SET 5

12.11)

Divide the circumference of the loop into a large number of straight lengths. Put each length in an inertial frame which is instantaneously at rest, so that the length moves with a speed, ωr. Each length then appears contracted by $\gamma = \sqrt{\frac{1}{1-\beta^2}}$ with $\beta = \omega r$. The radius in this frame does not change. Thus ratio of the circumference to the radius is;

$$\text{Ratio} = 2\pi\gamma$$

Then note that a rigid body cannot be spun to relativisitc velocities without distortion. The rotating frame is not in an inertial system as it is being accelerated, so one cannot transform the total system into an inertial frame at rest where the circumference would be 2π.

12.15)

Use the velocity transformation equations, as previously.

Speed Relative to	Ground	Police	Outlaw	Bullet	Escape
Ground	0	1/2 c	3/4 c	5/7 c	yes
Police	-1/2 c	0	2/5 c	1/3 c	yes
Outlaw	-3/4 c	-2/5 c	0 c	-1/13 c	yes
Bullet	-5/7	-1/3 c	1/13 c	0 c	yes

12.19)

See Lectures on rotations and rapidity

12.27)

For a particle in hyperbolic motion;

$$x(t) \;=\; \sqrt{b^2 + (ct)^2}$$

The proper time is;

$$d\tau \;=\; \sqrt{1-\beta^2}\, dt$$

The velocity is;

$$V \;=\; \frac{c^2 t}{b^2 + (ct)^2}$$

$$\tau \;=\; \int_0^t dt' \, \frac{b^2}{\sqrt{b^2 + (ct)^2}}$$