

Original Post

<https://plus.google.com/u/0/+WilliamNichols/posts/XGT5gZRfTty>

Travel time is an hour.

Questions

Req'd Accel

Req'd Energy

Flight or Ground

Assumptions & Equations

The routes are straight lines.

There aren't any holding patterns.

There isn't any traffic in the way.

Drag Coefficients - https://www.engineeringtoolbox.com/drag-coefficient-d_627.html

Drag Equation $F_d = c_d \frac{1}{2} \rho v^2 A$, *Force = Drag Coeff * 0.5 * Air Density * Velocity Squared * Frontal Area*

Air density - <https://www.digitaldutch.com/atmoscalc/>, which matches correctly

https://en.wikipedia.org/wiki/International_Standard_Atmosphere

Rolling resistance - https://en.wikipedia.org/wiki/Rolling_resistance

Energy is Force X Distance

Power is Force X Velocity

Force = Mass x Acceleration

-

T1 - Bus

Passengers	30	
Mass	2000	kg
Distance	5	km
Stops	5	
Average Speed	1.389	m/s
1 second accel	0.142	g
5 second accel	0.028	g
<i>Drag</i>	11.0E+0	N
<i>Rolling Friction</i>	117.7E+0	N
CD	0.800	
Frontal Area	10.965	m^2
Rolling Resistance	0.006	
Energy	643.5E+0	J

Power	178.8E+0	W

The average speed of this bus is 5km/h. That's an awful bus and poor tram. Walking would be quicker. The acceleration needed for this is less than 0.14 g. You've likely burped harder than that. A 30 passenger bus needs only one floor.

Bus frontal area -

<https://nzta.govt.nz/vehicles/vehicle-types/vehicle-classes-and-standards/vehicle-dimensions-and-mass/heavy-buses/>

Rolling resistance of a bus rubber wheel from wikipedia is 0.006

T2 - MTR

T2		
Passengers	150	
Mass	10000	kg
Distance	50	km
Stops	5	
Average Speed	13.889	m/s
1 second accel	1.416	g
5 second accel	0.283	g
<i>Drag</i>	1.1E+3	N
<i>Rolling Friction</i>	29.4E+0	N
CD	0.800	
Frontal Area	10.965	m^2
Rolling Resistance	0.0003	
Energy	56.4E+3	J
Power	15.7E+3	W

Frontal area is the same as a Bus

Rolling resistance of steel wheel on steel rail is 0.0003

T3 - Train

T3		
Passengers	300	
Mass	20000	kg

Distance	500	km
Stops	5	
Average Speed	138.889	m/s
1 second accel	14.158	g
5 second accel	2.832	g
<i>Drag</i>	109.9E+3	N
<i>Rolling Friction</i>	58.9E+0	N
CD	0.800	
Frontal Area	10.965	m^2
Rolling Resistance	0.0003	
Energy	55.0E+6	J
Power	15.3E+6	W

Frontal area is the same as a Bus

Rolling resistance of steel wheel on steel rail is 0.0003

This is about the limit of what you can do on the ground.

The drag is getting crazy high and to avoid losing time at the stops you're having to pull significant g.

T4 - Plane

T4		
Passengers	300	
Mass	20000	kg
Distance	5000	km
Stops	5	
Average Speed	1388.889	m/s
1 second accel	141.579	g
5 second accel	28.316	g
<i>Drag</i>	19.9E+6	N
<i>Rolling Friction</i>	58.9E+0	N
CD	0.270	
Frontal Area	58.780	m^2
Rolling Resistance	0.0003	
Energy	99.4E+9	J
Power	27.6E+9	W
Mach Number	4.049238743	

Frontal area of an A330 is ????. Can't find good data on this.

5.65 m wide cabin, so 25m^ for that.

Wings are 55m by 0.5 = 27.5m^2

Engines are 2m circle, so 3.14*2 = 6.28m^2

Total is ~58.78 m²

Drag Coefficient is ~0.27 (https://en.wikipedia.org/wiki/Drag_coefficient), approximated from the modern jetliners.

Rolling resistance of steel wheel on steel rail is 0.0003

This is a bad idea. You're now supersonic at sea level. People aren't going to be very pleased when you go past them.

If we do this at 20000 m altitude, the air density is now 0.0880349

Speed of Sound is now ~294.9 m/s (<http://www.fighter-planes.com/jetmach1.htm>)

You'll also need to slow down the acceleration to at least a minute to avoid pulping the passengers.

T4 at 20 km		
Passengers	300	
Mass	20000	kg
Distance	5000	km
Stops	5	
Average Speed	1388.889	m/s
1 second accel	141.579	g
60 second accel	2.360	g
<i>Drag</i>	1.3E+6	N
<i>Rolling Friction</i>	0.0E+0	N
CD	0.270	
Frontal Area	58.780	m ²
Rolling Resistance	0.0000	
Energy	6.7E+9	J
Power	1.9E+9	W
Mach Number	4.709694435	

That's better, now the drag is down to a lot less. You'll also not blast people's houses apart. You can ignore the rolling resistance as well.

T5 - Hyperspeed

T5		
Passengers	300	
Mass	20000	kg
Distance	50000	km
Stops	5	
Average Speed	13888.889	m/s
1 second accel	1415.789	g

60 second accel	23.596	g
<i>Drag</i>	5.1E+9	N
<i>Rolling Friction</i>	58.9E+0	N
CD	0.515	
Frontal Area	78.540	m^2
Rolling Resistance	0.0003	
Energy	253.3E+12	J
Power	70.4E+12	W
Mach Number	40.49238743	

Frontal area is the same as a Saturn V, which is 78.54

Rolling resistance of steel wheel on steel rail is 0.0003

CD as Saturn V = 0.515

(<https://space.stackexchange.com/questions/12649/how-can-i-estimate-the-coefficient-of-drag-on-a-saturn-v-rockets-a-simulator-or>)

It's not much better at 20km up

T5 at 20km		
Passengers	300	
Mass	20000	kg
Distance	50000	km
Stops	5	
Average Speed	13888.889	m/s
1 second accel	1415.789	g
60 second accel	23.596	g
<i>Drag</i>	343.4E+6	N
<i>Rolling Friction</i>	0.0E+0	N
CD	0.515	
Frontal Area	78.540	m^2
Rolling Resistance	0.0000	
Energy	17.2E+12	J
Power	4.8E+12	W
Mach Number	47.09694435	

For reference, you're going as fast as some these craft

-https://en.wikipedia.org/wiki/List_of_vehicle_speed_records#Spacecraft

Yeah, go to space. Preferable something like this - <https://en.wikipedia.org/wiki/LAPCAT>