ONE CAN ALWAYS SET UP 2 EQ, IN 2 UNKNOWNS AND SOLVE THE EIGENVALUE PROBLEM, BUT THERE IS A SIMPLER APPROACH.

IF \( X_L = X_R \) THE SPRING DOES NOT FLEX AND EXHIBITS NO FORCE, THEN \( \omega_a = \sqrt{\frac{g}{L}} \)

IF \( X_R = -X_L \) THE CENTER OF THE SPRING DOES NOT MOVE AND THE PROBLEM REDUCES TO

\[
\frac{2k}{m} \times \begin{bmatrix} M \\ L \end{bmatrix} = -m(\frac{w_a^2}{L})g - (2k)X = -m(\frac{g}{L} + \frac{2k}{m})X
\]

\[\Rightarrow \omega_s = \sqrt{\frac{g}{L} + \frac{2k}{m}}\]

THEN IN GENERAL

\[
X_L = a \sin (\omega_a t + \phi_a) + b \sin (\omega_s t + \phi_s)
\]
\[
X_R = a \sin (\omega_a t + \phi_a) - b \sin (\omega_s t + \phi_s)
\]

\[
X_L = a \omega_a \cos (\omega_a t + \phi_a) + b \omega_s \cos (\omega_s t + \phi_s)
\]
\[
X_R = a \omega_a \cos (\omega_a t + \phi_a) - b \omega_s \cos (\omega_s t + \phi_s)
\]

\[X_L = X_R = 0 \quad \text{AT} \ t = 0 \Rightarrow \phi_a = \phi_s = 0\]

\[\text{AT} \ t = 0^+ \quad I_0 / m = a \omega_a + b \omega_s \quad b \omega_s = a \omega_a \]
\[0 = a \omega_a - b \omega_s \quad a = \frac{T_0}{2m \omega_a} \]

\[
X_L(t) = \frac{T_0}{2m \omega_a} \left[ \sin(\omega_a t) + \frac{\omega_a}{\omega_s} \sin(\omega_s t) \right]
\]
Apply Gauss's law to a charge distribution uniform for $r < R$.

$$E_r(r) = \frac{1e_0}{r^2}, \quad r > R \quad \frac{1e_0}{r^2}, \quad r < R$$

Integrating $\mathbf{E} = -\nabla \phi$ gives

$$\phi(r) = \frac{1e_0}{r}, \quad r > R \quad \frac{1e_0}{2r^2} (3R^2 - r^2), \quad r < R$$

$$\mathbf{A} = \mathbf{A}_0 + \mathbf{A}_1$$

$$\mathbf{A}_1 = -\frac{1e_0}{r} \phi(r) - \left( -\frac{e^2}{r^2} \right), \quad r < R$$

$$\mathbf{A}_1(r) = 0, \quad r > R$$

$$\mathbf{A}_1 = \frac{1}{2} \frac{e^2}{R^2} (r^2 - 3R^2) + \frac{e^2}{r^2}$$

$$4_1s \approx \frac{1}{11} \frac{e^2}{a_0} \text{ in vicinity of nucleus!}$$

$$\Delta E = \langle |S| \mathbf{A}_1 |S \rangle = \frac{4}{a_0^3} \int_0^R h_1 r^2 dr$$

$$\int_0^R h_1 r^2 dr = \frac{1}{2} \frac{e^2}{R^2} \int_0^R r^2 dr - \frac{1}{2} \frac{e^2}{R} \int_0^R r^2 dr + \frac{e^2}{R^2} \int_0^R r dr = \frac{1}{10} e^2 R^3$$

$$-\frac{1}{10} e^2 R^3 - \frac{1}{2} e^3 R^2 + \frac{1}{2} e^2 R^2$$

$$\Delta E = \frac{2}{5} \frac{e^2}{a_0^2} \frac{(R^2)}{a_0}$$

Note: $E_0 = -\frac{1}{2} \frac{e^2}{a_0}$
\[ \psi \propto \sin k_n x \], \quad k_n L = \pi, \quad k_n = n \frac{\pi}{L} \]

\[ E_n = \frac{\hbar^2 k_n^2}{2m} \propto \frac{1}{m} \]

\[ \text{RATIO} = \frac{m_{\text{proton}}}{m_{\text{electron}}} \sim 2000 \]

\[ E_n = -\frac{\hbar^2 k_n^2}{2m} \]

\[ \mu_{\text{positronium}} = \frac{m_e}{m_e + m_e} = \frac{1}{2} m_e \]

\[ m_{\text{positronium}} = \frac{m_p m_e}{m_p + m_e} = m_e \quad \text{RATIO} \approx \frac{1}{2} \]

\[ \alpha = \frac{\hbar^2}{2I_0}, \quad E_\ell = \frac{\hbar^2}{2I_0} \ell (\ell + 1), \quad I_0 \propto M \]

\[ \Rightarrow \text{RATIO} = \frac{15}{14} \]

\[ \text{d}) \quad \Delta \psi_{\text{vib}} = \text{one normal mode} \quad = \frac{p^2}{2\mu} + \frac{1}{2} k_{\text{eff}} \ell^2 \]

\[ E_n = (n + \frac{1}{2}) \hbar \omega \quad \omega = \sqrt{\frac{k_{\text{eff}}}{\mu}} \quad \text{AND} \quad \mu \propto M \]

\[ \Rightarrow \text{RATIO} = \frac{\sqrt{15}}{14} \]
a) Incident and reflected wave electric fields must cancel at the surface.

Imagine an incident wave coming from behind the surface to make reflected wave:

\[ E_T = E_R + E_{inc} = 0 \]

At the surface satisfies \( E_T \to 0 \) inside the conductor.

\[ B_T = B_R + B_{inc} = 2B_{inc} \]

b) Ampère's law at the surface:

\[ \oint B \cdot ds = \frac{4\pi}{c} \iint J \cdot da \]

Only contribution to circuitnal integral is in vacuum.

\[ B_T l = \frac{4\pi}{c} \int J_S \cdot \hat{n} \]

\[ 2B_{inc} l \]

\[ J_S = \frac{cB_{inc}}{2\pi} \]
C) Lorentz pressure on the surface

\[ P = \frac{F}{A} = \frac{\vec{B}_{inc} \times \vec{J}}{c} = \frac{B_{inc}^2}{2\pi} \]

The intensity in the plane wave is determined by \( S \)

\[ S = \frac{c}{4\pi} \frac{E_{inc} \times B_{inc}}{B_{inc}} = \frac{c^2 B_{inc}}{4\pi} \quad \text{since} \quad B_{inc} = E_{inc} \]

\[ \frac{P}{S} = \frac{\text{Pressure}}{\text{Intensity}} = \frac{2}{c} \quad \text{comes from the reflection} \]
\[ \frac{m \, dv}{dt} = -c \, v^2 \]
\[ v^2 \, dv = -\frac{c}{m} \, dt \]
\[ -\frac{1}{v} + \frac{1}{V_0} = -\frac{c}{m} \, t \]
\[ \frac{1}{v} - \frac{1}{V_0} = \frac{c}{m} \, t \]
\[ \frac{dt}{dx} = \frac{c}{m} \, t + \frac{1}{V_0} \]
\[ \frac{dt}{t + \frac{m}{V_0 c}} = \frac{c}{m} \, dx \quad \Rightarrow \quad X = \frac{m}{c} \left[ \ln \left( t + \frac{m}{V_0 c} \right) - \ln \left( \frac{m}{V_0 c} \right) \right] \]
\[ = \frac{m}{c} \ln \left( \frac{V_0 c t}{m} + 1 \right) \]
(a) A beam of \( \overline{\nu}_e \) (from an accelerator-produced \( \pi^- \)) will only produce muons when incident on a target; a beam of \( \overline{\nu}_e \) will only produce electrons.

(b) Forbidden by lepton flavor conservation

(c) Positronium was moving in lab, when it decayed

(d) CP violation

(e) T violation
As $d$ decreases, get larger diffraction pattern
\[ \Delta \theta = \frac{\lambda}{d} \quad \text{so} \quad \text{usage} \quad \Delta S_1 = L \Delta \theta \approx \frac{\lambda L}{d} \]

As $d$ increases, get larger geometrical spot, size $d$

so \[ \Delta S_2 = d \]

Combine quadratically and minimize
\[ \Delta S_{\text{total}} = \sqrt{(\frac{\lambda L}{d})^2 + d^2} \]

\[ \frac{d}{d} \frac{\Delta S_1}{d} = \frac{1}{2} \left[ \frac{1}{\sqrt{\left( \frac{\lambda L}{d} \right)^2 + d^2}} \right] \left( 2d - \frac{2 \lambda L^2}{d^2} \right) = 0 \]

so \[ d^4 = \lambda^2 L^2 \]

or \[ d = \sqrt[4]{\lambda L} \] \( \text{SAME RESULT IF} \)

\[ \Delta S_1 = \Delta S_2, \text{which} \]

\[ \text{WOULD ALSO BE O.K.} \]
NEWTONIAN COSMOLOGY

USING HOMOGENEITY AND ISOPTROPY ASSUMPTION, ESTIMATE THE ENERGY IN A SHELL OF RADIUS R

ASSUME UNIFORM SMOOTH DENSITY IS $\rho$

HUBBLE LAW RADIAL VELOCITY OF MATTER IN SHELL

$V_r = HR$

KINETIC ENERGY OF THE SHELL

$K_{E, \text{shell}} = 4\pi HR^2 \Delta R \rho \frac{V_r^2}{2} = 2\pi \rho H^2 R^4 \Delta R$

Potential energy stored in the shell due to the gravitational interaction with the matter bounded by the shell

$P_{E, \text{shell}} = -\frac{G M_{\text{shell}} M_{\text{within}}}{R} = -\frac{G}{4\pi} R^3 \rho S \frac{V_r^2}{2} HR^2 \Delta R$

$= -\frac{16\pi^2}{3} G \rho S R^2 \Delta R$

TOTAL ENERGY OF THE SHELL

$E_{\text{tot}} = R^4 \Delta R \rho 2\pi \left[ H^2 - G \frac{8\pi}{3} \rho \right]$

CRITICAL DENSITY $\rho_{\text{crit}}$

$\rho_{\text{crit}} = \frac{3H^2}{8\pi G}$
Suppose you place two such hemispheres together, so as to form a spherical shell of uniformly distributed charge. By symmetry and Gauss' law there is no field inside. If there was an $\vec{E}$ field in the plane surface, then the radial component $E_r$ would have a divergence $\nabla \cdot \vec{E} \neq 0$ when two hemispheres form a complete sphere, implying $q \neq 0$ inside. But $q$ inside $= 0$ so $E_r = 0$. An $E_\theta$ has to be zero as otherwise $\nabla \times \vec{E} \neq 0$ and $\nabla \cdot \vec{E} = 0$ for $\vec{E}$ fields. Static
$\Pi(\epsilon, T) = \frac{1}{e^{\frac{\epsilon - \mu(T)}{kT}} + 1}$

$\Pi = \frac{1}{2}$ at $\epsilon = \mu$

$\mu(T)$ is the (temperature dependent) chemical potential. It is set by requiring that the average # of particles is equal to $N$:

$$N = \int_{-\infty}^{\infty} D(\epsilon) \Pi(\epsilon, T) d\epsilon$$

b) The particle (\Pi) hole (1-\Pi) symmetry about $\epsilon = \mu$ means that for $kT < \mu$ the temperature dependence of $\mu$ is determined by the derivative of the density of states at $\epsilon = \mu$.

$$\frac{d D(\epsilon)}{d\epsilon} \bigg|_{\epsilon = \mu} = 0 \quad \Rightarrow \quad \mu$$ does not change as $T$ increases

$$\frac{d D(\epsilon)}{d\epsilon} \bigg|_{\epsilon = \mu} > 0 \quad \Rightarrow \quad \mu$$ decreases

$$\frac{d D(\epsilon)}{d\epsilon} \bigg|_{\epsilon = \mu} < 0 \quad \Rightarrow \quad \mu$$ increases
CLOCKS IN ORBIT

NEED TO CONSIDER BOTH GRAVITATIONAL RED SHIFT
BECauses CLOCKS ARE OPERATING AT DIFFERENT
GRAVITATIONAL POTENTIALS, AND THE TIME DILATION
SINCE THE CLOCKS ARE IN RELATIVE MOTION

THE CLOCK FREQUENCY WHEN FAR FROM THE EARTH
IS \( \nu_0 \), THE PROPER FREQUENCY.

\[
\nu_E = \nu_0 \left(1 - \frac{G M_E}{R_E c^2}\right)
\]

ASSUMES THAT \( \frac{G M_E}{R_E c^2} \ll 1 \)

THE CLOCK ON THE EARTH MAINTAINS A RATE

\[
\nu_{\text{orb}} = \nu_0 \left(1 - \frac{G M_E}{R_{\text{orb}} c^2}\right)
\]

THE TRANSMISSION OF THE RADIO WAVES FROM THE ORBITING CLOCK TO THE CLOCK ON THE EARTH
MUST ALSO CONSIDER THE TIME DILATION (SECOND ORDER EFFECT).

\[
\nu_{\text{earth}} = \nu_{\text{orb}} \left(1 - \frac{\nu^2}{c^2}\right)^{1/2} = \nu_{\text{orb}} \left(1 - \frac{1}{2} \frac{\nu^2}{c^2} + \ldots\right)
\]

THE DIFFERENCE IN THE FREQUENCY OF THE SIGNAL
RECEIVED FROM THE ORBITING CLOCK AND THAT FROM THE CLOCK ON THE GROUND BOTH MEASURED ON THE EARTH

\[
\Delta \nu = \nu_{\text{earth}} - \nu_E = \nu_0 \left[1 - \frac{G M_E}{R_{\text{orb}} c^2} - \frac{1}{2} \frac{\nu^2}{c^2} - \left(1 - \frac{G M_E}{R_E c^2}\right)\right]
\]

ASSUME CIRCULAR ORBIT

\[
\frac{\nu^2}{R_{\text{orb}}^2} = \frac{G M_E}{R_{\text{orb}}^2 c^2} \quad \frac{\nu^2}{c^2} = \frac{G M_E}{R_{\text{orb}}^2 c^2}
\]

\[
\Delta \nu = \nu_0 \frac{G M_E}{c^2} \left[\frac{1}{R_E} - \frac{3}{2} \frac{1}{R_{\text{orb}}^2}\right]
\]

CAN GO TO 0 WHEN \( R_{\text{orb}} = 3/R_E \).
Ammonia inversion line

Eigenstates need to have equal probability for finding nitrogen on right or left.

Lowest energy eigenstates will have minimum curvature (second derivative).

1) Plausible states are

\[ \psi_{\text{Sym}}(x,t) = A(x) e^{-\frac{i}{\hbar} \frac{(E_0 - B)}{\hbar}} \]

\[ \psi_{\text{Anti}}(x,t) = B(x) e^{-\frac{i}{\hbar} \frac{(E_0 + B)}{\hbar}} \]

A time irreversent state with runaanco probability for finding the nitrogen on "say" the right side, would be superposition of the \( \psi_{\text{Sym}} \) and \( \psi_{\text{Anti}} \) states

\[ \psi(t) = C(x) \left[ e^{-\frac{i}{\hbar} \frac{(E_0 - B)}{\hbar}} + e^{-\frac{i}{\hbar} \frac{(E_0 + B)}{\hbar}} \right] \]

(The spatial function is not important in showing)

(The time irreversent)

\[ \psi(t) = C(x) e^{-i \frac{E_0}{\hbar} t} \left[ e^{\frac{i B^+}{\hbar}} + e^{-\frac{i B^+}{\hbar}} \right] \]

\[ = C(x) e^{-i \frac{E_0}{\hbar} t} 2 \cos \frac{B^+}{\hbar} \]
The probability of finding the nitrogren on the right side varis as:

$$\psi(t) \psi^*(t) \propto \cos^2 \frac{Bt}{\hbar}$$

Oscillates between 0 and 1 in a time

$$\frac{Bt}{\hbar} = \frac{n\pi}{2}$$

$$t = \frac{n\pi\hbar}{2B}$$

$\frac{1}{2}$ the inversion period

The larger $2B$ - the n uglc direrence between the sym. and anti sym. states - the higher the inversion frequency.
Condition on surface: surface
is normal to total force on
volume element at surface, mass m.

\[ \vec{F}_{\text{total}} = \vec{F}_s = \hat{x} F_x + \hat{y} F_y \]

\[ F_x = m \times \omega^2 \quad F_y = -mg \]

Surface is \( \perp \) to \( \vec{F}_s \): its slope (in xy-plane) = \( \frac{F_x}{-F_y} \)

So \( \frac{dy}{dx} = \frac{m \times \omega^2}{+mg} = \frac{\omega^2}{g} x \)

Integrate \( y = \frac{\omega^2}{2g} x^2 + \text{cont.} \) \( \Rightarrow \) Parabola
The relativistic velocity transformation for this symmetric case is:

\[ \beta_{\text{final}} = \frac{2\beta}{1 + \beta^2} \quad \text{and} \quad \beta = 1 - \frac{1}{\gamma^2} = \frac{\gamma^2 - 1}{\gamma^2} \]

So \[ \beta_f^2 = \frac{4\beta^2}{(1 + \beta^2)^2} \quad \text{algebra} \quad 1 - \beta_f^2 = \left(\frac{1 - \beta^2}{1 + \beta^2}\right)^2 \]

So \[ \gamma_{\text{final}} = \left(\frac{1 + \beta^2}{1 - \beta^2}\right) \quad \text{and} \quad m = \gamma \cdot m_0 \]

For \( \gamma = 10 \quad m = 199 \, m_0 \)
a) \( \frac{1}{2} m u^2 = m g h \) \( \Rightarrow \) \( h = \frac{u^2}{2g} \)

b) Note that neither \( h \) nor \( u \) is negative, and \( h \) is a single valued function of \( u \).

\[
p_h(h) \, dh = p_u(u) \, du
\]

\[
p_h(h) = p_u(u(h)) \frac{du(h)}{dh}
\]

\[
dh = \frac{1}{2} uv \, du \Rightarrow \frac{du}{dh} = \frac{g}{u}
\]

\[
p(h) = \frac{2u^2}{v_0^4} e^{-\frac{u^2}{2v_0^2}} (v \frac{dv}{dh})
\]

\[
= \frac{4g}{v_0^4} h e^{-\frac{g h}{v_0^2}} g
\]

Define \( h_0 = \frac{v_0^2}{2g} \)

\[
= \frac{1}{h_0^2} h e^{-h/h_0} \quad h > 0
\]

\[p(h)\]
PULSAR ENERGY LOSS

Energy stored in the rotation of the neutron star

\[ E_{\text{rot}} = \frac{1}{2} I \omega^2 = \frac{1}{5} \frac{M R^2}{\gamma} \omega^2 \]

Assume star is "stiff" enough that the moment of inertia is constant independent of the rotation frequency.

Relating a change in angular to a change in rotation frequency

\[ \frac{dE_{\text{rot}}}{dt} = I \omega \frac{d\omega}{dt} \]

1) Magnetic dipole radiation loss is entirely into the radiation field as

\[ \left. \frac{dE}{dt} \right|_{\text{Magnetic dipole radiation}} = -C \omega^4 \]

The pulsar rotation frequency is reduced

\[ \left. \frac{dE_{\text{rot}}}{dt} \right|_{\text{Magnetic dipole radiation}} = -C \omega^4 = \omega I \frac{d\omega}{dt} \]

\[ \Rightarrow \gamma = 3 \]

2) If gravitational radiation dominates - quadrupole radiation

\[ \left. \frac{dE}{dt} \right|_{\text{Grav radiation}} = C \omega^6 \]

\[ \left. \frac{dE}{dt} \right|_{\text{Grav radiation}} = -C \omega^6 = \omega I \frac{d\omega}{dt} \]

\[ \Rightarrow \gamma = 5 \]
(a) $C_o = \frac{A}{d}$ (in cm) in Gaussian units

(b) Treat II as two capacitors in series

\[
\frac{1}{C_a} = 2C_o \quad \frac{1}{C_b} = 2kC_o
\]

\[
C_{II} = \frac{C_aC_b}{C_a+C_b} = \frac{2k}{1+k}C_o
\]

Treat III as a pair of parallel capacitors

\[
C_a = \frac{C_o}{2} \quad C_b = kC_o/2
\]

\[
C_{III} = C_a + C_b = \frac{1+k}{2}C_o
\]

(C) Now $E_I = \frac{1}{2} \frac{Q_o^2}{C_o}$; energy in $C_o$

\[
E_{II} = \frac{1}{2} \frac{Q_o^2}{C_{II}} = \frac{k+1}{2k} E_I, \quad W_{I\rightarrow II} = E_{II} - E_I = \frac{1-k}{2k} E_I
\]

and $E_{III} = \frac{1}{k+1} E_I$

\[
W_{II\rightarrow III} = \frac{1-k}{1+k} E_I
\]
\[ \frac{dP}{dV} \bigg|_s = -\frac{1}{V} \left( \frac{1}{\kappa_s} \right) = -\frac{1}{V} \left( \frac{1}{\beta_s} \right) = -\frac{1}{V} \left( \frac{\gamma}{\beta_s} \right) \]

Since \( \beta_T / \beta_s = c_p / c_V = \gamma \)

But \( \beta_T = -\frac{1}{V} \frac{\partial P}{\partial V} \bigg|_T = -\frac{1}{V} \left( \frac{V}{P} \right) = \frac{1}{P_0} \)

so \( dF = A \left(-\frac{1}{V_0} P_0 \gamma\right) \) \( dX = -\frac{\gamma m g A}{V_0} \) \( dx = m \frac{d^2x}{dt^2} \)

\[ x'' + \left( \frac{\gamma g A}{V_0} \right) x = 0 \quad \Rightarrow \quad \omega = \sqrt{\frac{\gamma g A}{V_0}} \quad \text{where} \quad A = \frac{\pi d^2}{4} \]
\[ \psi(t=0+) = \sqrt{x} e^{-\frac{a}{2}\sqrt{x}} = c_0 \sqrt{x} e^{-\frac{a}{2}\sqrt{x}} + \int_0^\infty C(E) \psi_E(x) dE \]

\[ p(\text{still bound}) = |c_0|^2 \]

\[ c_0 = 2\sqrt{x} \sqrt{-\frac{d}{d\phi}} \int_0^\infty e^{-\frac{a}{2}\sqrt{x}} x \ d\chi = \frac{2\sqrt{x} \sqrt{-\frac{d}{d\phi}}}{\frac{d}{d\phi}} \]

**Use the wave eq. to relate \( \chi \) to \( v_0 \)**

\[ \begin{array}{c}
\sqrt{x} - \psi \\
\chi \end{array} \quad \begin{array}{c}
\sqrt{x} - \psi' \\
\chi \end{array} \quad \begin{array}{c}
\sqrt{x} - \psi'' \\
\chi \end{array} \quad \begin{array}{c}
\sqrt{x} - 2\sqrt{x} \delta(x) \end{array} \]

\[ -\frac{\hbar^2}{2m} \psi''(x) + U(x) \psi(x) = E \psi(x) \]

\[ \Rightarrow \chi = \frac{m}{\hbar^2} v_0 \]

So \( v_0 \rightarrow f v_0 \Rightarrow \chi \rightarrow f \chi = \chi' \)

\[ p(\text{still bound}) = \left( \frac{2\sqrt{f}}{1+f} \right)^2 = \frac{4 f}{(1+f)^2} \]
CLASSICAL PLOTTING OF MAGNITIC DIPOLARS

\[ \mathbf{S} = \mu \times \mathbf{B}_0 = \mu B_0 \sin \theta \]
\[ S_{xy} = S \Delta \phi \]
\[ \frac{\Delta \phi}{\Delta \tau} = \frac{\gamma \Delta \tau}{S} = \frac{\mu B_0}{S} \]
\[ \frac{\Delta \phi}{\Delta \tau} = \omega_{\text{precess}} = \frac{\mu B_0}{S} \]

ENERGY OF DIPOLAR IN \( \mathbf{B}_0 \)
\[ E = -\mathbf{\mu} \cdot \mathbf{B} = -\mu B \cos \theta \]

b) APPLYING \( \mathbf{B}_\text{RF} \) CIRCULARLY POLARIZED IN THE XY PLAN WITH FREQUENCY \( \omega \) PARALLEL AND ROTATION SENSITIVE TO THE SAME AS THE PRECCESSION, Larmor's THEOREM APPLIED IN ROTATING FRAME ELIMINATES \( B_0 \) AND \( \mathbf{B}_\text{RF} \) APPLIES STRAIGHT AND IN FIXED RELATION TO \( \mu \), \( \mu \) PAREMETERS ABOUT \( \mathbf{B}_\text{RF} \). THE BRAVCHING CHANGING \( \theta \) AND ENERGY OF \( \mu \) IN \( B_0 \) IN LAB IS CHANGED. IN THE ROTATING FRAME, THE PRECCESSION AROUND \( \mathbf{B}_\text{RF} \)
\[ \omega_{\text{RABI}} = \frac{\mu B_{\text{RF}}}{S} \]

THE TIME NECESSARY TO CHANGE THE ENERGY MAXIMALLY
\[ t = \omega_{\text{RABI}} t \]
\[ t = \frac{\pi S}{\mu B_{\text{RF}}} \]