9. $f(x,y) = 2x^2y - 4xy^2, P = (2,3).$

$\langle 1, 0, -12 \rangle$ $\langle f_x, f_y, -1 \rangle$

$\langle 0, 1, -40 \rangle$ $\langle -12, -40, -1 \rangle$

$\langle 2, 3, -48 \rangle$

$\langle 2, 3, -48 \rangle + \langle -12, -40, -1 \rangle t$

11. $f(x,y) = 3x - 5y, P = (4,2).$

$\frac{\partial f}{\partial x}$ $f_x = 3$ $\langle 3, -5, -1 \rangle$

$f_y = -5$

$\langle 4, 2, 2 \rangle$

$\langle 4, 2, 2 \rangle + \langle 3, -5, -1 \rangle t$

17. $f(x,y) = 2x^2y - 4xy^2, P = (2,3).$

$\langle -12, -40, -1 \rangle$

$\langle 2, 3, -48 \rangle$

$-12(x-2) + -40(y-3) + -1(z+48) = 0$

$-12x + 24 - 40y + 120 - z - 48 = 0$

$12x + 40y + z = 96$

---

19. $\langle 3, -5, -1 \rangle$ $0 = 3(x-4) - 5(y-2) \cancel{(z-2)}$

$\langle 4, 2, 2 \rangle$

$3x - 5y = z$

(a) $\int_2^5 (6x^2 + 4xy - 3y^2)\, dy$

(b) $\int_{-3}^{-2} \int_2^5 (6x^2 + 4xy - 3y^2)\, dy\, dx$

a) $6x^2y + 2xy^2 - y^3 + C \Big|_2^5$

$\int_{-3}^{-2} 18x^2 + 42x - 117\, dx$

$6x^3 + 21x^2 - 117x + C \Big|_{-3}^{-2}$

$-48 + 84 + 234$

270

$270 - 378$

378

-108

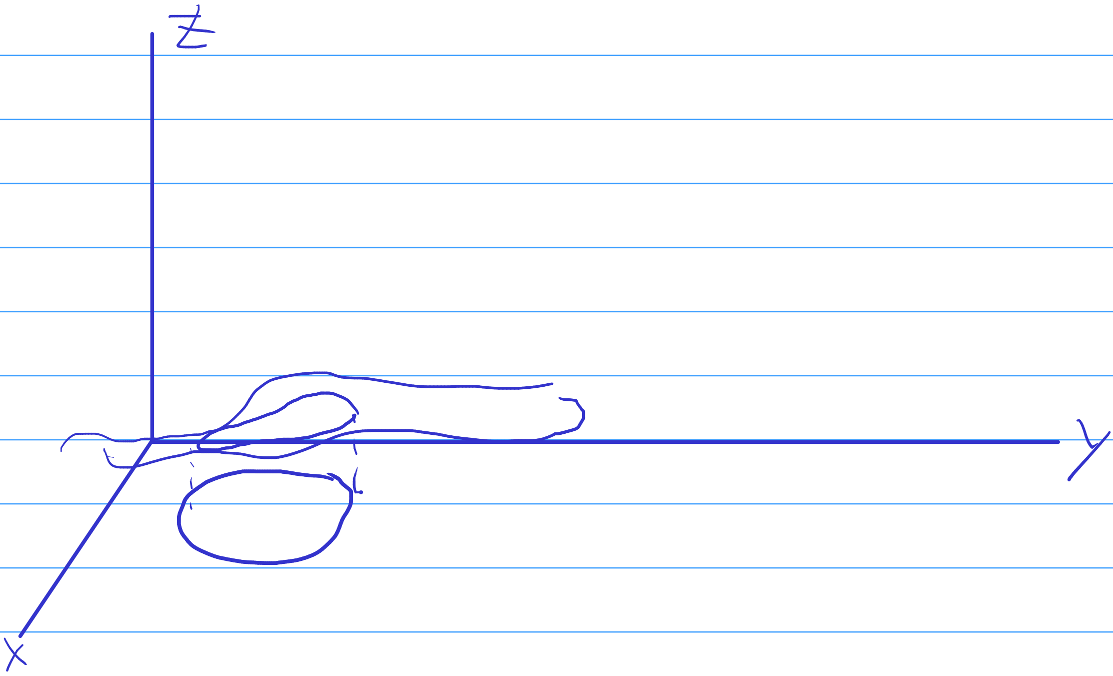
9. (a) $\int_0^y (\cos x \sin y)\, dx$

(b) $\int_0^{\pi} \int_0^y (\cos x \sin y)\, dx\, dy$

a) $\sin x \sin y + C \Big|_0^y = \sin^2 y$

$\int_0^{\pi} \sin^2(y)\, dy$ $\qquad \int_0^{\pi} \frac{1-\cos(2y)}{2}\, dy$

$\frac{1}{4}(y - \sin(2y)) \Big|_0^{\pi} = \frac{\pi}{4}$



$$\oint_S$$

$$\nabla f(x,y) \qquad [f_x(x,y), f_y(x,y)]$$

$$\left\langle \frac{\partial}{\partial x}, \frac{\partial}{\partial y} \right\rangle \qquad \left\langle \frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z} \right\rangle$$

$$\nabla \cdot \vec{F}\langle x, y, z\rangle$$

$$\frac{\partial}{\partial x}\vec{F} + \frac{\partial}{\partial y}\vec{F} + \frac{\partial}{\partial z}\vec{F}$$

$$\vec{F} = \langle x^2 y, \sin(x) y^2 \rangle$$

$$\frac{\partial}{\partial x} x^2 y + \frac{\partial}{\partial y} \sin(x) y^2$$

$$2xy + 2y\sin(x)$$

$$\vec{F} = \langle M, N \rangle$$

Curl: $N_x - M_y$

$$\vec{F} \langle M, N, P \rangle$$

$$\nabla \times \langle M, N, P \rangle$$

$M_y \hat{k}$ $N_z \hat{i}$ $P_x \hat{j}$

$$\begin{array}{ccccc} \hat{i} & \hat{j} & \hat{k} & \hat{i} & \hat{j} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} & \frac{\partial}{\partial x} & \frac{\partial}{\partial y} \\ M & N & P & M & N \end{array}$$

$P_y \hat{i}$ $M_z \hat{j}$ $N_x \hat{k}$

$$\langle P_y - N_z, M_z - P_x, N_x - M_y \rangle$$