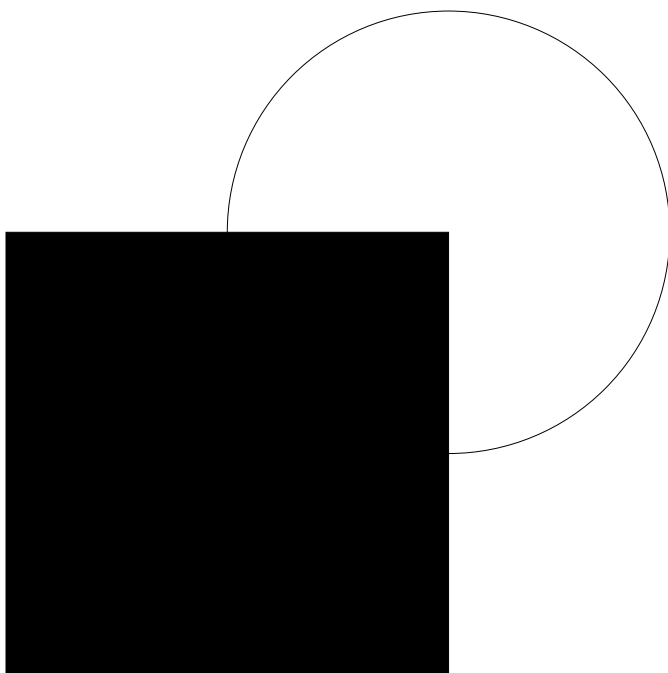


Графика

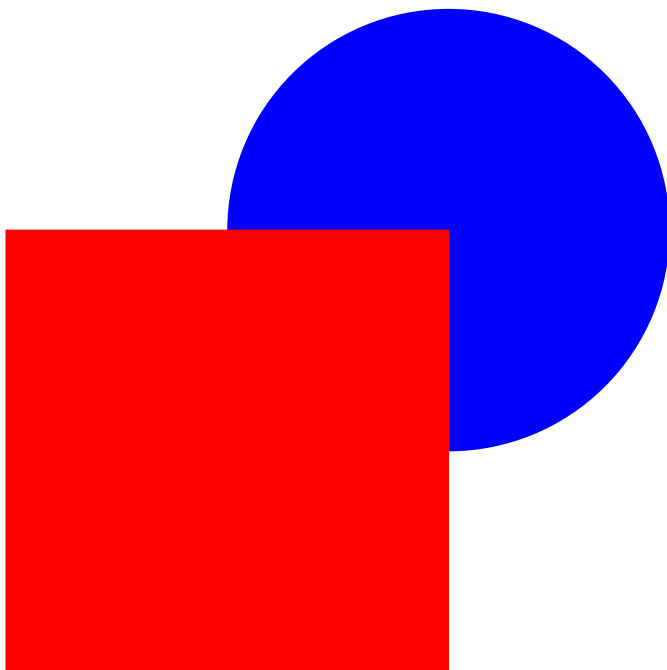
```
In[1]:= Graphics[{  
    Circle[{1, 1}, 1],  
    Rectangle[{-1, -1}, {1, 1}],  
}]
```

Out[1]=

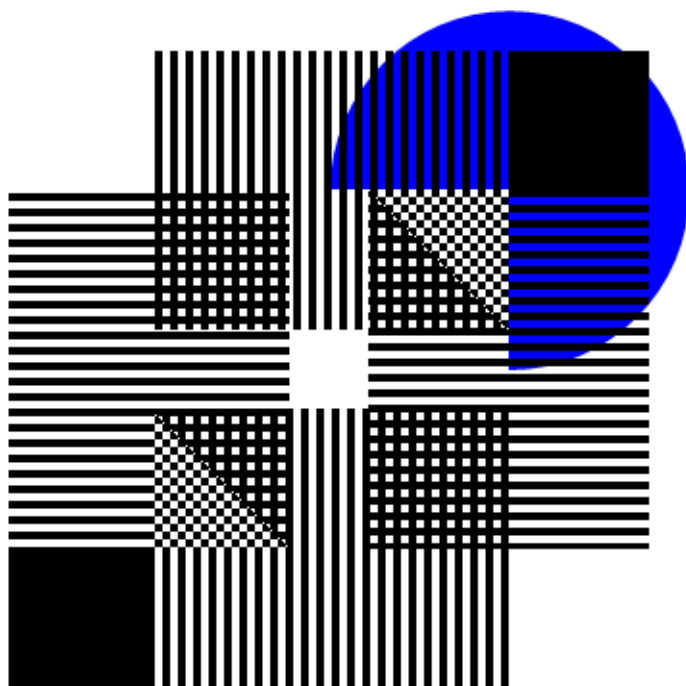


```
In[2]:= Graphics[{
  Blue, Disk[{1, 1}, 1],
  Red,
  Rectangle[{-1, -1}, {1, 1}],
}]
```

Out[2]=

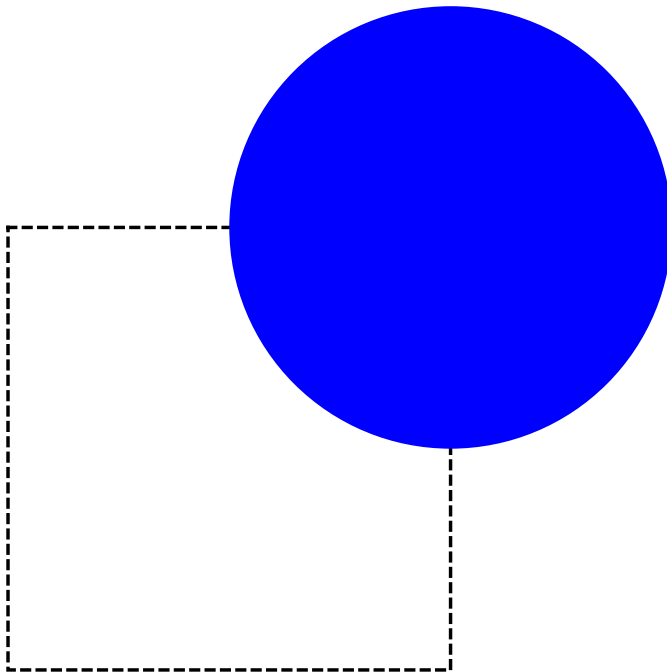


```
In[3]:= Graphics[{
  Blue, Disk[{1, 1}, 1],
  White, EdgeForm[Directive[Thickness[.5], Dashed]],
  Rectangle[{-1, -1}, {1, 1}],
}]
```



```
In[4]:= Graphics[{  
  White, EdgeForm[Directive[Thickness[.005], Dashed]],  
  Rectangle[{-1, -1}, {1, 1}],  
  EdgeForm[None],  
  Blue, Disk[{1, 1}, 1]  
}]
```

Out[4]=

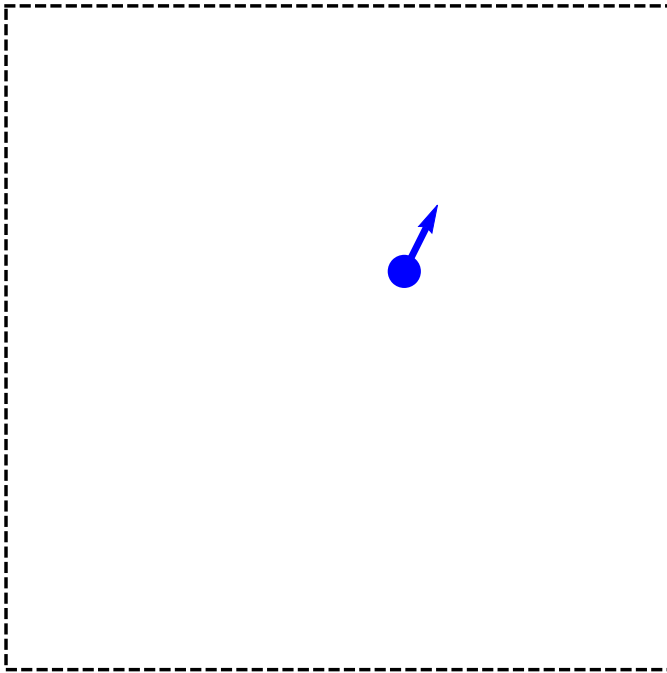


```

In[5]:= Graphics[{
  White, EdgeForm[Directive[Thickness[.005], Dashed]],
  Rectangle[{-1, -1}, {1, 1}],
  EdgeForm[None],
  Blue, {{Disk[.2 {1, 1}, .05]}},
  Thickness[.01],
  Arrow[ {.2 {1, 1}, {.3, .4}}]
}]


```

Out[5]=



Цвета

In[6]:= **Blue**

Out[6]= 


In[7]:=  // FullForm

Out[7]//FullForm= RGBColor[0, 0, 1]

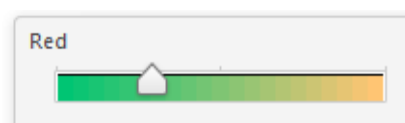
In[8]:= **RGBColor[.9, .2, .3]**

Out[8]= 


In[9]:= 

Out[9]= 


In[10] :=




In[10]:= **RGBColor**[.9, .2, .3, .4]

Out[10]= 

In[11]:= **ColorData**[3]

Out[11]= **ColorDataFunction** [ Index: 3 Colors: 10
Palette: ]

In[12]:= **ColorData**[3][4]

Out[12]= 


In[13]:= **ColorData**[3] /@ **Range**[10]

Out[13]= { , , , , , , , , ,  }

In[14]:= **ColorData** /@ **Range**[8]


Out[14]= { **ColorDataFunction** [ Index: 1 Colors: ∞
Palette: ],

ColorDataFunction [ Index: 2 Colors: 9
Palette: ],

ColorDataFunction [ Index: 3 Colors: 10
Palette: ],

ColorDataFunction [ Index: 4 Colors: 10
Palette: ],

ColorDataFunction [ Index: 5 Colors: 10
Palette: ],









ColorDataFunction [ Index: 6 Colors: 11
Palette: ],

ColorDataFunction [ Index: 7 Colors: 11
Palette: ],

ColorDataFunction [ Index: 8 Colors: 9
Palette: ] }


Задача

```
In[15]:= (Flatten[{RandomReal[{-1, 1}, 4], ColorData[3][#]}] & /@ Range[8])
```

```
Out[15]= {{-0.755888, 0.969415, 0.232613, -0.810135, },
{0.0697005, -0.915704, -0.0197519, -0.648394, },
{0.630061, -0.219442, 0.152534, -0.502579, },
{-0.687268, -0.876847, 0.696427, 0.114215, },
{-0.169385, -0.566104, 0.707201, 0.644766, },
{-0.136515, -0.727695, -0.587773, -0.785913, },
{-0.83959, -0.448895, 0.81154, 0.853577, },
{-0.84303, 0.646506, 0.00100485, -0.358778, }}
```

```
In[16]:= G[x_, y_, vx_, vy_, col_] :=
Module[{x1, y1},
  {x1, y1} = {x, y} + .2 {vx, vy};
  {col, EdgeForm[None], Disk[{x, y}, .035],
    Thickness[0.01], Arrow[{x, y}, {x1, y1}]}
];
```

```
In[17]:= G@@Flatten[{RandomReal[{-1, 1}, 4], ColorData[3][4]}]
```

```
Out[17]= {, EdgeForm[None], Disk[{0.435571, -0.779554}, 0.035],
  Thickness[0.01], Arrow[{0.435571, -0.779554}, {0.440272, -0.974175}]}]}
```

```
@@@ ≈ /@ + @@ (Map[] + Apply[])
```

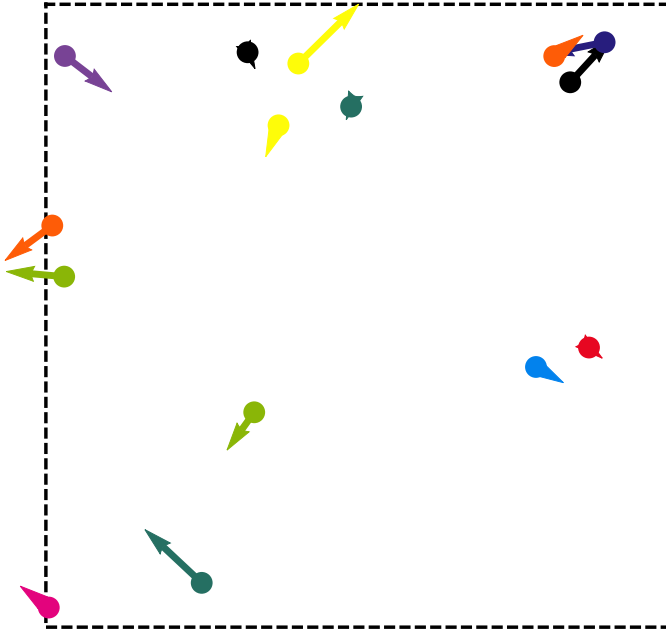
```

In[18]:= Graphics[{
  White, EdgeForm[Directive[Thickness[0.005], Dashed]],
  Rectangle[{-1, -1}, {1, 1}],
  EdgeForm[None], Thickness[.01],

  G@@@ (Flatten[{RandomReal[{-1, 1}, 4], ColorData[3][#]] & /@ Range[15])
}]

```

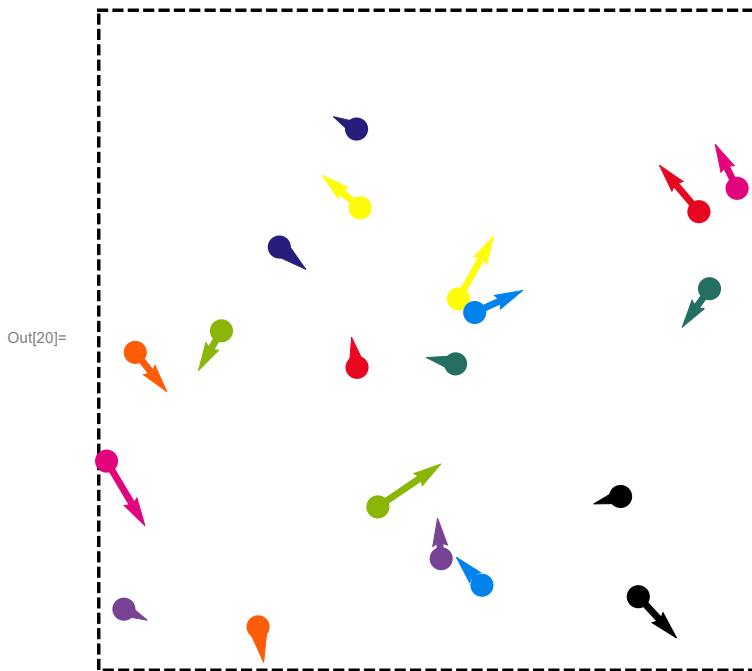
Out[18]=



```

In[19]:= SeedRandom[1];
Graphics[{
  White, EdgeForm[Directive[Thickness[.005], Dashed]],
  Rectangle[{-1, -1}, {1, 1}],
  EdgeForm[None],
  Thickness[.01],
  {#5, Disk[{#1, #2}, .035], Arrow[{#1, #2}, {#1, #2} + .2 {#3, #4}]} &@@
  Flatten[{RandomReal[{-1, 1}, 4], ColorData[3][#]}] & /@ Range[20]
}]

```



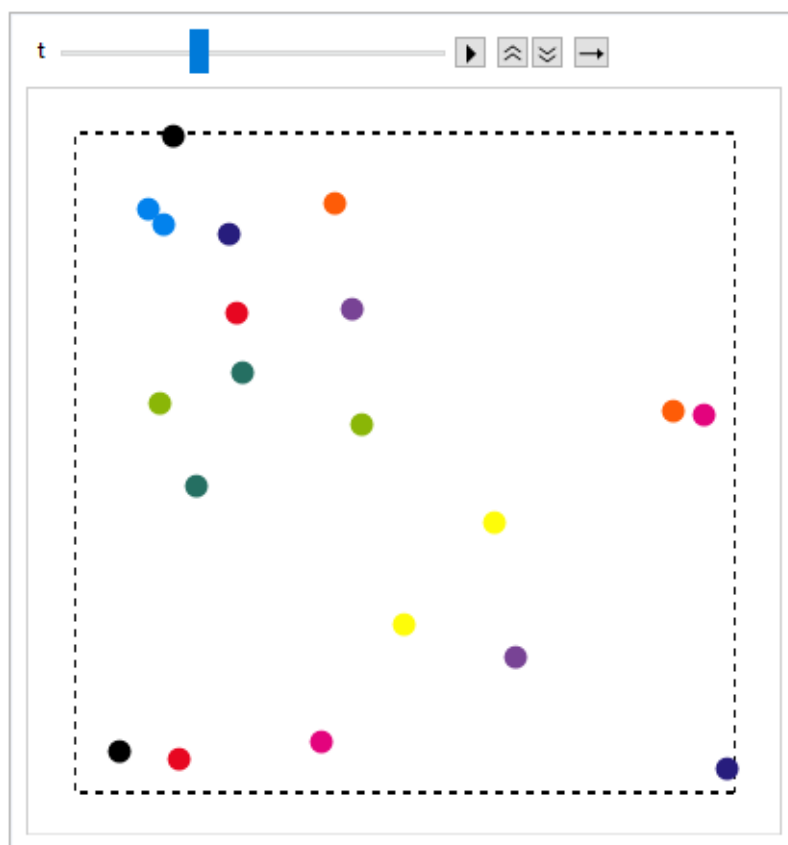
```

In[21]:= SeedRandom[1];
ic = Flatten[{(RandomReal[{-1, 1}, 4]), ColorData[3][#]}] & /@ Range[20];

pic0[t_] := Graphics[{
  White, EdgeForm[Directive[Thickness[.005], Dashed]],
  Rectangle[{-1, -1}, {1, 1}],
  EdgeForm[None],
  Thickness[.01],
  {#5, Disk[{TriangleWave[(#1 + #3 t)/4], TriangleWave[(#2 + #4 t)/4]}, .035]} &@@@
  ic
}, PlotRange -> 1.05 {{-1, 1}, {-1, 1}}]

Animate[pic0[t], {t, 0, 10}]

```

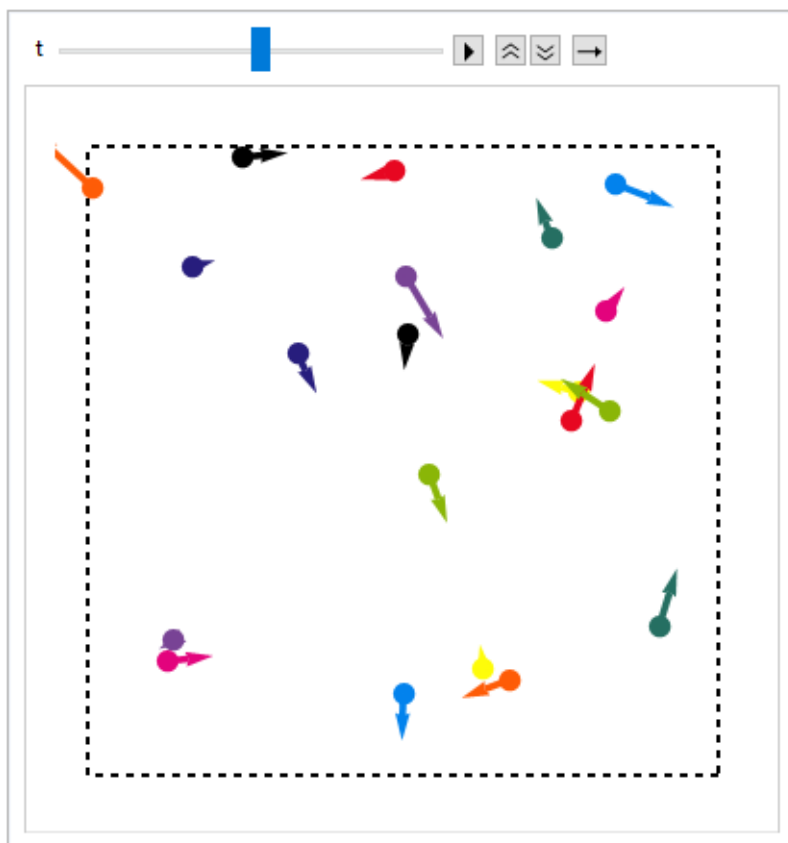



```

In[25]:= Clear[t];
pic1[t_] = Graphics[{
  White, EdgeForm[Directive[Thickness[.005], Dashed]],
  Rectangle[{-1, -1}, {1, 1}],
  EdgeForm[None],
  Thickness[.01],
  Function[{x, y, vx, vy, col},
    {col, Disk[{x, y}, .035], Arrow[{x, y}, {x, y} + .2 {vx, vy}]}] @@@
    ({TriangleWave[(#1 + t #3) / 4], TriangleWave[(#2 + t #4) / 4],
     D[TriangleWave[(#1 + t1 #3) / 4], t1] /. t1 -> t,
     D[TriangleWave[(#2 + t1 #4) / 4], t1] /. t1 -> t, #5} & @@@
     (Flatten[{RandomReal[{-1, 1}, 4], ColorData[3][#]}] & /@ Range[20]))
}, PlotRange -> 1.1 {{-1, 1}, {-1, 1}}];

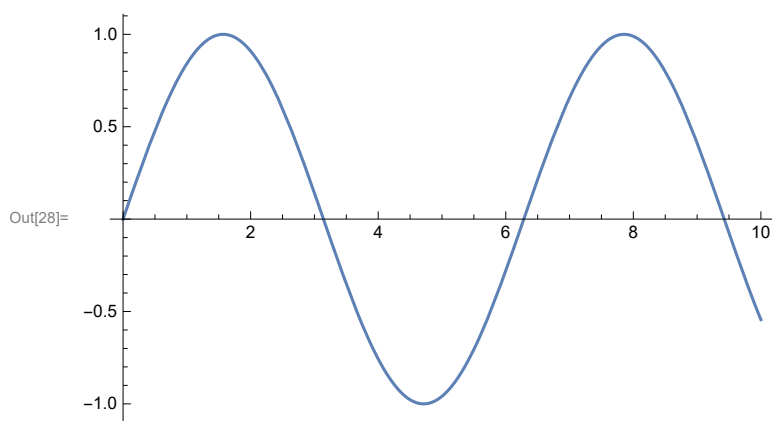
Animate[pic1[t], {t, 0, 10}]

```



Графики

In[28]:= `Plot[Sin[x], {x, 0, 10}]`



In[72]:= `Plot[Sin[x], {x, 0, 10}] // FullForm`

Out[72]//FullForm=

```
Graphics[
  List[List[List[List[], List[], Annotation[List[Directive[Opacity[1.], RGBColor[
    0.368417, 0.506779, 0.709798], AbsoluteThickness[1.6]]],
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    List[0.01226810457748711, 0.012267796841781068], List[0.02453600507334157,
```

```

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```

```

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List[Identity, Identity]]],
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List[Identity, Identity]]]],
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Identity],
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PlotRangePadding,
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Scaled[0.05`],
Scaled[0.05`]]]],
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Rule[
ImagePadding,
All],
Rule[
DisplayFunction,
Identity],
Rule[
AspectRatio,
Power[
GoldenRatio,
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Axes,
List[
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True]], Rule[
AxesLabel,

```

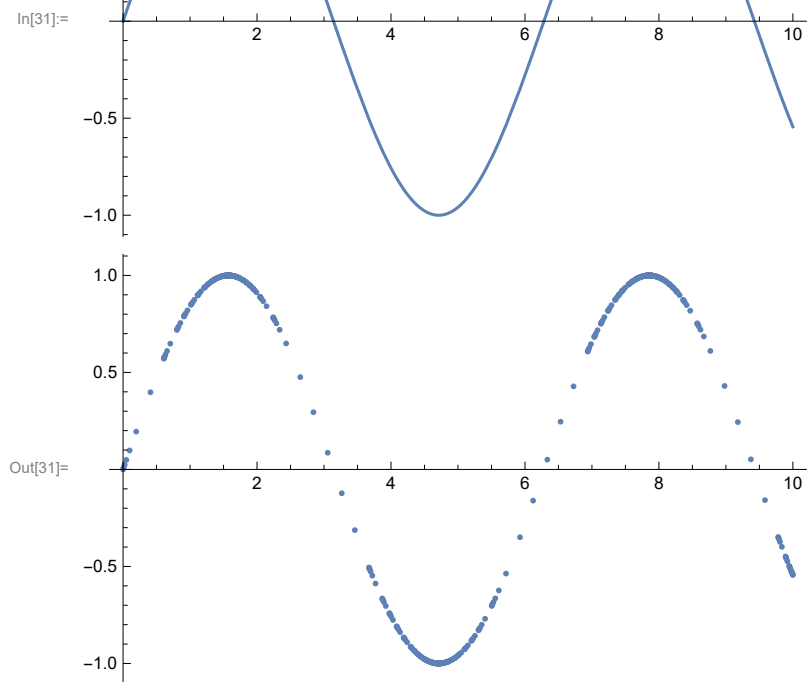
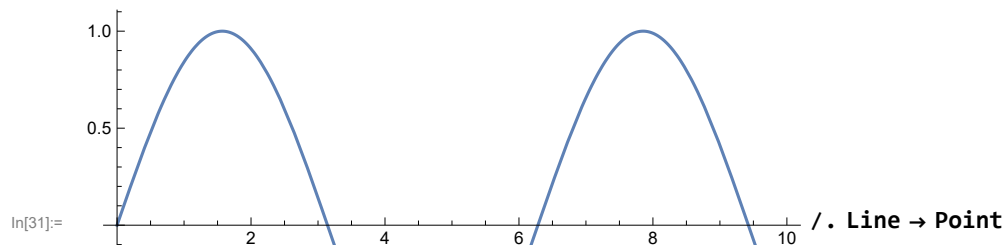
```

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  None]], Rule[
AxesOrigin,
List[
  0,
  0]],
RuleDelayed[DisplayFunction,
Identity],
Rule[
Frame,
List[
  List[
    List[
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      False], List[
        False,
        False]]],
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  None]]],
Rule[FrameTicks, List[List[Automatic, Automatic],
  List[
    Automatic,
    Automatic]]],
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  None]], Rule[
GridLinesStyle,
Directive[
  GrayLevel[
    0.5`,
    0.4`]]],
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  AbsolutePointSize[6]],
Rule["ScalingFunctions", None],
Rule[
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  List[Rule["DisplayFunction",
    Function[List[Function[Identity[Slot[1]]][Part[Slot[1], 1]],
    Function[Identity[Slot[1]]][Part[Slot[1], 2]]]]],
    Rule["CopiedValueFunction", Function[List[Function[Identity[Slot[1]]][
    Part[Slot[1], 1]], Function[Identity[Slot[1]]][Part[Slot[1], 2]]]]]]],
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  List[
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      Scaled[0.02`]],
    List[Scaled[0.02`], Scaled[0.02`]]]], Rule[
  Ticks,

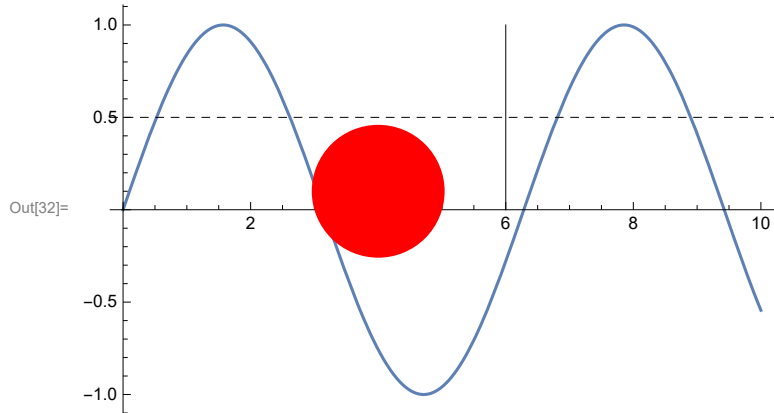
```

```
List[
  Automatic,
  Automatic]]]]
```

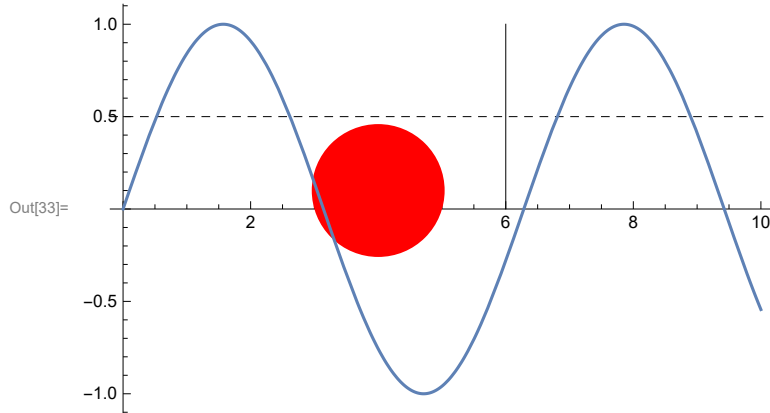
In[30]:=



In[32]:= **Plot**[Sin[x], {x, 0, 10}, Epilog → {Red, PointSize[.2], Point[{4, .1}],
 Black, Line[{6, 0}, {6, 1}],
 Dashed, InfiniteLine[{0, .5}, {1, 0}]
 }]



```
In[33]:= Plot[Sin[x], {x, 0, 10}, Prolog -> {Red, PointSize[.2], Point[{4, .1}],
      Black, Line[{6, 0}, {6, 1}]},
      Dashed, InfiniteLine[{0, .5}, {1, 0}]
    }, Method -> {"AxesInFront" -> False}]
```

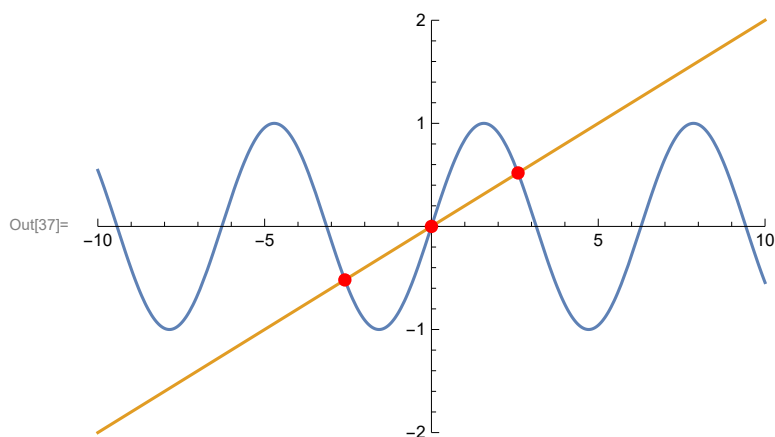


```
In[34]:= f1[x_] := Sin[x]; f2[x_] := x / 5;
```

```
sol = NSolve[f1[x] == f2[x], x, Reals];
```

```
list = {x, f1[x]} /. sol;
```

```
Plot[{f1[x], f2[x]}, {x, -10, 10}, PlotRange -> {{-10, 10}, {-2, 2}},
  Epilog -> {Red, PointSize[.02], Point /@ list}]
```

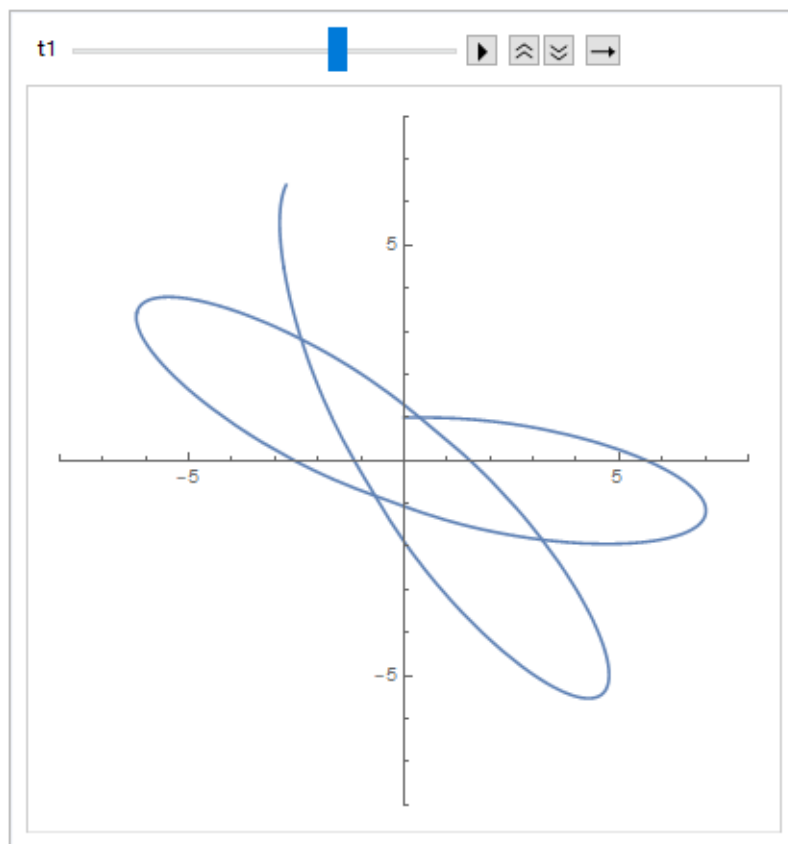


Задача 3.3

```
In[38]:= F[r_] := -1/r + 1/r^2;
T = 100;
```

```
sol = NDSolve[{
  x''[t] == F[r] x[t] / r, y''[t] == F[r] y[t] / r,
  x[0] == 0, x'[0] == 3/2,
  y[0] == 1, y'[0] == 0
} /. r -> Sqrt[x[t]^2 + y[t]^2], {x, y}, {t, 0, T}] [[1];
```

```
In[41]:= Animate[  
  ParametricPlot[{x[t], y[t]} /. sol, {t, 0, t1}, PlotRange → 8 {{-1, 1}, {-1, 1}},  
  {t1, 0.001, T}]
```



Анимация

```
In[42]:= Graphics[{  
  Disk[{x[t], y[t]}, .1] /. sol /. t -> 2  
}, PlotRange -> 8 {{-1, 1}, {-1, 1}}]
```

Out[42]=

•

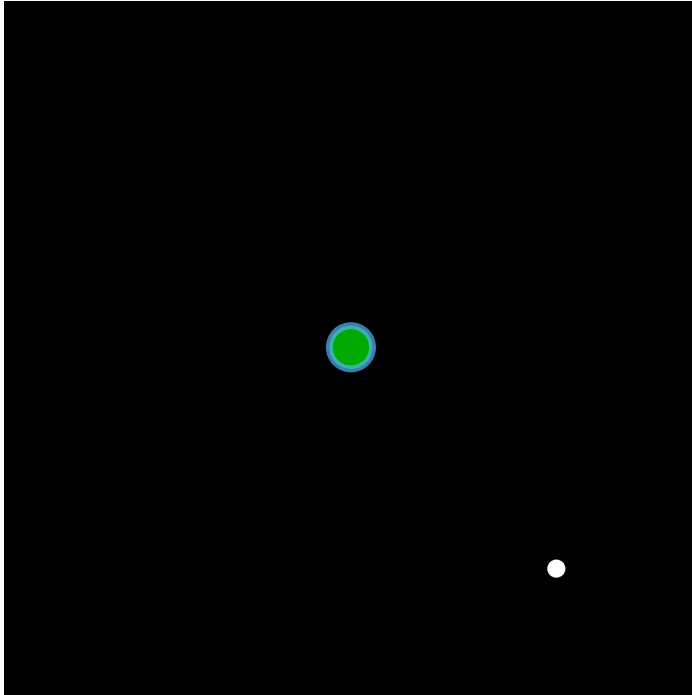
```


In[43]:= pic2[t_] :=
  Graphics[{Darker[Green], EdgeForm[Directive[Blue, Thickness[.01]]], Disk[{0, 0}, .5],
    White, EdgeForm[None], Disk[{x[t], y[t]}, .21] /. sol
  }, PlotRange -> 8 {{-1, 1}, {-1, 1}}, Background -> Black];

```

```
pic2[T/2]
```

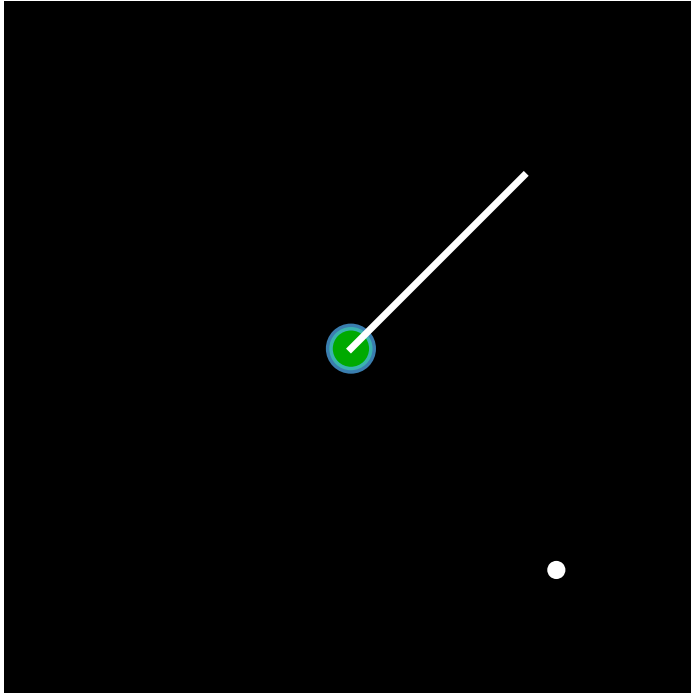
```
Out[44]=
```




```
In[45]:= pic2[t_] :=
  Graphics[{Darker[Green], EdgeForm[Directive[], Thickness[.01]]], Disk[{0, 0}, .5],
    White, Thickness[.01], Line[{{0, 0}, {4, 4}}],
    EdgeForm[None], Disk[{x[t], y[t]}, .21] /. sol
  }
  , PlotRange -> 8 {{-1, 1}, {-1, 1}}, Background -> Black];
```

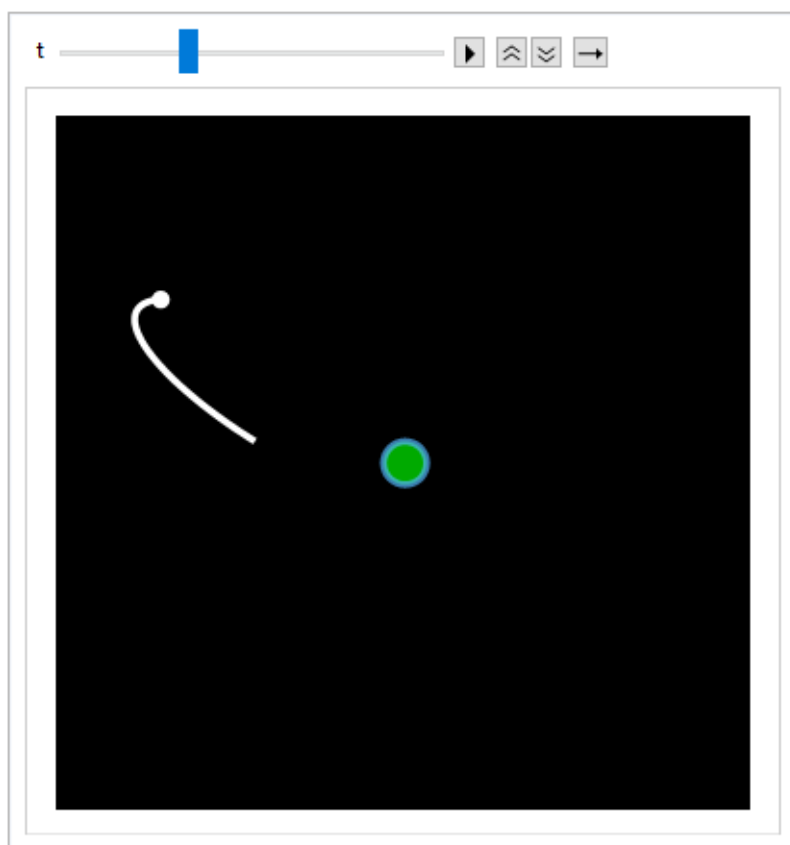
```
pic2[T/2]
```

```
Out[46]=
```




```
In[47]:= pic2[t_] :=
  Graphics[{Darker[Green], EdgeForm[Directive[], Thickness[.01]]], Disk[{0, 0}, .5],
    White, Thickness[.01],
    Line[{x[#], y[#]} /. sol & @Subdivide[Max[t - 10, 0], t, 100]],
    EdgeForm[None], Disk[{x[t], y[t]}, .21] /. sol
  }
  , PlotRange -> 8 {{-1, 1}, {-1, 1}}, Background -> Black];
```

```
Animate[pic2[t], {t, 0, T}]
```



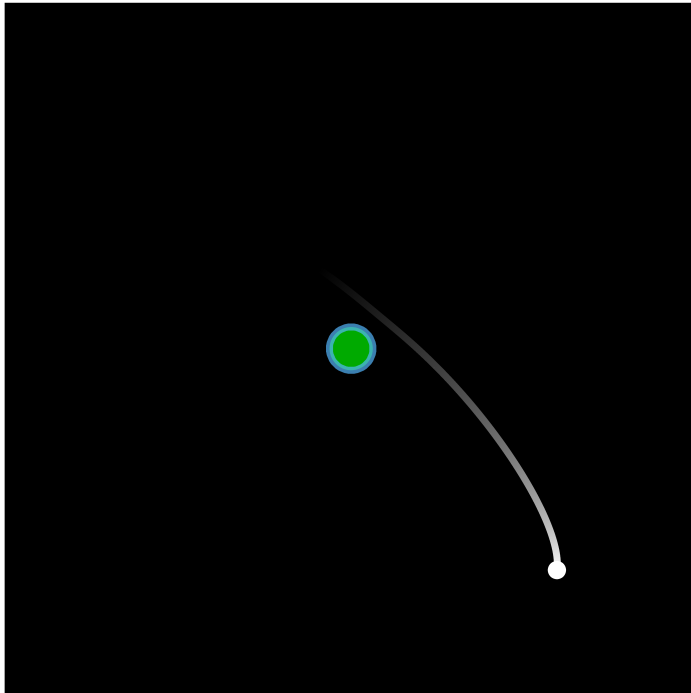
```

In[49]:= np = 100;
pic3[t_] :=
  Graphics[{Darker[Green], EdgeForm[Directive[, Thickness[.01]]], Disk[{0, 0}, .5],
    White, Thickness[.01], Line[{x[#], y[#]} /. sol & /@ Subdivide[Max[t - 10, 0], t, np],
    VertexColors -> (Opacity[#, White] & /@ Subdivide[0, 1, np])],
    EdgeForm[None], Disk[{x[t], y[t]}, .21] /. sol
  }
  , PlotRange -> 8 {{-1, 1}, {-1, 1}}, Background -> Black];

img = pic3[T/2]

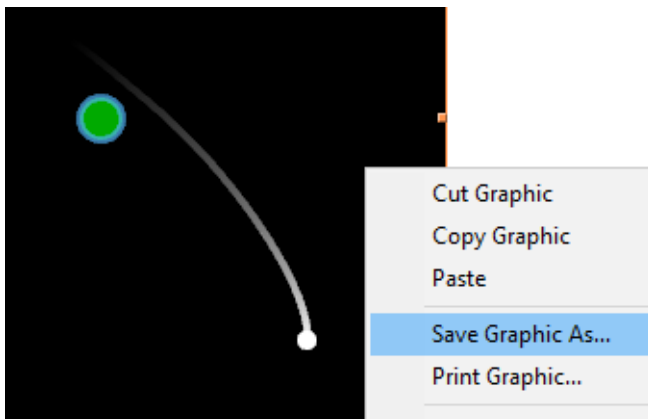
```

Out[51]=



Экспорт

In[50]:=



In[52]:= Directory[]

In[53]:= NotebookDirectory[]

```
In[54]:= SetDirectory[NotebookDirectory[]]
```

```
In[55]:= Directory[]
```

```
In[56]:= FileNames[]
```

```
In[57]:= Export["pic.pdf", img, "pdf"]
```

```
Out[57]= pic.pdf
```

```
In[58]:= Export["pic.png", img, "png"]
```

```
Out[58]= pic.png
```

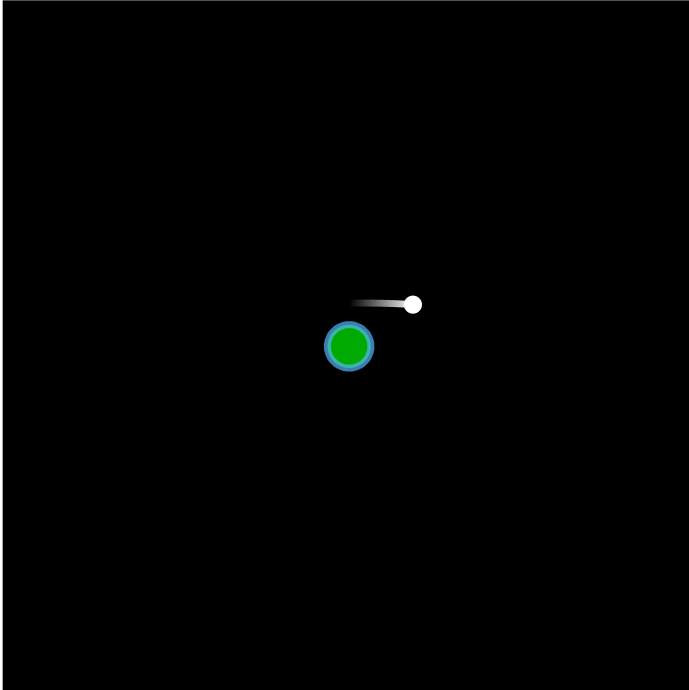
```
In[59]:= Export["pic.png", img, "png", ImageSize → 1000]
```

```
Out[59]= pic.png
```

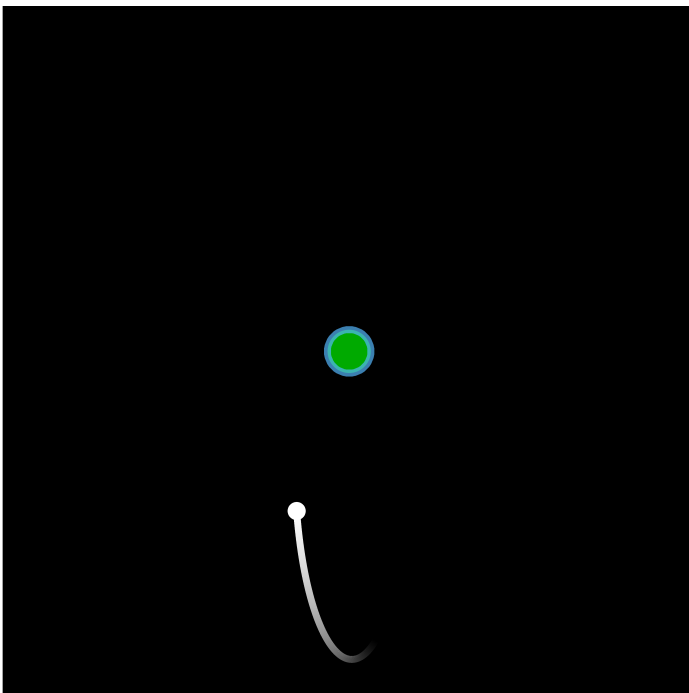
!

```
In[60]:= Pic[t_] := pic3[t T];  
pic3[1]  
Pic[1]
```

Out[61]=



Out[62]=



In[63]:= **Параметры анимации:**

```
dirname = "animation_frames"; (*имя анимации*)
size = 250; (*разрешение кадра в пикселях*)
time = 5; (*время анимации в секундах*)
fps = 25; (*частота кадров*)
loop = False; (*зацикливание анимации*)
```

Покадровый экспорт в .png:

```
Nframes = Ceiling[fps time]; (*количество кадров*)
SetDirectory@NotebookDirectory[];
Quiet@CreateDirectory[dirname]; (*создание папки для сохранения кадров*)
Export[
  dirname <> "//frame" <> StringPadLeft[ToString[# - 1], 4, "0"] <> ".png", Rasterize[
    Pic[ $\frac{\# - 1}{Nframes - \text{Boole}[\text{! loop}]}$ ], ImageSize -> size], "png"] & /@ Range[Nframes];
```