Design and analysis of Experiment

MEASURING THE HEIGHT A BALL RISES AFTER BEING DROPPED

IC 211 project
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The Experiment

- Experiment planning to maximize the bounce of some ball
- Problem : I want to measure the height a ball rises(B – Bounce of ball) as a function of (type of ball(T), height from which it is thrown(H), air pressure inside the ball(P), and the nature of surface on which it is dropped(N))
- From a given set of values of T, P, H and N I would like to determine the maximum bounce that it gets “B”

Identifying the control factors

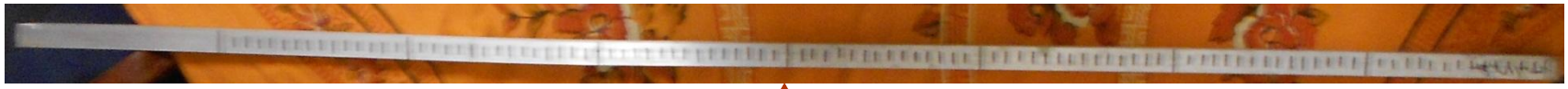
Level	T (Type of ball)	P (Pressure inside the ball)	H (Height from which it is dropped)	N (Nature of surface)
Level 1	Football	Low Presure	45cm	Bare Ground
Level 2	Basketball	Normal Pressure	75cm	Grass Surface
Level 3	Volleyball	High Pressure	105cm	Concrete Floor

Identifying the noise factor

- A noise factor which can affect the measured output but we have no control over it in this case is
- Irregularities in surface, wind speed, humidity of soil etc over which we have no control
- Therefore I have done the experiment three times in different times and different parts of the surface(grassy ground, bare ground or concrete floor) to average out the irregularities.

Prepare for experiment and measurement

- Create 3 values for each parameter as mentioned in the control factors
- Apparatus : Football , Volleyball, Basketball, A 105cm long scale, and a pump for setting the pressure of the football, and a video-camera.



105cm ruler (took a rod, and marked points on it with the help of a 15cm ruler)

Air pump (from Hostel) to vary the pressure. Tried to get a pressure measuring equipment desperately, but couldn't find out which could measure the pressure of a football, so used this to set the pressure to approximately low pressure, medium pressure or high pressure

Vid Camera

Planning the experiment

Exp No	T	P	H	N
1	Football	Low	45cm	Bare
2	Football	Med	75cm	Grass
3	Football	High	105cm	Floor
4	Basketball	Low	75cm	Floor
5	Basketball	Med	105cm	Bare
6	Basketball	High	45cm	Grass
7	Volleyball	Low	105cm	Grass
8	Volleyball	Med	45cm	Floor
9	Volleyball	High	75cm	Bare

This planning is achieved using the magic square method

Procedure of experiment

- Take appropriate ball.
- Set the pressure of the ball as desired using the air-pump
- Throw the ball from the required height using the ruler on required surface, and record a good-quality video of the experiment
- Conduct all the experiments in a similar manner
- Analyze the video carefully to find out the bounce of the ball, i.e. the height to which it rises in each case.

Conducting the exp and collecting the data

T	P	H	N	V1	V2	V3	V
Football	Low	45cm	Bare	17	17	16	16.66
Football	Med	75cm	Grass	40	38	39	39
Football	High	105cm	Floor	62	63	62	62.33
Basketball	Low	75cm	Floor	35	36	34	35
Basketball	Med	105cm	Bare	61	63	62	62
Basketball	High	45cm	Grass	31	29	29	29.66
Volleyball	Low	105cm	Grass	29	33	31	31
Volleyball	Med	45cm	Floor	32	32	31	31.66
Volleyball	High	75cm	Bare	51	52	52	51.66

Analyzing the measured data

- Factor effect for different types of ball

  Football-39.33

  Basketball-42.22

  Volleyball-38.11

- Factor effect for Air pressure inside the ball

  Low Pressure- 27.55

  Normal Pressure – 44.22

  High Pressure- 47.88

Analyzing the measured data

- Factor effect for different heights of the ball

  45cm-26

  75cm-41.88

  105cm-51.77

- Factor effect for different types of surface

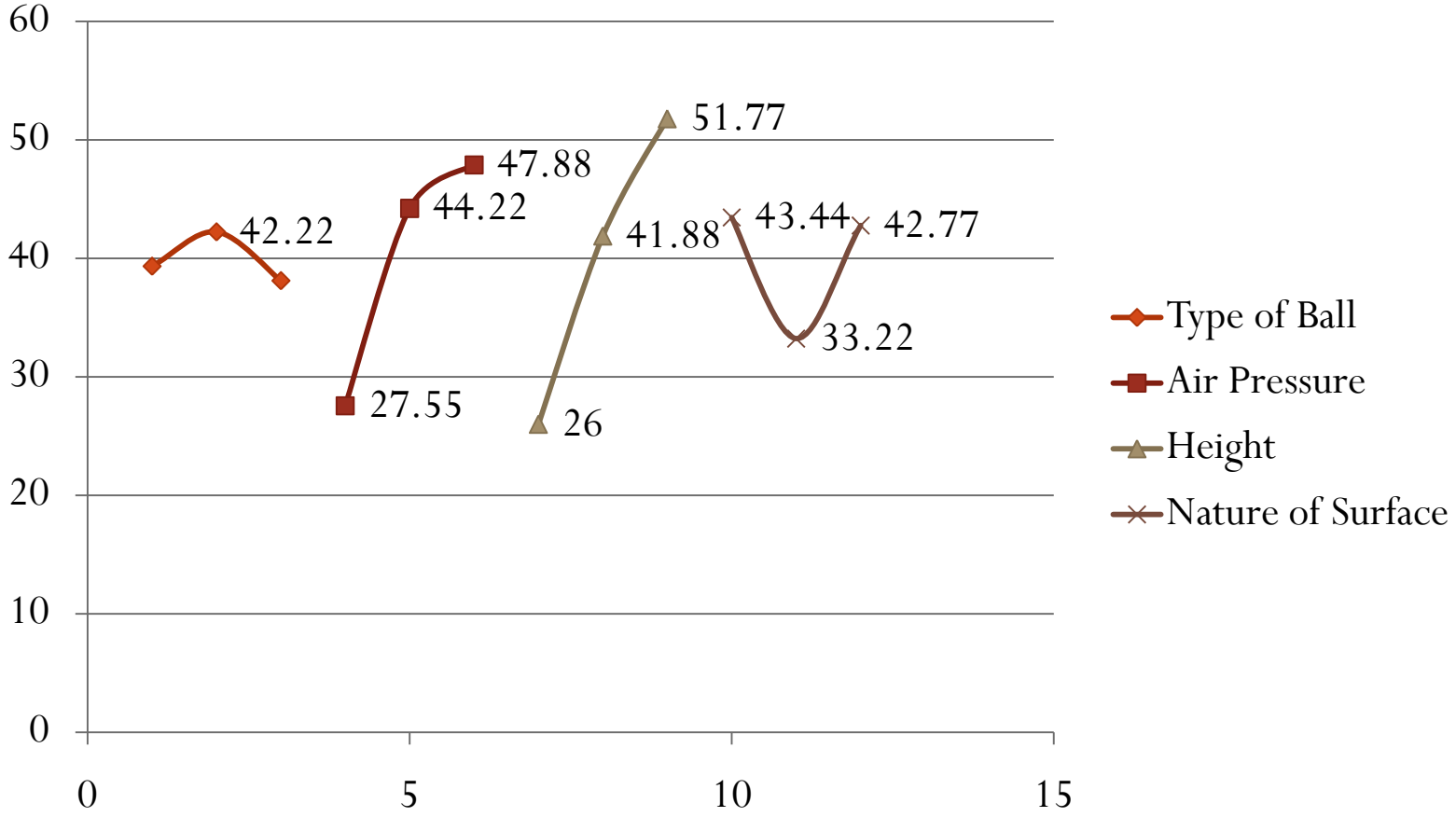
  Bare Ground- 43.44

  Grassy Ground – 33.22

  Concrete floor- 42.77

- Mean of all readings – 39.88

Factor Effect Plot for different control factors in maximizing the bounce



X axis : Levels of a control factor in sequential manner

Y-axis : Factor effect of the corresponding parameter

Best setting and best results

- From the plot, the best settings are
  - T -> Basketball
  - Pressure -> High Pressure
  - Height -> 105cm
  - Ground -> Bare Ground
- Best Results predicted by the magic square method are

  $$39.88 + (42.22-39.88) + (47.88-39.88) + (51.77-39.88) + (43.44-39.88) = 65.66$$

Confirmation Experiment

- Conducted the confirmation experiment where the final value comes out to be

T	P	H	N	V1	V2	V3	V
Basketball	High	105cm	Bare	59	59	59	59

- So confirmation experiment gives the maximum value as 59cm

Note

- All the readings were carefully taken using the video taken, because all experiments were done with a ruler beside the place of dropping of the ball
- However it may not be possible to verify the correctness of the reading from the submitted video, because it has been compressed to a large extent and the submitted video is therefore not so clear.