Train-Tunnel Problems

```
> restart:
```

L0 = tunnel length, T0 = tunnel length, v = beta [c=1]

```
> L0:=240: T0:=360: v:=0.6: gam:=1/sqrt(1-v^2);
```

$$gam := 1.250000000 \quad (1)$$

F1 - Front enters tunnel at t = 0 and x = contracted train length. Primed values obtained from Lorentz transformation

```
> F1x:=L0/gam; F1t:=0;
```

$$F1x := 192.0000000$$
$$F1t := 0 \quad (2)$$

```
> F1xp:=gam*(F1x-v*F1t); F1tp:=gam*(F1t-v*F1x);
```

$$F1xp := 240.0000000$$
$$F1tp := -144.0000000 \quad (3)$$

F2 - Front of train exiting tunnel.

```
> F2x:=T0+L0/gam; F2t:=T0/v;
```

$$F2x := 552.0000000$$
$$F2t := 600.0000000 \quad (4)$$

```
> F2xp:=gam*(F2x-v*F2t); F2tp:=gam*(F2t-v*F2x);
```

$$F2xp := 240.0000000$$
$$F2tp := 336.0000000 \quad (5)$$

Verification that Delta s^2 is invariant from Origin to F2.

```
> F2x^2-F2t^2 = F2xp^2-F2tp^2:
```

B1 - Back of Train enters tunnel

```
> B1x:=L0/gam; B1t:=B1x/v;
```

$$B1x := 192.0000000$$
$$B1t := 320.0000000 \quad (6)$$

```
> B1xp:=gam*(B1x-v*B1t); B1tp:=gam*(B1t-v*B1x);
```

$$B1xp := 0.$$
$$B1tp := 256.0000000 \quad (7)$$

B1 - on train - Watch back of train cover 192 m contracted in time (192/gamma)/v. This agrees with the above for B1tp.

```
> L0/gam/gam/v;
```

$$256.0000000 \quad (8)$$

B2 - Same *x* as F2 and for back of train to travel from origin to end of tunnel

```
> B2x:=F2x; B2t:=F2x/v;
```

$$B2x := 552.0000000$$
$$B2t := 920.0000000 \quad (9)$$

Also, **B2 prime system** - *x*' = 0 and back of train travels F2x/gamma in time

```
> B2xp:=0; B2tp:=F2x/gam/v;
```

$$B2xp := 0$$
$$B2tp := 736.0000000 \quad (10)$$

Verify two ways: ds^2 or Loretnz transformation

```
> B2x^2-B2t^2 = B2xp^2-B2tp^2:
```

```
> B2xp:=gam*(B2x-v*B2t): B2tp:=gam*(B2t-v*B2x):
```