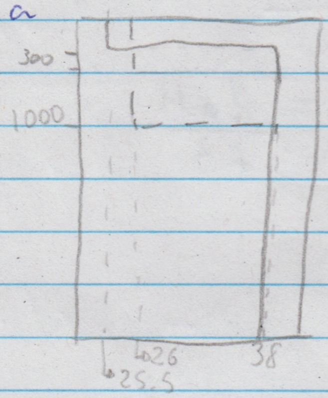
Large Scale Oc. Circ. Jnenio Pte

Hw 2.

1 - a



— 10°N

- - 45°N

For 45°N	For 10°N
$H_1 = 1000\,m$	$H_1 = 300\,m$
$H_2 = 4000\,m$	$H_2 = 4700\,m$
$\rho_1 = 1028$	$\rho_1 = 1025.5$
$\rho_2 = 1028$	$\rho_2 = 1028$
$f = 1.0313\times10^{-4}$	$f = 2.5325\times10^{-5}$
$g' = g\left(\frac{\rho_2-\rho_1}{\rho_1}\right)$	$g' = g\left(\frac{\rho_2-\rho_1}{\rho_1}\right)$
$g' = 0.0191$	$g' = 0.0239$

$$\lambda_1 = \frac{1}{f}\sqrt{\frac{g' H_1 H_2}{(H_1+H_2)}}$$

for 10°N

$$\lambda_1 = \frac{1}{2.5325\times10^{-5}}\sqrt{\frac{0.0239\times300\times4700}{5000}} = 1.0242\times10^{5} = 102.42\ Km$$

for 45°N

$$\lambda_1 = \frac{1}{1.0313\times10^{-4}}\sqrt{\frac{0.0191\times1000\times4000}{5000}} = 3.7905\times10^{4}m = 37.9\ Km$$

b - $i = 0$ (barotropic)

$$w = \frac{\beta_0 k}{k^2+l^2+\frac{f^2}{gH}}$$

$$\frac{\partial w}{\partial k} = \beta_0 \underbrace{\frac{\partial}{\partial k}\left[\frac{k}{k^2+l^2+\frac{f^2}{gH}}\right]}_{a}$$

using $\left[\frac{u(x)}{v(x)}\right]' = \frac{u'v - uv'}{v^2}$

$$a = \frac{\left(k^2+l^2+\frac{f^2}{gH}\right) - k\,(2k)}{\left(k^2+l^2+\frac{f^2}{gH}\right)^2} = \frac{-k^2+l^2+\frac{f^2}{gH}}{\left(k^2+l^2+f^2/gH\right)^2}$$

1

$$\frac{\partial \omega}{\partial k} = \frac{\beta_0\left(-k^2+l^2+\frac{f^2}{gH}\right)}{\left(k^2+l^2+\frac{f^2}{gH}\right)^2}$$

for long waves $k, l \to 0$

so

$$C_g = \frac{\beta_0\left(\frac{f^2}{gH}\right)}{\left(\frac{f^2}{gH}\right)^2} = \frac{\beta \cancel{f^2}}{\cancel{gH}}\,\frac{g^{\cancel{2}}H^{\cancel{2}}}{f^{\cancel{4}}} = \frac{\beta_0 g H}{f^2}$$

for $i = 1$ (1^{st} baroclinic)

$$\omega = \frac{\beta_0 k}{k^2+l^2+\left(\frac{1}{f}\sqrt{\frac{g' H_1 H_2}{(H_1+H_2)}}\right)^{-2}}$$

similarly to the barotropic mode

$$\frac{\partial \omega}{\partial k} = \frac{\beta_0\left(-k^2+l^2+\left[\frac{f^2(H_1+H_2)}{g' H_1 H_2}\right]\right)}{\left[k^2+l^2+\left(\frac{f^2(H_1+H_2)}{g' H_1 H_2}\right)\right]^2}$$

for long waves $l, k \to 0$

$$C_g = \frac{\beta_0\left[\frac{f^2(H_1+H_2)}{g' H_1 H_2}\right]}{\left[\frac{f^2(H_1+H_2)}{g' H_1 H_2}\right]^2} = \frac{\beta_0 \cancel{f^2}(H_1+H_2)}{\cancel{g' H_1 H_2}} \cdot \frac{g'^{\cancel{2}} H_1^{\cancel{2}} H_2^{\cancel{2}}}{f^{\cancel{4}}(H_1+H_2)^2}$$

$$c_g = \frac{\beta_0\, g' H_1 H_2 (H_1+H_2)}{f^2(H_1+H_2)^2} \quad \text{if } H_1 \ll H_2$$

$$c_g = \frac{\beta_0 g' H_1 \cancel{H_2^2}}{f^2 \cancel{H_2^2}} \to C_g = \frac{\beta_0 g' H_1}{f^2}$$

~~Deleted~~

1c. for 10°N

$H_1 = 300$ m

$H_2 = 4700$ m

$g' = 0.0239$

$f = 2.5325\times10^{-5}$

$\beta_o = \dfrac{2\Omega\cos(10)}{R_{earth}} = 2.2519\times10^{-11}$

$C_g = 0.2362$ m/s

for 45°N

$H_1 = 1000$

$H_2 = 4000$

$g' = 0.0191$

$f = 1.0313\times10^{-4}$

$\beta = 1.6169\times10^{-11}$

$C_g = 0.0232$ m/s

$$C_g = \frac{\beta_o\, g'\, H_1 H_2 (H_1 + H_2)}{f^2 (H_1 + H_2)^2}$$ (1st baroclinic mode)

$C_g = \dfrac{\Delta S}{\Delta t} \Rightarrow \Delta t = \dfrac{\Delta S}{C_g}$ $\quad \Delta S = 5000$ km $= 5\times10^6$ m

for 10N

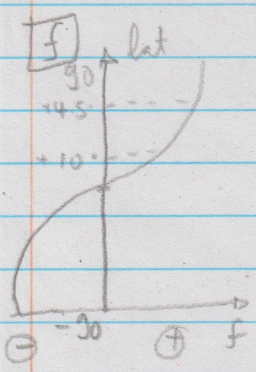
$\Delta T = \dfrac{5\times10^6}{0.2362} = 2.1169\times10^7$ s $\approx \boxed{0.67\text{ ys}}$

for 45°N

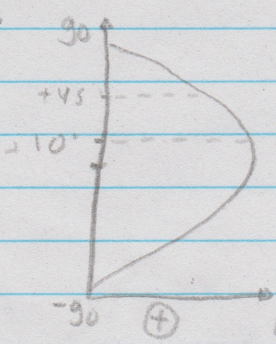
$\Delta T = \dfrac{5\times10^6}{0.0232} = 2.1552\times10^8$ s $= \boxed{6.8\text{ ys}}$

Important parameter,

f, β, g' and depth of the layers.



β.



3

1.d fastest Rossby wave $\pm \frac{C_{kelvin}}{3}$ 4

for kelvin $C_g = \sqrt{g H_e}$

$n = 1$

$$g He^2 - g H He + g' H_1 H_2 = 0$$

$$9.81 He^2 - (9.81 \times 5000) He + (0.0239 \times 300 \times 4700) = 0$$

$$He^2 - 5000 He + 3435.2 = 0$$

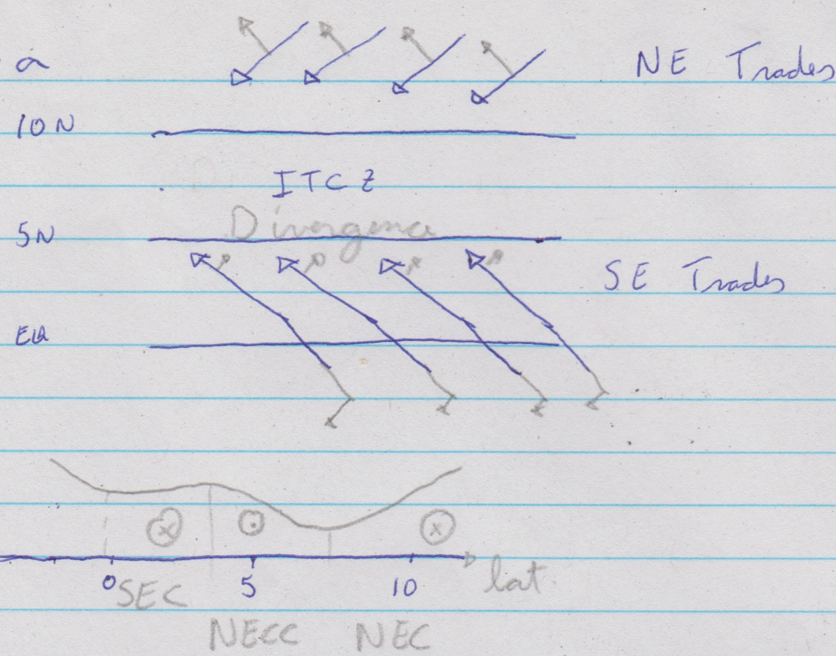
$$H_e = \frac{5000 \pm \sqrt{(-5000)^2 - 4(3435.2)}}{2}$$

$He' = 0.6871$ m or ~~$He^2 = 4999.3$ m~~

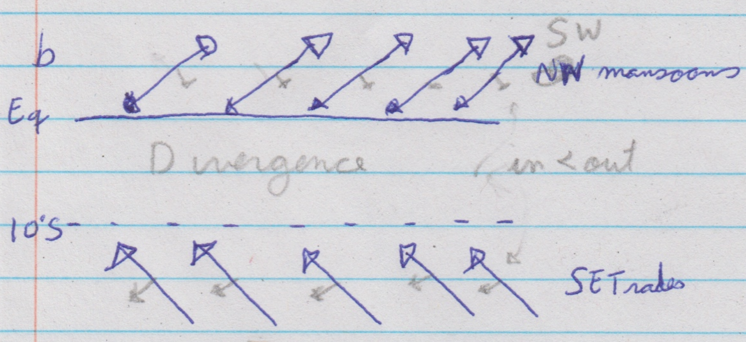
$$C_g = \sqrt{9.81 \times 0.6871} = 2.59 \text{ m/s}$$

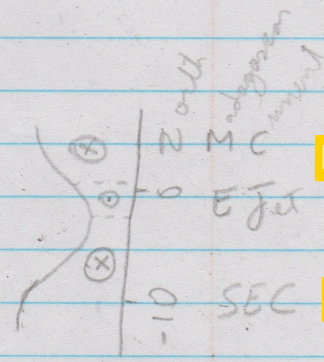
$$\Delta t = \frac{\Delta S}{C_x} = \frac{5 \times 10^6}{2.59} = 1.92 \times 10^6 \text{ s} = \boxed{22.29 \text{ days}}$$

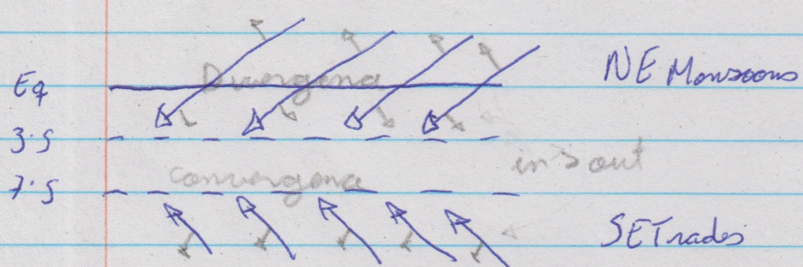
2- a

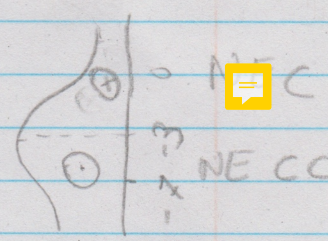

NE Trades
10 N
ITCZ
5N
Divergence
SE Trades
EQ
-5
0
SEC
5
10
lat
NECC
NEC

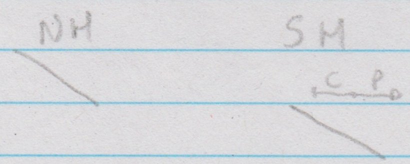
b

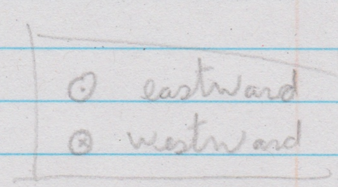

SW
NW monsoons
Eq
Divergence
in < out
10°S
SE Trades


NMC
E Jet
SEC


NE Monsoons
Eq
Divergence
3°S
in > out
7°S
convergence
SE Trades


NEC
NE CC


NH
SH


eastward
westward