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General Physics I, Final-I
PHYS1000AA, AB, AC Class year110/2021
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Final-1 Solution

1. **Solution :** ***(Similar to 15.4, text book 8th edition)***

(a)For a spring , F= - kx= ma

$$a=\frac{d^2x}{dt^2}=\frac{-kx}{m}$$

$$\frac{d^2x}{dt^2}=-\frac{k}{m}x=\omega^2x\text{ , where }\omega=\sqrt{\frac{k}{m}}$$

$$\frac{d^2x}{dt^2}+\omega^2x=0$$

(b) Here, s = Lθ

$$\text{So , F= ma = m }\frac{d^2s}{dt^2}=-mg\sin\theta$$

$$\frac{d^2s}{dt^2}=-g\sin\theta$$

$$\frac{d^2\theta}{dt^2}=-\frac{g}{L}\sin\theta \qquad \text{Since } s=L\theta$$

(c) $\frac{d^2\theta}{dt^2}=-\frac{g}{L}\theta$, if θ is very small , $\sin\theta=\theta$

$$\frac{d^2\theta}{dt^2}+\omega^2\theta=0\text{ , where }\omega=\sqrt{\frac{g}{L}}$$

Which is a simple harmonic motion equation

2. **Solution:** ***(Similar to 18.2 , text book 8th edition)***

(a)The wave function of the travelling waves are

$y_1=A\sin(kx-\omega t)$ (for right)

$y_2=A\sin(kx+\omega t)$ (for left)

(b) Wave function for the standing wave will be

$$Y=y_1+y_2$$
$$=A\sin(kx-\omega t)+A\sin(kx+\omega t)$$
$$=A[\sin(kx-\omega t)+\sin(kx+\omega t)]$$
$$=2A\sin kx\cos\omega t \qquad \text{Since } \sin C+\sin D=2\sin\frac{C+D}{2}\cos\frac{D-C}{2}$$

(c)The condition for the node can be found for $2A\sin kx=0$

or , $\sin kx=0$ or, $kx=n\pi$

$$\frac{2\pi x}{\lambda}=n\pi, \qquad \text{or, } x=\frac{n}{2}\lambda\text{ , where } n=0,1,2,3............N$$

So, $x=0,\frac{\lambda}{2},\lambda,\frac{3\lambda}{2}$,........................ are the condition for NODE

3. Solution: ***(Similar to page 472 , Halliday Book)***

The internal energy chnage

$\Delta E_{int} = \Delta(nC_v T) = C_v \Delta(nT)$..................................(1)

But we know , $PV = nRT$ for a ideal gas

So , $nT = \dfrac{PV}{R}$

Put this value in equation (1) , we get

$\Delta E_{int} = C_v \Delta(\dfrac{PV}{R})$, But here P,V, R are all constant

So there will no change of internal energy

$\Delta E_{int} = 0$

4. Solution: ***(Similar to 21.5 , text book 8th edition)***

(a) C_p needs to consider extra work done by (or be done to) the gas ,

so extra energy is required.

(b) We know , $\Delta E_{in} = nC_v dT = Q + W = 0 - PdV$ (for adiabatic process)

$nC_v dT = -PdV$ or, $ndT = -\dfrac{PdV}{C_v}$

Now for a ideal gas, PV=nRT

Using differntiation we can write ,

$PdV + VdP = nRdT$

$PdV + VdP = -\dfrac{PdV}{C_v}R = -\dfrac{(C_p - C_v)PdV}{C_v}$, Since $R = C_p - C_v$

$PdV[1 + \dfrac{(C_p - C_v)}{C_v}] = -VdP$

$\dfrac{dV}{V}(1 + \gamma - 1) + \dfrac{dP}{P} = 0$, Since $\dfrac{C_p}{C_v} = \gamma$

Using integration we get, $\ln P + \ln V^{\gamma} = \ln C$, Where C is constant

$\therefore \ PV^{\gamma} =$ Constant

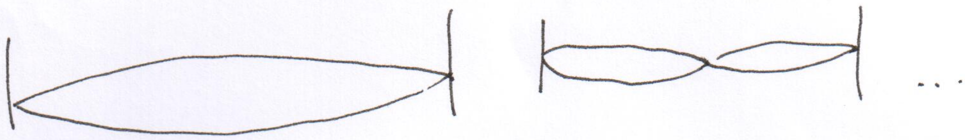
5. let two waves being

$y_1 = A\sin(kx - \omega t)$ A is the amplitude

$y_2 = A\sin(kx + \omega t)$ k = wavenumber

ω = angular frequency

$\Downarrow$ after interaction



$y = y_1 + y_2 = A\sin(kx - \omega t) + A\sin(kx + \omega t)$

$= \underline{2A\ \sin(kx)}\ \cos(\omega t)$

use $\sin(a \pm b) = \sin a \cos b \pm \cos a \sin b$

The new wave is no longer a traveling wave.
it oscillates at ω frequency and the new amplitude is $2A\sin(kx)$, i.e. a function of x

when $kx = n\pi$, $2A\sin(kx) = 0$ it has minimum amplitude

when $\frac{2\pi}{\lambda} x = n\pi$

$x = \frac{n}{2}\lambda$, amplitude is zero
Called node.

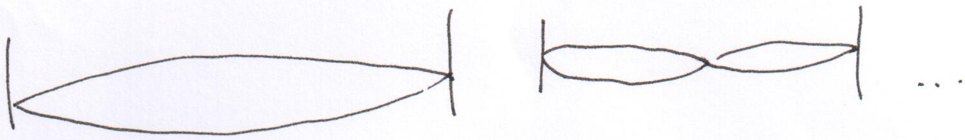
5. let two waves beig

$y_1 = A\sin(kx - wt)$ A is the amplitude

$y_2 = A\sin(kx + wt)$ k = wavenumber

w = angular frequency

$\Downarrow$ after interaction



$y = y_1 + y_2 = A\sin(kx - wt) + A\sin(kx + wt)$

$= \underbrace{2A\sin(kx)}\cos(wt)$

use $\sin(a \pm b) = \sin a \cos b \pm \cos a \sin b$

The new wave is no longer a traveling wave, it oscillates at ω frequency and the new amplitude is $2A\sin(kx)$, i.e. a function of x

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