Advancing Science & Engineering through Laboratory Learning

SPORTY SCIENCE

STUDENT manual

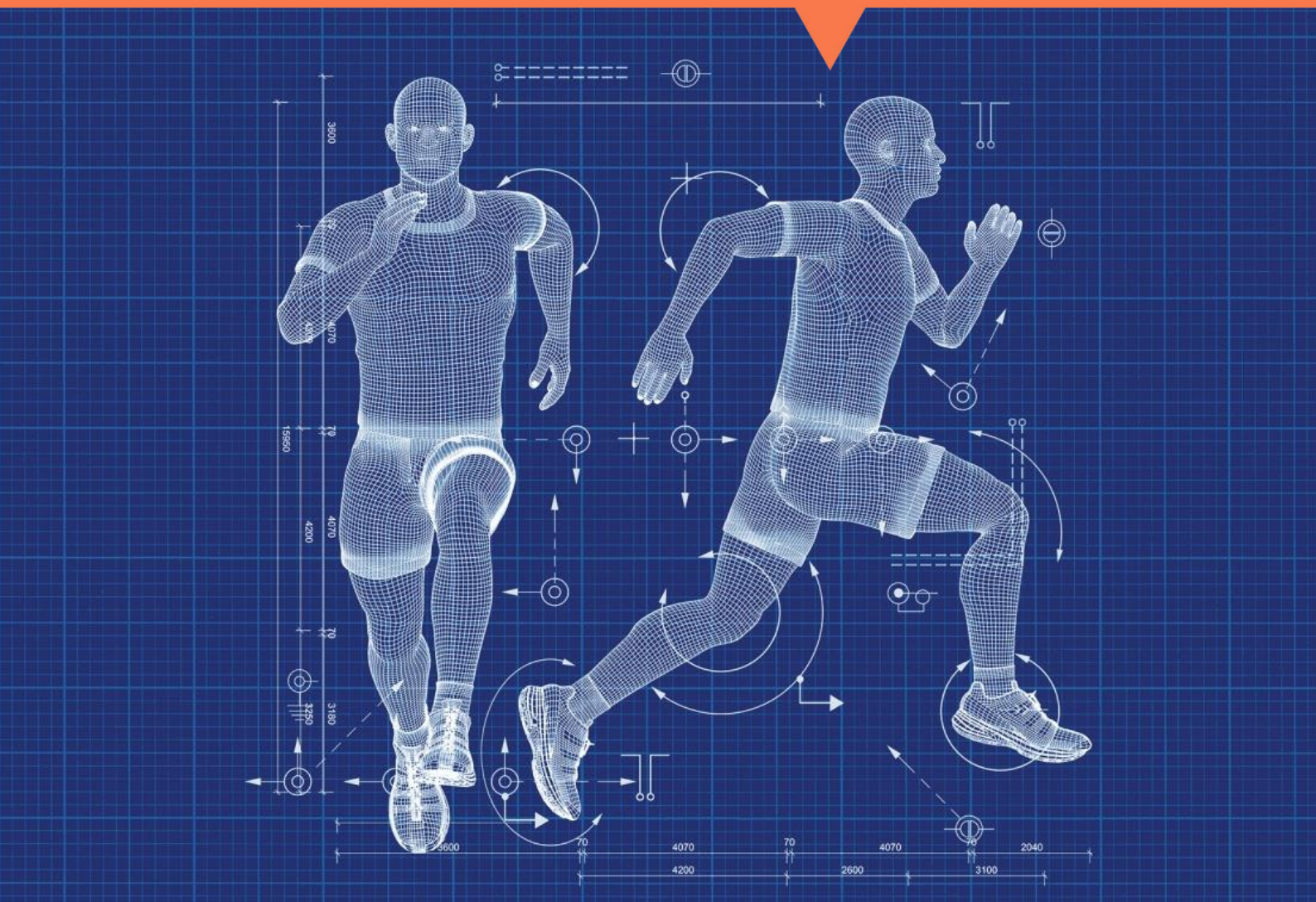


Image credit: newstatesman.com/politics/sport/2016/04/how-science-and-statistics-are-takin
over-sport

Introduction

Have you ever wondered how to make the perfect pass? What angle you should hit a ball to reach the furthest? What kind of material would make the best cricket bat?

Sport scientists use the scientific method to answer these questions every day!

Photo credit: http://www.wallpaper.com/fashion/a-tour-of-nikes-state-of-the-art-sport-research-lab-in-portland

Today, we'll become sport scientists by looking at the *efficiency* of balls as they bounce.

The total energy of any system is conserved and never changes, but it transforms between different forms – kinetic energy, gravitational potential energy, thermal energy (heat), and many other forms.

Energy principles can be used to design better balls, or help basketball players improve their game with physics!

Hazards

- Don’t throw the balls. Not only could somebody get hit, but you’d also be giving them extra kinetic energy, giving you inaccurate results.
- Keep track of where the balls are, and don’t lose them. Don’t leave them out in the open where they may become a slipping hazard.
- Have a “catcher” in your team to maintain control of the ball and stop any runaway balls.

Aim

The Australian Institute of Sport (AIS) has hired you, an up-and-coming sport scientist, to investigate the science of bouncing balls. They will use your findings to develop better balls, and optimise techniques to give Australian athletes a competitive advantage.

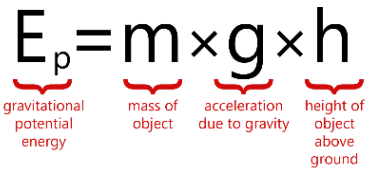
Materials

You will be provided with the following:

- A selection of balls (eg. basketballs, tennis balls, high-bounce balls, softballs, cricket balls, ping-pong balls…)
- Safe ways to vary the temperature of a ball – eg ice, hair dryer
- A way of measuring height (eg. a measuring tape against a wall)
- An open space (eg. sports hall, courtyard)
- A calculator

Physics Background (Optional)

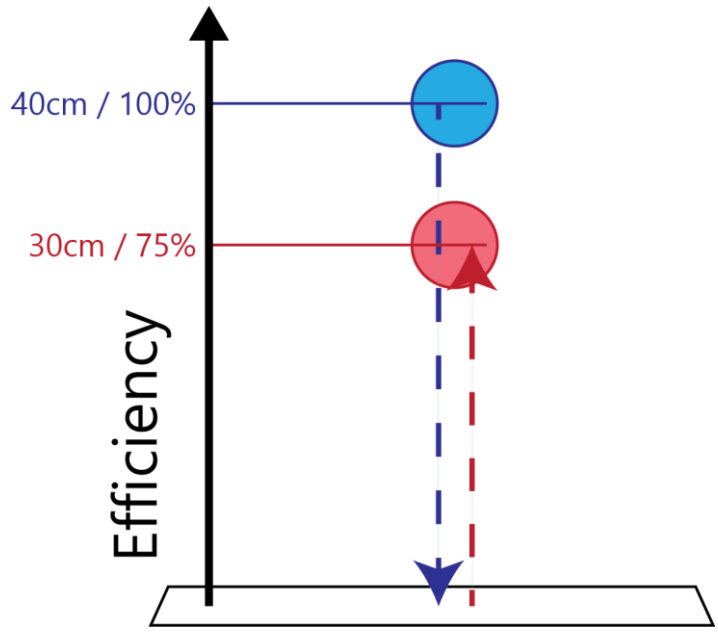
At the top of a ball's bounce (just before you release it, or at the highest point after a bounce), the ball will have no kinetic energy – it is actually completely still for a fraction of a second! So all of the ball's energy is in potential energy, making it very easy to measure. You might have seen the following equation before:



Since the potential energy increases *proportionally* to height, when we compare two heights, we are also comparing potential energy.

Procedure

We can work out how much energy was lost in a bounce by considering the greatest height *after* the bounce as a percentage of the greatest height *before* the bounce.



So to calculate *efficiency*, measure the drop height, measure the greatest height it rebounds back to, and use the formula below!

$$\text{Efficiency (\%)} = \frac{\text{Bounce height}}{\text{Drop height}} \times 100$$

Make sure you get it as straight as possible! If the ball goes sideways, you aren't accounting for all the kinetic energy and your results might be wrong.

Also, keep in mind that the ball must be dropped, and not thrown or pushed. If you give it any extra energy, it will change your results.

Research Question

You can choose what to investigate! Using efficiency principles, you could investigate how efficiency is affected by:

- Drop height
- Ball temperature
- Type of ball
- Brand of ball
- Surface (carpet, concrete, etc…)
- Inflation/deflation of ball
- Any other clever idea you might have! You could discover something new.

Write down your research question below.

_____

_____?

Recording and Analysis

Calculate efficiency for each trial you conducted using the given formula.

$$\text{Efficiency (\%)} = \frac{\text{Bounce height}}{\text{Drop height}} \times 100$$

Record your findings in the following table.

Independent variable (eg. ball type)	Drop height (cm)	Bounce height (cm)	Efficiency (%)

Discussion

Look at the data you have collected. What can you see?

Is there any noticeable trend? Does your dependent variable (efficiency) increase, decrease, or stay the same as you change your independent variable?

_____
_____
_____.

Are there any outliers? Do any of your data points not follow the general trend?

_____
_____
_____.

Anything else you notice?

_____
_____
_____
_____
_____.

Look at your original research question. How would you answer it?

_____
_____
_____
_____
_____
_____
_____.

Share your findings with the class, and write down the results of other groups in the section below.

Conclusion

In one or two sentences, summarise what the other groups found.

Group 1:

_____
_____.

Group 2:

_____
_____.

Group 3:

_____
_____.

Group 4:

_____
_____.

Group 5:

_____
_____.

Group 6:

_____
_____.

Answer the following questions and discuss them with your teacher. If you have trouble answering a question, ask your teacher about the concepts that you are finding hard.

When we bounce a ball, energy is _____.
(destroyed/transformed)

What happens to energy that is "lost" during a bounce?

_____
_____
_____.

The efficiency of a bounce can be above 100% if we use a high-tech material. (TRUE/FALSE)

The efficiency of a ball can be improved by:

(using a material that stores potential energy better / throwing the ball down instead of dropping it / both)

BONUS: The mysterious double drop!

Your teacher will demonstrate a bizarre phenomenon to you.

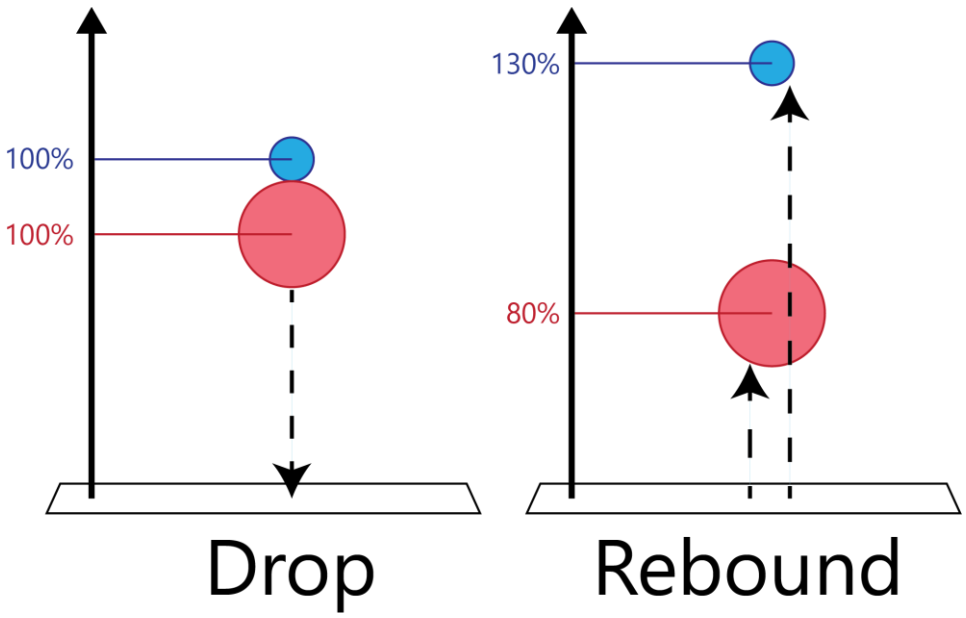
What is going on? Have we created energy and broken physics? Is conservation of energy really as bulletproof as physicists tell you?

Let's use our newfound skills to find out!

Procedure

In the same groups as before, conduct a double drop with a basketball and high-bounce ball. Make sure you get it as straight as possible! If the ball goes sideways, you aren't accounting for all the kinetic energy and your results might be wrong.

Make sure you control the height – otherwise efficiency might change! Measure the efficiencies for both balls in a single drop. Then, in a double drop, measure the efficiencies of both balls at the same time! This is hard to do, so make sure you have at least one group member per ball.



Analysis

Compare the efficiencies of each ball for a double and single drop.

High-bounce ball:

Initial height: _____ cm

	Rebound height (cm)	Efficiency (%)
Single drop		
Double drop		

Basketball:

Initial height: _____ cm

	Rebound height (cm)	Efficiency (%)
Single drop		
Double drop		

Where is the extra energy in the high-bounce ball coming from?

_____
_____
_____.

Did we violate the law of conservation of energy? (YES / NO)