Using Excel sheet to calculate the errors in Physics experiments

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Abstract:

***Teaching Physics** is fascinating to the young undergraduates. As the subject is close to nature, the concepts can be well described, explained and demonstrated with the real-life situations. As it is an application-oriented subject, learners would appreciate it better if it is a demonstrative lecture instead of a pure lecture method. With my teaching experience spanning more than three decades, experimenting with different methods of teaching, evolving different procedures, I have found **simulations** are of great help. They provide a comprehensive understanding of the concepts with a scope for exploring. The present situation of the whole world experiencing **COVID-19 pandemic conditions**, these simulations allowed to continue the learning process without any interruption. In this paper the simulation of a simple pendulum and experimental determination of acceleration gravity in different planets is explained. Also the error estimation in the calculations and plotting of a **Normal distribution** curve with the help of **Excel sheet** is explained.*

*Key words:**Teaching Physics,Simulations, COVID-19 pandemic conditions,Normal distribution, Excel sheet.***

Introduction:

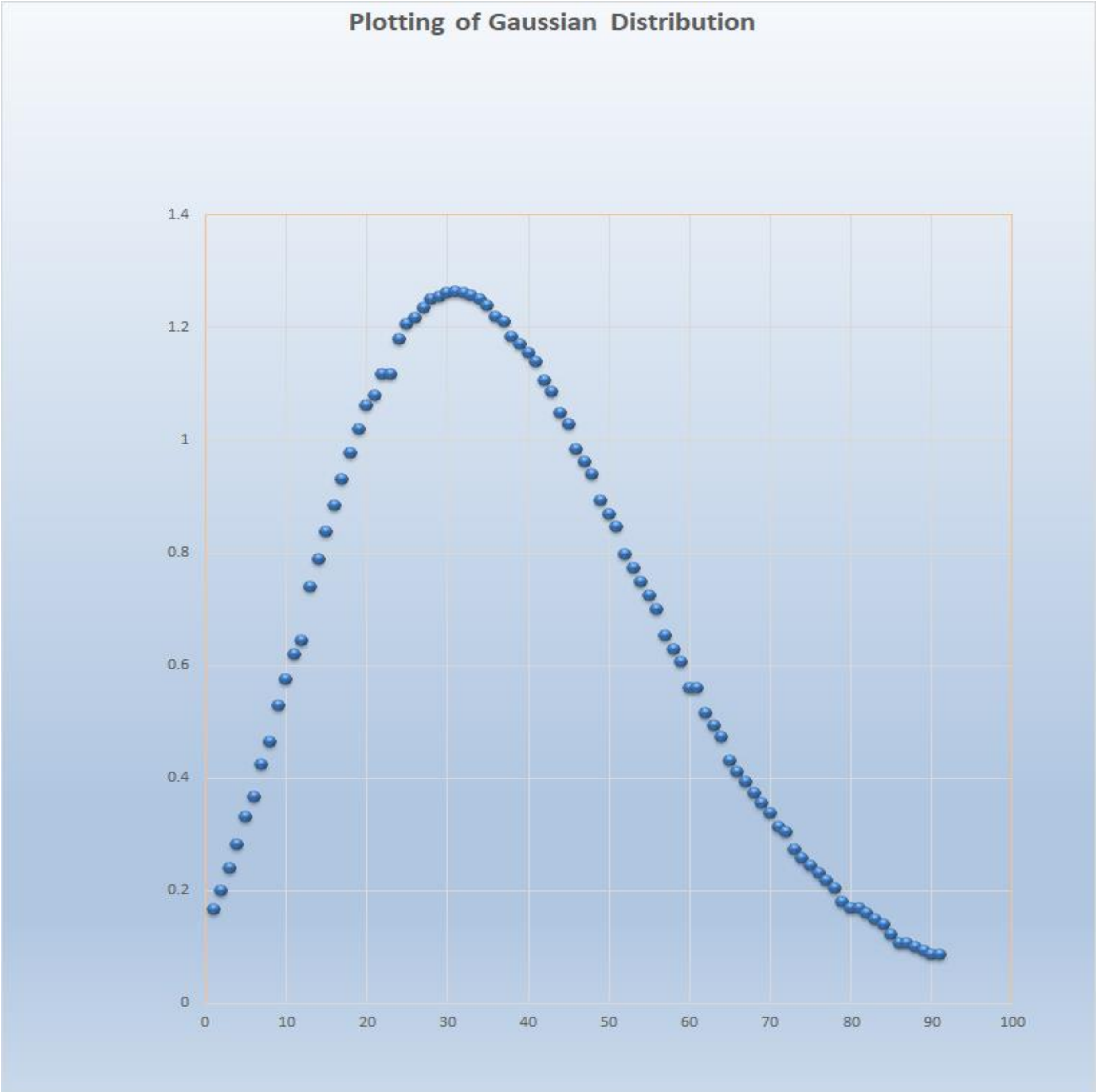
When a particular experiment is performed, record the observations and calculate a given parameter, one tends to get a value different from the actual value. That means there is a deviation from the actual results. This deviation is referred to as the error in calculation. For example, if we perform a simple pendulum experiment to calculate the acceleration due to gravity, the expected value is 9.8 m/sec^2. Most often one doesn't get an accurate value. There are many reasons for this: inaccuracy in taking the observations, place where the experiment is conducted, the observer's ability to take precise values. The experiment is considered accurate if it is performed correctly, not the one which gives a value close to the actual value. Precision and accuracy are very important in conducting experiments. Precision can be the possible errors in the result of an observation, accuracy refers to the error in the results due to variations in the laboratory equipment, place where it is conducted. The best experiment is the one which reduces the gap between precision and accuracy. [1,2]]

Possible errors in Simple pendulum experiment: The proper timing of starting and stopping a stop watch, counting the number of oscillations, instrument error,random error.

Due to pandemic conditions, I have introduced simulations and virtual laboratories to my students with which the the present experiment on Simple Pendulum and calculation of 'g', the acceleration due to gravity was carried out.

Students were asked to perform the experiment at different times, with large number of sample data, and instructed to plot the graph using excel, plotting normal distribution. The results were very encouraging and a smooth distribution was obtained.

Scope and extendibility: The experiment can be performed on different planets like Mercury, Jupiter, Moon and compared with the theoretical values. There is also a provision for varying the mass of the bob and observe the changes. With these simulations, students are able to get the overview of the experiment and the behaviour of the pendulum on different planets.



Ref [3]

Plotting Gaussian Distribution - Simple pendulum				
Length (L) in m	Time Period T in secs	Normal Distribution	Mean	Standard Deviation
0.1	0.63	0.165605	1.2668	0.3159365
0.11	0.66	0.199635		
0.12	0.69	0.238499		
0.13	0.72	0.282371		
0.14	0.75	0.331313		
0.15	0.77	0.366725		
0.16	0.8	0.423869		
0.17	0.82	0.464498		
0.18	0.85	0.528869		
0.19	0.87	0.573785		
0.2	0.89	0.620026		
0.21	0.9	0.643558		

0.22	0.94	0.739515		
0.23	0.96	0.787982		
0.24	0.98	0.836268		
0.25	1	0.883962		
0.26	1.02	0.93064		
0.27	1.04	0.975865		
0.28	1.06	1.019194		
0.29	1.08	1.06019		
0.3	1.09	1.079679		
0.31	1.11	1.116377		
0.32	1.11	1.116377		
0.33	1.15	1.179295		
0.34	1.17	1.204808		
0.35	1.18	1.215942		
0.36	1.2	1.234802		
0.37	1.22	1.24894		
0.38	1.23	1.254184		

0.39	1.25	1.260941		
0.4	1.26	1.262435		
0.41	1.28	1.261631		
0.42	1.3	1.255784		
0.43	1.31	1.25099		
0.44	1.33	1.23773		
0.45	1.35	1.219713		
0.46	1.36	1.208985		
0.47	1.38	1.184247		
0.48	1.39	1.170308		
0.49	1.4	1.155375		
0.5	1.41	1.139491		
0.51	1.43	1.105048		
0.52	1.44	1.086584		
0.53	1.46	1.047425		
0.54	1.47	1.026834		
0.55	1.49	0.983897		

0.56	1.5	0.96166		
0.57	1.51	0.938984		
0.58	1.53	0.892538		
0.59	1.54	0.868876		
0.6	1.55	0.844996		
0.61	1.57	0.796787		
0.62	1.58	0.772562		
0.63	1.59	0.748323		
0.64	1.6	0.724119		
0.65	1.61	0.699997		
0.66	1.63	0.652172		
0.67	1.64	0.628555		
0.68	1.65	0.605185		
0.69	1.67	0.559338		
0.7	1.67	0.559338		
0.71	1.69	0.514896		
0.72	1.7	0.493275		

0.73	1.71	0.47209		
0.74	1.73	0.431111		
0.75	1.74	0.411357		
0.76	1.75	0.392115		
0.77	1.76	0.373398		
0.78	1.77	0.355219		
0.79	1.78	0.337587		
0.8	1.795	0.312179		
0.81	1.8	0.30399		
0.82	1.82	0.272641		
0.83	1.83	0.257814		
0.84	1.84	0.243548		
0.85	1.85	0.229841		
0.86	1.86	0.216689		
0.87	1.87	0.204084		
0.88	1.89	0.180489		
0.89	1.9	0.16948		

0.9	1.9	0.16948		
0.91	1.91	0.158984		
0.92	1.92	0.148988		
0.93	1.93	0.13948		
0.94	1.95	0.12188		
0.95	1.97	0.106075		
0.96	1.97	0.106075		
0.97	1.98	0.09881		
0.98	1.99	0.09195		
0.99	2	0.085481		
1	2	0.085481		

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4.