

**AMERICAN INTERNATIONAL UNIVERSITY – BANGLADESH**

**FACULTY OF SCIENCE & TECHNOLOGY**

**DEPARTMENT OF PHYSICS**

**PHYSICS LAB**

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**Section: B21, Group:08**

**LAB REPORT ON**

Verification of newton’s second law of motion by Atwood machine.

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|  |  |  |
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**1. Theory**

Newton’s second of motion tells that force causes acceleration and the relationship between net force acting on an object, Fnet and its acceleration , a is: Fnet = ma , where m is the mass of that object.

In Atwood machine, two masses m and M are suspended by a piece of inelastic light string that passes over a pulley in a vertical plane as the fig. 2.1 shows. The two masses are connected with a string, because of this, they must have same tension, T and acceleration, a .

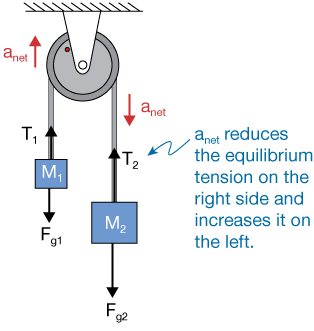


Figure 2.1: Arrangement of an Atwood machine. Here M1>M2

Considering the upward direction as positive, neglecting friction and mass of the pulley and applying Newton’s second law of motion we get

for M : Fnet = T – Mg = – Ma

for m : Fnet = T – mg = ma

Solving these two equations, we get the theoretical acceleration as

a th = (M-m)

As acceleration due to gravity g is constant in a particular place and taking total mass (M+m) constant for the Atwood machine, according to Newton’s second law we get

a th ∝ (M-m)

According to fig. 2.1 the mass M falls a distance D in time t from rest. Applying the knowledge of equations of motion (D = ut +1/2 at2 ), we can calculate the experimental acceleration by

aex =

For different mass combination, (M-m) we will get different experimental accelerations, aex. If we find a linear relationship between aex and (M-m) for the Atwood machine, we can say that Newton’s second law is verified.

**2.** **Apparatus**

* Pulley
* Two hangers
* Different masses
* String
* Stand and clamp
* Meter scale
* Stop watch

**3. Procedure**

* We hold the lighter mass on the floor attached to one end of a string. The heavier one attached to the other end of the string is up in the air at a height D from the floor. Measure D with a meter scale.
* Now we release the lighter mass and measure the time the heavier mass takes to fall onto the floor. Run the experiment for 7 different mass-differences, (M - m). For each run, obtain the value of the acceleration in (m/s2) experimentally as well as theoretically. Then we make sure to keep total mass (M + m) always constant.
* We are using Excel plot acceleration (ath and aex) versus mass difference (M - m) graph.

**4. Experimental Data**

**Table 2.1: Acceleration for different mass combination.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **M**  **(gm)** | **m**    **(gm)** | **Height**  **D**  **(cm)** | **Time**  **t**  **(s)** | **Mean**  **Time**  **t**  **(s)** | **aex =**  **( cm.s-2)** | **ath=**  **( cm.s-2)** | **(M – m)**  **(gm)** |
| 500 | 200 | 78.8 | 0.56 | 0.563 | 497.2095063 | 420.4286 | 300 |
| 0.58 |
| 0.55 |
| 475 | 225 | 78.8 | 0.61 | 0.627 | 400.8862231 | 350.3571 | 250 |
| 0.63 |
| 0.64 |
| 450 | 250 | 78.8 | 0.76 | 0.75 | 280.1777778 | 280.2857 | 200 |
| 0.74 |
| 0.75 |
| 425 | 275 | 78.8 | 0.80 | 0.813 | 238.4378087 | 210.2143 | 150 |
| 0.82 |
| 0.82 |
| 400 | 300 | 78.8 | 0.90 | 0.913 | 189.066532 | 140.1429 | 100 |
| 0.91 |
| 0.93 |
| 375 | 325 | 78.8 | 1.09 | 1.093 | 131.9215937 | 70.0714 | 50 |
| 1.10 |
| 1.09 |
| 350 | 350 |  | 0 |  | 0 | 0 | 0 |

**5. Analysis and Calculation**

1. **The slope of the straight line :**

From the graph –

Slope = = 1.258

Or, M+m = = 779.8092 gm

1. Error = = 11.4013%

**6. Result**

From the ‘acceleration vs mass difference’ graph, the relationship between experimental

acceleration and mass difference is linear for the Atwood machine same as the

theory says. Thus, we can say that Newton’s second law is verified.

**7. Discussion**

1. Readings might not have been taken to eye level for measuring height.
2. Reaction time while taking reading from stop-watch might have affected our result.
3. We take minimum 3 reading of time from a stop-watch and then calculate mean value to minimize errors.
4. As there are lots of variable, calculation should be done carefully.
5. The string was not moving freely because of some frictional problem.

**8. References**

* **Fundamental of Physics (10th Edition):**

Newton’s second law of motion (Chapter 5, page 98-109)

* **Video Links:**
* Newton’s second law: https://www.youtube.com/watch?v=xzA6IBWUEDE
* Atwood Machine: https://www.youtube.com/watch?v=a0KVxh8iPP