In[1]:=
```
((*single charge, V= kq/r *))
```

In[1]:=
```
V[x_, y_, q_] := ke q / Sqrt[x^2 + y^2]
```

In[2]:=
```
repSI := {ke → 9 × 10^9, q → 10^-9}
```

In[3]:=
```
ef1 = -Grad[V[x, y, q], {x, y}] /. repSI
```

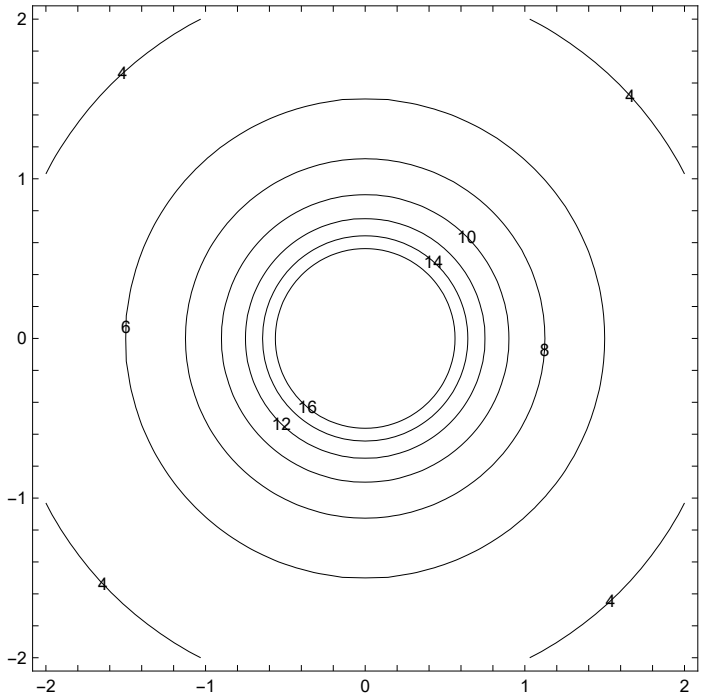
Out[3]=
$$\left\{\frac{9\,x}{\left(x^2+y^2\right)^{3/2}},\ \frac{9\,y}{\left(x^2+y^2\right)^{3/2}}\right\}$$

In[4]:=
```
V1 = V[x, y, q] /. repSI
```

Out[4]=
$$\frac{9}{\sqrt{x^2+y^2}}$$

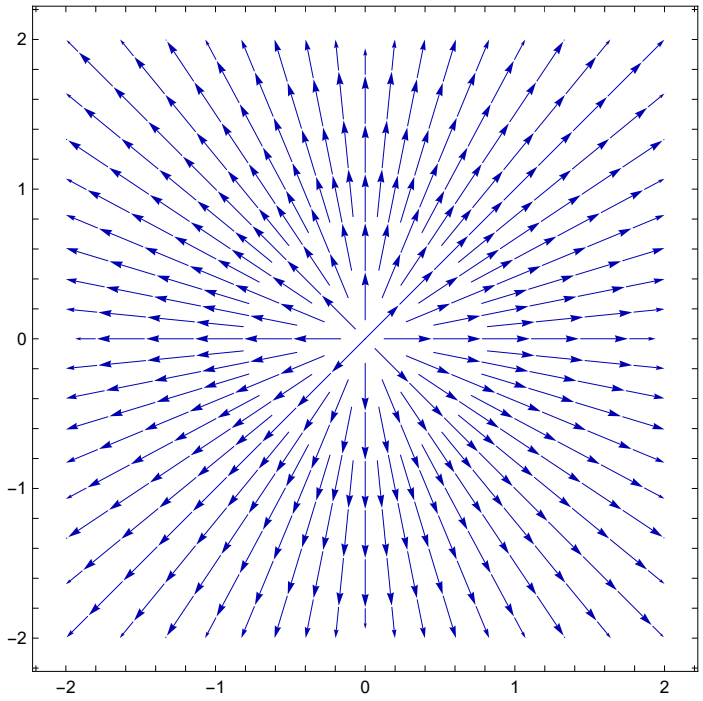
In[5]:=
```
fig1V = ContourPlot[V1, {x, -2, 2}, {y, -2, 2}, ContourShading → None, ContourLabels → True]
```

Out[5]=



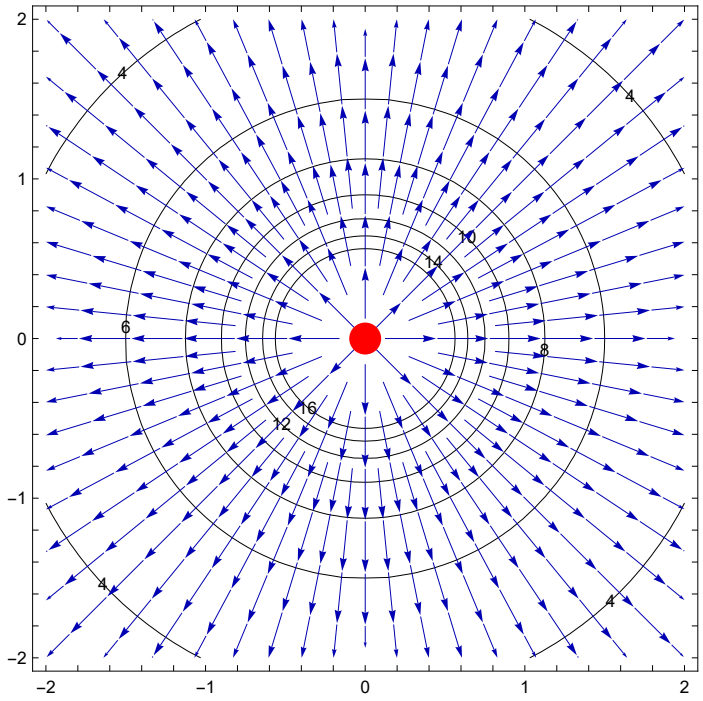
In[6]:=
```
fig1E = StreamPlot[ef1, {x, -2, 2}, {y, -2, 2}]
```

Out[6]=



In[7]:=
```
fig1 = Show[fig1V, fig1E, Graphics[{Red, Disk[{0, 0}, .1]}]]
```

Out[7]=



In[8]:=
```
(*dipole*)
```

In[9]:=
```
V1p = V1 /. {x → x + 1}
```

Out[9]=
$$\frac{9}{\sqrt{(1+x)^2+y^2}}$$

In[10]:=
```
V1m = -V1 /. x → x - 1
```

Out[10]=
$$-\frac{9}{\sqrt{(-1+x)^2+y^2}}$$

In[11]:=
```
Vdip = V1p + V1m
```

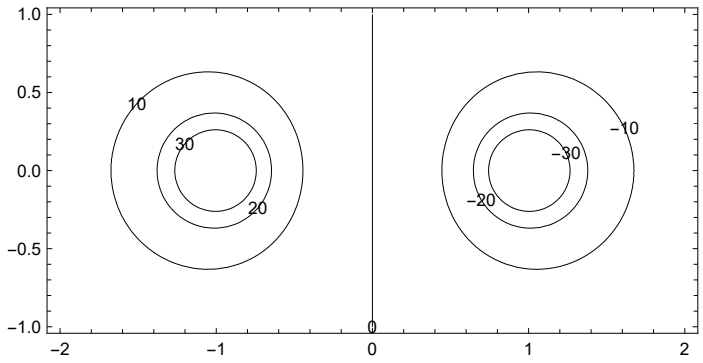
Out[11]=
$$-\frac{9}{\sqrt{(-1+x)^2+y^2}}+\frac{9}{\sqrt{(1+x)^2+y^2}}$$

In[12]:=
```
edip = -Grad[Vdip, {x, y}] // Simplify
```

Out[12]=
$$\left\{-\frac{9\,(-1+x)}{\left((-1+x)^2+y^2\right)^{3/2}}+\frac{9\,(1+x)}{\left((1+x)^2+y^2\right)^{3/2}},\ -\frac{9\,y}{\left((-1+x)^2+y^2\right)^{3/2}}+\frac{9\,y}{\left((1+x)^2+y^2\right)^{3/2}}\right\}$$

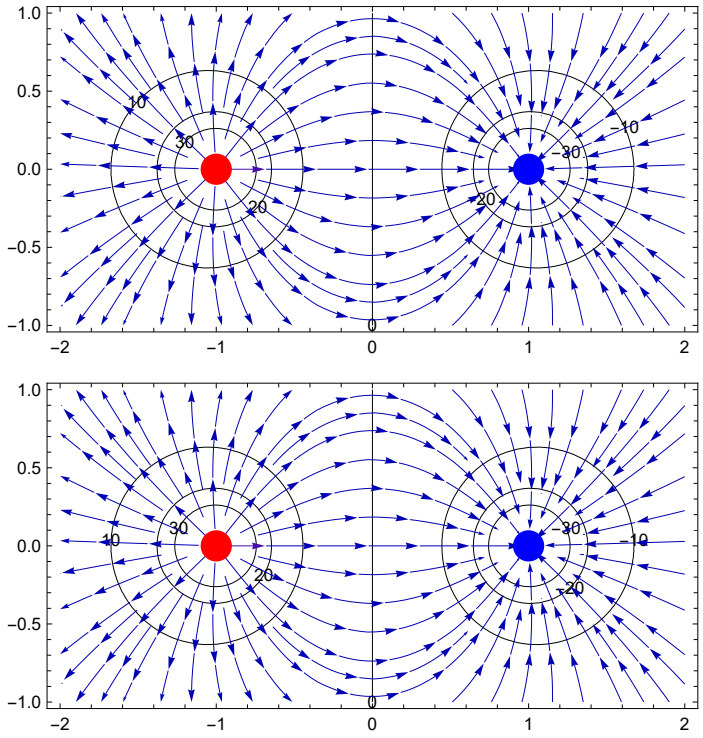
In[13]:=
```
Show[ContourPlot[Vdip, {x, -2, 2}, {y, -1, 1},
  ContourShading → None, ContourLabels → True, AspectRatio → Automatic]]
```

Out[13]=



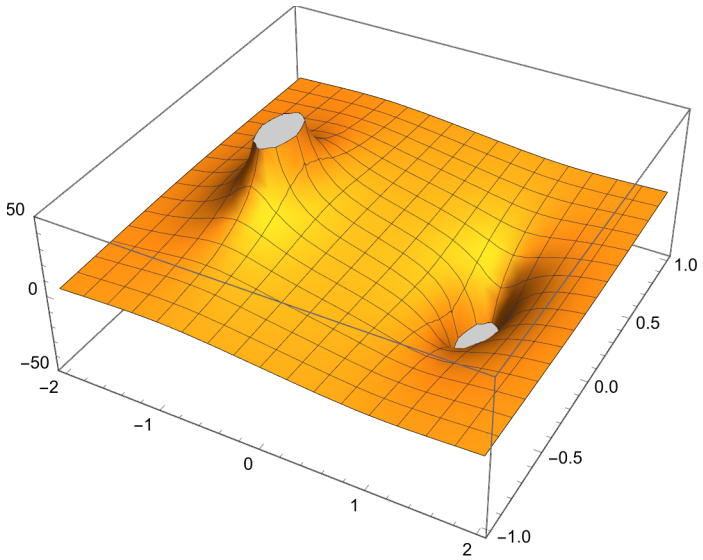
In[14]:=
```
figdip = Show[%, StreamPlot[edip, {x, -2, 2}, {y, -1, 1}],
  Graphics[{Red, Disk[{-1, 0}, .1], Blue, Disk[{1, 0}, .1]}]]
```

Out[14]=



In[15]:=
```
Plot3D[Vdip, {x, -2, 2}, {y, -1, 1}, PlotRange → {-50, 50}]
```

Out[15]=



In[16]:=

In[17]:=
```
(*Rod  , *)
```

In[18]:=
```
Integrate[ke lambda / Sqrt[(x - X)^2 + y^2], {X, -L/2, L/2}, Assumptions -> {L > 0 && y > 0 && x > 0}]
```

Out[18]=

$$\text{ke lambda Log}\left[\frac{L + 2x + \sqrt{(L+2x)^2 + 4y^2}}{-L + 2x + \sqrt{(L-2x)^2 + 4y^2}}\right]$$

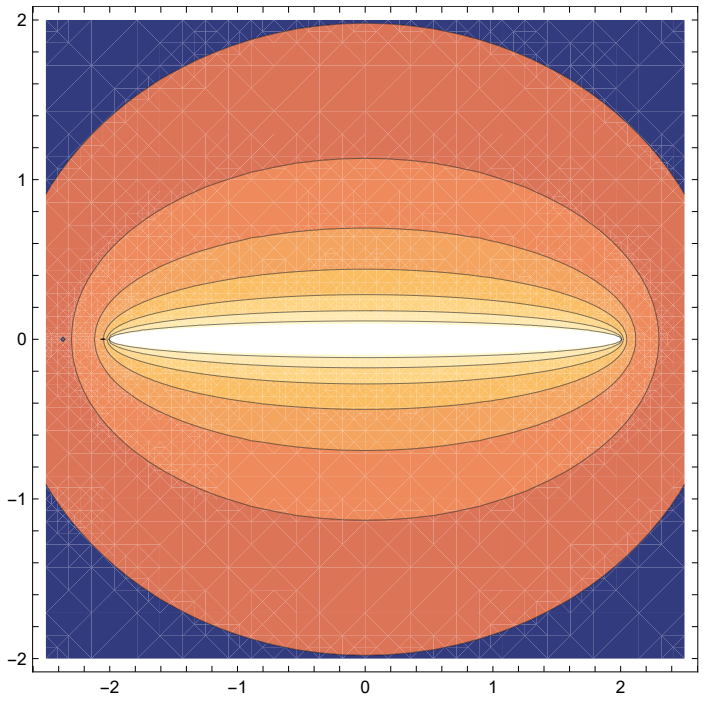
In[19]:=
```
Vrod = % /. {L -> 4, ke -> 9, lambda -> 1/4} // Simplify
```

Out[19]=

$$\frac{9}{4}\,\text{Log}\left[\frac{2 + x + \sqrt{4 + 4x + x^2 + y^2}}{-2 + x + \sqrt{4 - 4x + x^2 + y^2}}\right]$$

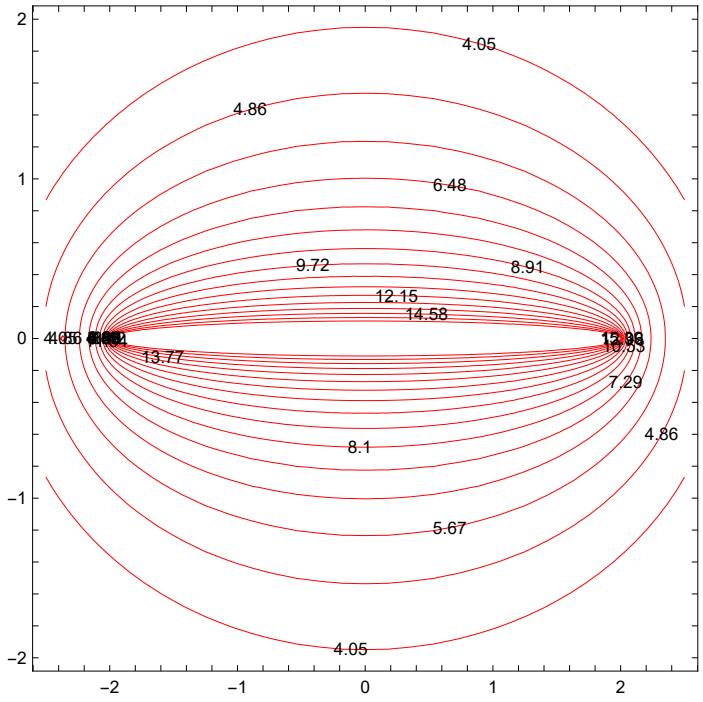
In[20]:=
```
ContourPlot[Vrod, {x, -2.5, 2.5}, {y, -2, 2}]
```

Out[20]=



In[21]:=
```
figRodV = ContourPlot[Vrod, {x, -2.5, 2.5}, {y, -2, 2},
  ContourStyle → Red, ContourLabels → True, ContourShading → None, Contours → 16]
```

Out[21]=



In[22]:=
```
efRod = -Grad[Vrod, {x, y}] // Simplify
```

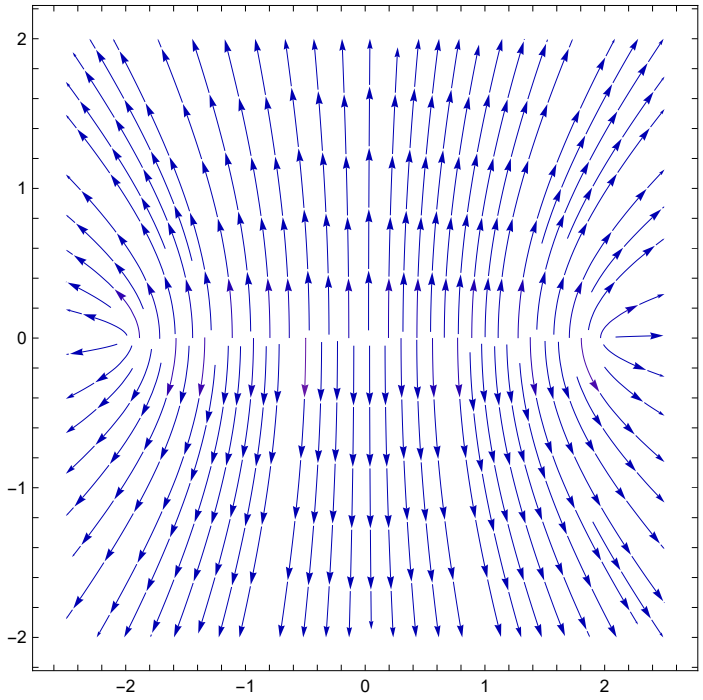
Out[22]=

$$\left\{\frac{9}{4}\left(\frac{1}{\sqrt{4-4x+x^2+y^2}}-\frac{1}{\sqrt{4+4x+x^2+y^2}}\right),\right.$$

$$\left.\frac{9}{4}y\left(\frac{1}{\sqrt{4-4x+x^2+y^2}\left(-2+x+\sqrt{4-4x+x^2+y^2}\right)}-\frac{1}{\sqrt{4+4x+x^2+y^2}\left(2+x+\sqrt{4+4x+x^2+y^2}\right)}\right)\right\}$$

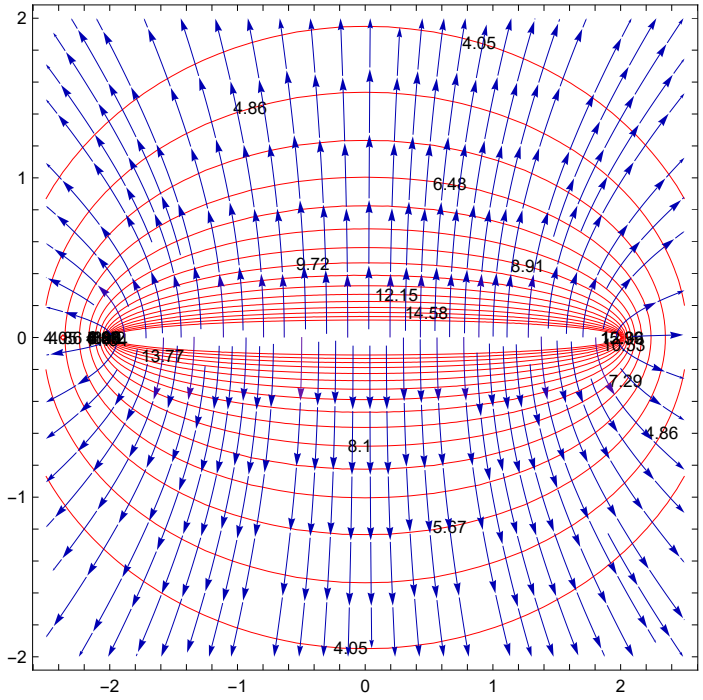
In[23]:=
```
figErod = StreamPlot[efRod, {x, -2.5, 2.5}, {y, -2, 2}]
```

Out[23]=



In[24]:=
```
figRod = Show[figRodV, figErod]
```

Out[24]=



In[25]:=
```
(*point charge+ rod*)
```

In[26]:=
```
-V1 /. y → y - 2.2
```

Out[26]=

$$-\frac{9}{\sqrt{x^2+(-2.2+y)^2}}$$

In[27]:=
```
% + Vrod
```

Out[27]=

$$-\frac{9}{\sqrt{x^2+(-2.2+y)^2}}+\frac{9}{4}\,\text{Log}\left[\frac{2+x+\sqrt{4+4x+x^2+y^2}}{-2+x+\sqrt{4-4x+x^2+y^2}}\right]$$

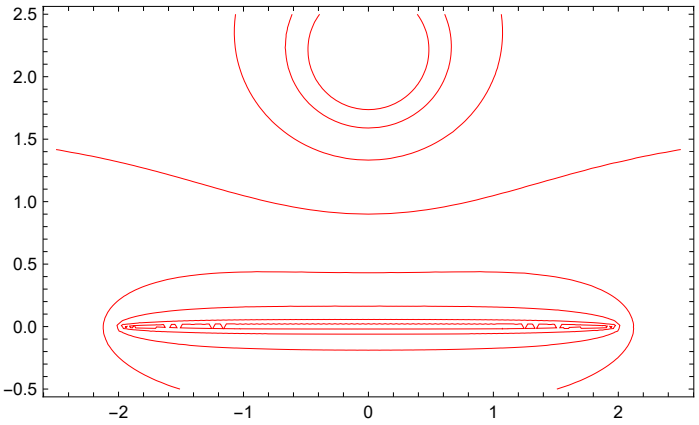
In[28]:=
```
V1rod = %
```

Out[28]=

$$-\frac{9}{\sqrt{x^2+(-2.2+y)^2}}+\frac{9}{4}\,\text{Log}\left[\frac{2+x+\sqrt{4+4x+x^2+y^2}}{-2+x+\sqrt{4-4x+x^2+y^2}}\right]$$

In[29]:=
```
fig1rodV = ContourPlot[V1rod, {x, -2.5, 2.5}, {y, -.5, 2.5},
  ContourStyle → Red, ContourShading → None, AspectRatio → Automatic]
```

Out[29]=



In[30]:=
```
e1rod = -Grad[V1rod, {x, y}] // Simplify
```

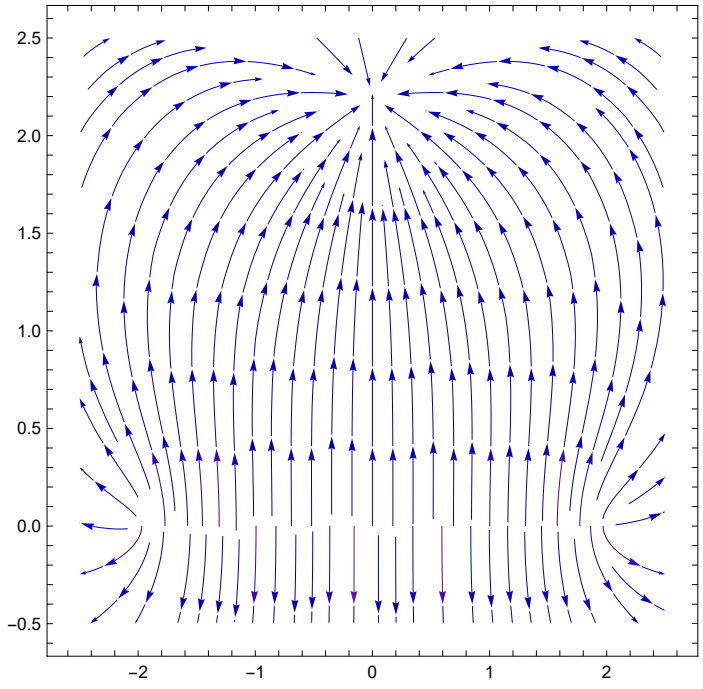
Out[30]=

$$\left\{\frac{9}{4}\left(\frac{1}{\sqrt{4-4x+x^2+y^2}}-\frac{1}{\sqrt{4+4x+x^2+y^2}}-\frac{4.x}{\left(4.84+x^2-4.4y+y^2\right)^{3/2}}\right),-\frac{9\,(-2.2+y)}{\left(x^2+(-2.2+y)^2\right)^{3/2}}+\right.$$

$$\left.\frac{9}{4}y\left(\frac{1}{\sqrt{4-4x+x^2+y^2}\,\left(-2+x+\sqrt{4-4x+x^2+y^2}\right)}-\frac{1}{\sqrt{4+4x+x^2+y^2}\,\left(2+x+\sqrt{4+4x+x^2+y^2}\right)}\right)\right\}$$

In[31]:=
```
fig1rodE = StreamPlot[e1rod, {x, -2.5, 2.5}, {y, -.5, 2.5}]
```

Out[31]=

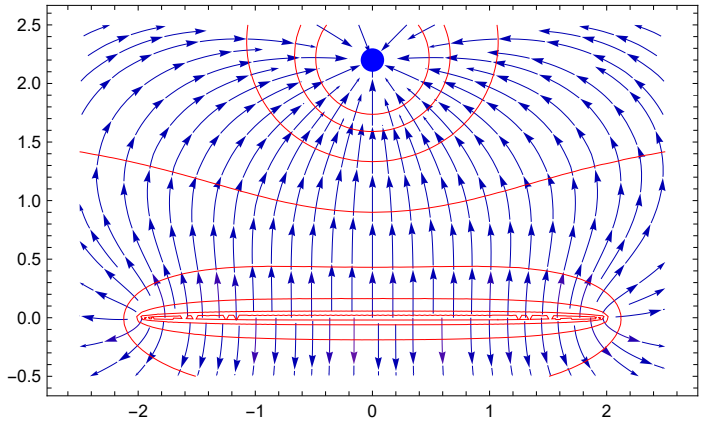


In[32]:=

In[33]:=

In[34]:=
```
fig1rod =
 Show[{fig1rodE, fig1rodV, Graphics[{Blue, Disk[{0, 2.2}, .1]}]}, AspectRatio → Automatic]
```

Out[34]=



In[35]:=

In[36]:=

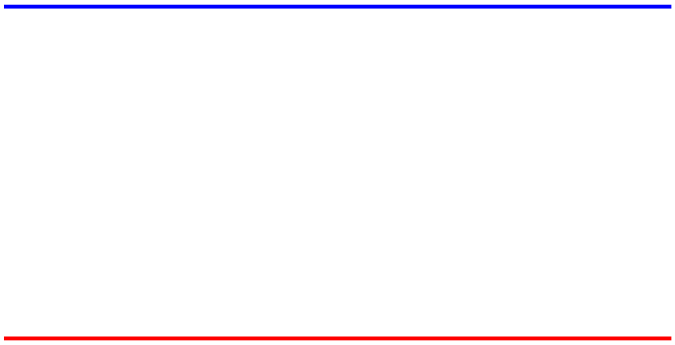
In[37]:=

In[38]:=

In[39]:=
```
(*two rods *)
```

In[40]:=
```
fig2lines =
 Graphics[{Thick, Red, Line[{{-2., 0}, {2., 0}}], Blue, Line[{{-2., 2}, {2., 2}}]}]
```

Out[40]=



In[41]:=

In[42]:=

In[ ]:=

In[43]:=

In[44]:=

In[45]:=

In[46]:=

In[47]:=

In[48]:=

In[49]:=

In[50]:=

In[ ]:=

In[51]:=

In[52]:=

In[53]:=

In[ ]:=

In[54]:=

In[55]:=
```
V2rods = Vrod - (Vrod /. y → y - 2)
```

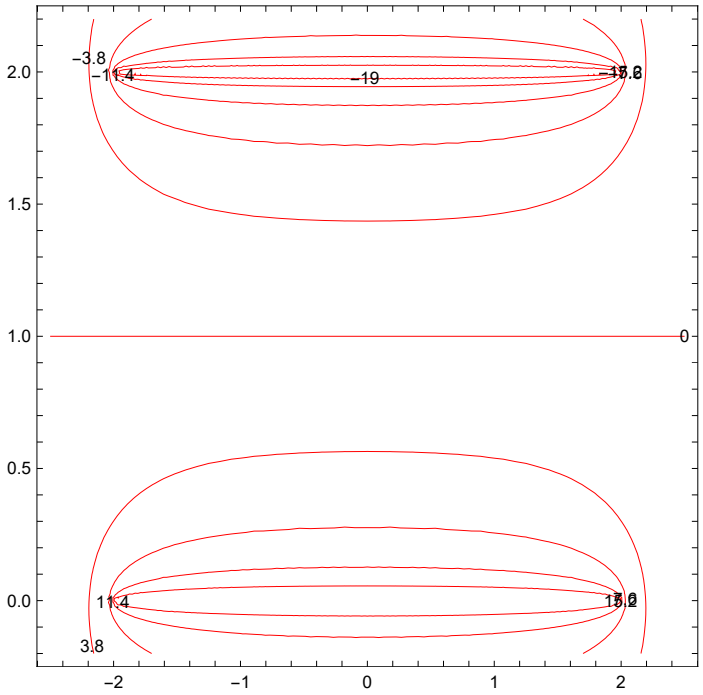
Out[55]=

$$-\frac{9}{4}\,\text{Log}\left[\frac{2+x+\sqrt{4+4x+x^2+(-2+y)^2}}{-2+x+\sqrt{4-4x+x^2+(-2+y)^2}}\right]+\frac{9}{4}\,\text{Log}\left[\frac{2+x+\sqrt{4+4x+x^2+y^2}}{-2+x+\sqrt{4-4x+x^2+y^2}}\right]$$

In[56]:=

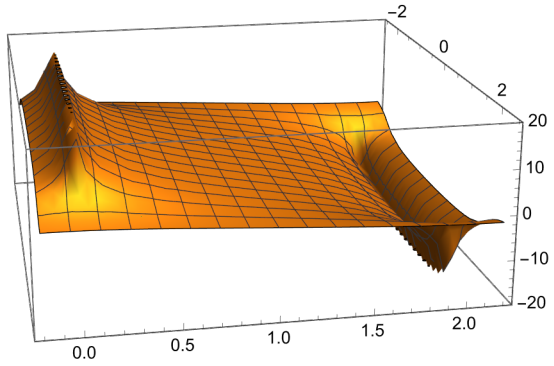
In[57]:=
```
fig2rodsV = ContourPlot[V2rods, {x, -2.5, 2.5}, {y, -.2, 2.2},
  Contours → 10, ContourStyle → Red, ContourShading → None, ContourLabels → True]
```

Out[57]=



In[58]:=
```
fig3D2rods = Plot3D[V2rods, {x, -2.5, 2.5}, {y, -.2, 2.2}, PlotRange → {-20, 20}]
```

Out[58]=



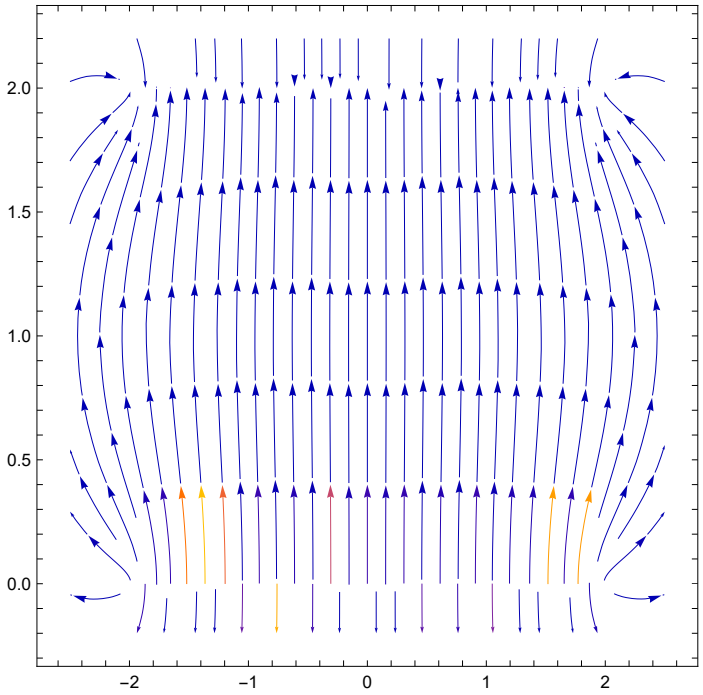
In[59]:=
```
ef = -Grad[V2rods, {x, y}];
```

In[60]:=

In[61]:=

In[62]:=
```
StreamPlot[ef, {x, -2.5, 2.5}, {y, -0.2, 2.2}]
```

Out[62]=



In[63]:=

In[64]:=
```
Show[fig2rodsV, StreamPlot[ef, {x, -2.5, 2.5}, {y, -0.2, 2.2}], fig2lines]
```

Out[64]=