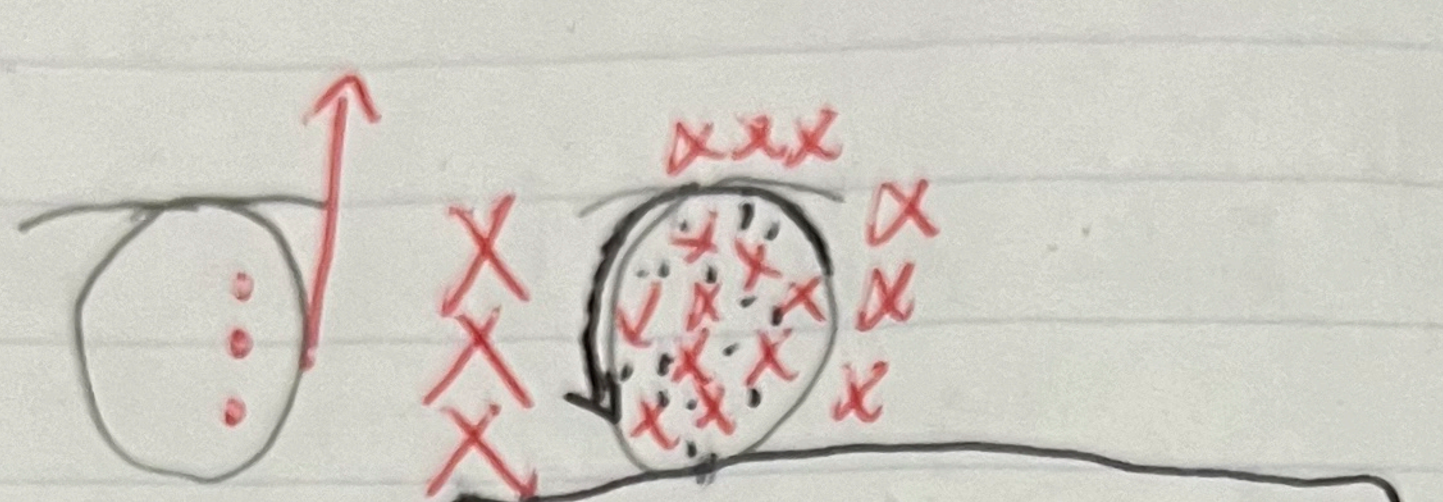
Michael Lopez
Professor Hanson
Physics 135B
29 April 2024

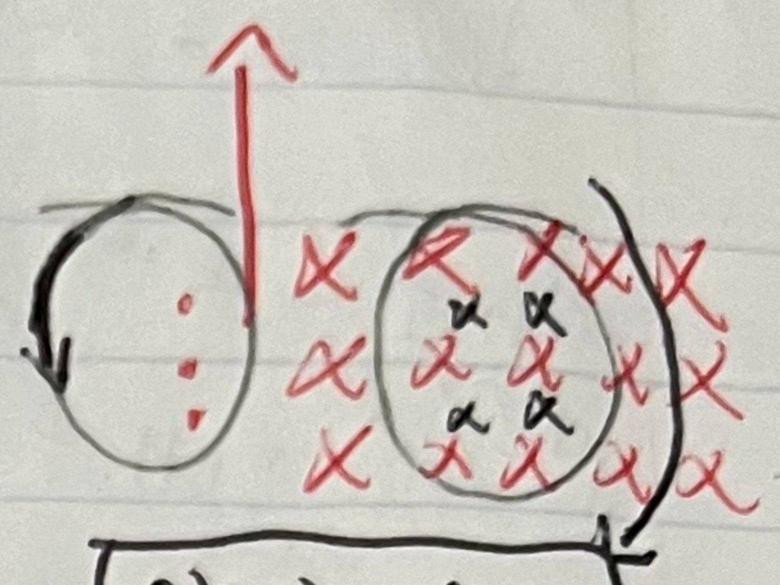
# Midterm 2

- Unit 4: Magnetism II

1) a)

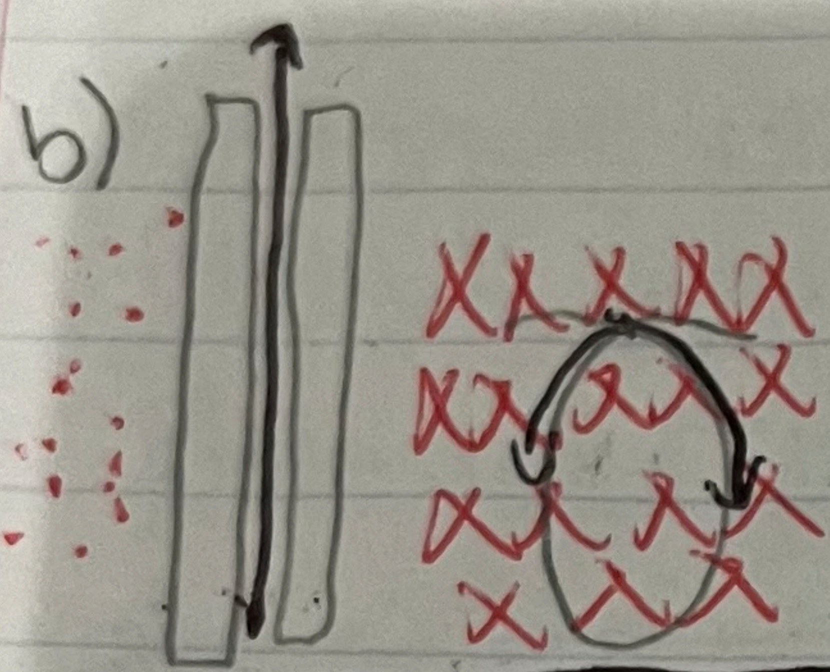


$\boxed{\text{counterclockwise}}$

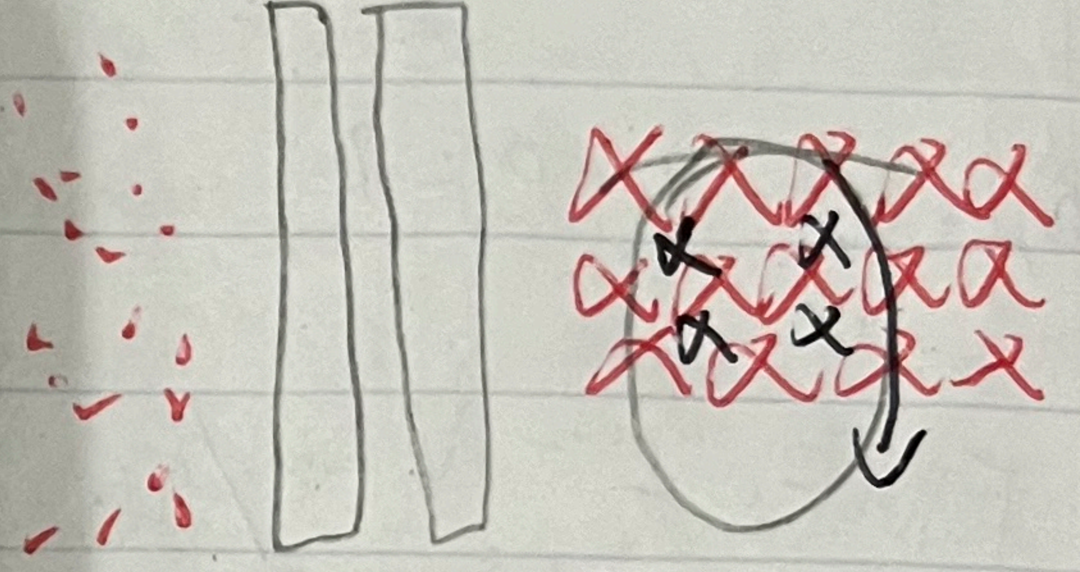


$\boxed{\text{clockwise}}$

b)

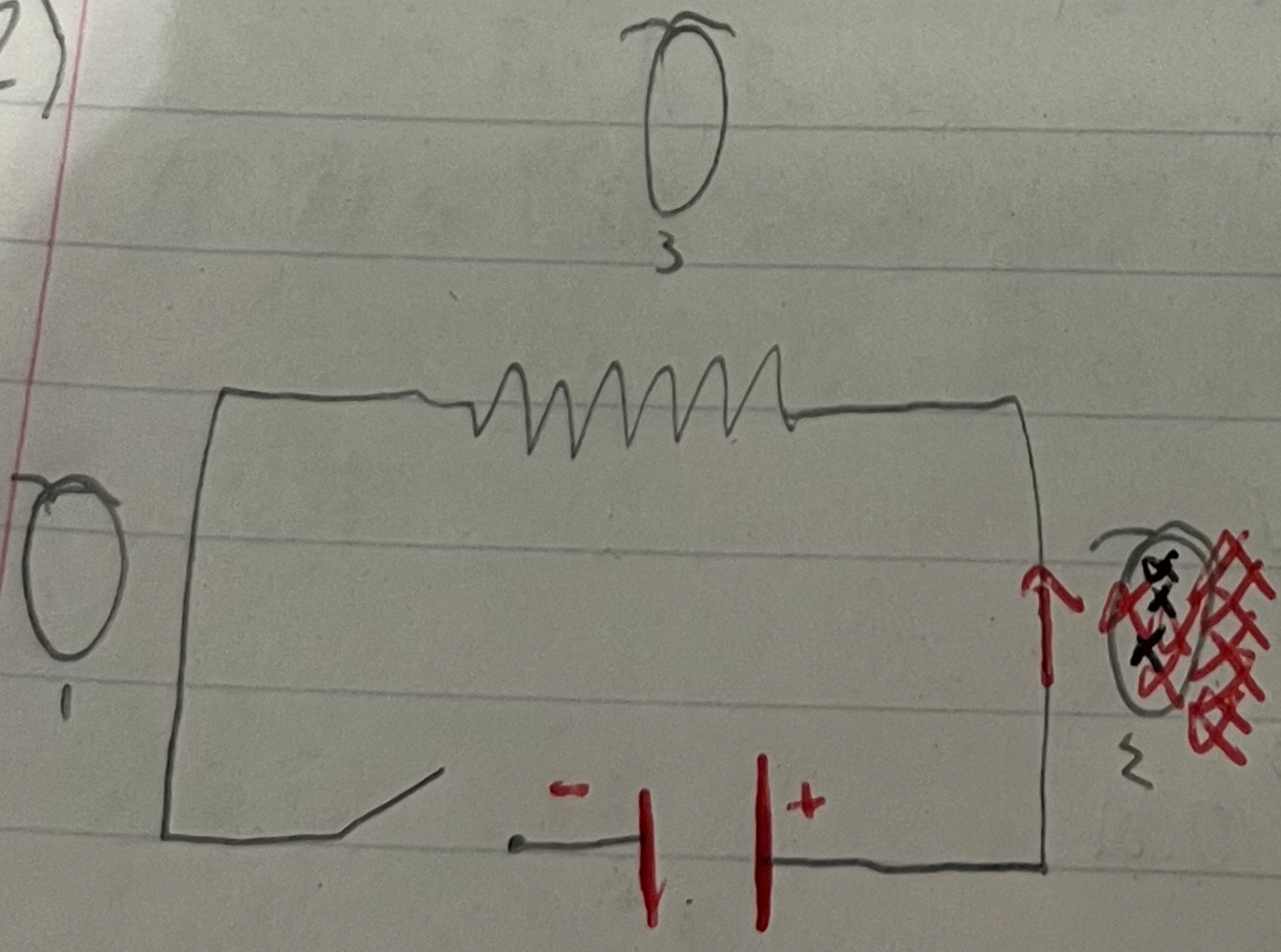


$\boxed{\text{counterclockwise}}$



$\boxed{\text{clockwise}}$

2)



a) 1 - counterclock
2 - Counterclockwise
3 - None

b) All 3 coils = none

c) 1 - Clockwise
2 - Clockwise
3 - None

3) $\Delta\phi/\Delta t$ = volts

$\Delta\phi/\Delta t$ = wb/s

emf $= -d\phi/dt$

$d\phi/dt$ = emf

$\Delta\phi/\Delta t$ = wb/s = $\boxed{V}$

4) a) $\Delta B = 2-0 = 2$

$EMF_i = -N\Delta\phi/\Delta t$

$EMF_i = -N\,\Delta BA\cos\theta/\Delta t$

$EMF_i = -1^{2}\left(\pi\left(2.20/2\times10^{-2}\right)^2\cos(0)/0.25\right.$

$\boxed{EMF = -3.04\times10^{-3}\,V}$

b) $EMF = 3.04\times10^{-3}\,V$

$V = IR$

$I = V/R$ $\quad I = 3.04\times10^{-3}/0.01$

$\boxed{I = 3.04\times10^{-1}\,A}$

c) $P = IV$

$P = 3.04\times10^{-1}(3.04\times10^{-3})$

$\boxed{P = 9.24\times10^{-4}\,W}$

5) Motional emf = $Blv\sin\phi$

$B$ = magnetic field
$l$ = length
$V$ = velocity

The rod and magnetic field are 2 different components:

- Perpendicular = length
- other component = lying inside of it
- emf produced by perpendicular
- Magnetic field - $B$(perpendicular) = $B\sin\phi$ $\quad \varepsilon = Bvl\sin\phi$
- Velocity component = produces emf
- Perpendicular component of velocity = $V$(perpendicular) $v = s\sin\phi$

$\boxed{\text{They are NOT mutually perpendicular}}$

6) a) $V_p = N \cdot A \cdot B \cdot w$

$N = V_p / A \cdot B \cdot w$

$N = 18 / 3\times10^{-4}(0.64)(1875)$

$\boxed{N = 50}$

b) $T = 2\pi / w$

$= 2\pi / 1875\ 1/s$

$= \boxed{3.35 \times 10^{-3}\ s}$

7) a) $\left(V_s/V_p = N_s/N_p\right)$

$V_p/V_s = N_p/N_s$

$240/120 = N_p/N_s = \boxed{2}$

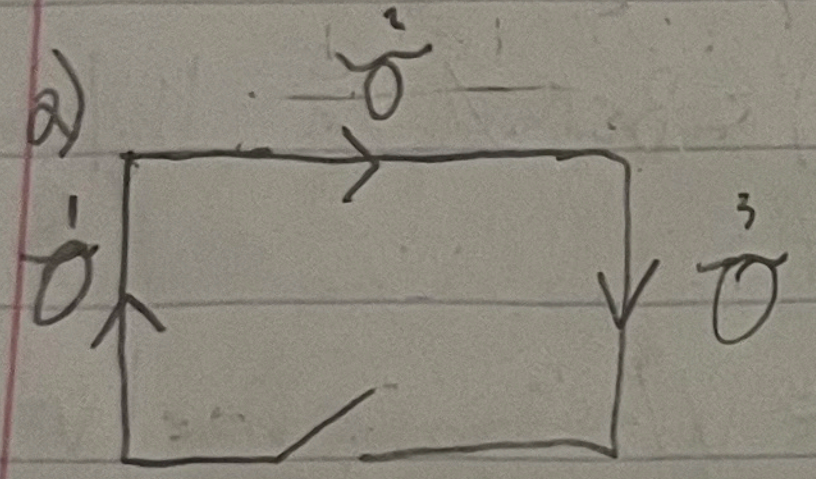
b) $\left(I_s/I_p = N_p/N_s\right)$

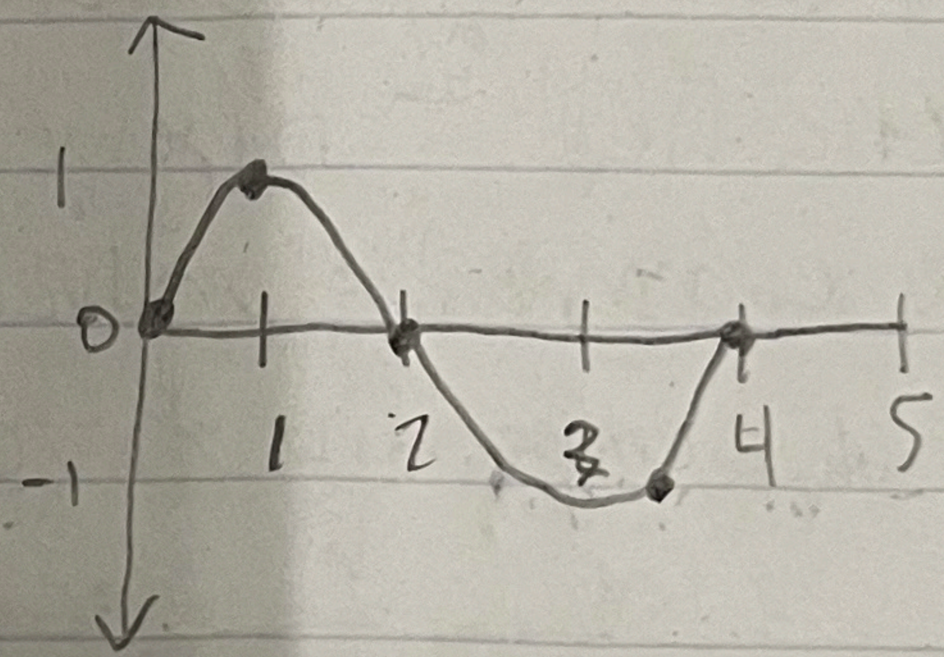
$I_p/I_s = N_s/N_p$

$I_p/I_s = \boxed{1/2}$

c) She would need to switch the coils or plug in output of 1.

8) a)






n = 6 turns

$\sin(90 \cdot 0) = 0$ $\sin(90 \cdot 1) = 1$

$\sin(90 \cdot 2) = 0$ $\sin(90 \cdot 3) = -1$

b) $\cos(90 \cdot 0) = 1$, $\cos(90 \cdot 1) = 0$, $\cos(90 \cdot 2) = -1$, $\cos(90 \cdot 3) = 0$

c) $v(t) = V_0 \sin(wt)$

$0 = 120 \sin(240\pi t)$

$\boxed{t = 0}$

9) $\Delta t = L \, \Delta I / EMF$

$\Delta t = 2 \times 10^{-3} (0.1)/500$

$\boxed{\Delta t = 4 \times 10^{-7} s}$

10) a) $EMF = L \, \Delta I / \Delta t$

$EMF = 25 (100 / 80 \times 10^{-3})$

$\boxed{EMF = 3.13 \times 10^{4} V}$

b) $E_{ind} = 1/2 \, L I^2$

$E = 1/2 (25)(100)^2$

$\boxed{E = 1.25 \times 10^{5} J}$

c) $P = J/s = watts$

$P = 1.25 \times 10^{5} / 80 \times 10^{-3}$

$\boxed{1.56 \times 10^{6}}$

d) Wo

e) $L = 25H$

$A = 8m^2$

$N = 421$

$l = 0.3m$

$L = \mu_0 N^2 A / l$

$= \frac{(4\pi \cdot 10^{-7} Tm/A)(421)^2 (8 \ldots}{0.3m}$

$= \boxed{5.94 H}$

11) a) $R \cdot \tau = L$

$5 \times 10^{6} / 20 \times 10^{-9}) = L$

$\boxed{0.100H = L}$

b) $R = L / \tau$

$R = 0.1 / 1 \times 10^{-9}$

$\boxed{R = 1 \times 10^{8} \Omega}$

c) $I = I_0 (1 - e^{-t/\tau})$

12) a) $L = ?$

$X_L = 2 \times 10^3$

$f = 15 \times 10^3$

$X_L / 2\pi f = L$

$2 \times 10^3 / 2\pi(15 \times 10^3) = L$

$2 / 2\pi(15) = L$

$\boxed{2.12 \times 10^{-2} H = L}$

b) $X_L = 2\pi f L$

$X_L = 2\pi(60)(2.12 \times 10^{-2})$

$\boxed{X_L = 8.00 \Omega}$

13) a) $X_C = 1/2\pi f C$

freq(f) in denominator ↑,

$X_C$ ↓ from frequency being low.

inductance = low

14) $R = 0.1\,K\Omega$
$C = 1\,\mu F$
$L = 10\,mH$

a) $f_0 = 1/2\pi\sqrt{L \cdot C}$
$= 1/2\pi\sqrt{(10 \cdot 10^{-3})(1 \cdot 10^{-6})}$
$= \boxed{1.592 \cdot 10^3\,Hz}$

b) $\sqrt{R^2 + (X_L - X_C)^2}$
$(0.1 \cdot 10^3)^2 + (10 - 1)^2$
$\boxed{Z = 994.74\,\Omega}$

15) Same R, L, C values as #14

a) $I_{rms} = V_{rms}/z$
10 to $I_{rms}$ = 10 to $/120v/995.04$
$\boxed{I_{rms} = 0.121\,A}$

b) $\cos\phi = R/z = 0.1 \cdot 10^3 / 994.74$
$\cos\phi = 0.101$
$\cos\phi = (0.101)$
$\phi = 84.2^\circ$

$P_{rms} = I_{rms} V_{rms} \cos\phi$
$= (0.121)(120)(0.101)$
$\boxed{P_{rms} = 1.467}$

16) a) $f_c = 1.4\cdot10^6\ Hz$

$f_c - f_m = (1.4\cdot10^6) - (10\cdot10^3) = \boxed{1.39\cdot10^6\ Hz}$

$f_c + f_m = (1.4\cdot10^6) + (10\cdot10^3) = \boxed{1.41\cdot10^6\ Hz}$

b) $1.4\cdot10^6\ Hz$

resistance ↓ by widening the band of reciever circuit

• Unit 5: Waves, Optics, Med Physics:

1) a) $B = \mu_0 I / 2\pi r$

$= (4\pi\cdot10^{-7})(0.1)/2\pi$

$= \boxed{2\cdot10^{-6}\ T}$

2) X

3) a) $I = P/A = 1000w / (10 \cdot 10^{2})(1m)$
$= \boxed{10,000\ w/m^2}$

b) $1m / 3 \cdot 10^{8}\ ms^{-1}$
$= \boxed{3 \cdot 10^{-9}\ s}$

c) $E_0 = \sqrt{2I / c\varepsilon_0} = \sqrt{2(10000) / (3 \cdot 10^8)(8.85 \cdot 10^{-12})}$
$E_0 = \boxed{2744.62\ v/m}$

d) $I = P/A$
$= 1000w / 4\pi m^2$
$= \boxed{7834\ w/m^2}$

4) a) $n_1 \sin\phi_1 = n_2 \sin\phi_2$
b) $n_2 \sin\phi_2 = n_3 \sin\phi_3 \rightarrow n_1 \sin\phi_1 = n_3 \sin\phi_3$

c) $1/d_o + 1/d_i = 1/f \rightarrow 1/(1/f - 1/d_o) = d_i = (1/0.15 - 1/0.135)$
$= 1/0.741$
$= \boxed{-1.35m}$

d) $-d_i/d_o = m = -\ {-1.35}/0.135 = \boxed{10}$

e) diameter $= (10)(0.01) = \boxed{0.1m}$

5) a) $n = c/v$

Ice $= 1.309$

$n = 3 \cdot 10^8 / 1.309$

$= \boxed{2.292 \cdot 10^8 \text{ m/s}}$

snow $= 1.333$

$n = 3 \cdot 10^8 \text{ m/s} / 1.333$

$= \boxed{2.251 \cdot 10^8 \text{ m/s}}$

$n_{ice}/n_{snow} = 3 \cdot 10^8/1.309 \cdot 1.333/3 \cdot 10^8$

$= \boxed{1.018}$

b) $n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.333 \sin(30)/1.309$

$(\sin^{-1})\, 0.509 = \sin\phi\, (\sin^{-1})$

$\boxed{30.61° = \phi}$

6. X