第五部分　振　动

FangYi

[1]谐振判据

定平衡　给偏移　证线恢

动力学:物体受线性恢复力(矩)作用

运动学:物体运动微分方程形式: $\underbrace{d^2y/dt^2+\omega^2y=0}$

位移是时间的余(正)弦函数

弹簧振子　单摆　复摆

[2]谐振方程

$x=A\cos(\omega t+\varphi)$

$v=-\omega A\sin(\omega t+\varphi)$

$a=-\omega^2A\cos(\omega t+\varphi)$

振幅取决于能量 $A=\sqrt{x_0^2+\dfrac{v_0^2}{\omega^2}}=\sqrt{x^2+\dfrac{v^2}{\omega^2}}$

初相……初态 $\varphi=tg^{-1}(-\dfrac{v_0}{\omega x_0})$

圆频率……系统 $\omega=\sqrt{k/m}$

[3]谐振合成(同向同频率)

旋转矢量法

$2\pi:T=\Delta\phi:\Delta t$

逆时针

相位与速度符号

公式法

$A=\sqrt{A_1^2+A_2^2+2A_1A_2\cos(\varphi_2-\varphi_1)}$

$\varphi=\tan^{-1}\dfrac{A_1\sin\varphi_1+A_2\sin\varphi_2}{A_1\cos\varphi_1+A_2\cos\varphi_2}$

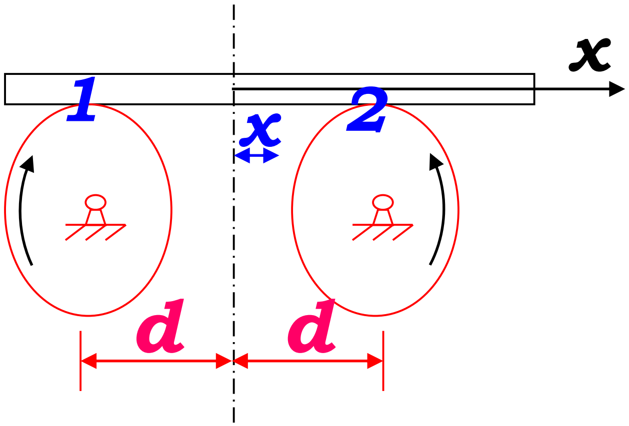
[4]谐振位相 $\phi=\omega t+\varphi$

位相差：同一振动不同时刻；不同振动同一时刻

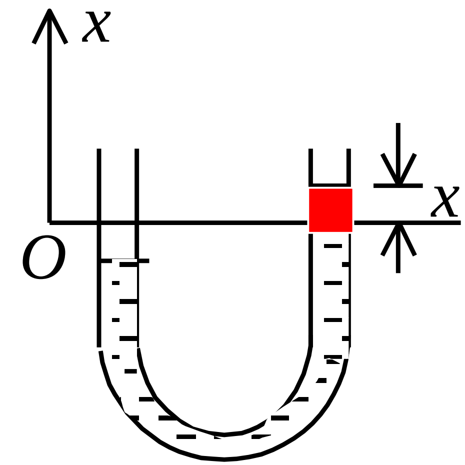
[5]谐振能量 $E=E_k+E_p=\dfrac{1}{2}mv^2+\dfrac{1}{2}kx^2=\dfrac{1}{2}kA^2$

能量方法

[习题1]两轮同转速反转向，μ、d已知，
起初棒的质心偏中心x，求T



[讨论1]直立U形管有$m = 240g$水银($\rho = 13.6\ g/cm^3$),
管截面$S=0.30cm^2$.证经微扰作谐振. 并求T



[讨论2]均匀弹簧$\boldsymbol{k}$, $\boldsymbol{m_s}$, 球$\boldsymbol{M}$, 求其ω

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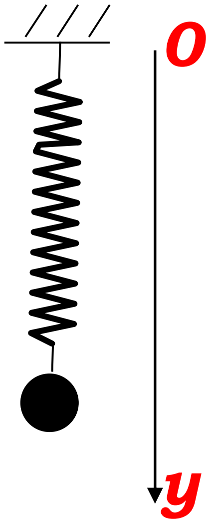
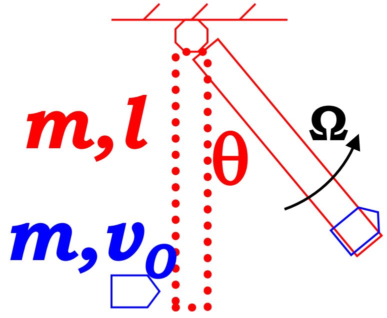


[习题2]已知m、l 、v_0,小角振动,

(1)证碰后系统谐振

(2)写振动方程



(碰时计时)

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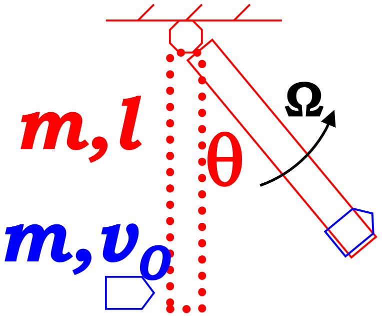
[习题2]已知$\boldsymbol{m}$、$\boldsymbol{l}$ 、$\boldsymbol{v_0}$,小角振动，

(3)棒摆至$\theta_m/2$需时t_{min}



(碰时计时)

[讨论3]匀细棒悬点可调, 从θ_m静止释放, 求(1)**T**的极值及对应悬点到质心的距离(2)角速度函数**Ω(θ)**

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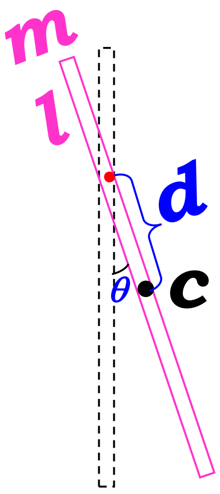

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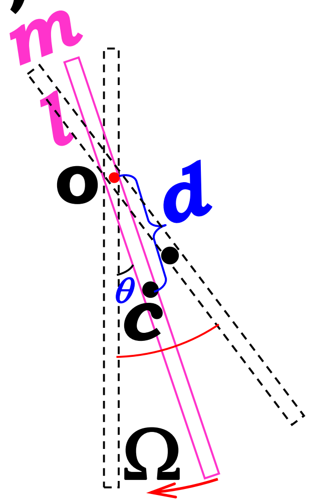

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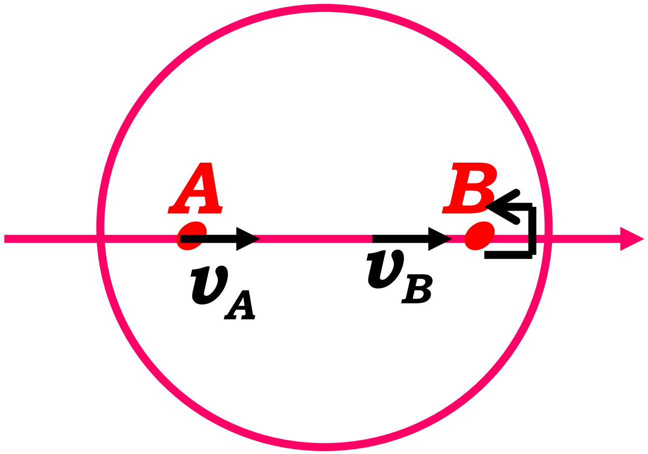
[习题3]谐振质点一个T内先后通过$\boldsymbol{A,B}$.费时$\boldsymbol{t_1}$

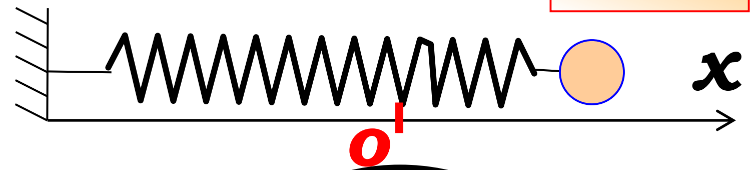
$\boldsymbol{AB=8, t_1=2, v_B=v_A}$,再经过$\boldsymbol{t_2=2}$, 质点又从另一方向过B点. 求(1) $\boldsymbol{T}$ (2) $\boldsymbol{A}$

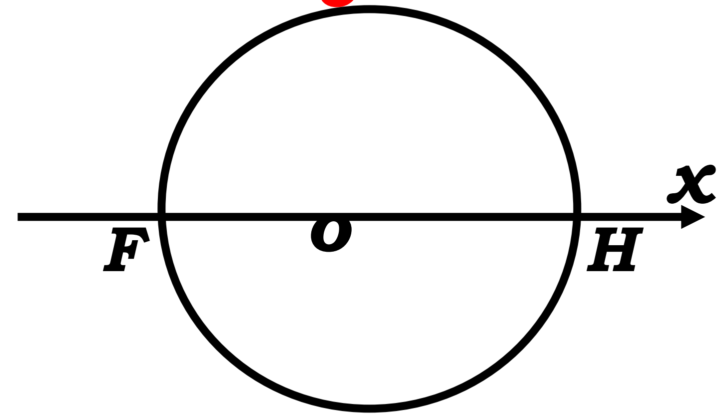


[讨论4]小球过o向右E_{k0}, $T=1s$

(1)再过1/3s至B点,求E_{kB}/E_{k0}

(2)此后到第2次$E_k=E_p$的费时t





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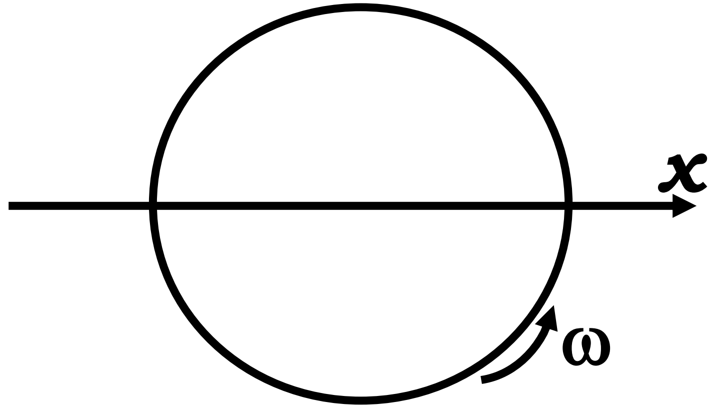
[习题4]质点同时参与3谐振, 合运动方程为$x =$

$$x_1 = A\cos(\omega t + \frac{1}{3}\pi)$$

$$x_2 = A\cos(\omega t + \frac{5}{3}\pi)$$

$$x_3 = A\cos(\omega t + \pi)$$



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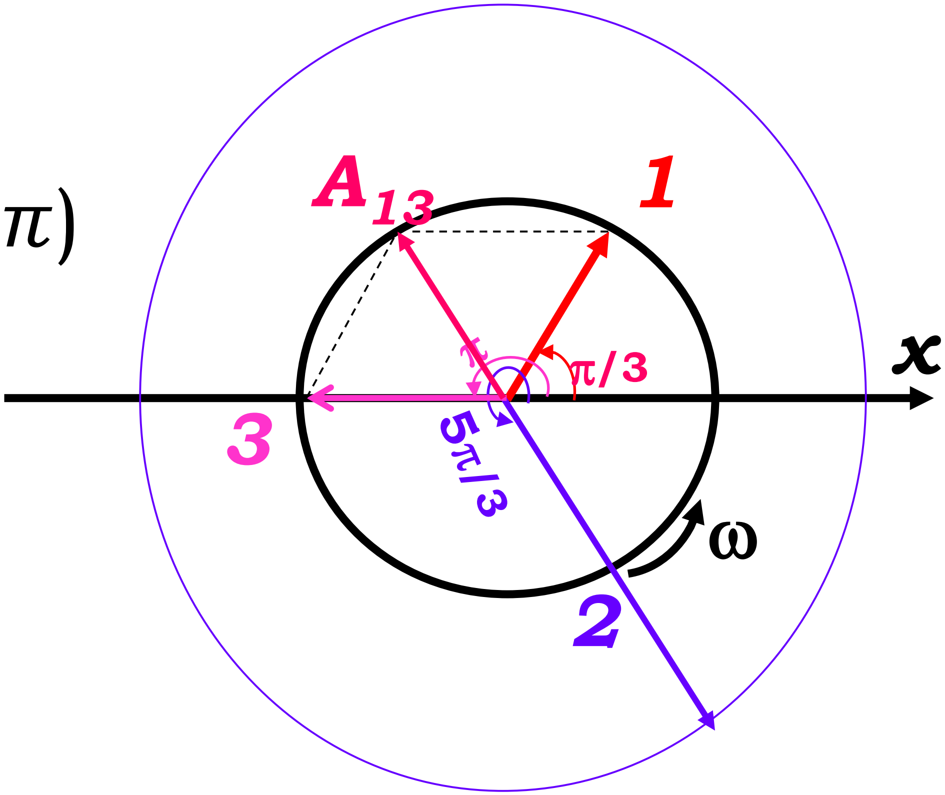
[讨论5]质点同时参与3谐振, 合运动方程为$x =$

$$x_1 = A\cos(\omega t + \frac{1}{3}\pi)$$

$$x_2 = 2A\cos(\omega t + \frac{5}{3}\pi)$$

$$x_3 = A\cos(\omega t + \pi)$$

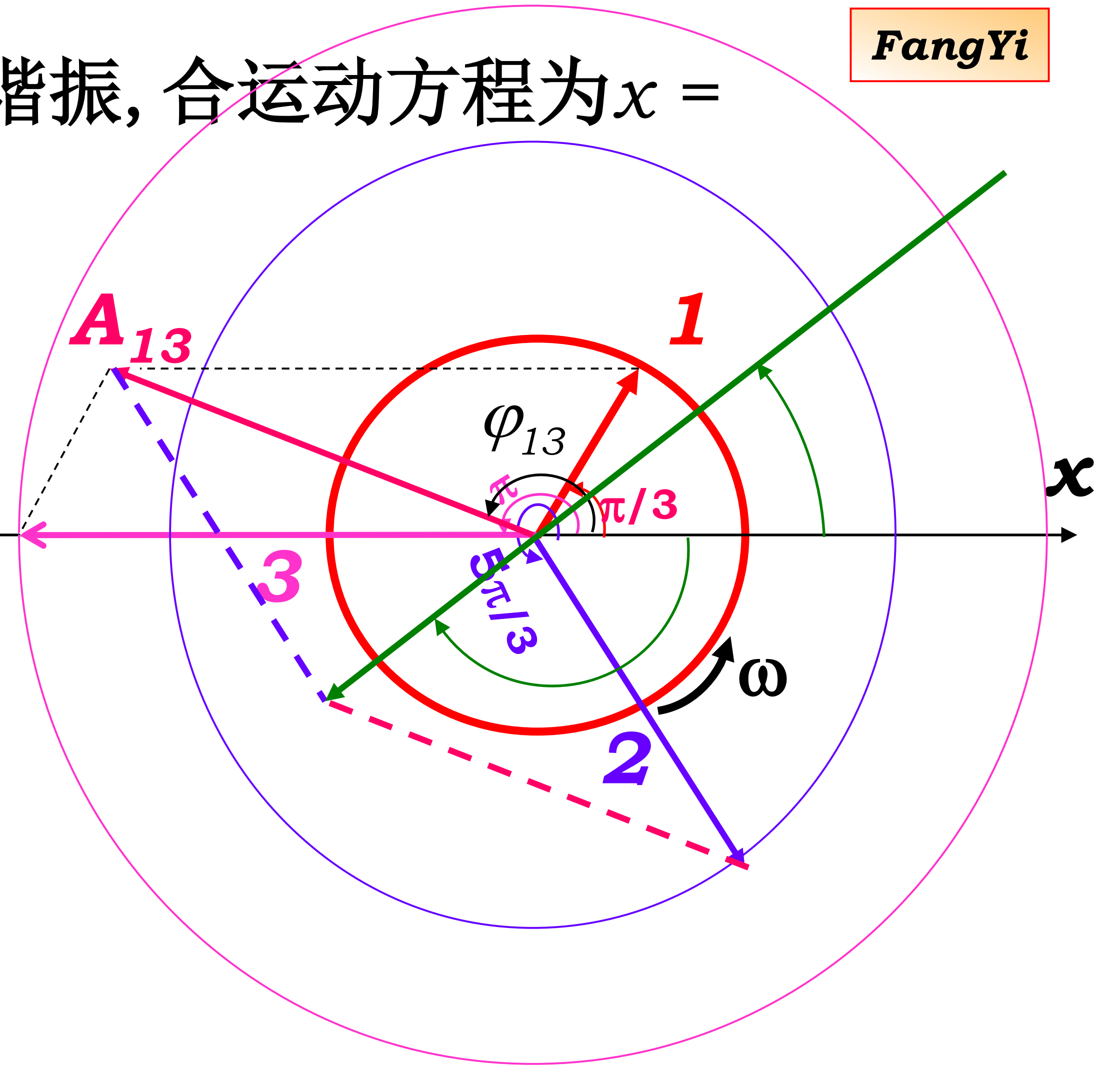


[讨论6]质点同时参与3谐振, 合运动方程为$x =$

$$x_1 = A\cos(\omega t + \frac{1}{3}\pi)$$

$$x_2 = 2A\cos(\omega t + \frac{5}{3}\pi)$$

$$x_3 = 3A\cos(\omega t + \pi)$$



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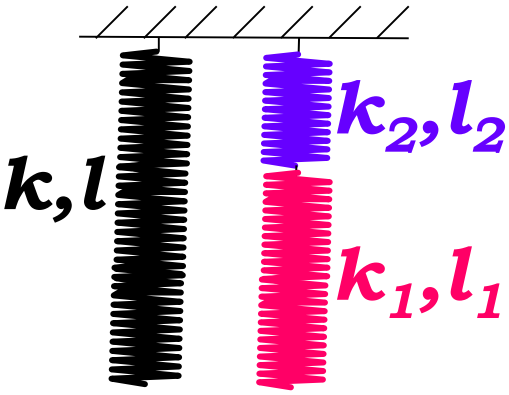
[习题5] l、k匀轻弹簧分成l_1、l_2,且$l_1 = n\,l_2$, n为整数.
则k_1和k_2为

$$(A)\ k_1 = \frac{kn}{n+1} \quad k_2 = k(n+1)$$

$$(B)\ k_1 = \frac{k(n+1)}{n} \quad k_2 = \frac{k}{n+1}$$

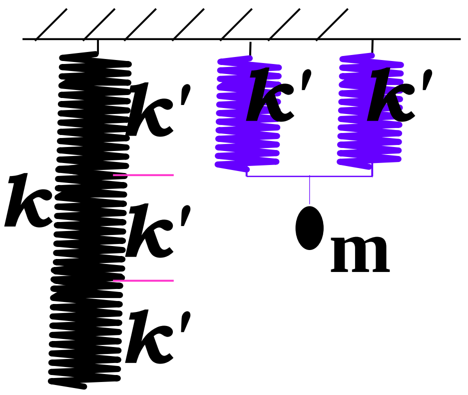
$$(C)\ k_1 = \frac{k(n+1)}{n} \quad k_2 = k(n+1)$$ √

$$(D)\ k_1 = \frac{kn}{n+1} \quad k_2 = \frac{k}{n+1}$$



$$\frac{1}{k_{串}} = \frac{1}{k_2} + \frac{1}{k_1}$$

[讨论7] 轻弹簧k截成3等份,取其中两根并联,下挂m,求振动系统 υ



[习题6] 轻弹簧小盘平衡位置为原点, 位移向下为正, 小盘于最低位置有一物体落在盘上并粘住, 设新平衡位置对原平衡位置下移<原振幅, 若以新平衡位置为原点, 物体碰盘计零时, 则新位移表达式的初相在

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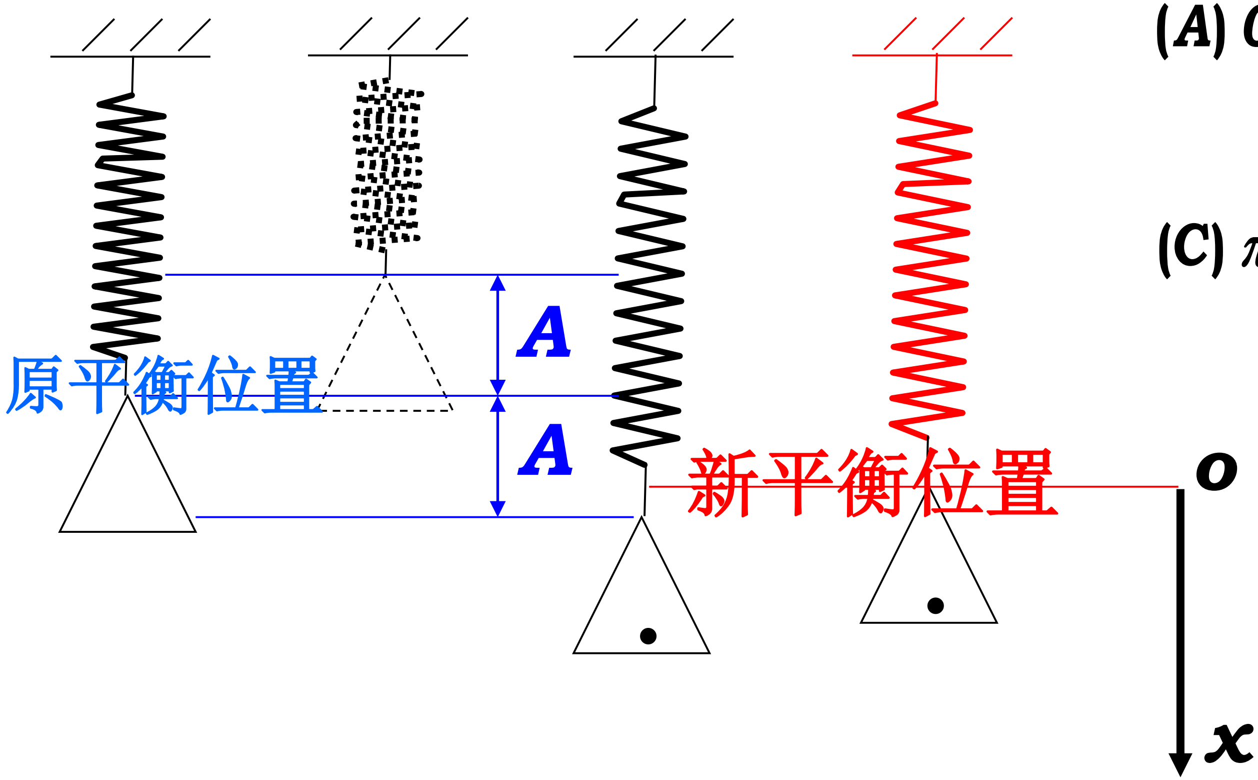


(A) $0 \sim \dfrac{\pi}{2}$　(B) $\dfrac{\pi}{2} \sim \pi$

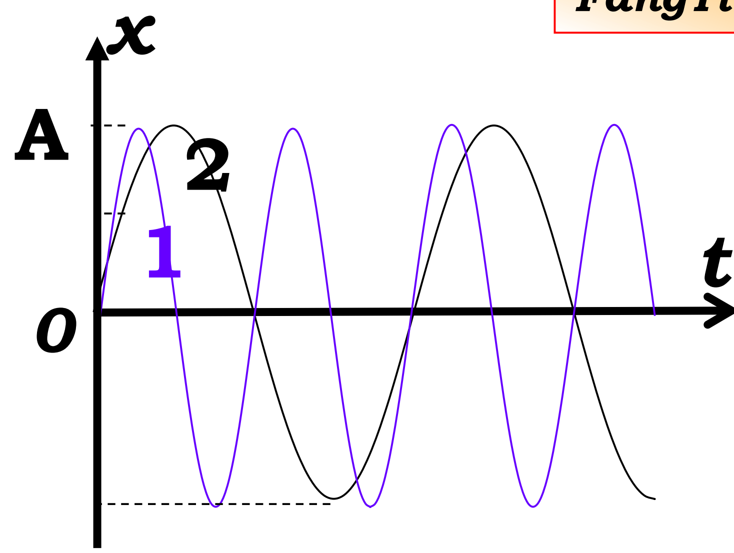
(C) $\pi \sim \dfrac{3\pi}{2}$　(D) $\dfrac{3\pi}{2} \sim 2\pi$

[习题7]两谐振曲线，

求f_1:f_2；

$a_{1\max}$:$a_{2\max}$；

$v_{1\max}$: $v_{2\max}$

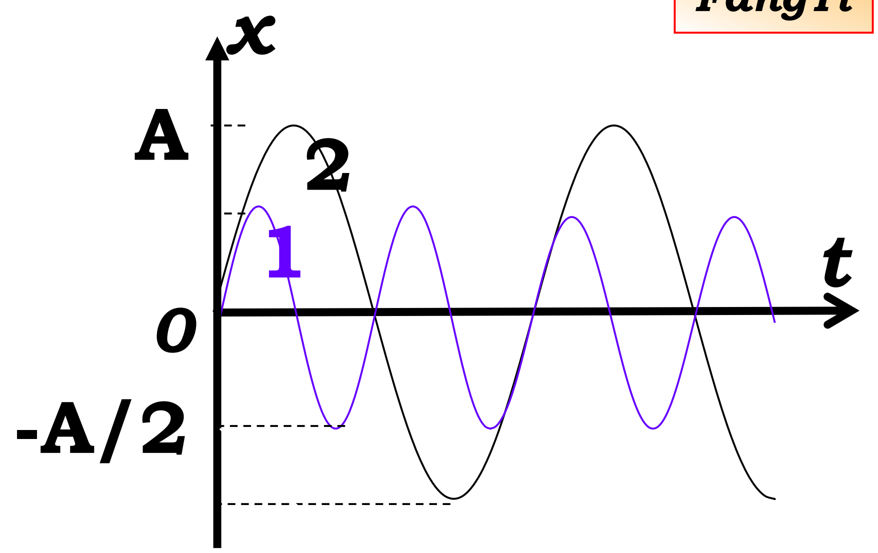


[习题7]两谐振曲线，

求$f_1:f_2$；

$a_{1max}:a_{2max}$；

$v_{1max}:v_{2max}$



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