### etwinning experiment: team 1

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# • ORIENTATION

We are going to measure the speed of the bicycle wheel. Therefore we will change the gears. We will also calculate the angular velocity and track speed change of the bicycle wheel. We will do this experiment by attaching a smartphone to a bicycle wheel. With the app we will measure the angular velocity and the acceleration. We will calculate the track speed.

**research question:** When you change the gears of the bike, how does it affect the speed of the wheel?

**sub - questions:** What happens with the angular velocity and track speed, when you change the gears of the bike?

## • HYPOTHESIS

The angular velocity will be smaller when you turn the gear up (so when the chain is on a bigger sprocket). The track speed will also be smaller when you turn the gear up, because the speed will reduce. This is because your rear wheel then does less revs each time you pedal on the bike.

The angular velocity will be bigger when you turn the gear down (when the chain is on a smaller sprocket). The track speed will also be bigger when you turn the gear up because the speed will increase. That's because your rear wheel revs more each time you pedal on the bike's pedals.

#### PREPARATION

#### <u>material</u>:

- bicycle with gears
- phyphox app
- smartphone
- tape
- ruler (to measure the radius of the wheel)

#### <u>method:</u>

- turn the bike upside down (don't actually ride the bike, but just turn the pedals.
  this is much safer for your phone);
- measure the radius of the wheel;
- attach the smartphone to the back wheel with tape;
- turn on the app phyphox (the experiment on the app that we will use is centrifugal acceleration > mechanics);
- make the wheel spin by pushing the pedals;

### using phyphox:

- press on the three points in the right upper corner and press on timed measurement;
- delayed start 5s and duration experiment 10s;
- press on the start button and start spinning around in circles for 15s;
- watch the results of this experiment on the phyphox app and export the data;
- repeat the experiment 3 times;

# <u>2<sup>nd</sup> part of the experiment:</u>

- change the gears;
- repeat the previous steps (also do this experiment 3 times);
- change the gears one last time (so you have 3 different gear settings in total);
- repeat the previous steps (also do this experiment 3 times);
- DATA ANALYSIS and DISCUSSION

#### observations and measurements:

- measurements of the first part of the experiment:

#### (measurement 1)

Data	Metadata Device	Metadata Ti
Time (s)	Angular velocAcceleration (m/s^2)	
1,0923796	2!0,00852470!0,03340045:	
1,5926926	2:0,00404970:0,03291948:	
2,0930078	7! 0,01151063! 0,08050255!	
2,5933198	7!0,00895060:0,01296660:	
3,0936315	4:0,00071378:0,04594193:	
3,5939435	4:0,00877354:0,019907214	
4,0942542	9:0,48460868:0,55105153	
4,5945642	9:0,00445706:0,03167854:	
5,09487	4 0,0133304410,042156940	
5,59518	3 0,00881966(0,03578292!	
6,5957983	7! 0,02071702! 0,053514634	
7,0961052	5 0,04604432 0,04196800	
7,5964122	5 0,00860450: 0,305749900	
8,09671	8 0,03374410(0,24014045(	
9,1083505	8:3,57380511:3,40500001	
9,6085525	4: 4,52404812: 3,00802118:	
10,108756	5 4,41455609 5,54777106	
10,608961	6 4,17788102 4,36831152	
11,109165	6 4,52073052 4,69831950	
11,609369	7 4,40688678 5,36952411	
12,109573	7 4,00325857 2,68035265	
12,609778	5 4,23982462: 4,02472104	
13,109982	5 4,15141669 5,16357814	
13,610187	5 3,28816630 6,25534494	
14,110391	5 3,73372954 2,30272533!	
14,610596	1 4,12277267 5,54330171	
15,110801	1 3,28800828 2,69240036	
15,611005	5 3,84814825 1,44569890	
16,111210	5 4,18388818 3,70898669	
16,611413	9:3,40536415(3,53427512	
17,111618	9:3,22931564 1,83469405	
17,611822	2:3,74998605:2,63798705:	
18,112027	2 4,00617776 3,74073706	

#### (measurement 2)

Data	Metadata I	Device	Metadata	Tir
Time (s)	Angular velocAccelerat	tion (m/s^2)		T
1,09237962	0,00852470!0,03340	045:		
1,59269262	0,00404970 0,03291	948:		
2,09300787	0,01151063 0,08050	2559		
2,59331987	0,00895060: 0,01296	660:		
3,09363154	0,00071378!0,04594	193:		
3,59394354	0,00877354:0,01990	7214		
4,09425429	0,48460868:0,55105	153		
4,59456429	0,0044570610,03167	854		
5,094874	0,0133304410,04215	694(		
5,595183	0,00881966(0,03578	292!		
6,59579837	0,0207170210,05351	4634		
7,09610525	0,04604432 0,04196	800:		
7,59641225	0,00860450:0,30574	990(		
8,096718	0,03374410(0,24014	0450		
9,10835058	3,57380511: 3,40500	001		
9,60855254	4,52404812 3,00802	118:		
10,1087565	4,41455609 5,54777	106		
10,6089616	4,17788102 4,36831	1524		
11,1091656	4,52073052 4,69831	950:		
11,6093697	4,40688678: 5,36952	4114		
12,1095737	4,00325857 2,68035	265		
12,6097785	4,23982462: 4,02472	104		
13,1099825	4,15141669(5,16357	8149		
13,6101875	3,28816630 6,25534	494		
14,1103915	3,73372954 2,30272	533!		
14,6105961	4,12277267! 5,54330	1714		
15,1108011	3,28800828 2,69240	0364		
15,6110055	3,84814825: 1,44569	890:		
16,1112105	4,18388818 3,70898	669		
16,6114139	3,40536415(3,53427	512		
17,1116189	3,22931564 1,83469	4054		
17,6118222	3,74998605: 2,63798	705:		
18,1120272	4,00617776 3,74073	706		

# (measurement 3)

Data	Metadata Dev	vice	Metadata T	'i ı
Time (s)	Angular velocAcceleration	(m/s^2)		Т
1,09237962	0,00852470:0,03340045:			L
1,59269262!	0,00404970 0,03291948			L
2,09300787	0,01151063 0,08050255			L
2,59331987	0,00895060: 0,01296660:			L
3,09363154	0,00071378:0,04594193			L
3,59394354	0,00877354:0,019907214			L
4,09425429	0,48460868:0,551051538			
4,594564293	0,00445706 0,03167854			L
5,094874	0,0133304410,042156940			L
5,595183	0,00881966(0,03578292!			
6,59579837!	0,02071702 0,05351463			÷.,
7,09610525	0,04604432 0,04196800			
7,59641225	0,00860450:0,30574990(			
8,096718	0,03374410(0,24014045(			
9,10835058	3,57380511:3,40500001			
9,60855254	4,52404812 3,00802118			
10,10875654	4,41455609 5,54777106			
10,6089616	4,17788102 4,368311524			
11,1091656	4,52073052 4,69831950			
11,60936979	4,40688678: 5,369524114			
12,1095737	4,00325857 2,68035265			
12,6097785	4,23982462:4,02472104			
13,1099825	4,15141669(5,16357814			
13,6101875	3,28816630 6,25534494			
14,1103915	3,73372954 2,30272533!			
14,6105961	4,12277267 5,543301714			
15,1108011	3,28800828 2,69240036			
15,61100554	3,84814825: 1,44569890:			
16,1112105	4,18388818 3,70898669			
16,6114139	3,40536415(3,53427512)			
17,11161893	3,22931564 1,83469405			
17,6118222	3,74998605: 2,63798705:			
18,1120272	4,00617776 3,74073706			

# - measurements of the second part of the experiment;

# (measurement 1)

# (measurement 2)

Data	Metadata Device	Metada	Data	Metadata Device	Metada
Time (s)	Angular velocAcceleration (m/s^2)		Time (s)	Angular velocAcceleration (m/s^2)	
0,30590941	2,26085190 2,20122774:		0,30590941	2,26085190 2,20122774	
0,80613562	6,43582532: 3,727005228		0,80613562	2! 6,43582532: 3,727005228	
1,30636262	2,53706756: 3,65252777:		1,30636262	2! 2,53706756: 3,65252777:	
1,80659037	2,86843785 6,76632862		1,80659037	7! 2,86843785 6,766328628	
2,30681637	4,24620505: 3,92000655:		2,30681637	7! 4,24620505: 3,92000655:	
2,8070415	4,74052338 5,33896077!		2,8070415	5 4,74052338 5,33896077!	
3,3072675	3,26368409 2,86438229		3,3072675	5 3,26368409 2,86438229:	
3,80749391	3,12768102 1,735812983		3,80749391	1,73581298	
4,30771991	5,10630465 1,628299486		4,30771991	5,10630465 1,628299480	
4,80794429	3,15123845 2,87182893:		4,80794429	3,15123845 2,87182893:	
5,30816929	7,53982924 6,59312782		5,30816929	0.7,53982924 6,59312782	
5,80839366	3,67978448 0,70334004		5,80839366	5 3,67978448 0,70334004	
6,30861666	3,41691311 2,297500899		6,30861666	5 3,41691311 2,297500899	
6,80883991	1,92589598 2,92264706		6,80883991	1,92589598 2,92264706	
7,30906291	4,61958979! 1,590824898		7,30906291	1 4,61958979! 1,590824898	
7,80928612	3,98698691 3,272031530		7,80928612	2 3,98698691 3,272031536	
8,30951012	4,11928559: 8,477497398		8,30951012	2 4,11928559 8,477497398	
8,80973391	7,81476609 10,6370712		8,80973391	1 7,81476609 10,6370712	
9,30995991	3,42114391 1,05713673		9,30995991	1 3,42114391 1,05713673	

### (measurement 3)

Data	Meta	data Dev	vice	Metada
Time (s)	Angular velo	Acceleration (	m/s^2)	
0,30590941	2,26085190	2,20122774		
0,80613562	6,43582532	3,727005228		
1,30636262	2,53706756	3,65252777:		
1,80659037	2,86843785	6,766328628		
2,30681637	4.24620505	3,92000655		
2.8070415	4.74052338	5.33896077		1
3,3072675	3.26368409	2.86438229:		
3.80749391	3.12768102	1,73581298:		
4.30771991	5,10630465	1.628299486		
4.80794429	3,15123845	2.87182893		
5,30816929	7.53982924	6.59312782		
5,80839366	3.67978448	0.70334004		
6 30861666	3 41691311	2 297500899		
6 80883991	1 925895989	2 922647066		
7 30906291	4 61958979	1 590824895		
7,80928612	3 98698691	3 272031536		
8 30951012	4 11028550	8 477407305		
8 80073301	7 91476600	10 6270712		
0,009/3391	3 421142010	1 05713672		

# - measurement taken after changing the gears the second time:

# (measurement 1)

(measurement 2)

Data	Metadata Device	e N	Data	Metadata Device	N
Time (s)	Angular velocAcceleration (m/s/	<u>`2)</u>	Time (s)	Angular velocAcceleration (m/s^2)	
0,30590941	2,26085190 2,20122774		0,30590941	2,26085190 2,20122774:	
0,80613562	6,43582532: 3,72700522		0,80613562	6,43582532:3,727005221	
1,30636262	2,53706756: 3,65252777:		1,30636262!	2,53706756: 3,65252777:	
1,80659037	2,8684378546,766328628		1,80659037	2,8684378546,766328621	
2,30681637	4,24620505: 3,92000655:	1	2,30681637	4,24620505: 3,92000655:	
2,8070415	4,74052338 5,33896077!		2,8070415	4,74052338 5,33896077!	
3,3072675	3,26368409 2,86438229		3,3072675	3,26368409 2,86438229	
3,80749391	3,12768102 1,73581298:		3,80749391	3,12768102 1,73581298:	
4,30771991	5,10630465 1,628299480		4,30771991	5,10630465 1,628299480	
4,807944292	3,15123845 2,87182893:		4,807944293	3,15123845 2,87182893	
5,308169293	7,53982924 6,59312782:		5,308169293	7,53982924 6,59312782	
5,80839366	3,67978448 0,70334004:		5,80839366	3,67978448: 0,70334004:	
6,30861666	3,41691311 2,297500899		6,30861666	3,41691311 2,29750089	
6,80883991	1,92589598 2,92264706		6,80883991	1,92589598 2,92264706	
7,30906291	4,61958979! 1,59082489		7,30906291	4,61958979! 1,59082489	
7,80928612	3,98698691 3,272031530		7,80928612	3,98698691 3,272031530	
8,30951012	4,11928559: 8,47749739		8,30951012	4,11928559: 8,47749739	
8,80973391	7,81476609 10,6370712;		8,80973391	7,81476609 10,6370712:	
9,30995991	3,42114391 1,05713673		9,30995991	3,42114391 1,057136734	

### (measurement 3)

Data	Metadata Device	N
Time (s)	Angular velocAcceleration (m/s^2)	
0,30590941	2.26085190 2.20122774	- 1
0.80613562	6.43582532 3.72700522	- 1
1,30636262!	2.53706756; 3.65252777;	- 1
1,80659037	2.86843785 6.76632862	- 1
2,30681637	4,24620505; 3,92000655;	
2,8070415	4,74052338 5,33896077!	
3,3072675	3,26368409 2,86438229	
3,80749391	3,12768102 1,73581298:	
4,30771991	5,10630465 1,628299480	
4,807944293	3,15123845 2,87182893	
5,308169293	7,53982924 6,59312782:	
5,80839366	3,67978448 0,70334004:	
6,30861666	3,41691311 2,297500899	
6,80883991	1,92589598 2,92264706	
7,30906291	4,61958979! 1,590824898	
7,80928612	3,98698691 3,272031530	
8,30951012	4,11928559: 8,477497398	
8,80973391	7,81476609 10,6370712.	
9,30995991	3,42114391 1,057136734	

### • DISCUSSION

During the experiment we could see how, changing the gears of the bicycle, in all the measurements, the speed continued to increase.

Another thing that we noticed in doing the experiment is that, when we change the gears of the bicycle, in addition to increasing the speed also the angular velocity increases.

first part of the experiment	measurement 1	average: 0.06	
	measurement 2	average: 2.56	average: 2.16
	measurement 3	average: 3.88	
second part of the experiment	measurement 1	average: 3.66	
-	measurement 2	average: 3.87	average: 3.91

	measurement 3	average: 4.22	
last part (when we	measurement 1	average: 4.11	
gears)	measurement 2	average: 5.47	average: 4.6
	measurement 3	average: 4.22	

# • **REFLECTION**

**Conclusion**: By doing the experiment we understood that by changing the gears of the bicycle (from the lightest to the toughest) the speed of the means of transport increases and, with it, also the angular speed.

Comparison of the results of the different countries