

SHM Pendulum with added mass about 3/4 way towards the end.

In[173]:=

(* Data table: A, T, δT *)

```
data = Sort[

|          |           |          |
|----------|-----------|----------|
| 2.61547  | 1.71472   | 0.00377  |
| 2.29086  | 1.48336   | 0.0015   |
| 2.33661  | 1.50592   | 0.00174  |
| 2.76102  | 1.86304   | 0.00552  |
| 1.509608 | 1.1792593 | 0.000367 |
| 0.910681 | 1.083249  | 0.00015  |
| 2.671101 | 1.782503  | 0.0052   |
| 1.474483 | 1.184373  | 0.000322 |
| 1.060796 | 1.104144  | 0.000169 |
| 0.846448 | 1.075407  | 0.00014  |
| 0.61615  | 1.05245   | 0.00012  |
| 0.53114  | 1.04581   | 0.00013  |
| 0.46480  | 1.04162   | 0.00013  |
| 0.41218  | 1.03827   | 0.00014  |
| 0.35733  | 1.03550   | 0.00017  |
| 0.29789  | 1.03290   | 0.00018  |
| 0.25626  | 1.03138   | 0.00023  |
| 0.21397  | 1.03004   | 0.00025  |
| 0.18082  | 1.02933   | 0.00031  |
| 0.13770  | 1.02782   | 0.00039  |
| 2.02537  | 1.35560   | 0.00089  |

];
```

```
In[193]:=
pdata = Map[{#[[1]], Around[#[[2]], #[[3]]]} &, data] (* Data for plot *);
TableForm[pdata, TableHeadings → {None, {"Amplitude (rad)", "Period (s)"}}]
```

```
Out[194]//TableForm=
```

Amplitude (rad)	Period (s)
0.1377	1.0278 ± 0.0004
0.18082	1.02933 ± 0.00031
0.21397	1.03004 ± 0.00025
0.25626	1.03138 ± 0.00023
0.29789	1.03290 ± 0.00018
0.35733	1.03550 ± 0.00017
0.41218	1.03827 ± 0.00014
0.4648	1.04162 ± 0.00013
0.53114	1.04581 ± 0.00013
0.61615	1.05245 ± 0.00012
0.846448	1.07541 ± 0.00014
0.910681	1.08325 ± 0.00015
1.0608	1.10414 ± 0.00017
1.47448	1.18437 ± 0.00032
1.50961	1.1793 ± 0.0004
2.02537	1.3556 ± 0.0009
2.29086	1.4834 ± 0.0015
2.33661	1.5059 ± 0.0017
2.61547	1.715 ± 0.004
2.6711	1.783 ± 0.005
2.76102	1.863 ± 0.006

```
In[195]:=
ndata = Map[{#[[1]], #[[2]]} &, data] (* (Numerical A, T) Data for fit *);
```

```
In[196]:=
weights = Map[1 / #[[3]]^2 &, data];
```

Models

```
In[197]:=
firstorder[T0_, θ_] := T0 *  $\left(1 + \frac{1}{16} \theta^2\right)$ 
```

```
In[198]:=
exact[T0_, θ_] :=  $\left(\frac{2}{\pi} T0\right) \text{EllipticK}[\text{Sin}[\theta/2]^2]$ 
```

```
In[199]:=
firstorderfit =
  NonlinearModelFit[ndata, firstorder[T0, θ], {T0}, θ, Weights → weights];
```

```
In[200]:=
exactfit = NonlinearModelFit[ndata, exact[T0, θ], {T0}, θ, Weights → weights];
```

In[201]:=

```
Show[{ListPlot[pdata, PlotStyle → Red, PlotLegends → {"Data"},
  AxesLabel → {"Amplitude (radians)", "Period (s)"},
  LabelStyle → Larger, ImageSize → Scaled[0.75], PlotRange → All],
Plot[{Mean[ndata[[Range[5], 2]], firstorderfit[θ], exactfit[θ]],
  {θ, 0, Max[pdata[[All, 1]]}],
  PlotLegends → {"Constant", "Parabolic Correction", "Elliptic Integral"}]],
PlotRange → All
]
```

Out[201]=

