```
p1 = {x1, y1, z1};
v1 = {vx1, vy1, vz1};
r1 = 1;
p2 = {x2, y2, z2};
v2 = {vx2, vy2, vz2};
r2 = 1;
abs ((p1 + v1 t) - (p2 + v2 t))
```

$$\{\text{abs}(t\,vx1 - t\,vx2 + x1 - x2),\ \text{abs}(t\,vy1 - t\,vy2 + y1 - y2),\ \text{abs}(t\,vz1 - t\,vz2 + z1 - z2)\}$$

```
((p1 + v1 t) - (p2 + v2 t))^2
```

$$\{(t\,vx1 - t\,vx2 + x1 - x2)^2,\ (t\,vy1 - t\,vy2 + y1 - y2)^2,\ (t\,vz1 - t\,vz2 + z1 - z2)^2\}$$

```
Total[((p1 + v1 t) - (p2 + v2 t))^2]
```

$$(t\,vx1 - t\,vx2 + x1 - x2)^2 + (t\,vy1 - t\,vy2 + y1 - y2)^2 + (t\,vz1 - t\,vz2 + z1 - z2)^2$$

```
sqrt[Total[((p1 + v1 t) - (p2 + v2 t))^2]]
```

$$\text{sqrt}\left[(t\,vx1 - t\,vx2 + x1 - x2)^2 + (t\,vy1 - t\,vy2 + y1 - y2)^2 + (t\,vz1 - t\,vz2 + z1 - z2)^2\right]$$

```
sqrt[Total[((p1 + v1 t) - (p2 + v2 t))^2]] == r1 + r2
```

$$\text{sqrt}\left[(t\,vx1 - t\,vx2 + x1 - x2)^2 + (t\,vy1 - t\,vy2 + y1 - y2)^2 + (t\,vz1 - t\,vz2 + z1 - z2)^2\right] == r1 + r2$$

```
Solve[sqrt[Total[((p1 + v1 t) - (p2 + v2 t))^2]] == r1 + r2, t]
```

Solve::ifun : Inverse functions are being used by Solve, so
some solutions may not be found; use Reduce for complete solution information. ≫

$$\Big\{\Big\{t \to \Big(-2\,vx1\,x1 + 2\,vx2\,x1 + 2\,vx1\,x2 - 2\,vx2\,x2 - 2\,vy1\,y1 + 2\,vy2\,y1 + 2\,vy1\,y2 - 2\,vy2\,y2 - 2\,vz1\,z1 + 2\,vz2\,z1 + 2\,vz1\,z2 - 2\,vz2\,z2 - \sqrt{(2\,vx1\,x1 - 2\,vx2\,x1 - 2\,vx1\,x2 + 2\,vx2\,x2 + 2\,vy1\,y1 - 2\,vy2\,y1 - 2\,vy1\,y2 + 2\,vy2\,y2 + 2\,vz1\,z1 - 2\,vz2\,z1 - 2\,vz1\,z2 + 2\,vz2\,z2)^2 - 4\left(vx1^2 - 2\,vx1\,vx2 + vx2^2 + vy1^2 - 2\,vy1\,vy2 + vy2^2 + vz1^2 - 2\,vz1\,vz2 + vz2^2\right)\left(x1^2 - 2\,x1\,x2 + x2^2 + y1^2 - 2\,y1\,y2 + y2^2 + z1^2 - 2\,z1\,z2 + z2^2 - \text{sqrt}^{(-1)}[r1 + r2]\right)}\Big)\Big/\left(2\left(vx1^2 - 2\,vx1\,vx2 + vx2^2 + vy1^2 - 2\,vy1\,vy2 + vy2^2 + vz1^2 - 2\,vz1\,vz2 + vz2^2\right)\right)\Big\},$$
$$\Big\{t \to \Big(-2\,vx1\,x1 + 2\,vx2\,x1 + 2\,vx1\,x2 - 2\,vx2\,x2 - 2\,vy1\,y1 + 2\,vy2\,y1 + 2\,vy1\,y2 - 2\,vy2\,y2 - 2\,vz1\,z1 + 2\,vz2\,z1 + 2\,vz1\,z2 - 2\,vz2\,z2 + \sqrt{(2\,vx1\,x1 - 2\,vx2\,x1 - 2\,vx1\,x2 + 2\,vx2\,x2 + 2\,vy1\,y1 - 2\,vy2\,y1 - 2\,vy1\,y2 + 2\,vy2\,y2 + 2\,vz1\,z1 - 2\,vz2\,z1 - 2\,vz1\,z2 + 2\,vz2\,z2)^2 - 4\left(vx1^2 - 2\,vx1\,vx2 + vx2^2 + vy1^2 - 2\,vy1\,vy2 + vy2^2 + vz1^2 - 2\,vz1\,vz2 + vz2^2\right)\left(x1^2 - 2\,x1\,x2 + x2^2 + y1^2 - 2\,y1\,y2 + y2^2 + z1^2 - 2\,z1\,z2 + z2^2 - \text{sqrt}^{(-1)}[r1 + r2]\right)}\Big)\Big/\left(2\left(vx1^2 - 2\,vx1\,vx2 + vx2^2 + vy1^2 - 2\,vy1\,vy2 + vy2^2 + vz1^2 - 2\,vz1\,vz2 + vz2^2\right)\right)\Big\}\Big\}$$

```
(t vx1 - t vx2 + x1 - x2)^2 + (t vy1 - t vy2 + y1 - y2)^2 + (t vz1 - t vz2 + z1 - z2)^2 == (r1 + r2)^2
```

$$(t\,vx1 - t\,vx2 + x1 - x2)^2 + (t\,vy1 - t\,vy2 + y1 - y2)^2 + (t\,vz1 - t\,vz2 + z1 - z2)^2 == (r1 + r2)^2$$

```
(t (vx1 - vx2) + x1 - x2)^2 + (t (vy1 - vy2) + y1 - y2)^2 + (t (vz1 - vz2) + z1 - z2)^2 == (r1 + r2)^2
```

$$(t\,(vx1 - vx2) + x1 - x2)^2 + (t\,(vy1 - vy2) + y1 - y2)^2 + (t\,(vz1 - vz2) + z1 - z2)^2 == (r1 + r2)^2$$

```
dvx = vx1 - vx2;
dvy = vy1 - vy2;
dvz = vz1 - vz2;
dx = x1 - x2;
dy = y1 - y2;
dz = z1 - z2;
r0 = r1 + r2;
(t dvx + dx)^2 + (t dvy + dy)^2 + (t dvz + dz)^2 == r0^2
```

$$(t\,(vx1 - vx2) + x1 - x2)^2 + (t\,(vy1 - vy2) + y1 - y2)^2 + (t\,(vz1 - vz2) + z1 - z2)^2 == (r1 + r2)^2$$

```
Clear[dx, dvx, dy, dvy, dz, dvz, r0]
```

$$(t\,dvx + dx)^2 + (t\,dvy + dy)^2 + (t\,dvz + dz)^2 == r0^2$$

$$(dx + dvx\,t)^2 + (dy + dvy\,t)^2 + (dz + dvz\,t)^2 == r0^2$$

```
Solve[(dx + dvx t)^2 + (dy + dvy t)^2 + (dz + dvz t)^2 == r0^2, t]
```

$$\left\{\left\{t \to \frac{1}{2\left(dvx^2 + dvy^2 + dvz^2\right)}\left(-2\,dvx\,dx - 2\,dvy\,dy - 2\,dvz\,dz - \sqrt{\left((2\,dvx\,dx + 2\,dvy\,dy + 2\,dvz\,dz)^2 - 4\left(dvx^2 + dvy^2 + dvz^2\right)\left(dx^2 + dy^2 + dz^2 - r0^2\right)\right)}\right)\right\},\ \left\{t \to \frac{1}{2\left(dvx^2 + dvy^2 + dvz^2\right)}\left(-2\,dvx\,dx - 2\,dvy\,dy - 2\,dvz\,dz + \sqrt{\left((2\,dvx\,dx + 2\,dvy\,dy + 2\,dvz\,dz)^2 - 4\left(dvx^2 + dvy^2 + dvz^2\right)\left(dx^2 + dy^2 + dz^2 - r0^2\right)\right)}\right)\right\}\right\}$$

```
Solve[dx^2 + 2 dx dvx t + (dvx t)^2 + dy^2 + 2 dy dvy t + (dvy t)^2 + dz^2 + 2 dz dvz t + (dvz t)^2 == r0^2, t]
```

$$\left\{\left\{t \to \frac{1}{2\left(dvx^2 + dvy^2 + dvz^2\right)}\left(-2\,dvx\,dx - 2\,dvy\,dy - 2\,dvz\,dz - \sqrt{\left((2\,dvx\,dx + 2\,dvy\,dy + 2\,dvz\,dz)^2 - 4\left(dvx^2 + dvy^2 + dvz^2\right)\left(dx^2 + dy^2 + dz^2 - r0^2\right)\right)}\right)\right\},\ \left\{t \to \frac{1}{2\left(dvx^2 + dvy^2 + dvz^2\right)}\left(-2\,dvx\,dx - 2\,dvy\,dy - 2\,dvz\,dz + \sqrt{\left((2\,dvx\,dx + 2\,dvy\,dy + 2\,dvz\,dz)^2 - 4\left(dvx^2 + dvy^2 + dvz^2\right)\left(dx^2 + dy^2 + dz^2 - r0^2\right)\right)}\right)\right\}\right\}$$

$$dx^2 + dy^2 + dz^2 + 2\,dvx\,dx\,t + 2\,dvy\,dy\,t + 2\,dvz\,dz\,t + dvx^2\,t^2 + dvy^2\,t^2 + dvz^2\,t^2 == r0^2$$

```
a = dvx^2 + dvy^2 + dvz^2;
b = 2 dvx dx + 2 dvy dy + 2 dvz dz;
c = dx^2 + dy^2 + dz^2 - r0^2;
c + b t + a t^2 == 0
```

$$dx^2 + dy^2 + dz^2 - r0^2 + (2\,dvx\,dx + 2\,dvy\,dy + 2\,dvz\,dz)\,t + \left(dvx^2 + dvy^2 + dvz^2\right)t^2 == 0$$

```
Clear[a, b, c];
Solve[c + b t + a t^2 == 0, t]
```

$$\left\{\left\{t \to \frac{-b - \sqrt{b^2 - 4\,a\,c}}{2\,a}\right\},\ \left\{t \to \frac{-b + \sqrt{b^2 - 4\,a\,c}}{2\,a}\right\}\right\}$$