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Applying Concepts of Physics 201 in Daily Workout Exercises

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ABSTRACT
Exercise and physical activity play a crucial role in maintaining overall health and wellbeing. However, many individuals may struggle to properly execute certain exercises or may not fully understand the mechanics behind certain movements. The purpose of this research paper is to explore the ways in which concepts of physics can be applied to daily workouts in order to enhance their effectiveness and efficiency. By understanding the principles of force, momentum, and energy, individuals can better understand how to optimize their exercise routines in order to achieve their desired results. This paper will review the relevant physics concepts and their applications in the context of exercise, as well as provide practical examples of how these principles can be incorporated into daily workouts. The aim is to provide a resource for fitness enthusiasts looking to improve their understanding of the underlying science behind their workouts and gain a competitive edge in their physical fitness endeavors.

KEYWORDS
Daily Exercise, Physics, Force, Energy, Hands-on experiment, Applications, workouts Algebra based Physics courses.

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I. INTRODUCTION

The regular practice of physical activity brings physical and mental well-being, in addition to contributing to the proper functioning of the heart, blood circulation, breathing, and even hormones. Physical exercises can be performed in many ways, there are exercises such as running, biking, HIIT, and bodybuilding. dancing. etc. By performing all these exercises, whether we realize it or not, we end up applying physics concepts in this day-to-day. In some exercises, we apply the concept of linear motion, or in others circular motion. Linear motion is the movement that a body or material point performs when moving only in straight paths, and circular motion is one in which an object or material point moves in a circular path. A centripetal force changes the direction of the velocity vector, being continuously applied toward the center of the circle. Taking this into account, I chose 11 exercises I perform on daily or weekly bases and applied the physics concepts of Phy 201 course I took in fall 2022 that I learned during the classes to optimize these exercises.

The exercises I picked are walking running, jogging, and elliptical to apply the linear motion concept, and jumping jacks, squats, Romanian deadlifts, leg extensions, leg press, crunches, lad pull down and regular jumping to apply the motion concept. During this research, many physical quantities are analyzed such as: The velocity of a body is the rate of change of its position as a function of time. Because it is a vector quantity, velocity has magnitude, direction, and direction. [1, 2] The module of velocity is its intensity, measured in SI in meters per second, and is associated with the concept of speed, period is called period the time required for a movement performed by a body to be repeated. For example, in a pendulum clock, the pendulum's period is determined by the time it takes to make the round-trip movement. The angular velocity of a particle or a rigid body describes the rate at which its orientation changes. [3] The centripetal acceleration is the acceleration caused by the variation in the direction of the velocity vector of a moving body, characteristic of curvilinear or circular motions. [4] The centripetal force is the force that pulls the body towards the center of the path in a curvilinear or circular motion. [5] Objects moving in uniform rectilinear motion have constant modular velocity.

II. MATERIALS AND METHODS

In order to conduct research on the application of physics principles to daily workouts, several materials were used. One of the main tools employed was a smartwatch, which was used to track the intensity and duration of various exercises, as well as to monitor heart rate and other biometric data. A stopwatch was also used to measure the time taken to complete certain exercises or workouts. In addition to these tools, a set of

20-pound dumbbells was used to perform various weightlifting exercises, while a measuring tape was used to measure distance and size.

Several pieces of gym equipment were also utilized in the research, including a leg extension machine, a leg press machine, an elliptical machine, and a lat pull-down machine. These machines allowed for the execution of various exercises that targeted specific muscle groups and involved the application of physics principles. For instance, the leg press machine utilizes the principles of work and energy to enable the user to push against a resistance, while the elliptical machine employs concepts of torque and angular momentum to enable a smooth, circular motion. Overall, these materials were essential for conducting research on the application of physics principles to daily workouts.

III. THEORY USED

The formulas used in this experiment were.

$V=D/t$ (1)

$K=1/2*mv^2$ (2)

$P=m*v$ (3)

$T = t/n$ (4)

$\omega = 2*pi/T$ (5)

$v = r*\omega$ (6)

$Ac = v^2/r$ (7)

$Fc = m*ac$ (8)

During these experiments, as previously mentioned, two theories were used. The theory of linear motion encompasses the speed stipulated by the equation v=D/t where velocity is the ratio of the distance, traveled to the time it travels. In equation one v, d and t are speed, distance, and time respectively. In the second equation, K, m, and v are Kinetic energy, mass, and speed respectively. In equation three P, m and v represent momentum, mass, and speed, respectively. In equation four T, t, and n represent the period, time, and the number of repetitions respectively. Equations five to eight fall in the circular motion theory. The equations of Circular motion formulas were also used, including the equation of the period (T), the frequency angles (ω), the angular velocity (v), the centripetal acceleration (Ac), and centripetal force (Fc). Work is the amount of force required to move an object a certain distance, described by the equation W = Fd, and is measured in Newton per meter.

IV. DETAILS OF THE PROJECT

During this project, my goal is to see how concepts of physics of speed, work, and momentum can be implemented in daily workouts exercises. To do this project I picked 11 different workout exercises that I practice in my daily life and interested to examined them. The details of those 11 exercises are shown in the Table A below with workout figures shown from Figures 1-11. [6-17]

Table A – Exercises picked.

Figure 1. Walking [13]	Exercise 1- Walking The first exercise chosen was walking. In order to analyze the velocity given by the linear motion equation. Three qualitatively different velocities were chosen (slow, fast, and normal) and the velocity, momentum, and kinetic energy expended were calculated quantitatively.

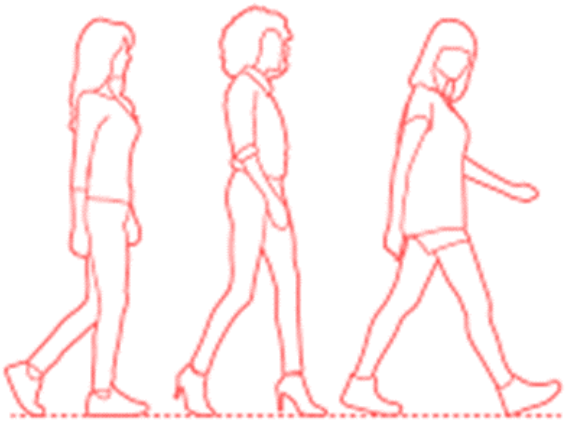
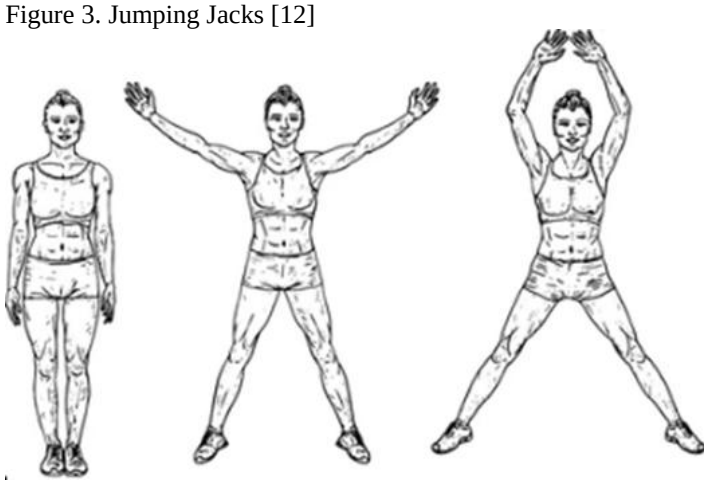


Figure 2. Running [11]

The second and third exercises chosen were running and jogging where the same parameters mentioned above were calculated.

Figure 3. Jumping Jacks [12]



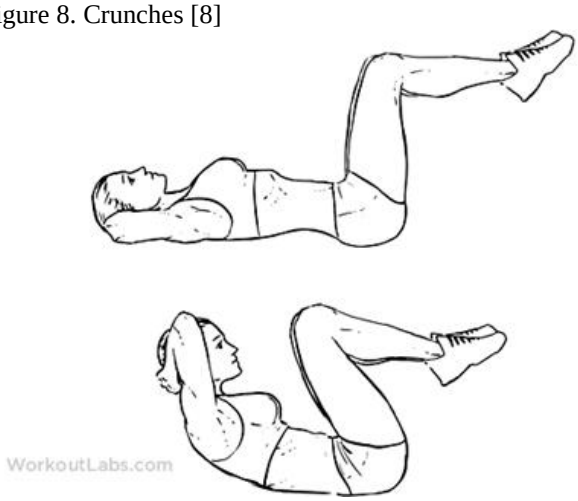
Exercise 4 Jumping Jacks
The fourth exercise, known as the jumping jacks, is carried out by leaping into a position where the legs are spread wide, and the hands are raised aloft, often in the shape of a clap. Then, the performer jumps back into the place where the feet are together, and the arms are at the sides.

Figure 4. Sumo Squats [14]

Exercise 5 Squats
The fifth exercise chosen was the squat, which is a strength exercise in which the practitioner lowers the hips from a standing position and then stands up. To enhance this movement, 20lbs dumbbells were added.

	
Figure 5. Deadlift [10]	The sixth exercise chosen was the deadlift, which consists of a bodybuilding exercise in which a loaded barbell is lifted from the floor to the hips, then lowered back to the floor. To enhance this exercise, a total of 40lbs dumbbells (20lbs on each side) were added
	
Figure 6. Leg extensions [9]	The seventh exercise chosen was the Leg extensions, which was performed usually done with a lever machine. this exercise consists of sitting on a padded seat and raising a padded bar with your legs. The exercise aims to work the quadriceps muscles of the front of the thigh. To enhance this exercise, a 41kg weight was used.
	
Figure 7. Leg press [15]	The eighth exercise is the leg press which like the leg extension is performed on a leg press machine and is performed by pushing a weight (in this case 72kg) away from them using the legs.

Figure 8. Crunches [8]



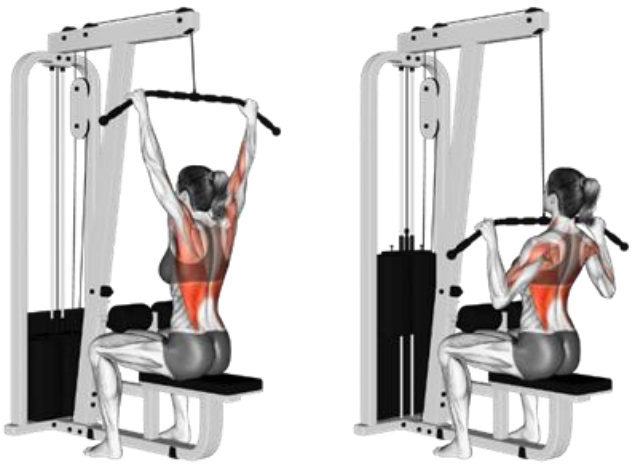
Crunches were the night exercise picked. They are an exercise that works the abdominal muscles and is performed by lying down on your back planting the feet on the floor, hip-width apart, bending the knees and placing your arms across the chest, finally contracting your abs and inhaling

Figure 9. Elipticall [7]

The elliptical machine simulates a walk/run (depending on the intensity applied) but instead of being in free space it is performed on a machine where it is possible to regulate the intensity of the movement

Figure 10. Lat exercises [16]

The 11th exercise chosen was the lat pull down which works the arms, shoulders, and back. Is performed by pulling a hanging bar toward you to reach chin level, then releasing it back up with control for one repetition, while



seated. These exercises were performed with the addition of 18 kg

Figure 11. Jumping [17]

The last exercise chosen was jumping. Jumping can be defined as lifting our body weight from the ground.

V. RESULTS

Linear Motion Exercises:

Linear motion is the movement that a body or material point performs when moving only in straight paths. In this movement, the direction of the velocity vector is constant. The exercises used to show the practical application of this concept in everyday life were walking (at three different speeds), running, jogging, and elliptical. During these exercises, time and distance were measured, and later using the formulas presented in the theory section, velocity, kinetic energy, and momentum were calculated. All these detailed calculated data including raw data can be seen in the tables from Table 1-11.

Table 1: Data Details of Linear motion exercises

For linear motion	D (miles)	t (min)	D (m)	t (s)	v (m/s)	m(kg)	P=mv (Ns)	KE (J)
Walking slow	1.06	23.45	1705.0	1407	1.21	72	87.29	52.92
Walking medium	0.52	9.46	836.8	567	1.47	72	106.15	78.25
Walking fast	0.59	9	949.5	540	1.75	72	126.60	111.30
Running	0.24	2.23	386.2	133.8	2.8	72	207.84	299.98
Jogging	0.59	10.1	949.5	606	1.56	72	112.81	88.38

Eliptical	0.88	15.35	1416.2	921	1.55	72	110.72	85.12

Circular Motion Exercises:

Circular motion is found in various movements of the human body such as flexion, abduction, elevation, and rotation, among others. Human body movements imply moving a part of the human body from one location to another. To apply. To show the practical application of the physics concept of circular motions the exercises jumping jacks, squats, Romanian deadlifts, leg press, lat pull downs, crunches, and jumping were chosen. During these exercises, the time, distance, and number of repetitions were measured, and later, using the formulas presented in the theory section, tension, work, centripetal acceleration, and centripetal force were calculated.

Table 2: Data Details of Jumping Jacks

Jumping jacks	t(s)	T = t/n (s)	n	w = 2*pi/T (rad/s)	r (m)	v = r*w (m/s)	ac = v^2/r (m/s^2)	m(kg)	Fc = m*ac (N)
Trial 1	60	1.2	50	5.22	0.7	3.66	19.17	72	1380.3
Trial 2	60	1.17	51	5.33	0.7	3.73	19.94	72	1436.1
Trial 3	60	1.22	49	5.12	0.7	3.59	18.41	72	1325.6
Trial 4	60	1.17	51	5.33	0.7	3.73	19.94	72	1436.1
Trial 5	60	1.27	47	4.91	0.7	3.44	16.93	72	1219.6
Average	60	1.21	49.6	5.19	0.7	3.63	18.86	72	1358.3

Table 3: Data Details of Squats

Squats	t(s)	T = t/n (s)	n	w = 2*pi/T (rad/s)	r (m)	v = r*w (m/s)	ac = v^2/r (m/s^2)	m(kg)	Fc = m*ac (N)
Trial 1	60	1.27	47	4.91	0.46	2.26	11.13	46	512.1
Trial 2	60	1.31	46	4.81	0.47	2.26	10.89	47	512.1
Trial 3	60	1.33	45	4.71	0.52	2.44	11.53	52	599.8
Trial 4	60	1.57	38	3.97	0.46	1.82	7.27	46	334.7
Trial 5	60	1.46	41	4.29	0.45	1.93	8.28	45	372.9
Average	60	1.39	43.4	4.54	0.47	2.14	9.74	47.2	459.7

Table 4: Data Details of Romanian Deadlift

RDL	t(s)	T = t/n (s)	n	w = 2*pi/T (rad/s)	r (m)	v = r*w (m/s)	ac = v^2/r (m/s^2)	m(kg)	Fc = m*ac (N)
Trial 1	60	4	15	1.57	0.54	0.84	1.33	91.14	138.02
Trial 2	60	3.75	16	1.67	0.54	0.90	1.51	91.14	121.31
Trial 3	60	4	15	1.57	0.54	0.84	1.33	91.14	121.31
Trial 4	60	4	15	1.57	0.54	0.84	1.33	91.14	155.81

Trial 5	60	3.52	17	1.77	0.54	0.94	1.71	91.14	155.81
Average	60	3.85	15.6	1.63	0.54	0.88	1.43	91.14	138.45

Table 5: Data Details of Leg Extensions

Leg Extensions	t(s)	T = t/n (s)	n	w = 2*pi/T (rad/s)	r (m)	v = r*w (m/s)	ac = v^2/r (m/s^2)	m= 36+61(kg)	Fc = m*ac (N)
Trial 1	60	2.72	22	2.30	0.7	1.61	3.71	97	360.02
Trial 2	60	2	30	3.14	0.7	2.19	6.90	97	669.46
Trial 3	60	5	12	1.25	0.7	0.87	1.10	97	107.11
Trial 4	60	2.14	28	2.93	0.7	2.05	6.01	97	583.18
Trial 5	60	2.72	22	2.30	0.7	1.61	3.71	97	360.02
Average	60	2.91	22.8	2.38	0.7	1.67	4.28	97	415.96

Table 6: Data Details of Leg Press

Leg press	t(s)	T = t/n (s)	n	w = 2*pi/T (rad/s)	r (m)	v = r*w (m/s)	ac = v^2/r (m/s^2)	m= 36+ 72 (kg)	Fc = m*ac (N)
Trial 1	60	2.5	24	2.51	0.45	1.13	2.83	108	306.67
Trial 2	60	2	30	3.14	0.45	1.41	4.43	108	479.17
Trial 3	60	2.14	28	2.93	0.45	1.31	3.86	108	417.41
Trial 4	60	2.14	28	2.93	0.45	1.31	3.86	108	417.41
Trial 5	60	2.72	22	2.30	0.45	1.03	2.38	108	257.6
Average	60	2.30	26.4	2.76	0.45	1.24	3.47	108	375.6

Table 7: Data Details of Crunches

Crunches	t(s)	T = t/n (s)	n	w = 2*pi/T (rad/s)	r (m)	v = r*w (m/s)	ac = v^2/r (m/s^2)	m(kg)	Fc = m*ac (N)
Trial 1	60	1.33	45	4.71	0.45	2.11	9.98	36	359.38
Trial 2	60	1.25	48	5.02	0.45	2.26	11.35	36	408.89
Trial 3	60	1.53	39	4.08	0.45	1.83	7.49	36	269.97
Trial 4	60	1.71	35	3.66	0.45	1.64	6.03	36	217.40
Trial 5	60	1.5	40	4.18	0.45	1.88	7.88	36	283.95
Average	60	1.48	41.4	4.33	0.45	1.94	8.55	36	307.91

Table 8: Data Details of Lat Pull-Down

Lat pull down	t(s)	T = t/n (s)	n	w = 2*pi/T (rad/s)	r (m)	v = r*w (m/s)	ac = v^2/r (m/s^2)	m(kg)	Fc = m*ac (N)
Trial 1	60	2.5	24	2.512	0.45	1.13	2.83	56	153.3
Trial 2	60	2	30	3.14	0.45	1.41	4.43	56	239.58
Trial 3	60	2.14	28	2.93	0.45	1.32	3.86	56	208.71
Trial 4	60	2.14	28	2.93	0.45	1.32	3.86	56	208.71
Trial 5	60	2.72	22	2.30	0.45	1.03	2.38	56	128.8
Average	60	2.30	26.4	2.76	0.45	1.24	3.47	56	187.8

Table 9: Data Details of Jumping

Jumping	t(s)	T = t/n (s)	n	w = 2*pi/T (rad/s)	r (m)	v = r*w (m/s)	ac = v^2/r (m/s^2)	m(kg)	Fc = m*ac (N)
Trial 1	60	1.01	59	6.17	0.25	1.54	9.53	72	686.42
Trial 2	60	1	60	6.28	0.25	1.57	9.86	72	709.89
Trial 3	60	1.05	57	5.96	0.25	1.49	8.89	72	640.67
Trial 4	60	1.03	58	6.07	0.25	1.51	9.21	72	663.35
Trial 5	60	1	60	6.28	0.25	1.57	9.85	72	709.89
Average	60	1.02	58.8	6.15	0.25	1.53	9.47	72	682.04

VI. DISCUSSION

For the linear motion exercise, I chose walking, running, jogging, and elliptical experiment. One can buy the elliptical exercise that was done on a machine in an enclosed space with the walking, running, and jogging that were done in open spaces. we can observe that by the speed that the elliptical exercise had the speed most similar to jogging with 1.56 m/s, 1.55 m/s respectively. This information can be useful when choosing an indoor exercise to replace an outdoor exercise because it proves to us that although these two exercises are different, they can bring the same result.

To apply the concepts of circular motion, exercises were chosen, jumping jacks, squats, Romanian deadlifts (RDLs), leg extensions, leg press, crunches, Lat pull down and jumping which are considered strength training mainly squats, Romanian, deadlifts, leg extensions, leg press (where you hear adding weights in addition to body weight) on and they fall under the second law of physics. Moving a heavy mass with minimal acceleration will produce one type of strength. This can be observed in the sport of powerlifting, in which athletes compete to lift the most weight in the barbell deadlift, barbell squat and barbell bench press. Rapidly accelerating a mass generates a significant amount of power, which can be seen in the barbell snatch and barbell clean-and-jerk performed in the sport of Olympic weightlifting. Knowing the exact values of acceleration, work and power (obtained through the physical formulas displayed in the theory section) is essential to know what the best speed and best weight is to obtain desired results, whether they be more muscle development or more energy expenditure. energy. For example, in the table of crunches we can see that we had the lowest number of centripetal force (with an Fc= 307.91 N average) spending less energy in general however the angular speed (w average of 4.33 rad/s) necessary to execute this movement was higher than means that despite consuming less energy in general, the muscle was worked more (which is essential for the development of this muscle) because it had the lowest period (average T = 1.48) which means a greater time of contraction of the muscle remembering that those muscles are programmed to contract by the nervous system. Doing the same weights for the same reps at the same time. Training the muscles to increase their overall force output will then, according to

the laws of physics, help you maximize the return on your time invested in exercising. Thus, to get the greatest benefits from your workouts, it is important to do a variety of different types of exercise so that your body is exposed to a variety of different forces. That's why diversified exercises were chosen to cover most of our body's muscles.

Table 10: Summary of exercise with the highest values for circular motion

	w = 2*pi/T (rad/sec)	v = r*w (m/s)	ac = v^2/r (m/s^2)	Fc = m*ac (N)
Jumping jacks	5.19	3.63	18.86	1358.30
Squats	4.54	2.14	9.74	459.70
Leg Extension	2.38	1.67	4.28	415.96
Jumping	6.15	1.53	9.47	682.04

The table above expresses the exercises where I obtained the highest values of angular velocity, linear velocity, centripetal acceleration, and centripetal force.

Table 11: Summary of exercise with the highest values for linear motion

For linear motion	v (m/s)	P=mv (Ns)	KE (J)
Walking fast	1.76	126.60	111.30
Running	2.89	207.84	299.98
Jogging	1.56	112.81	88.38

The table above expresses the maximum values of speed, momentum, and kinetic energy for linear motion exercises.

This study highlights the importance of using physics to analyze exercises every day since Whenever we lift weights, we are exerting force against the barbell. In physics, we measure force using Newton's Second Law of Motion via the equation f = ma or put differently, force is equal to mass multiplied by acceleration. To generate more force, we must either increase mass or acceleration (or both). We measure force in terms of Newton's (N) which we can also translate into other measurements including horsepower Velocity is the rate at which an object travels a specific distance in a certain time. When we know what our objective is (losing weight or gaining mass), physics helps us to reach the ideal speed and load to perform these movements.

This information may also be used in the future to emphasize just about any muscle group in a given compound movement. Furthermore, these concepts can be applied to justify various issues related to the muscles used during an exercise, for example, justify the reasons why the calves are so hard to build. This knowledge can also be used to modify exercises based on desired results.

VII. CONCLUSION

By analyzing the data collected for 11 exercises for motion of body for linear motion and circular motion, it can be said that concepts of Physics, specially, the Physics I can be applied in our daily life. From the data obtained for linear motion, it can be seen that the highest KE was acquired when performing running (KE= 299.9 J) despite being the one that took the least time (133.8 J), being able to reach the conclusion that if the objective is to spend more energy performing short exercises at a higher speed is more effective than long exercises at a lower speed. It is also concluded that physical indoor exercises are more similar to outdoor jogging and the elliptical. For circular motion exercises, which are consistent with exercises more focused on bodybuilding, the trials that obtained the highest values were Fc =1358.3 N in the jumping jacks' experiment, Fc = 459.7 N in the squats, and Fc =682.4 N for jumping. I believe that the jumping jacks had the highest involvement of the whole body as we use the whole body to perform this movement (which means greater mass) and the repetitions were the highest, which uses more calories or energy. The squats are in third place because the repetitions were also higher and in third place the less press because that's where I managed to use the

highest number of external loads (72 kg more). All exercises were repeated in 5 trials in order to minimize errors and compare the trials with each other and have a better idea of how physics is applied in everyday exercises.

Overall, the experiment went very well. It was possible to see physics in every day's life day-to-day activities and to understand more concepts that normally remain only in theories in the classroom in practical situations. It is known that Physics improves our quality of life by providing the basic understanding necessary for developing new instrumentation and techniques for medical applications, such as computer tomography, magnetic resonance imaging, positron emission tomography, ultrasonic imaging, and laser surgery. And being able to see this more directly in exercises that I already applied in day-to-day life was extremely important for deepening and learning the concepts of physics 1 learned during classes.

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