In[1]:=
```
(* Jackson Problem 3.12 *)
(* ---------------------- *)
```

In[2]:=
```
(* Integral for part a *)
(* ---------------------- *)
Integrate[BesselJ[0, k * r] * r, {r, 0, a}]
```

Out[2]=
$$\frac{a\,\text{BesselJ}[1,\,a\,k]}{k}$$

In[3]:=
```
(* Integral for part b *)
(* ---------------------- *)
Integrate[BesselJ[1, k * a] * Exp[-k * z], {k, 0, Infinity}, Assumptions → {z > 0, a > 0}]
```

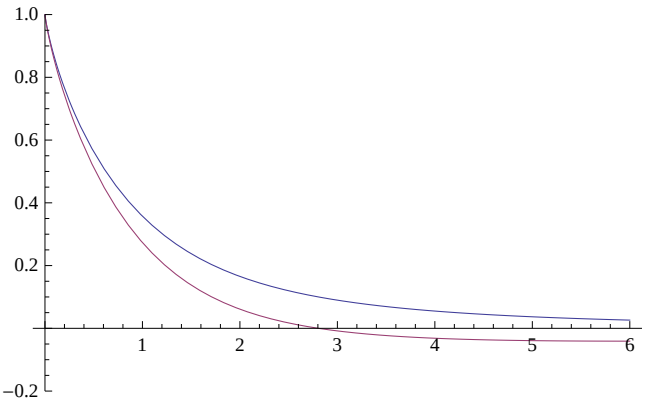
Out[3]=
$$\frac{1 - \frac{z}{\sqrt{a^2+z^2}}}{a}$$

In[4]:=
```
(* Integral for part c *)
(* ---------------------- *)
Integrate[BesselJ[0, k * a] * BesselJ[1, k * a] * Exp[-k * z],
 {k, 0, Infinity}, Assumptions → {a > 0, z > 0}]
```

Out[4]=
$$\frac{\pi - 2\,\text{EllipticK}\left[-\frac{4\,a^2}{z^2}\right]}{2\,a\,\pi}$$

In[5]:=
```
(* compare to Jackson's result *)
(* ------------------------------- *)
f1[z_] := 1 - 2 / Pi * EllipticK[-4 / z^2]
kk[z_] := 2 / Sqrt[z^2 + 4]
f2[z_] := 1 - z * kk[z] / Pi * EllipticK[kk[z]]
```

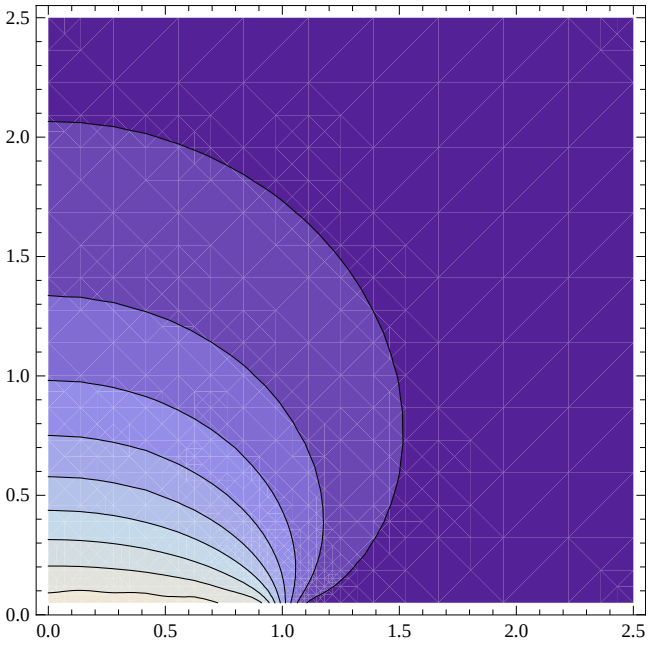
In[8]:=
```
Plot[{f1[z], f2[z]}, {z, 0, 6}, PlotRange → {-0.2, 1}]
```

Out[8]=


In[9]:=
```
(* Plot potential for a=1 *)
(* ------------------------- *)
phi[rho_, z_] := NIntegrate[BesselJ[1, k] * BesselJ[0, k * rho] * Exp[-k * z], {k, 0, 25}]
```

In[10]:=
```
ContourPlot[phi[x, y], {x, 0, 2.5}, {y, 0.05, 2.5}, PlotPoints → 10, PlotRange → {0, 1}]
```

Out[10]=



In[11]:=
```
(* agrees with my result, not with Jackson*)
(* ------------------------------------------------ *)
Plot[{phi[1, z], f1[z] / 2}, {z, 0.0, 2}, PlotRange → {0, 0.5}]
```

Out[11]=