to compute

$$\iint_D \sin(xy)\, dA.$$

8. (10 points) Compute

$$\int_0^1 \int_0^{2y^{2/3}} x^2\sqrt{x^3+y^2}\,dx\,dy.$$

9. (10 points) Write down (but do not evaluate) an iterated integral that gives the value of

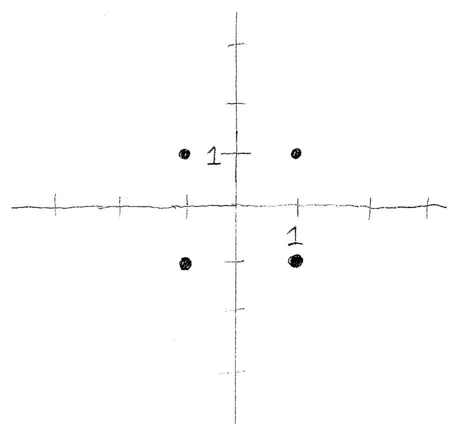
$$\iiint\limits_E xyz\,dV$$

where E is the solid in the first octant bounded by $z=\sqrt{y}$, $z=x-2$ and $y=4$.

10. Consider the vector field

$$\mathbf{F}(x,y) = \langle 2x, x+y\rangle.$$

(a) (4 points) Sketch the vectors $\mathbf{F}(x,y)$ at each point depicted on the graph below. **Draw directly on the graph.**



(b) (6 points) Compute $\int_C \mathbf{F}\cdot d\mathbf{r}$ where C is the line segment from (1,1) to (3,2).