

```

> restart;

with(plots);

unprotect( $\gamma$ );

Digits := 50;

c := 299792458;

 $\lambda := \frac{c}{10.0\text{E}6}$ ;

NumberOfLoops := 1;
SingleLoopLength := 5;

TotalArmLength := NumberOfLoops·SingleLoopLength;

Altitude :=  $0 \cdot \frac{\pi}{180}$ ;

Azimuth := 180;

vWind := -486000;

v := evalf(vWind·abs(cos(Altitude)) );

# ArmA: Cable OUT is coaxial cable
#       Cable IN is single-mode optic fiber

# ArmB: Cable OUT is single-mode optic fiber
#       Cable IN is coaxial cable

n1 := 1.19;
n2 := 1.44975;

unitXcomponent := abs(cos( $\theta$ )2);

unitYcomponent := abs(sin( $\theta$ )2);

 $\gamma := \text{evalf}\left(\frac{1}{\text{sqrt}\left(1 - \left(\frac{v}{c}\right)^2\right)}\right)$ ;

L1 := L + L·( $\gamma - 1$ ) ;

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$$Eqdtn := dtDiagonal = \frac{L \cdot n}{c} + \left(\frac{L1 - L}{c} \right);$$

$$L := unitXcomponent \cdot TotalArmLength;$$

$$n := n1; \quad \# \text{ Coaxial cable}$$

$$dtTotalArmLengthAout := solve(Eqdtn, dtDiagonal);$$

$$n := n2; \quad \# \text{ Optic fiber}$$

$$dtTotalArmLengthAin := solve(Eqdtn, dtDiagonal);$$

$$dtPerpendicularComponentArmA := dtTotalArmLengthAout + dtTotalArmLengthAin;$$

$$n := n2; \quad \# \text{ Optic fiber}$$

$$dtTotalArmLengthBout := solve(Eqdtn, dtDiagonal);$$

$$n := n1; \quad \# \text{ Coaxial cable}$$

$$dtTotalArmLengthBin := solve(Eqdtn, dtDiagonal);$$

$$dtPerpendicularComponentArmB := dtTotalArmLengthBout + dtTotalArmLengthBin;$$

$$L := 'L';$$

$$n := 'n';$$

$$FractionOfTimeLightIsHeldByMoleculesUp := \frac{(n - 1)}{n};$$

$$TimeLightIsHeldByMoleculesInMovingFrameUp := FractionOfTimeLightIsHeldByMoleculesUp \cdot \frac{L \cdot n}{c};$$

$$TimeLightIsHeldByMoleculesInAetherFrameUp := \gamma \cdot TimeLightIsHeldByMoleculesInMovingFrameUp;$$

$$opticalPathLengthUp := \frac{L}{\gamma} + v \cdot dtup - v \cdot TimeLightIsHeldByMoleculesInAetherFrameUp;$$

$$dtupEqn := dtup = \frac{opticalPathLengthUp}{c} + TimeLightIsHeldByMoleculesInAetherFrameUp;$$

$$dtup := solve(dtupEqn, dtup);$$

$$\text{FractionOfTimeLightIsHeldByMoleculesDown} := \frac{(n-1)}{n};$$

$$\begin{aligned} \text{TimeLightIsHeldByMoleculesInMovingFrameDown} \\ := \text{FractionOfTimeLightIsHeldByMoleculesDown} \cdot \frac{L \cdot n}{c}; \end{aligned}$$

$$\begin{aligned} \text{TimeLightIsHeldByMoleculesInAetherFrameDown} := \gamma \\ \cdot \text{TimeLightIsHeldByMoleculesInMovingFrameDown}; \end{aligned}$$

$$\begin{aligned} \text{opticalPathLengthDown} := \frac{L}{\gamma} - v \cdot \text{dtdown} + v \\ \cdot \text{TimeLightIsHeldByMoleculesInAetherFrameDown}; \end{aligned}$$

$$\begin{aligned} \text{dtdownEqn} := \text{dtdown} = \frac{\text{opticalPathLengthDown}}{c} \\ + \text{TimeLightIsHeldByMoleculesInAetherFrameDown}; \end{aligned}$$

$$\text{dtdown} := \text{solve}(\text{dtdownEqn}, \text{dtdown});$$

$$L := \text{unitYcomponent} \cdot \text{TotalArmLength};$$

$$n := n1; \quad \# \text{ Coaxial cable}$$

$$\text{dtArmAout} := \text{dtup};$$

$$n := n2; \quad \# \text{ Optic fiber}$$

$$\text{dtArmAin} := \text{dtdown};$$

$$\text{dtParallelComponentArmA} := \text{dtArmAout} + \text{dtArmAin};$$

$$\text{dtArmA} := \frac{1}{\gamma} \cdot (\text{dtPerpendicularComponentArmA} + \text{dtParallelComponentArmA});$$

$$L := \text{unitYcomponent} \cdot \text{TotalArmLength};$$

$$n := n2; \quad \# \text{ Optic fiber}$$

$$\text{dtArmBout} := \text{dtup};$$

$$n := n1; \quad \# \text{ Coaxial cable}$$

$$\text{dtArmBin} := \text{dtdown};$$

$$\text{dtParallelComponentArmB} := \text{dtArmBout} + \text{dtArmBin};$$

$$dtArmB := \frac{1}{\gamma} \cdot (dtPerpendicularComponentArmB + dtParallelComponentArmB);$$

$L := 'L';$
 $Lcontracted := 'Lcontracted';$
 $v := 'v';$
 $n := 'n';$

$$TimeDifference := \frac{Shift \cdot \lambda}{c};$$

$$dtdiff := dtArmA - dtArmB;$$

$$dtsum := dtArmA + dtArmB;$$

$$dtEq := TimeDifference = dtsum;$$

$$FringeShift := evalf(solve(dtEq, Shift));$$

$$plot1a := plot(dtArmA \cdot 1E12, \theta = 0 .. 2 \pi);$$

$$plot1b := plot(dtArmB \cdot 1E12, \theta = 0 .. 2 \pi);$$

$$plot3a := plot(dtdiff \cdot 1E12, \theta = 0 .. 2 \pi);$$

$$plot3b := plot(dtsum \cdot 1E12, \theta = 0 .. 2 \pi);$$

$$plot4 := plot(FringeShift, \theta = 0 .. 2 \pi);$$

$$plot5 := plot(FringeShift \cdot \lambda, \theta = 0 .. 2 \pi);$$

$$display([plot1a]);$$

$$display([plot1b]);$$

$$display([plot3a]);$$

$$display([plot3b]);$$

$$display([plot4]);$$

$$display([plot5]);$$

$$\theta := \frac{\pi}{2};$$

$$evalf(dtArmA \cdot 1E12);$$

$$evalf(dtArmB \cdot 1E12);$$

$$evalf(dtdiff \cdot 1E12);$$

$$dtsum1 := dtsum;$$

$$\theta := 0;$$

$$dtsum2 := dtsum;$$

$$\text{MaximumTimeDifferenceInPicosecondsOnRotation} := \text{evalf}((\text{dtsum1} - \text{dtsum2}) \cdot 1\text{E12});$$

[*animate, animate3d, animatecurve, arrow, changecoords, complexplot, complexplot3d, conformal, conformal3d, contourplot, contourplot3d, coordplot, coordplot3d, densityplot, display, dualaxisplot, fieldplot, fieldplot3d, gradplot, gradplot3d, implicitplot, implicitplot3d, inequal, interactive, interactiveparams, intersectplot, listcontplot, listcontplot3d, listdensityplot, listplot, listplot3d, loglogplot, logplot, matrixplot, multiple, odeplot, pareto, plotcompare, pointplot, pointplot3d, polarplot, polygonplot, polygonplot3d, polyhedra_supported, polyhedraplot, rootlocus, semilogplot, setcolors, setoptions, setoptions3d, spacecurve, sparsematrixplot, surfdata, textplot, textplot3d, tubeplot*]

Digits := 50

$$c := 299792458$$
$$\lambda := 29.979245800$$
$$NumberOfLoops := 1$$

SingleLoopLength := 5

$$TotalArmLength := 5$$
$$Altitude := 0$$
$$Azimuth := 180$$
$$vWind := -486000$$
$$v := -4.86000 \cdot 10^5$$
$$n1 := 1.19$$
$$n2 := 1.44975$$
$$unitXcomponent := |\cos(\theta)|^2$$
$$unitYcomponent := |\sin(\theta)|^2$$
$$\gamma := 1.0000013140200531667147878326958937956802502954117$$
$$Ll := 1.0000013140200531667147878326958937956802502954117 L$$
$$Eqdtn := dtDiagonal = \frac{1}{299792458} L n$$
$$+ 4.3830991010678286904492303598767659802015823226614 \times 10^{-15} L$$
$$L := 5 \left| \cos(\theta) \right|^2$$
$$n := 1.19$$
$$dtTotalArmLengthAout :=$$
$$1.9847085579785552288890266757409450835488501438747 \cdot 10^{-8} |\cos(\theta)|^2$$
$$n := 1.44975$$
$$dtTotalArmLengthAin :=$$
$$2.4179249266171552032753069336652455007394653927747 \cdot 10^{-8} |\cos(\theta)|^2$$
$$dtPerpendicularComponentArmA :=$$

$$4.4026334845957104321643336094061905842883155366494 \cdot 10^{-8} |\cos(\theta)|^2$$

$$n := 1.44975$$

$$dtTotalArmLengthBout :=$$

$$2.4179249266171552032753069336652455007394653927747 \cdot 10^{-8} |\cos(\theta)|^2$$

$$n := 1.19$$

$$dtTotalArmLengthBin :=$$

$$1.9847085579785552288890266757409450835488501438747 \cdot 10^{-8} |\cos(\theta)|^2$$

$$dtPerpendicularComponentArmB :=$$

$$4.4026334845957104321643336094061905842883155366494 \cdot 10^{-8} |\cos(\theta)|^2$$

$$L := L$$

$$n := n$$

$$FractionOfTimeLightIsHeldByMoleculesUp := \frac{n-1}{n}$$

$$TimeLightIsHeldByMoleculesInMovingFrameUp := \frac{1}{299792458} (n-1) L$$

$$TimeLightIsHeldByMoleculesInAetherFrameUp :=$$

$$3.3356453350806215635844575939795449946917954000421 \cdot 10^{-9} (n-1) L$$

$$opticalPathLengthUp := 0.99999868598167347971648838783612394919328641647623 L$$

$$- 4.86000 \cdot 10^5 dtup$$

$$+ 0.0016211236328491820799020463906740588674202125644205 (n-1) L$$

$$dtupEqn := dtup = 3.3356365688881789004728344027791517997203465888266 \cdot 10^{-9} L$$

$$- 0.0016211215026630189609373028323481039673119461864514 dtup$$

$$+ 3.3410528214585783502088297334236735686915462962585 \cdot 10^{-9} (n-1) L$$

$$dtup := -5.4074863779567866243721394441285739997508962161054 \cdot 10^{-12} L$$

$$+ 3.3356453350806215635844575939795449946917954000421 \cdot 10^{-9} L n$$

$$FractionOfTimeLightIsHeldByMoleculesDown := \frac{n-1}{n}$$

$$TimeLightIsHeldByMoleculesInMovingFrameDown := \frac{1}{299792458} (n-1) L$$

$$TimeLightIsHeldByMoleculesInAetherFrameDown :=$$

$$3.3356453350806215635844575939795449946917954000421 \cdot 10^{-9} (n-1) L$$

$$opticalPathLengthDown := 0.99999868598167347971648838783612394919328641647623 L$$

$$+ 4.86000 \cdot 10^5 dtdown$$

$$- 0.0016211236328491820799020463906740588674202125644205 (n-1) L$$

$$dtdownEqn := dtdown = 3.3356365688881789004728344027791517997203465888266 \cdot 10^{-9} L$$

$$+ 0.0016211215026630189609373028323481039673119461864514 dtdown$$

$$+ 3.3302378487026647769600854545354164206920445038257 \cdot 10^{-9} (n-1) L$$

$$dtdown := 5.4074863779567866243721394441285739997508962166955 \cdot 10^{-12} L$$

$$+ 3.3356453350806215635844575939795449946917954000421 \cdot 10^{-9} L n$$

$$n := 1.19$$

$$dtArmAout := 1.9820052311839914370205661986957649848417428149169 \cdot 10^{-8} |\sin(\theta)|^2$$

$$n := 1.44975$$

$$dtArmAin := 2.4206296554555439492154697681579869650270906387138 \cdot 10^{-8} |\sin(\theta)|^2$$

$$dtParallelComponentArmA :=$$

$$4.4026348866395353862360359668537519498688334536307 \cdot 10^{-8} |\sin(\theta)|^2$$

$$dtArmA := 4.4026276994546267215445150493381662998613610635607 \cdot 10^{-8} |\cos(\theta)|^2$$

$$+ 4.4026291014966093643356431601758307075223353350672 \cdot 10^{-8} |\sin(\theta)|^2$$

$$L := 5 \left| \sin(\theta) \right|^2$$

$$n := 1.44975$$

$$dtArmBout := 2.4152221690775871625910976287138583910273397424974 \cdot 10^{-8} |\sin(\theta)|^2$$

$$n := 1.19$$

$$dtArmBin := 1.9874127175619482236449383381398935588414937111333 \cdot 10^{-8} |\sin(\theta)|^2$$

$$dtParallelComponentArmB :=$$

$$4.4026348866395353862360359668537519498688334536307 \cdot 10^{-8} |\sin(\theta)|^2$$

$$dtArmB := 4.4026276994546267215445150493381662998613610635607 \cdot 10^{-8} |\cos(\theta)|^2$$

$$+ 4.4026291014966093643356431601758307075223353350672 \cdot 10^{-8} |\sin(\theta)|^2$$

$$L := L$$

$$L_{contracted} := L_{contracted}$$

$$v := v$$

$$n := n$$

[illegible]

$$dtdiff := 0.$$

$$dtsum := 8.8052553989092534430890300986763325997227221271214 \cdot 10^{-8} |\cos(\theta)|^2$$

$$+ 8.8052582029932187286712863203516614150446706701344 \cdot 10^{-8} |\sin(\theta)|^2$$

[illegible]

$$= 8.8052553989092534430890300986763325997227221271214 \cdot 10^{-8} |\cos(\theta)|^2$$

$$+ 8.8052582029932187286712863203516614150446706701344 \cdot 10^{-8} |\sin(\theta)|^2$$

$$FringeShift := 0.88052553989092534430890300986763325997227221271214 |\cos(\theta)|^2$$

$$+ 0.88052582029932187286712863203516614150446706701344 |\sin(\theta)|^2$$

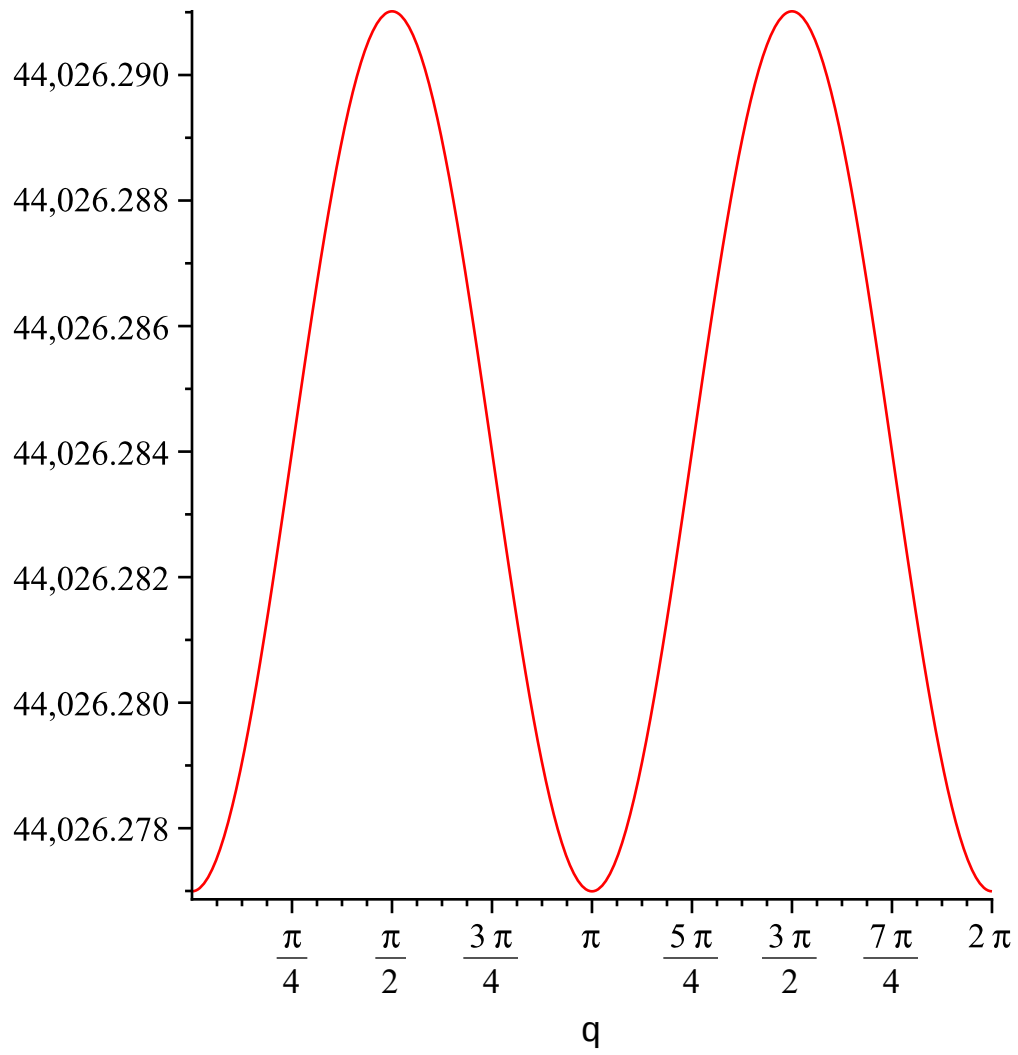
$$plot1a := PLOT(\dots)$$

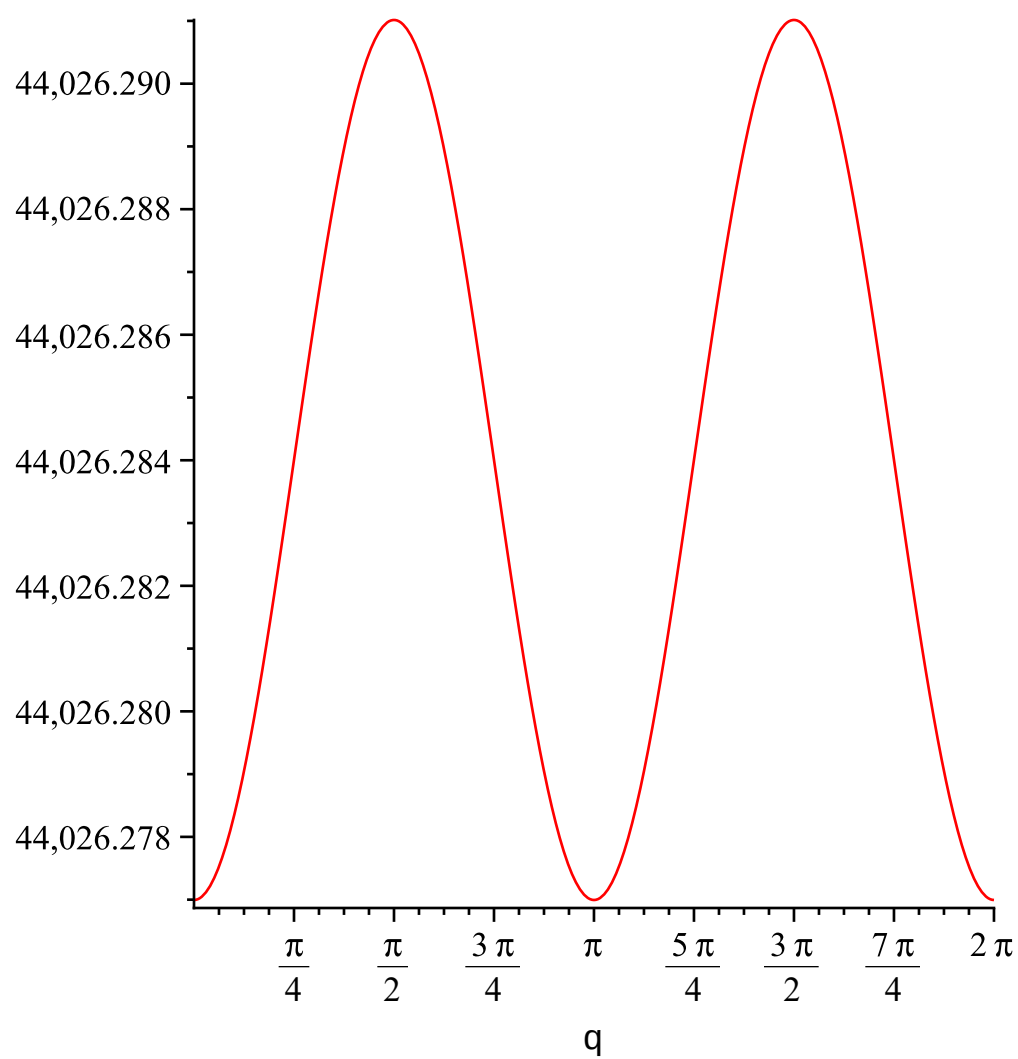
$$plot1b := PLOT(\dots)$$

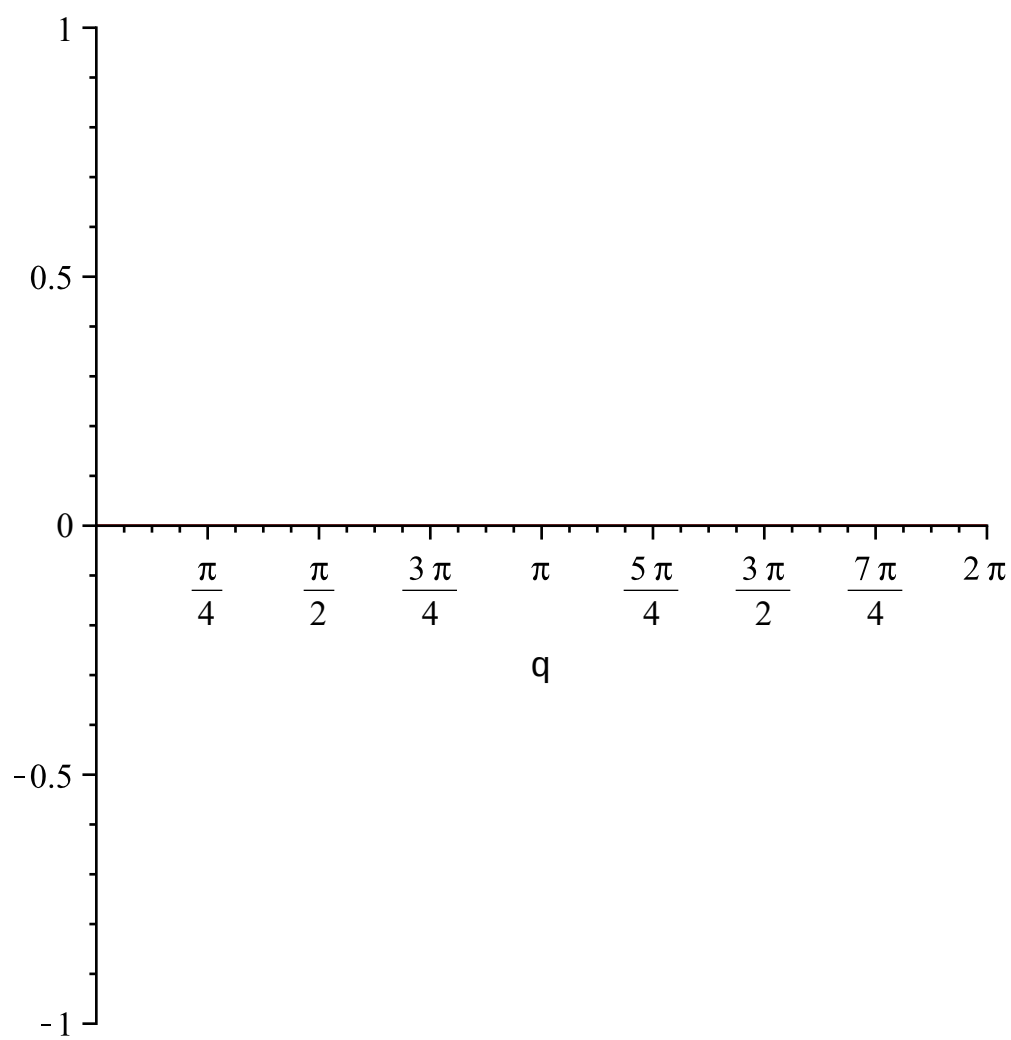
```
plot3a := PLOT(...)
```

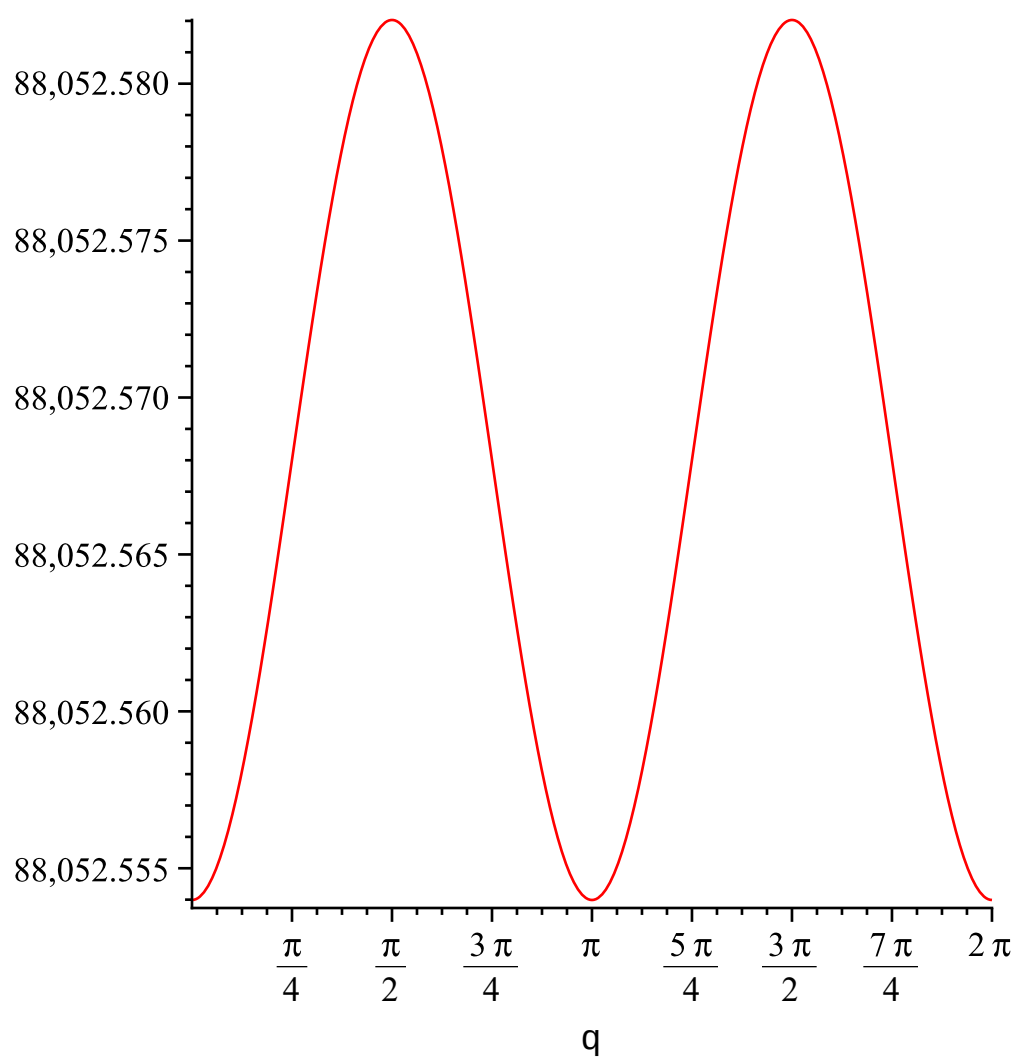
```
plot3b := PLOT(...)
```

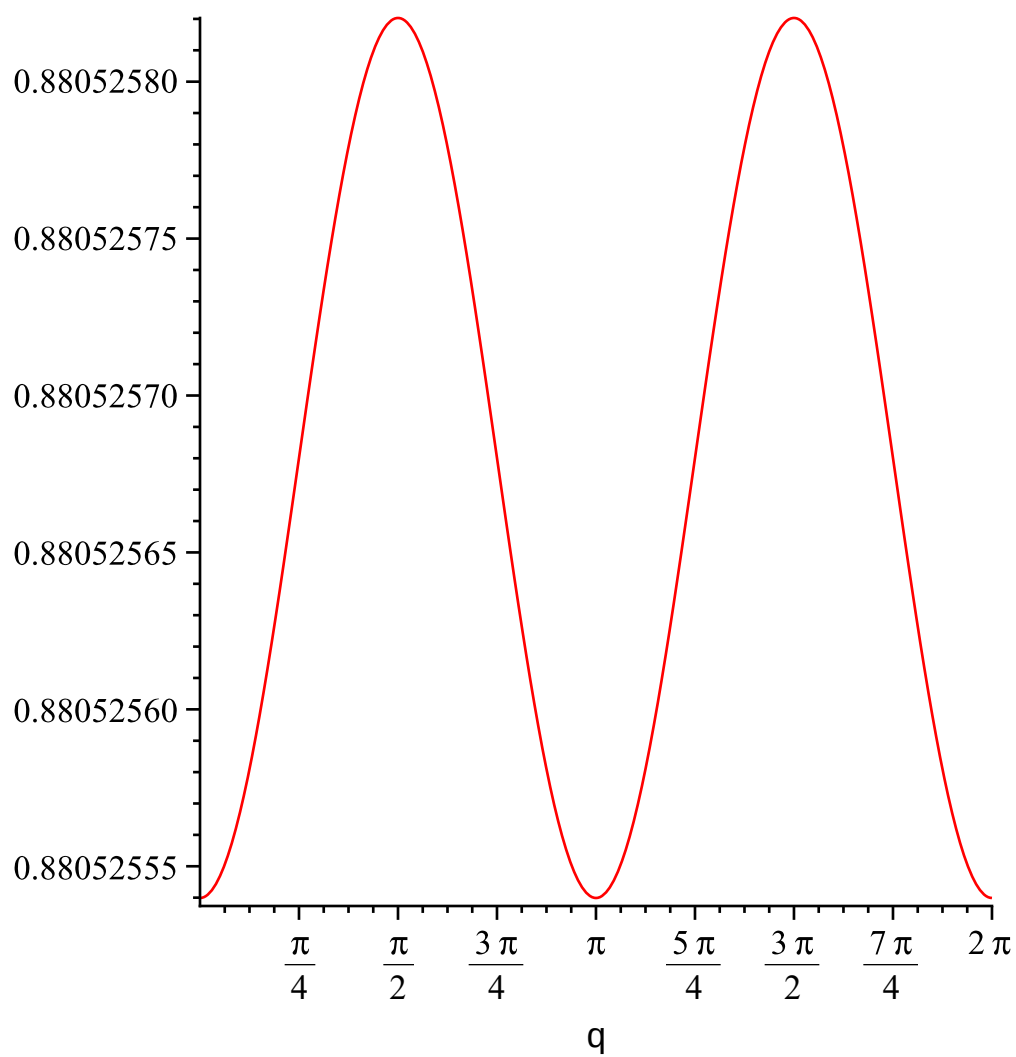
plot4 := PLOT(...)
plot5 := PLOT(...)

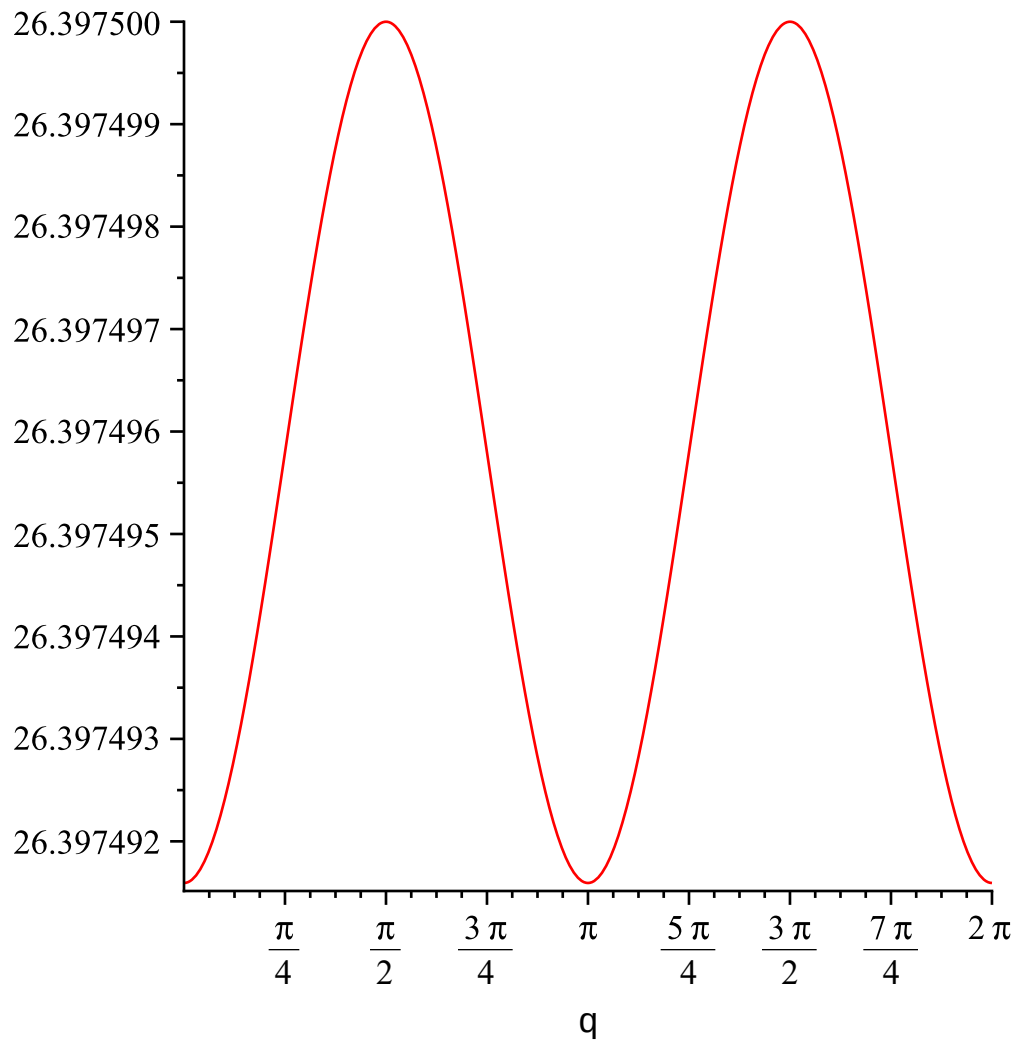












$$\theta := \frac{1}{2} \pi$$

44026.291014966093643356431601758307075223353350672

44026.291014966093643356431601758307075223353350672

0.

$dtsum1 := 8.8052582029932187286712863203516614150446706701344 \cdot 10^{-8}$

$\theta := 0$

$dtsum2 := 8.8052553989092534430890300986763325997227221271214 \cdot 10^{-8}$

MaximumTimeDifferenceInPicosecondsOnRotation :=

0.028040839652855822562216753288153219485430130

(1)