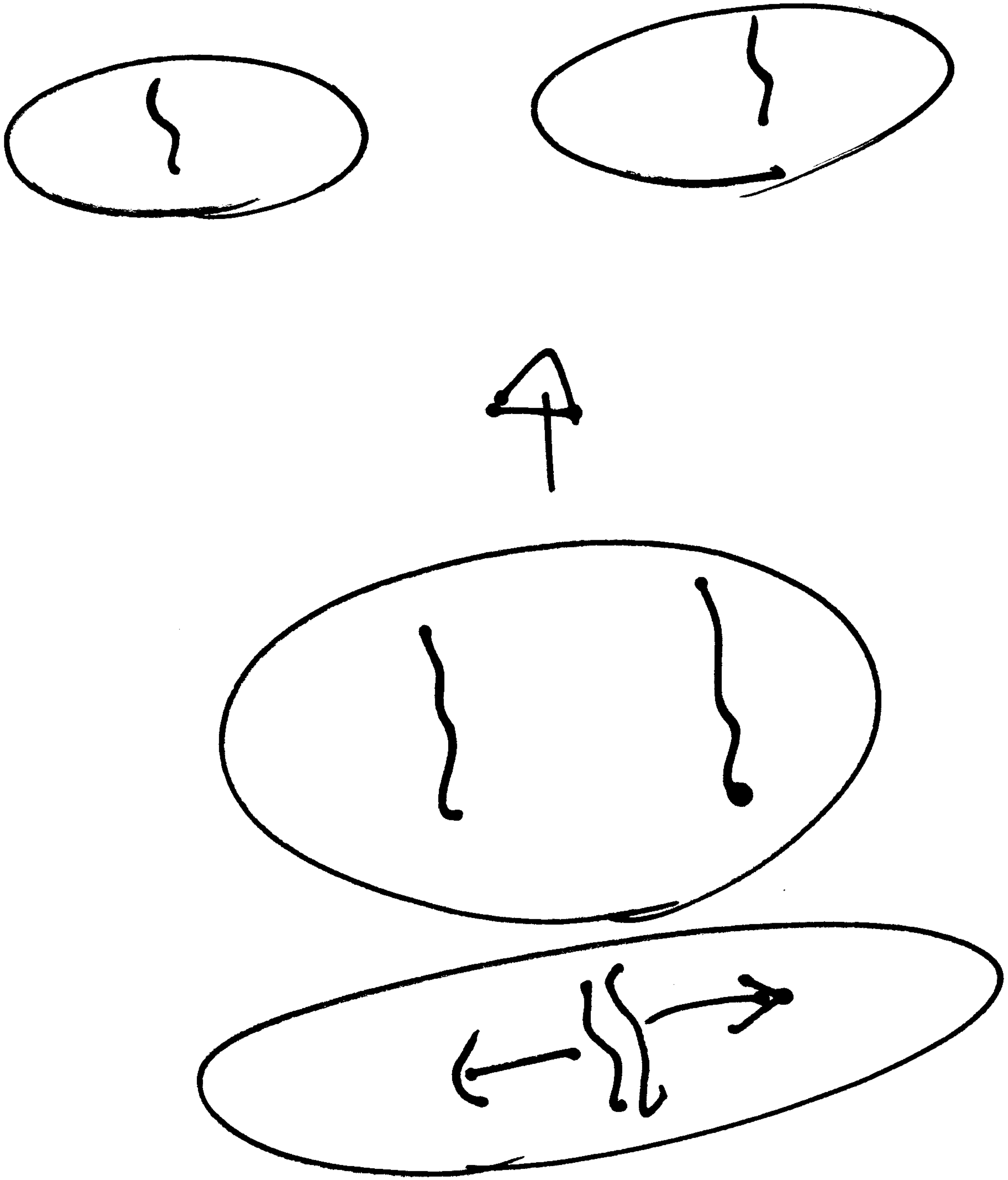
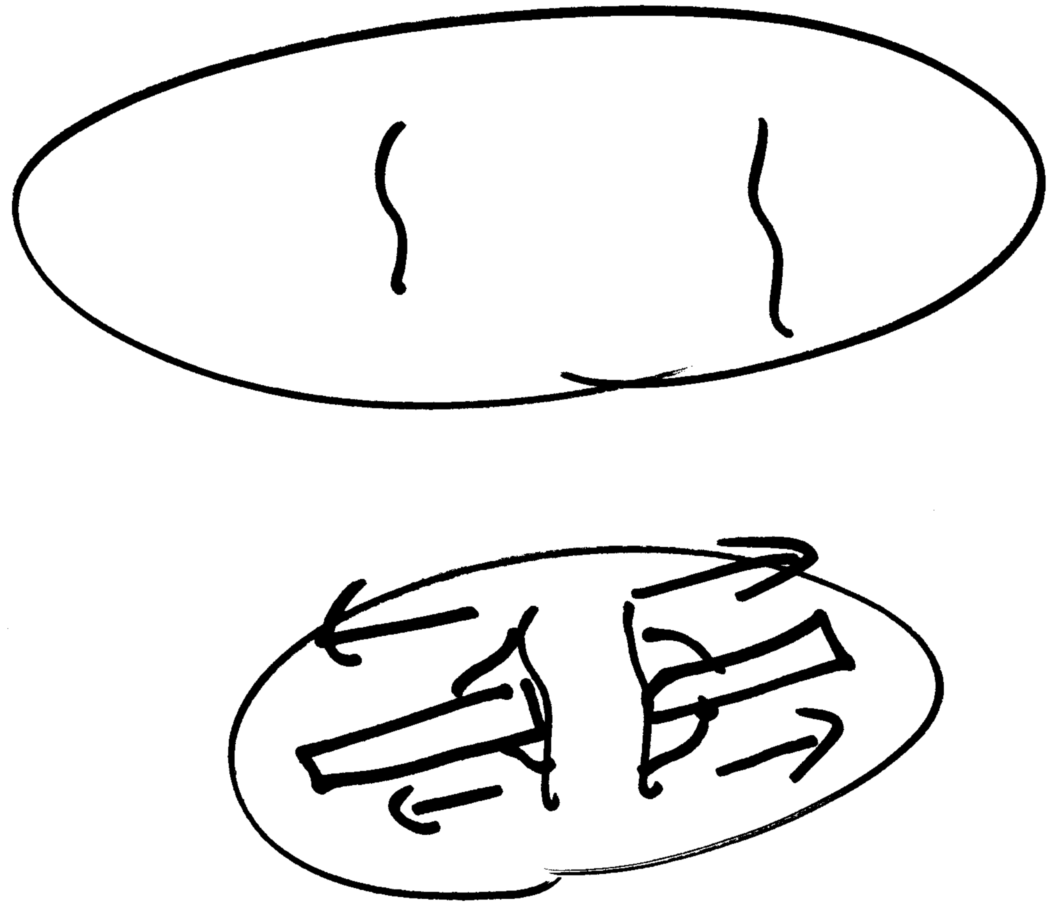
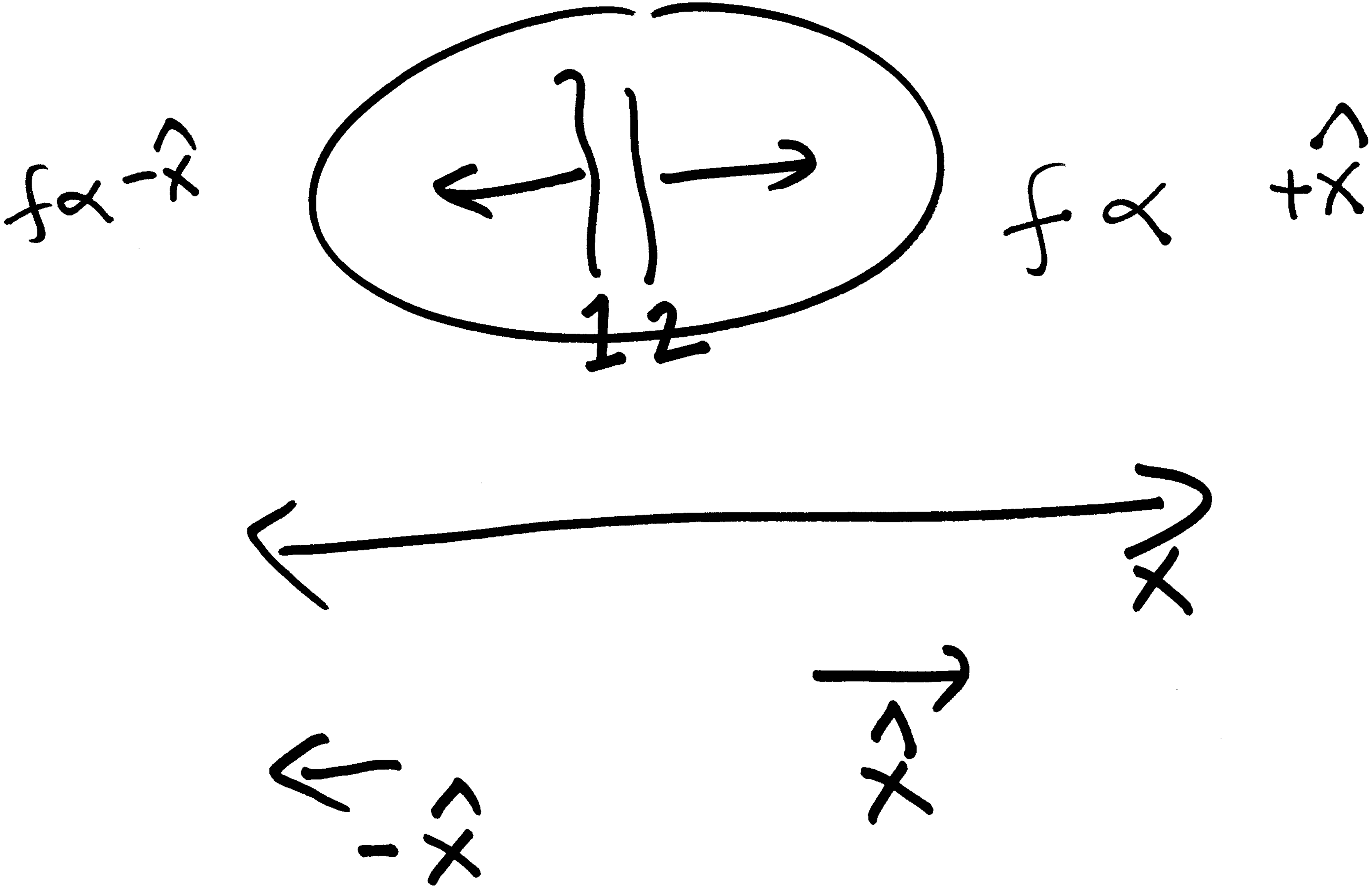
Lec. 33 (14/4/12)






$f\alpha - \hat{x}$
$f\alpha \quad + \hat{x}$
12
x
$\hat{x}$
$-\hat{x}$

$$-\frac{\partial}{\partial a}\sqrt{\pi/a} = \sqrt{\pi}\left(\frac{-\partial}{\partial a} a^{-\frac{1}{2}}\right)$$

$$= \frac{1}{2}\sqrt{\pi}\, a^{-3/2}$$

$$\int_{-\infty}^{\infty} x^2 e^{-ax^2}\,dx = \frac{\sqrt{\pi}}{2}\, a^{-3/2}$$

$$\int_{-\infty}^{\infty} \underline{x^2 e^{-ax^2}}\, dx$$

$$\underline{-\frac{\partial}{\partial a} e^{-ax^2}} = -\,-x^2 e^{-ax^2} = \underline{x^2 e^{-ax^2}}$$

$$-\int_{-\infty}^{\infty} \frac{\partial}{\partial a} e^{-ax^2}\, \underline{dx} = -\frac{\partial}{\partial a} \int_{-\infty}^{\infty} dx\, e^{-ax^2}$$

$$\int_0 \int_{-\infty}^{\infty} e^{-ax^2}\,dx = \sqrt{\frac{\pi}{a}}$$

$$A\int x e^{-ax^2} \cdot dx = \langle x \rangle$$

$$A\int x^2 e^{-ax^2} dx = \langle x^2 \rangle$$

$$I^2 = \frac{\pi}{a} \Rightarrow I = \sqrt{\pi/a}$$

$$\pi\left[0 - \frac{-1}{a}\right]$$

$$\pi \int_0^{\infty} e^{-at}\, dt$$

$$\pi \left[\frac{e^{-at}}{-a} \Bigg|_0^{\infty} \right]$$

$$\pi \left[-\frac{e^{-a\infty}}{a} - \frac{e^{-a0}}{-a} \right]$$

$$2\pi \int_0^\infty \underline{dr\ r}\, e^{-ar^2}$$

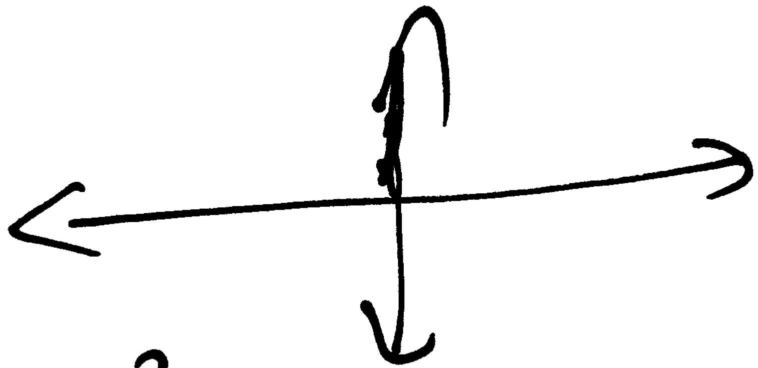
$$r^2 = t$$

$$2r\,dr = dt$$

$$r\,dr = \frac{dt}{2}$$

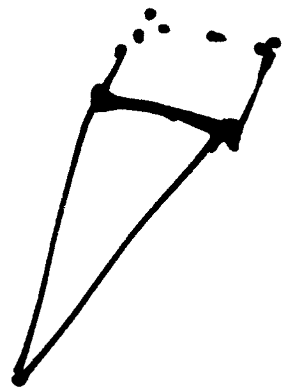
$$\cancel{2}\pi \int_0^\infty \frac{dt}{\cancel{2}}\, e^{-ta}$$

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} dx\,dy\; e^{-ar^2}$$



$$\int\int r\,d\theta\,dr\; e^{-ar^2}$$

$$\int_{0}^{2\pi} d\theta \int_{0}^{\infty} dr\; r\,e^{-ar^2}$$



$$x = r\cos\theta$$

$$y = r\sin\theta$$

$$e^{-a(x^2+y^2)} = e^{-ar^2}$$

$$\iint \underline{dx\,dy} \rightarrow r\,d\theta\,dr$$

$$I = \int_{-\infty}^{\infty} dx \, e^{-ax^2}$$

$$I = \int_{-\infty}^{\infty} dy \, e^{-ay^2}$$

$$I^2 = \int_{-\infty}^{\infty} dx \int_{-\infty}^{\infty} dy \, e^{-ax^2} \cdot e^{-ay^2}$$

use plane-polar coordinates

$$= \int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \underline{dx\,dy}\; e^{-a(x^2+y^2)}$$

$$I^2 = \int_{-\infty}^{-\infty} dx \int_{-\infty}^{\infty} dy \; e^{-a(x^2+y^2)}$$

Integral of e^{-ax^2}

$$\int_{-\infty}^{\infty} e^{-ax^2}\,dx = ?$$

$$J = -D \frac{\partial c}{\partial x} \hat{x}$$

$$= -D \frac{\partial}{\partial x} 10x^2 = -D\, 20x$$

$$= -20Dx\, \hat{x}$$

$$\frac{\partial c}{\partial t} : \boxed{D \frac{\partial^2 c}{\partial x^2} = -20D}$$

$$\frac{\partial c}{\partial t} = D \frac{\partial^2 c}{\partial x^2}$$

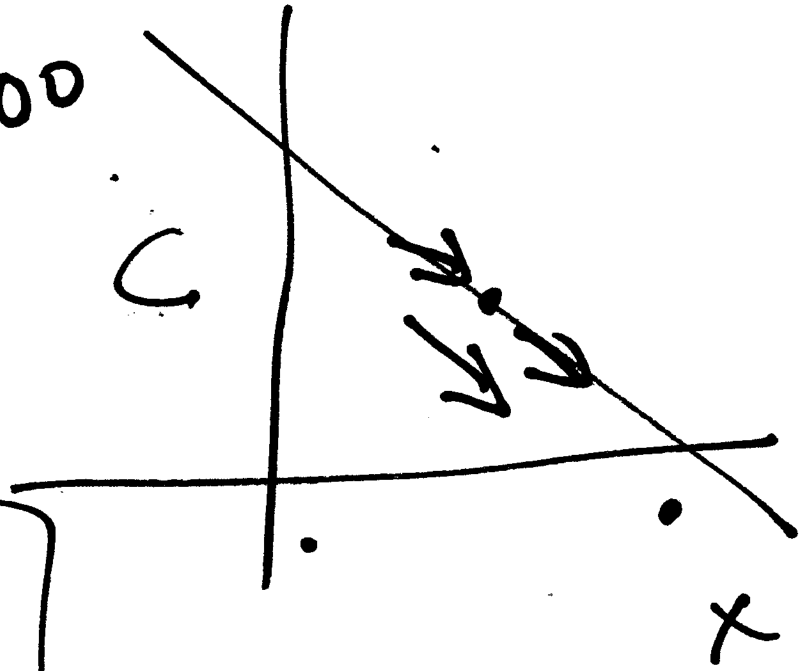
$J = 10D$

$$= \frac{\partial}{\partial x} J$$

$$= \frac{\partial}{\partial x} 10D = 0$$

$$\frac{\partial c}{\partial t} = 0 \Rightarrow C : \text{a const.}$$

$C = -10x + 100$



$$\boxed{\vec{J} = D\,10\,\hat{x}}$$

$$= D\left[\frac{\partial}{\partial x}10x \mp \frac{\partial}{\partial x}100\right]$$

$$\vec{J} = -D \frac{\partial \vec{c}}{\partial x} \hat{x}$$

$$c = -10x + 100$$

$$-D \frac{\partial c}{\partial x} = -D \frac{\partial}{\partial x} \left[-10x + 100 \right]$$

$$D = \frac{4\,(10^{-2})^2}{2 \times 3600} = \frac{4 \times 10^{-4}}{7.2 \times 10^{3}}$$

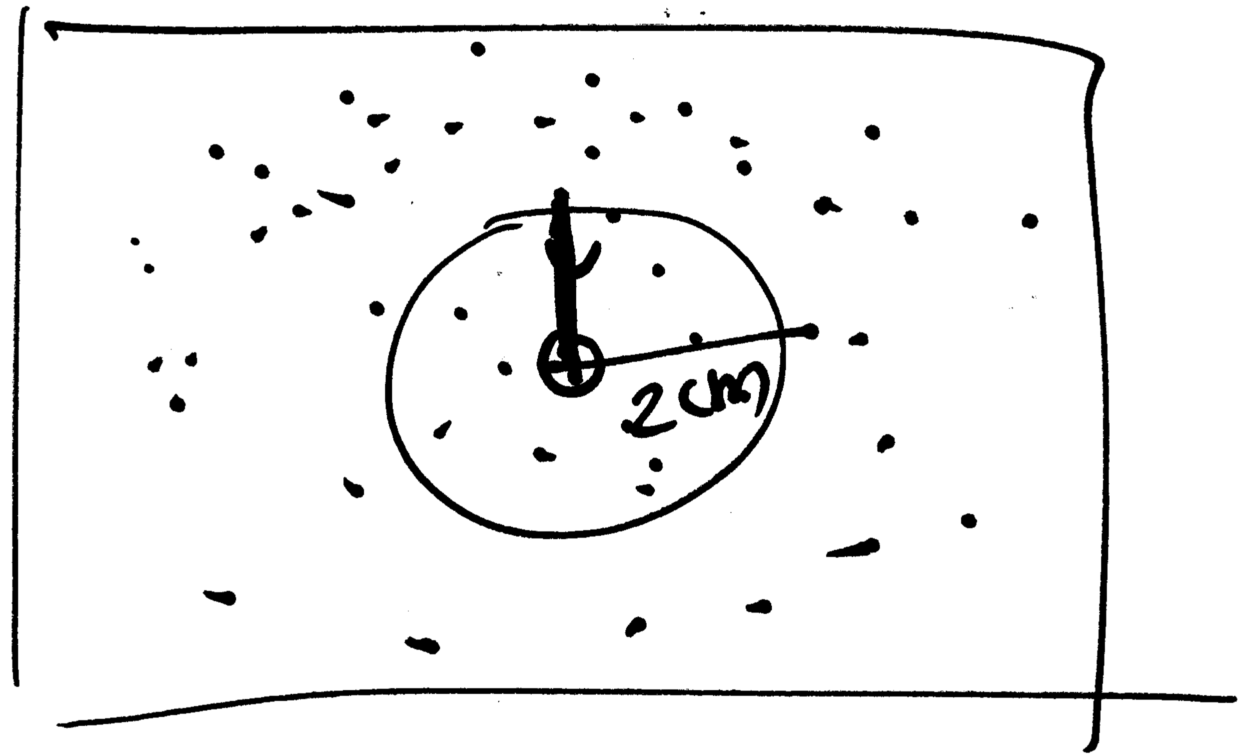
$$\approx \frac{1}{2}\, 10^{-7}\, \frac{m^2}{s}$$

$$\langle r^2 \rangle = 2Dt$$

$$t = 1 \text{ hour} = 60 \text{ min}$$
$$= 3600 s$$

$$\langle r^2 \rangle = 4 \text{ cm}^2$$

$$4(10^{-2})^2 \text{ m}^2 = 2D\, 3600 s$$



$\approx$ 1 hour

$$\zeta = \frac{k_B T}{D}$$

$T \approx 10^{2} K$

$k_B \simeq 10^{-23} (\ )$

$$\simeq \frac{10^{-21} J}{D}$$

$$\zeta \approx \frac{10^{-21} J}{10^{-12} cm^2/s} \simeq 10^{-9} \frac{J}{cm^2 s}$$

$$D = 10^{-12}\,\frac{(3\times10^{7}\ bp)^2}{s}$$

$$= 10^{-12}\times 9\times 10^{14}\,\frac{bp^2}{s}$$

$$= 9\times10^{2}\,\frac{bp^2}{s} = 900\,\frac{bp^2}{s}$$

$$D = 10^{-12} \frac{cm^2}{s}$$

$$3bp = 1nm = 10^{-9} m$$

$$3bp = 10^{-7} cm$$

$$1cm = \frac{3}{10^{-7}} bp = 3 \times 10^{7} bp$$

$$D = 10^{-12}\ \frac{cm^2}{s}$$

$$D = \frac{k_B T}{6\pi\eta a} = \frac{k_B T}{\zeta}$$

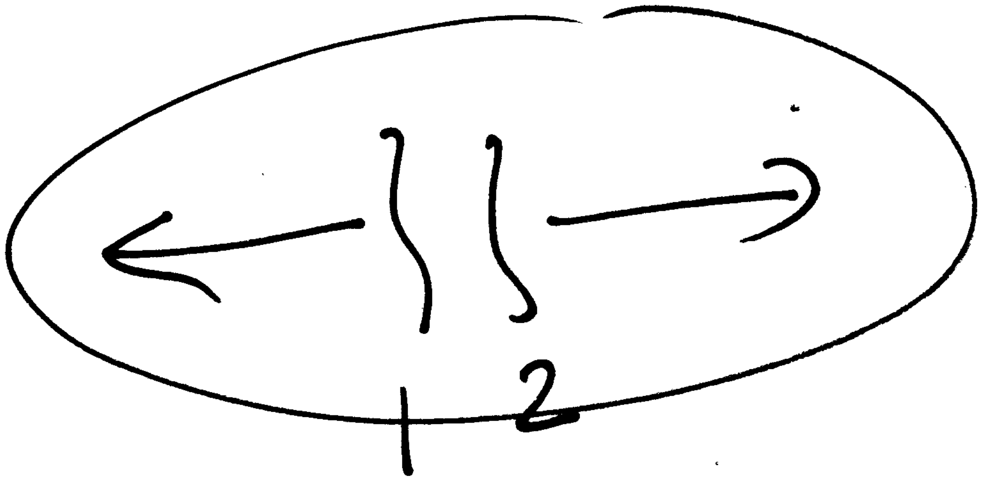
$$\cancel{\vec{f}_2 = g(x)}$$

$$\boxed{\begin{aligned} \vec{f}_2 &= g(x,t)\,\hat{x} \\ \vec{f}_1 &= -p(x,t)\,\hat{x} \end{aligned}}$$

$$\vec{f}_1 = f_0(t)\,\hat{x}$$

$$\vec{f}_2 = -f_0(t)\,\hat{x}$$

$$\cancel{\vec{f}_1 = g(\dot{x})\,\hat{x}}$$



f

$$\boxed{\begin{aligned}\vec{f}_2 &= f_0\,\hat{x} \\ \vec{f}_1 &= -f_0\,\hat{x}\end{aligned}}$$

$$\vec{f}_2 = g_1\hat{x} + g_2\hat{y}$$

$$f_1 = (\quad)^{-\hat{f}_2}$$