```
> restart ;
> Fs := 2000*sqrt(tr/V) ;
```

$$Fs := 2000 \sqrt{\frac{tr}{V}} \tag{1}$$

```
> dc := sqrt(Q*R/(16*Pi)) ;
```

$$dc := \frac{\sqrt{\frac{Q\,R}{\pi}}}{4} \tag{2}$$

```
> R := S*alpha/(1-alpha) ;
```

$$R := \frac{S\,\alpha}{1-\alpha} \tag{3}$$

```
> eq := tr = -0.16*V/(S*log(1-alpha))  ;
```

$$eq := tr = -\frac{0.16\,V}{S \ln(1-\alpha)} \tag{4}$$

```
> solve(eq,alpha) ;
```

$$-1.\,e^{-\frac{0.1600000000\,V}{tr\,S}} + 1. \tag{5}$$

```
> alpha := 1 - exp(-.1600000000*V/(tr*S)) ;
```

$$\alpha := 1 - e^{-\frac{0.1600000000\,V}{tr\,S}} \tag{6}$$

```
> tr := k*(V/V0)^(1/3) ;
```

$$tr := k \left(\frac{V}{V0} \right)^{1/3} \tag{7}$$

```
> V := h^3*kl*kL ;
```

$$V := h^3\,kl\,kL \tag{8}$$

```
> S := 2*h^2*(kl+kL+kl*kL);
```

$$S := 2\,h^2\,(kl\,kL + kL + kl) \tag{9}$$

```
> Fs := simplify(Fs) assuming V>0 , V0>0 , h>0, kl>0, kL>0;
```

$$Fs := \frac{2000\,\sqrt{k}}{h\,V0^{1/6}\,kl^{1/3}\,kL^{1/3}} \tag{10}$$

```
> Fsl := Fs*h*kl ;
```

$$Fsl := \frac{2000\,kl^{2/3}\,\sqrt{k}}{V0^{1/6}\,kL^{1/3}} \tag{11}$$

```
> alpha ;
```

$$1 - e^{-\frac{0.08000000000\,h\,kl\,kL}{k\left(\frac{h^3\,kl\,kL}{V0}\right)^{1/3}\,(kl\,kL + kL + kl)}} \tag{12}$$

```
> alpha := simplify(alpha) assuming h>0, kl>0, kL>0 ;
```

$$\alpha := 1 - e^{-\frac{0.08\,kl^{2/3}\,kL^{2/3}}{k\left(\frac{1}{V0}\right)^{1/3}\,(kl\,kL + kL + kl)}} \tag{13}$$

```
> unassign('dc') ; unassign('R') ;
```

```
> dc:= (1/4)*sqrt(Q*R/Pi) ;
```

$$dc := \frac{\sqrt{\frac{Q\,R}{\pi}}}{4} \tag{14}$$

```
> R := S*alpha/(1-alpha) ;
```

$$R := \frac{2\,h^2\,(kl\,kL + kL + kl)\left(1 - e^{-\frac{0.08\,kl^{2\,|\,3}\,kL^{2\,|\,3}}{k\left(\frac{1}{V0}\right)^{1\,|\,3}\,(kl\,kL + kL + kl)}}\right)}{e^{-\frac{0.08\,kl^{2\,|\,3}\,kL^{2\,|\,3}}{k\left(\frac{1}{V0}\right)^{1\,|\,3}\,(kl\,kL + kL + kl)}}} \tag{15}$$

```
> S := 2*h^2*(kl+kL+kl*kL);
```

$$S := 2\,h^2\,(kl\,kL + kL + kl) \tag{16}$$

```
> dcR := simplify(dc/(h*kl)) assuming h>0 ;
```

$$dcR := \tag{17}$$

$$\frac{1}{4\sqrt{\pi}\,kl}\left(\sqrt{2}\sqrt{-(kl\,kL + kL + kl)\left(-1 + e^{-\frac{0.08\,kl^{2\,|\,3}\,kL^{2\,|\,3}}{k\left(\frac{1}{V0}\right)^{1\,|\,3}\,(kl\,kL + kL + kl)}}\right)\,Q\,e^{\frac{0.08\,kl^{2\,|\,3}\,kL^{2\,|\,3}}{k\left(\frac{1}{V0}\right)^{1\,|\,3}\,(kl\,kL + kL + kl)}}}\right)$$

```
> h := 3 ; kl:= 1.4 ; kL:=1.9 ; V0:=100; k:=0.4 ; Q:= 12.86 ;
```

$$h := 3$$
$$kl := 1.4$$
$$kL := 1.9$$
$$V0 := 100$$
$$k := 0.4$$
$$Q := 12.86 \tag{18}$$

```
> V ; S ; evalf(R) ; tr; evalf(alpha) ; evalf(dcR) ; evalf(Fsl);
```

$$71.82$$
$$107.28$$
$$37.39146298$$
$$0.3582133701$$
$$0.2584577650$$
$$0.7364147774$$
$$593.2359774 \tag{19}$$

```
> h := 5 ; kl:= 1.4 ; kL:=1.9 ; V0:=100; k:=0.15 ; Q:= 12.86  ;
```

$$h := 5$$
$$kl := 1.4$$
$$kL := 1.9$$
$$V0 := 100$$

$$k := 0.15$$

$$Q := 12.86 \quad \textbf{(20)}$$

```
> V ; S ; evalf(R) ; tr; evalf(alpha) ; evalf(dcR); evalf(Fsl) ;
  evalf(Fs);
```

332.50

298.00

363.4858415

0.2238833564

0.5494990501

1.377625795

363.2813604

51.89733721 **(21)**