Kaushik Chakram
Professor Julia Kamenetzky
phys 425 &01
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Problem 2.27)b)

```
$Assumptions = {x, t, A, a, k, m, ℏ, α, α₁, V₀, a₁, n} ∈ Reals
```

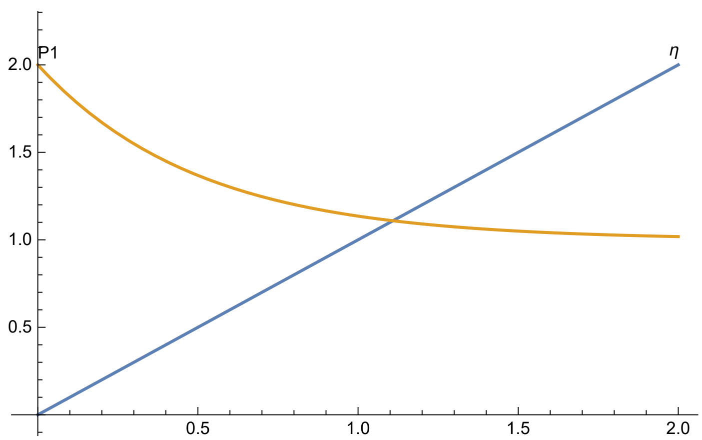
$(x \mid t \mid A \mid k \mid n) \in \text{Reals}$

$$\alpha := \frac{\hbar^2}{m * a^2}$$

$$\text{P1} := \frac{(m * a * \alpha)}{\hbar^2} * \left(1 + e^{-2*\eta}\right)$$

$$\alpha_1 := \frac{\alpha}{4}$$

```
a := 1
m := 1
ℏ := 1
Plot[{η, P1}, {η, 0, 2}, PlotLabels → Placed[{"η", "P1"}, Above]]
```

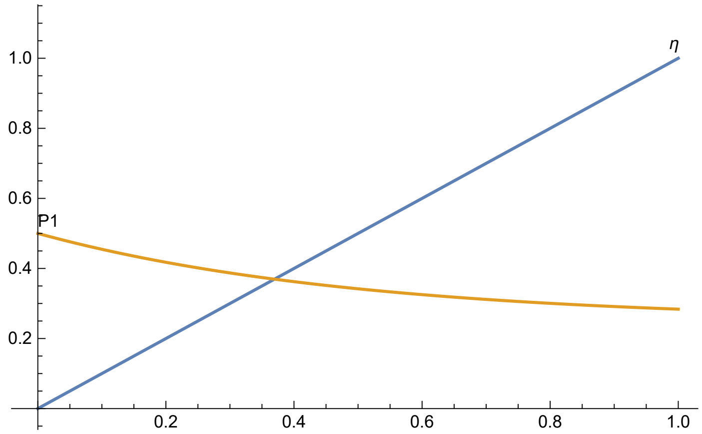



```
N[Solve[η == P1, η], 8]
```

Solve: Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information.

$\{\{\eta \to 1.1088576\}\}$

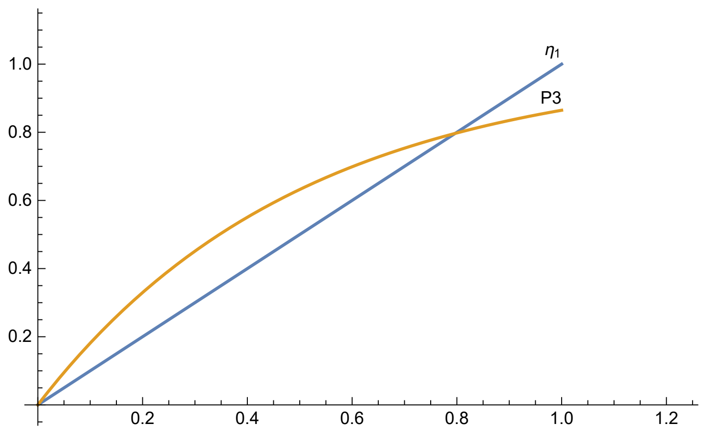
```
P2 := (m * a * α1)/ħ^2 * (1 + e^(-2*η))
Plot[{η, P2}, {η, 0, 1}, PlotLabels → Placed[{"η", "P1"}, Above]]
N[Solve[η == P2], 8] (* Now we must account for the odds solutions.*)
```



Solve: Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information.

{{η → 0.36941752}}

```
P3 := (m * a * α)/ħ^2 * (1 - (e^(-2*η1)))
Plot[{η1, P3}, {η1, 0, 1}, PlotLabels → Placed[{"η1", "P3"}, Above]]
N[Solve[η1 == P3], 8]
(* The intersection at η1= 0 implies the energy is zero so we pick the other solution.*)
```

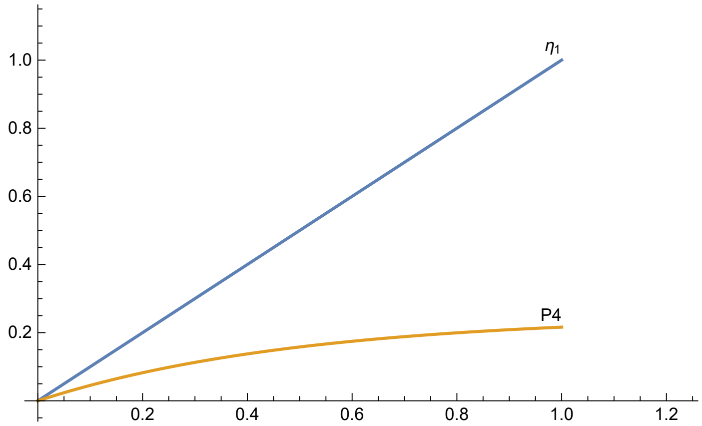


Solve: Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information.

{{η1 → 0}, {η1 → 0.79681213}}

```
P4 := (m * a * α1)/ħ^2 * (1 - (e^(-2*η1)))
Plot[{η1, P4}, {η1, 0, 1}, PlotLabels → Placed[{"η1", "P4"}, Above]]
N[Solve[η1 == P4], 8]
```

$$P4 := \frac{(m * a * \alpha_1)}{\hbar^2} * \left(1 - \left(e^{-2*\eta_1}\right)\right)$$



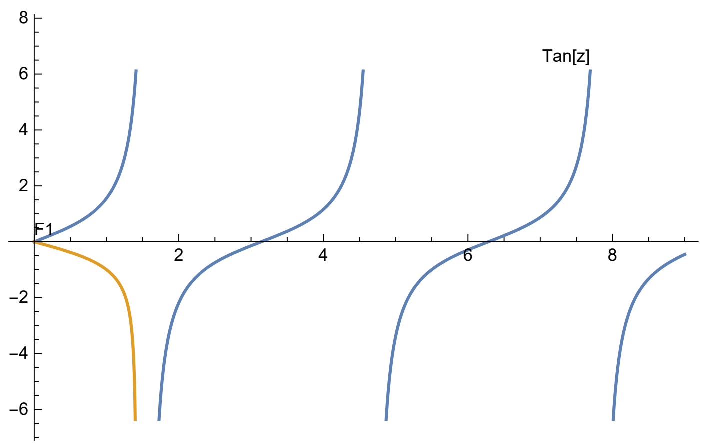
Solve: Inverse functions are being used by Solve, so some solutions may not be found; use Reduce for complete solution information.

$\{\{\eta_1 \to 0\}, \{\eta_1 \to -0.62821560\}\}$

1)Problem 2.29)

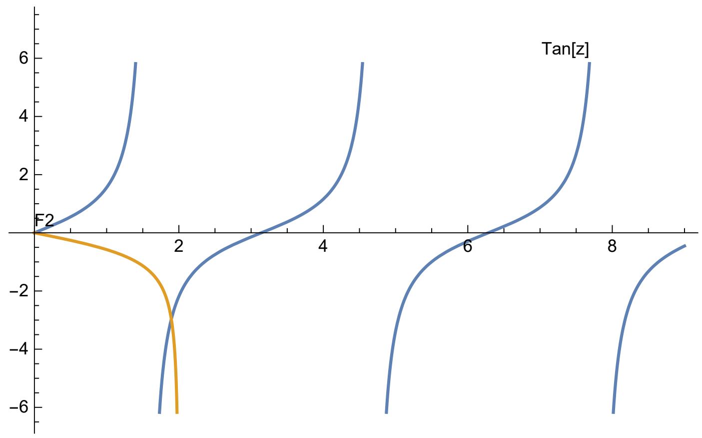
$$F1 := \frac{-1}{\sqrt{\left(\frac{\sqrt{2}}{z}\right)^2 - 1}}$$

```
Plot[{Tan[z], F1}, {z, 0, 9}, PlotLabels → Placed[{"Tan[z]", "F1"}, Above]]
(*No bound state here.*)
```



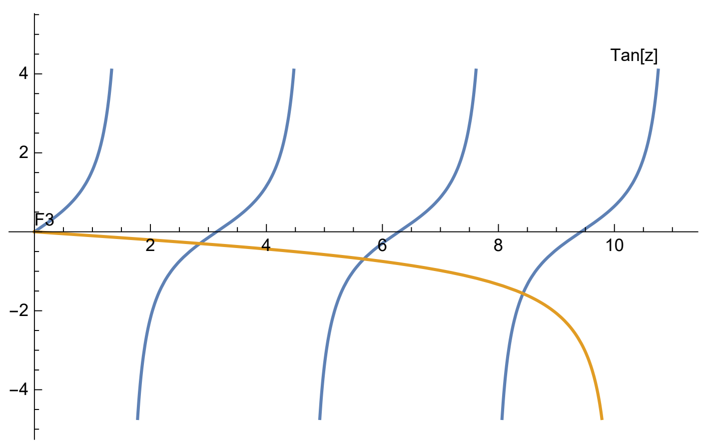
$$\text{F2} := \frac{-1}{\sqrt{\left(\frac{2}{z}\right)^2 - 1}}$$

```
Plot[{Tan[z], F2}, {z, 0, 9}, PlotLabels → Placed[{"Tan[z]", "F2"}, Above]]
(* One bound state here.*)
```



$$\text{F3} := \frac{-1}{\sqrt{\left(\frac{10}{z}\right)^2 - 1}}$$

```
Plot[{Tan[z], F3}, {z, 0, 11}, PlotLabels → Placed[{"Tan[z]", "F3"}, Above]]
(* Three bound states here.*)
```



$$\text{Integrate}\left[\left(\frac{1}{\sqrt{a_1}}\right) * \left(\sqrt{\frac{2}{a_1}}\right) \text{Sin}\left[\frac{\pi * x}{a_1}\right] * \left(\text{Sin}\left[\frac{(n * \pi * x)}{2 * a_1}\right]\right), \{x, 0, a_1\}\right]$$

$$\frac{4\sqrt{2}\ \text{Sin}\left[\frac{n\pi}{2}\right]}{4\pi - n^2\pi}$$

$$\text{C1}[n\_] := \frac{\left(4\sqrt{2}\right) * \text{Sin}\left[\frac{n\pi}{2}\right]}{4\pi - n^2\pi}$$

(*Here we are setting it up to calculate the probabilities for the first 6 states*)

In[10]:= $\left(\text{C1}[1]\right)^2$

Out[10]= $\frac{32}{9\pi^2}$

In[12]:= $\left(\text{Integrate}\left[\left(\frac{1}{\sqrt{a_1}}\right) * \left(\sqrt{\frac{2}{a_1}}\right) \text{Sin}\left[\frac{\pi * x}{a_1}\right] * \left(\text{Sin}\left[\frac{(2*\pi*x)}{2*a_1}\right]\right), \{x, 0, a_1\}\right]\right)^2$

Out[12]= $\frac{1}{2}$

In[13]:= $\left(\text{C1}[3]\right)^2$

Out[13]= $\frac{32}{25\pi^2}$

In[14]:= $\left(\text{C1}[4]\right)^2$

Out[14]= 0

In[15]:= $\left(\text{C1}[5]\right)^2$

Out[15]= $\frac{32}{441\pi^2}$

In[16]:= $\left(\text{C1}[6]\right)^2$

Out[16]= 0

$$\text{Integrate}\left[\left(\frac{-\hbar^2}{2*m}\right) * \left(\sqrt{\frac{2}{a_1}}\right)^2 \text{Sin}\left[\frac{\pi * x}{a_1}\right] * \text{D}\left[\left(\text{Sin}\left[\frac{(\pi*x)}{a_1}\right]\right), \{x, 2\}\right], \{x, 0, a_1\}\right]$$

(* This is just E_2*)

Out[18]= $\frac{\pi^2\hbar^2}{2\,m\,a_1^2}$