Building a Bicycle-Powered Centrifuge

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Abstract

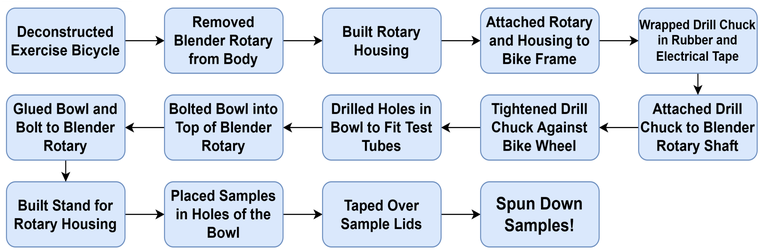
Centrifuges are very common instruments utilized in research and clinical settings. The purpose of a centrifuge is to separate the components of a mixture using centrifugal force. An example of a process that utilizes centrifugation is the acquisition of a hematocrit, where red blood cells are separated from blood plasma and the other cellular components. Industrial centrifuges are expensive and generally employed in academic or clinical contexts. A bicycle centrifuge, on the contrary, may be designed and implemented in more generalized settings. Moreover, a bicycle centrifuge affords the opportunity to relate principles in physics to concepts specific to other scientific disciplines, such as biology and kinesiology.

Methods, Materials, and Design

The primary design of this centrifuge was inspired by a bicycle powered blender built and demonstrated by FoodShare. Some of the primary materials included:

- An Exercise Bicycle
- Plywood
- A Blender
- A Plastic Bowl
- WeldBond Glue
- A Drill Chuck
- Electrical and Rubber Tape
- Wood Screws

Process:



Results

- The goal of this research project was to successfully centrifuge test samples of yeast and saliva.
- We were able to analyze the relationship between the angular velocity of the centrifuge chamber and the number of layers of rubber and electrical taping wrapped around the drill chuck. (Table 2)
- There was a positive relationship between the number of layers of rubber wrapped around the drill chuck and the angular speed achieved by the centrifuge chamber. (Figure 1)
- The maximal angular speed obtained by the bicycle centrifuge was approximately 2360 RPMs.
- This yields a ratio of 0.79 when compared to the angular speed suggested to centrifuge blood in 15 minutes.
- Calculations involving metabolic equivalents were applied to participants operating our bicycle centrifuge.
- Important factors in this calculation include the subject's body weight (in kg) and the number of calories expended per minute.
- This data is organized below.

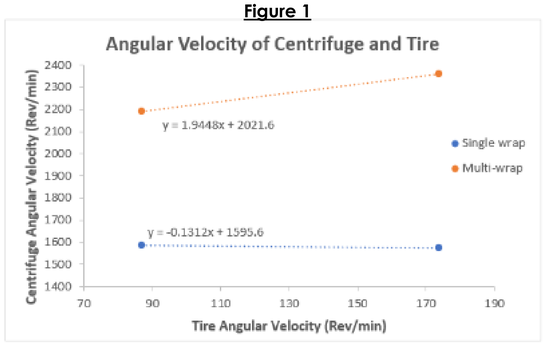
Table 1

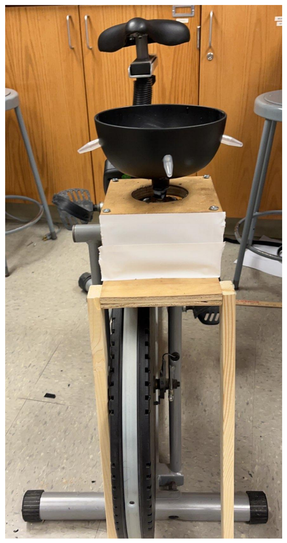
Time Duration	Speed	Rate of Caloric Expenditure	Metabolic Equivalents
15 seconds	10 mph	4 kcal/min	2.4 METs
15 seconds	15 mph	4 kcal/min	2.4 METs
30 seconds	10 mph	4 kcal/min	2.4 METs
30 seconds	15 mph	5 kcal/min	3 METs
60 seconds	10 mph	5 kcal/min	3 METs
60 seconds	15 mph	6 kcal/min	3.8 METs

Table 2

Condition	Centrifuge Speed	Bike Speed
Single Wrap	$14.1m/s \pm 0.4m/s$	$5mph$
Single Wrap	$14m/s \pm 0.3m/s$	$10mph$
Multi-wrap	$19.5m/s \pm 1m/s$	$5mph$
Multi-wrap	$21.0m/s \pm 1m/s$	$10mph$

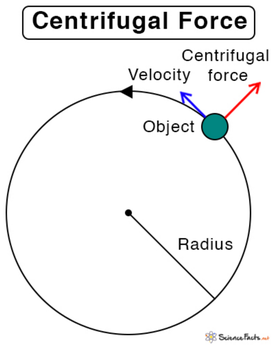
Figure 1

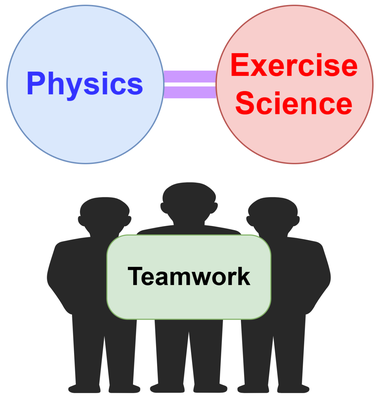




Applications

- Hands on learning experience for physics students
- Able to be completed in high school or college labs
- Encourages creative problem solving as students collaborate to overcome challenges
- Interconnect knowledge of physics and exercise science
- Create interest in mechanical design and engineering
- Application in classrooms and labs with a lack of resources or a small budget





Conclusion

- Successful separation of yeast and saliva samples of varying amounts.
- Demonstrated the relationship between pedaling duration, speed, caloric expenditure, and metabolic equivalents while centrifuging samples.
- Explored relationship and efficiency of pedaling speed to centrifuge speed via differing amounts of tape wrapping on the drill chuck positioned against the bike wheel.
- Applied methods of building a homemade centrifuge to alternative learning and real-world scenarios.
- Implemented inter-disciplinary ideas and techniques to demonstrate the relevance and importance of creative problem solving in the pursuit of knowledge.

Resources and Acknowledgements

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