Science English

Data Analysis “Conservation of mechanical energy”

English Activity

Today's Words

1. velocity
2. uniform motion
3. free-fall acceleration
4. direction
5. mass
6. unit
7. kinetic energy
8. gravitational potential energy
9. be proportional to
10. conservation of mechanical energy

Velocity

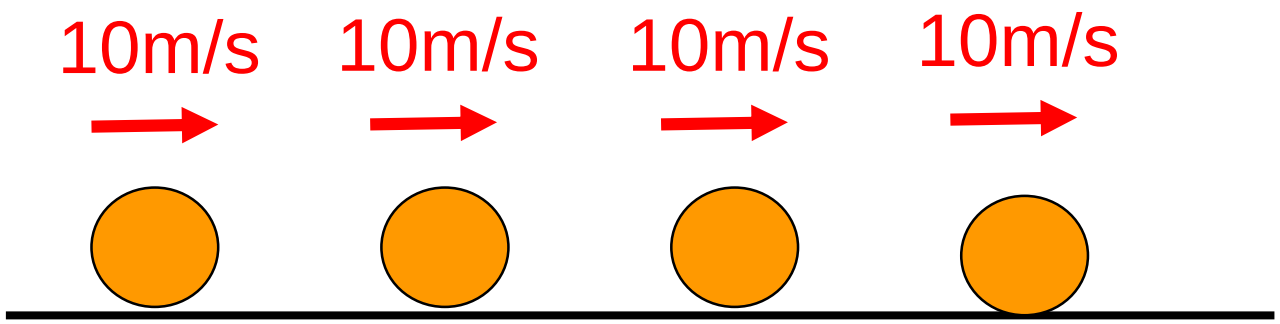
速度

40km/h

the speed of something in a particular direction

Uniform motion

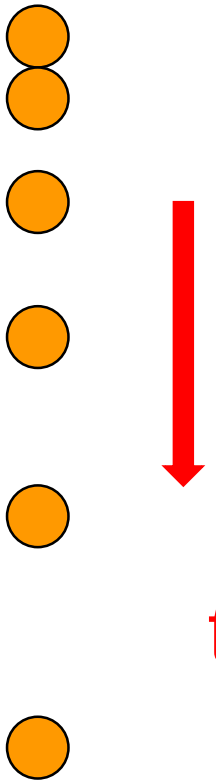
等速直線運動



the motion of an object that travels in a straight line at a constant velocity

Free-fall acceleration
Gravitational acceleration

重力加速度

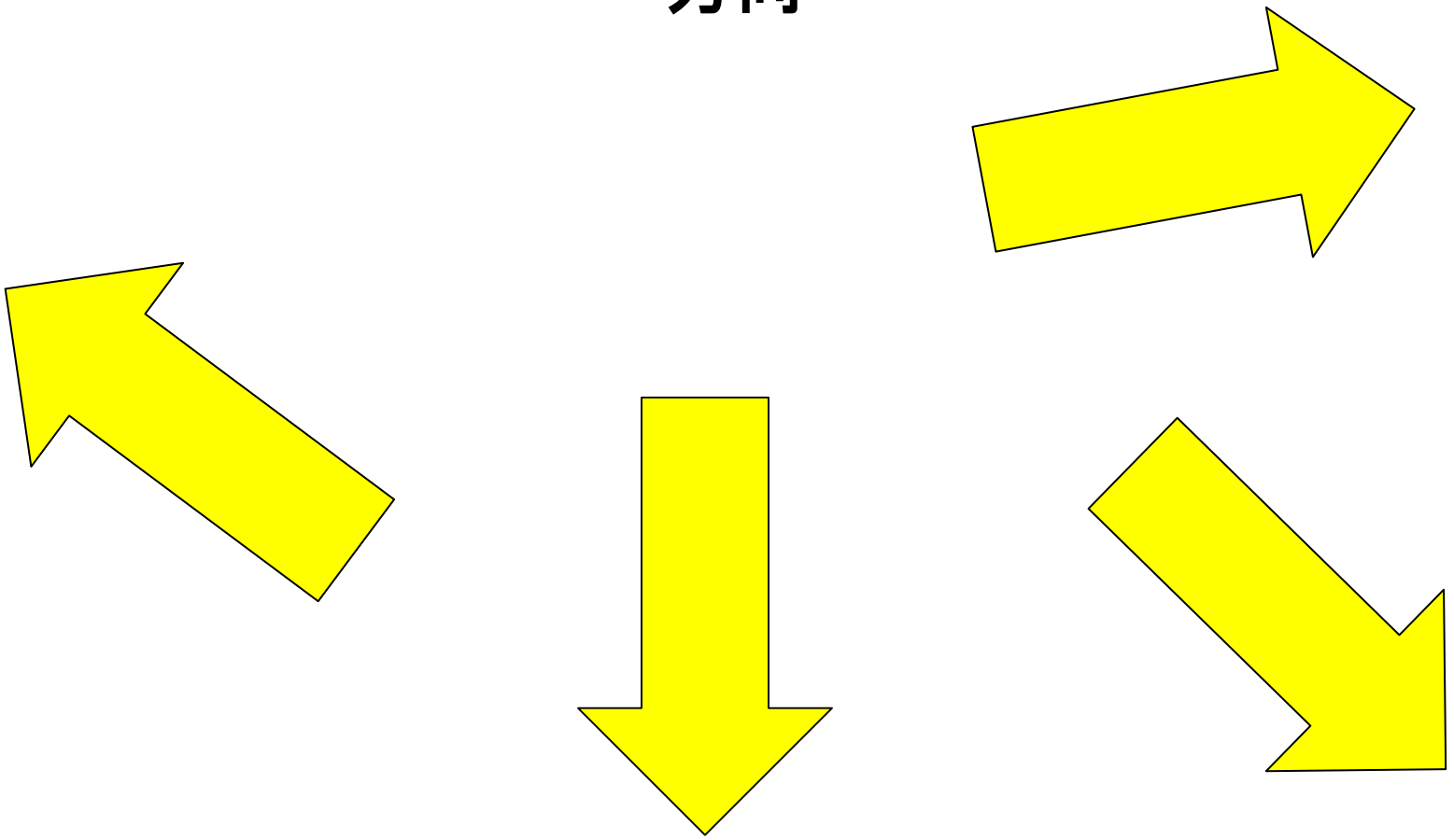


$g=9.8m/s^2$

the acceleration due to gravity

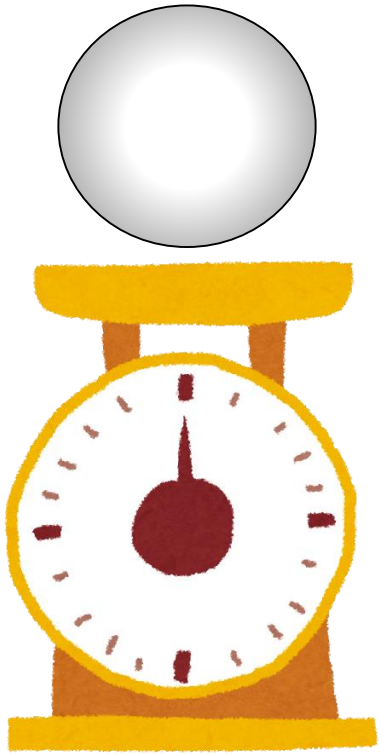
Direction

方向



Mass

質量



Unit

単位

重力加速度(m/s^2)

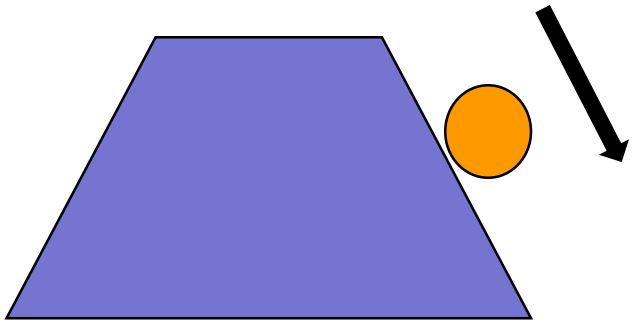
速度
(m/s)

質量
(kg)

高さ
(m)

Kinetic energy

運動エネルギー

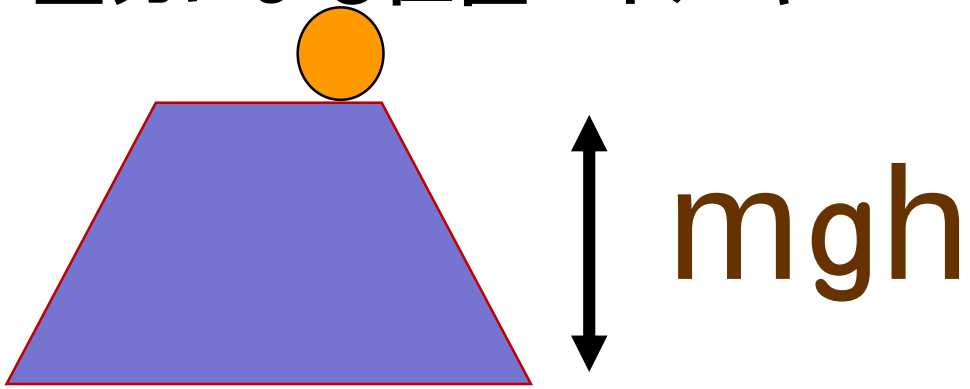


$$\frac{1}{2} m v^2$$

the energy an object has because it is in motion

Gravitational potential energy

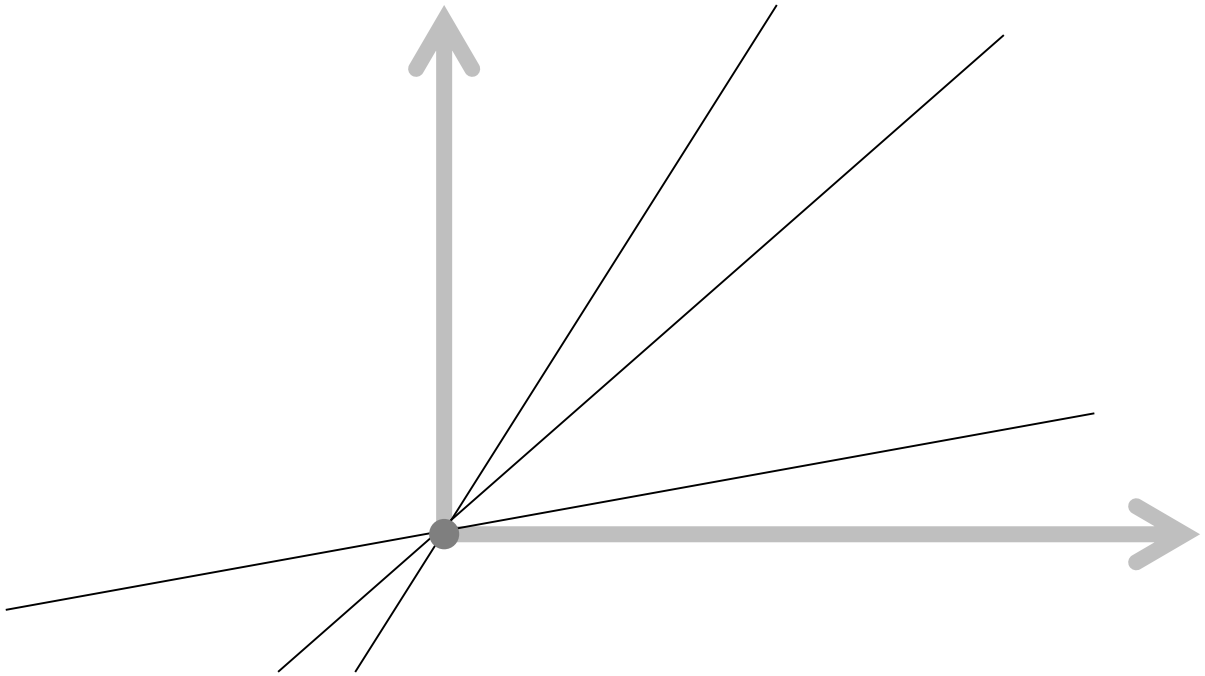
重力による位置エネルギー



the energy stored in an object because of its posit

be proportional to

比例する



Conservation of mechanical energy

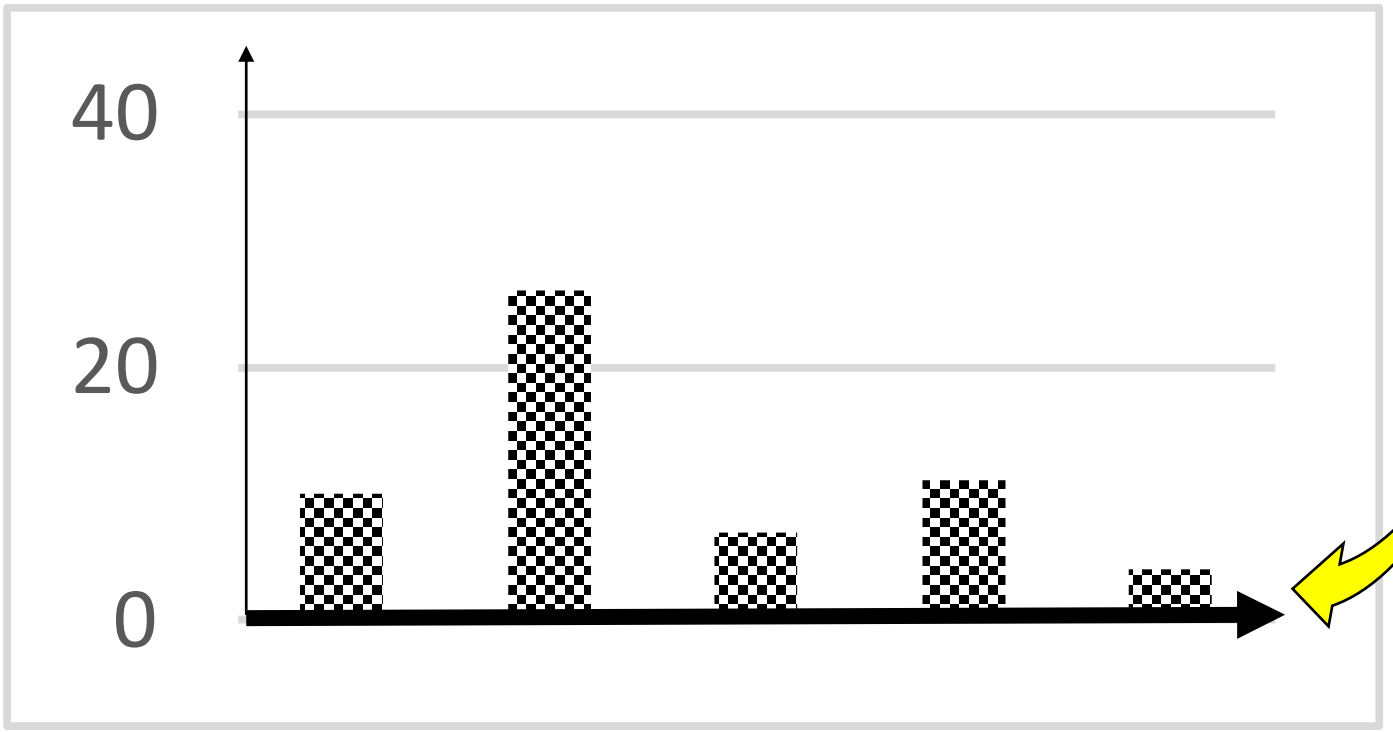
力学的エネルギー保存の法則

$$1/2\ mv^2_{\ initial} + mgh_{initial} = 1/2\ mv^2_{\ final} + mgh_{\ final}$$

the total mechanical energy in a system remains constant

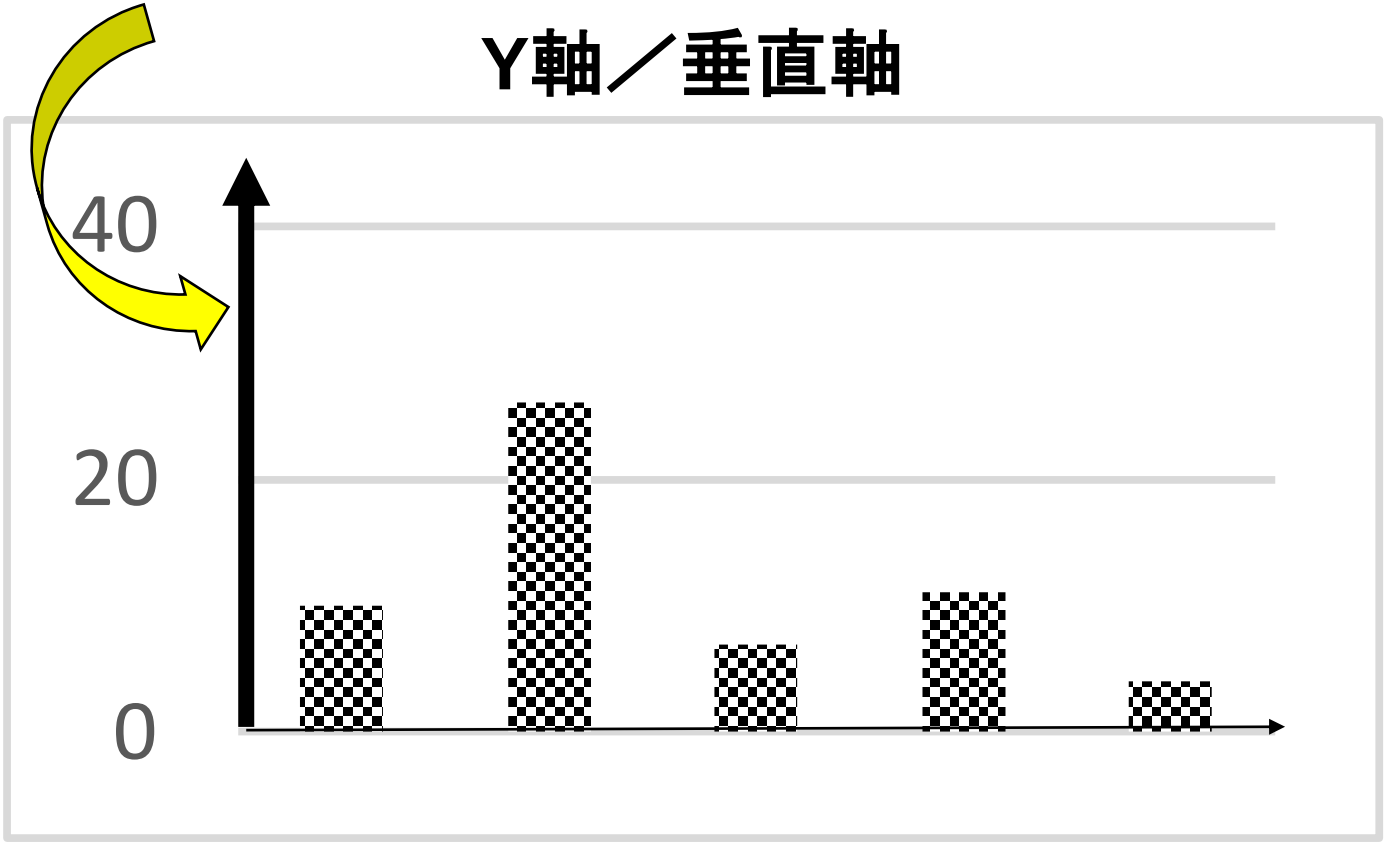
Horizontal axis

X軸／水平軸



Vertical axis

Y軸／垂直軸



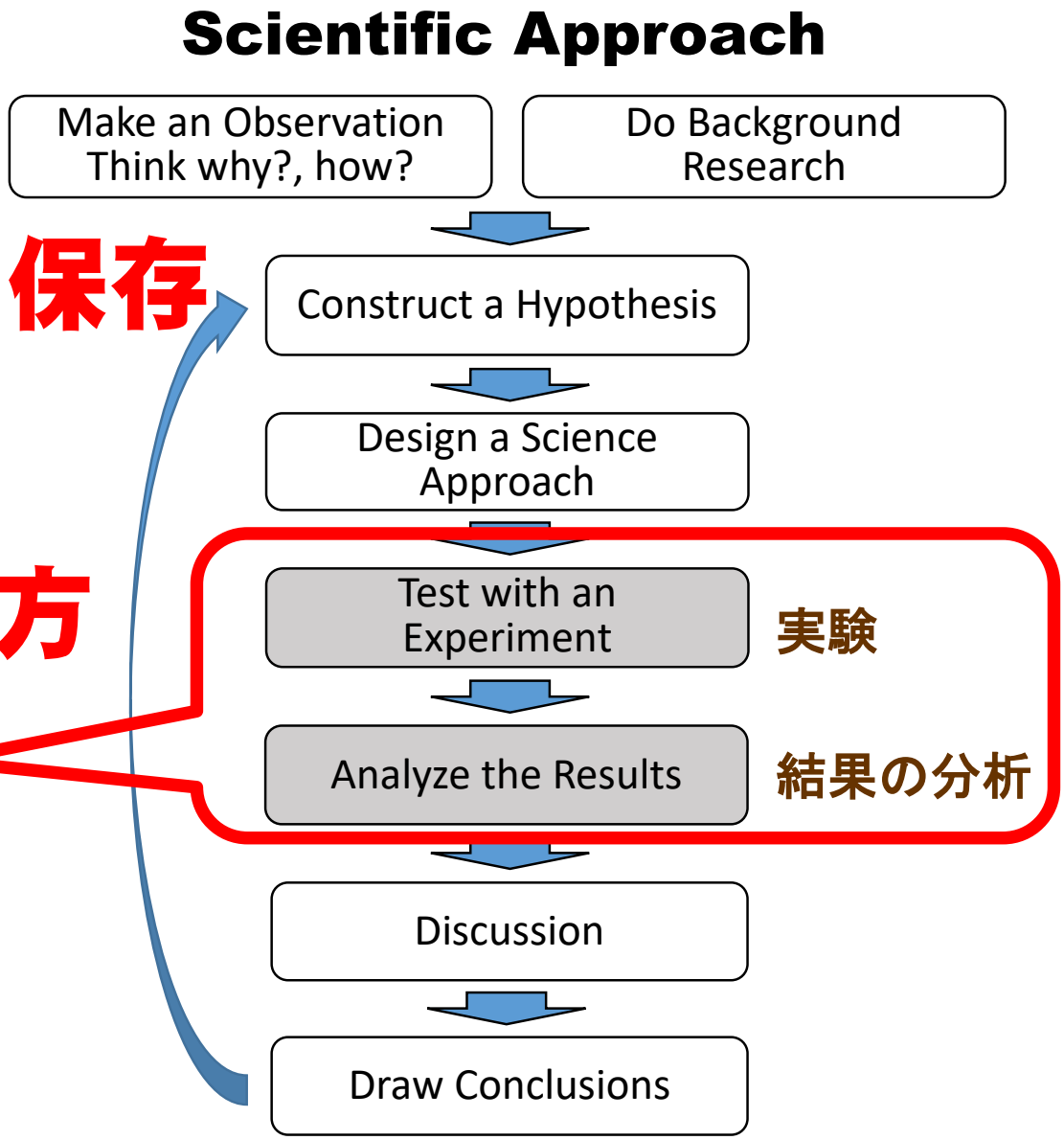
Science Experiment

今日のポイント

①エネルギーの保存

②データの扱い方

グラフの表現



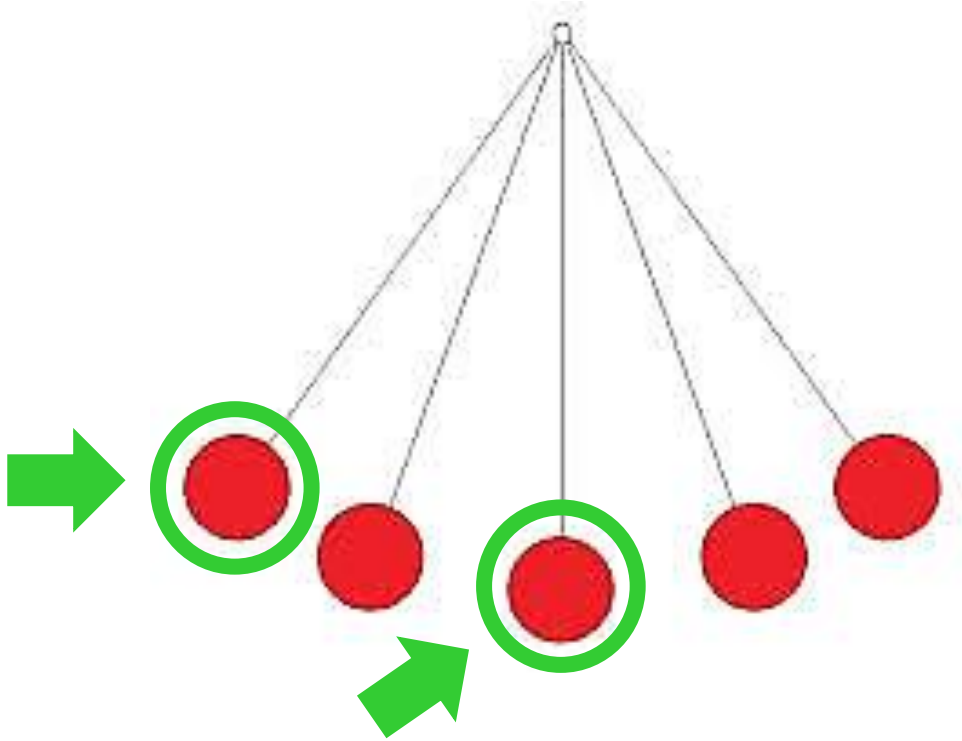
調べる　　関係

Let’s try to investigate the relationship

between kinetic energy and gravitational

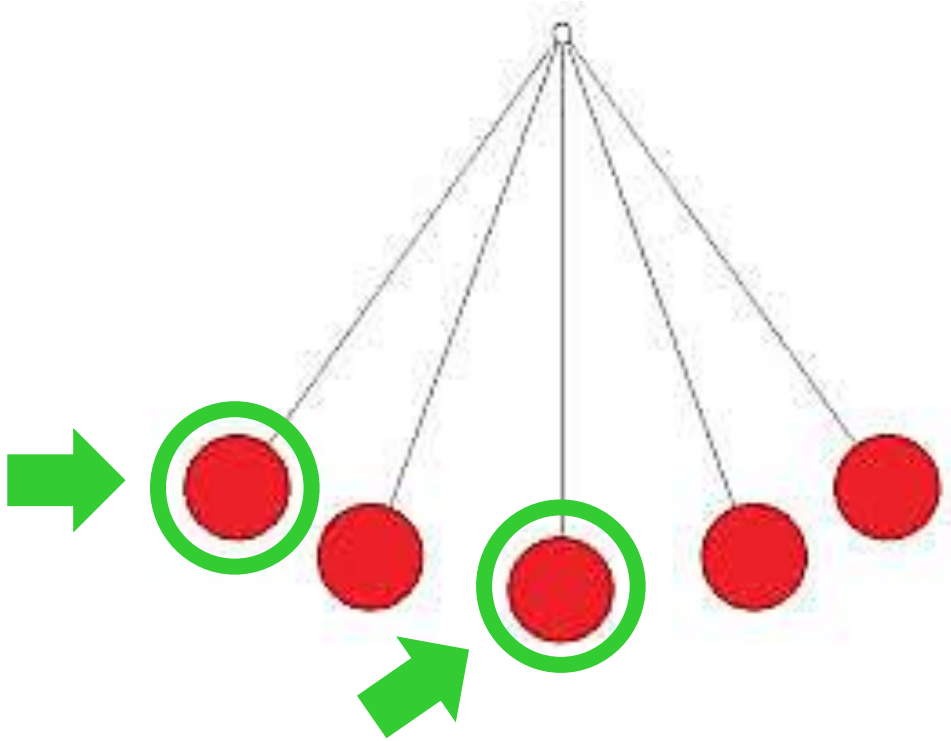
振り子

potential energy by using a pendulum.



Mechanical energy = Kinetic energy + Gravitational potential energy

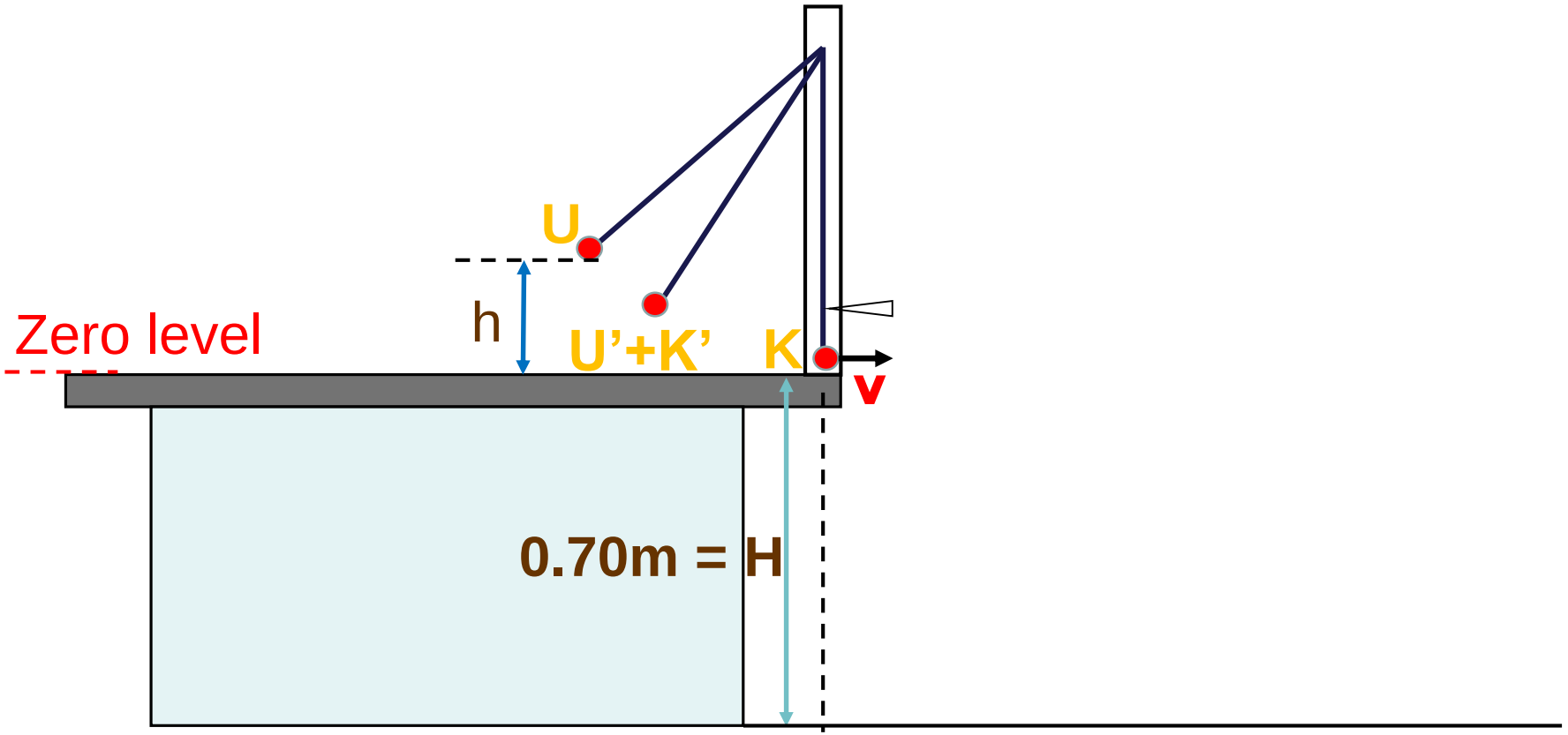
力学的エネルギー　運動エネルギー　重力による位置エネルギー



TA's Questions & Answers

Page.1 E&A1 Q1~6

Kinetic energy(K) & Gravitational potential energy(U)

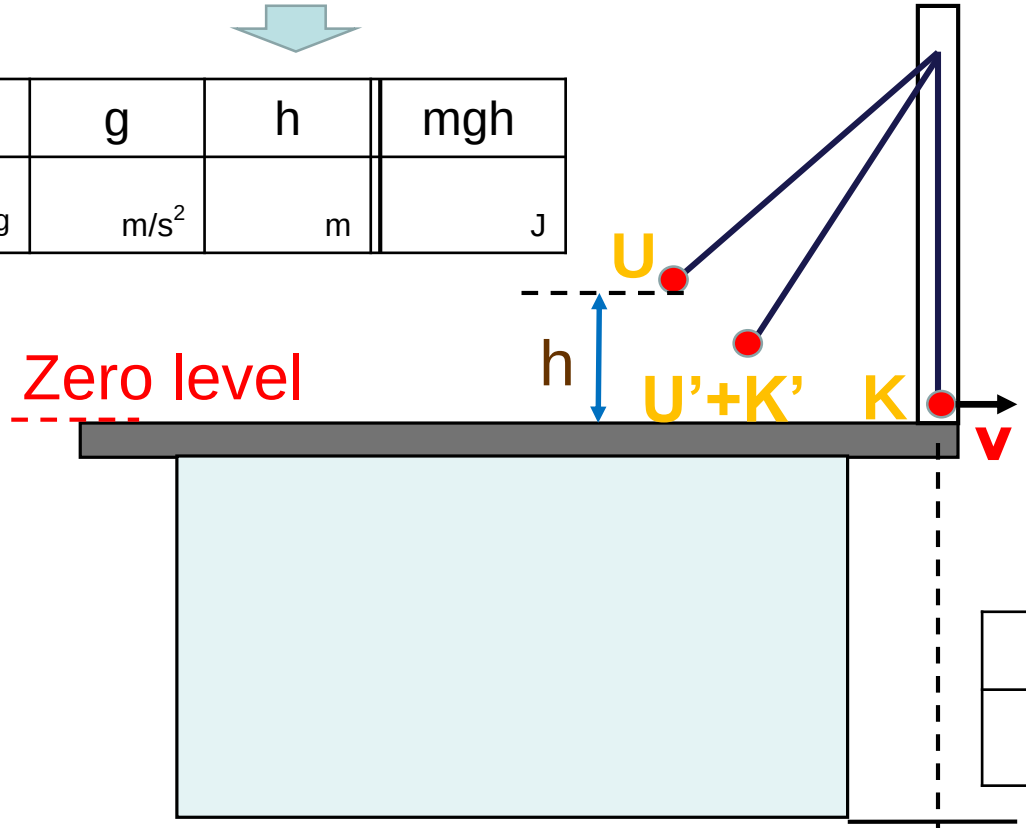


Kinetic energy(K) & Gravitational potential energy(U)

Potential energy

mgh

m	g	h	mgh
kg	m/s^2	m	J

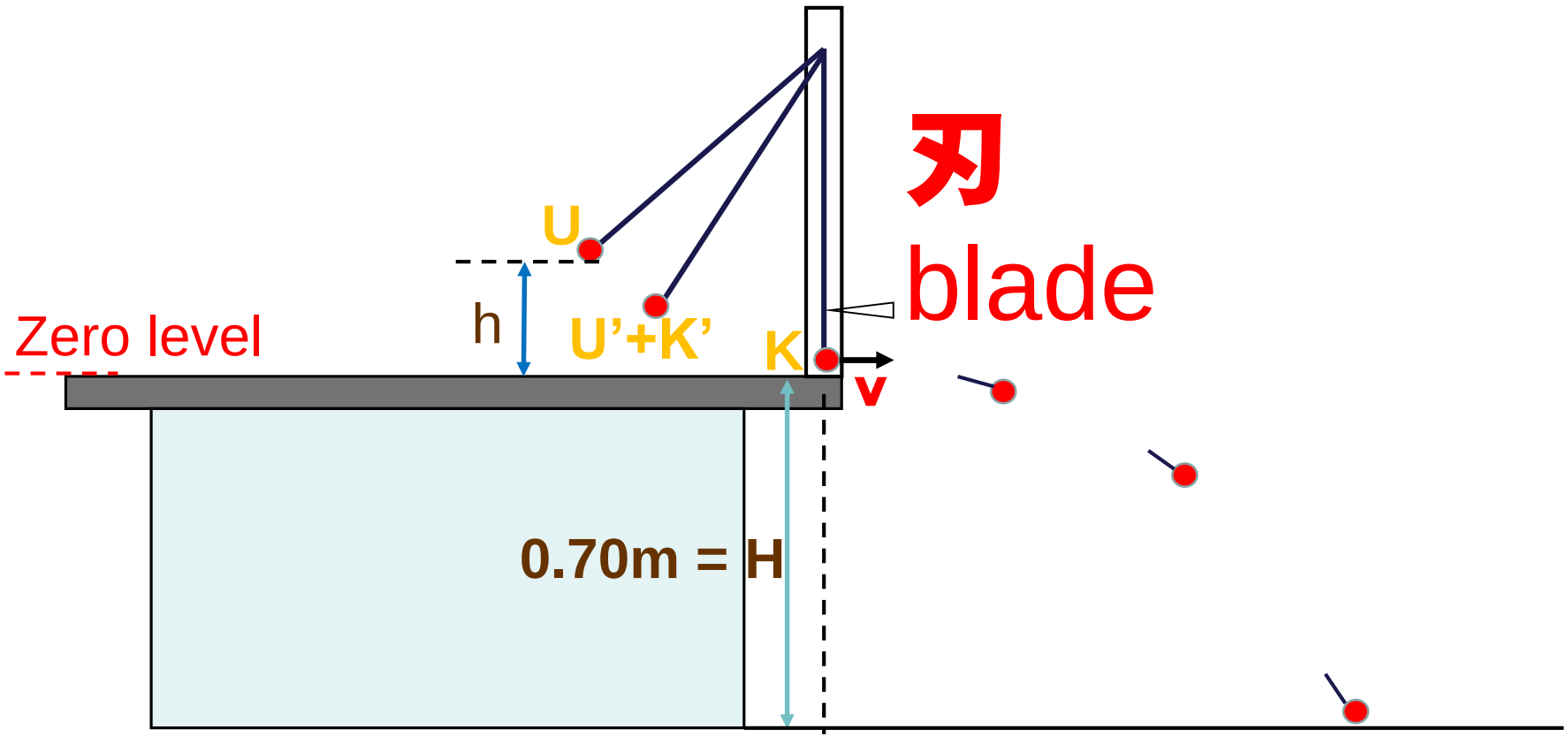


Kinetic energy

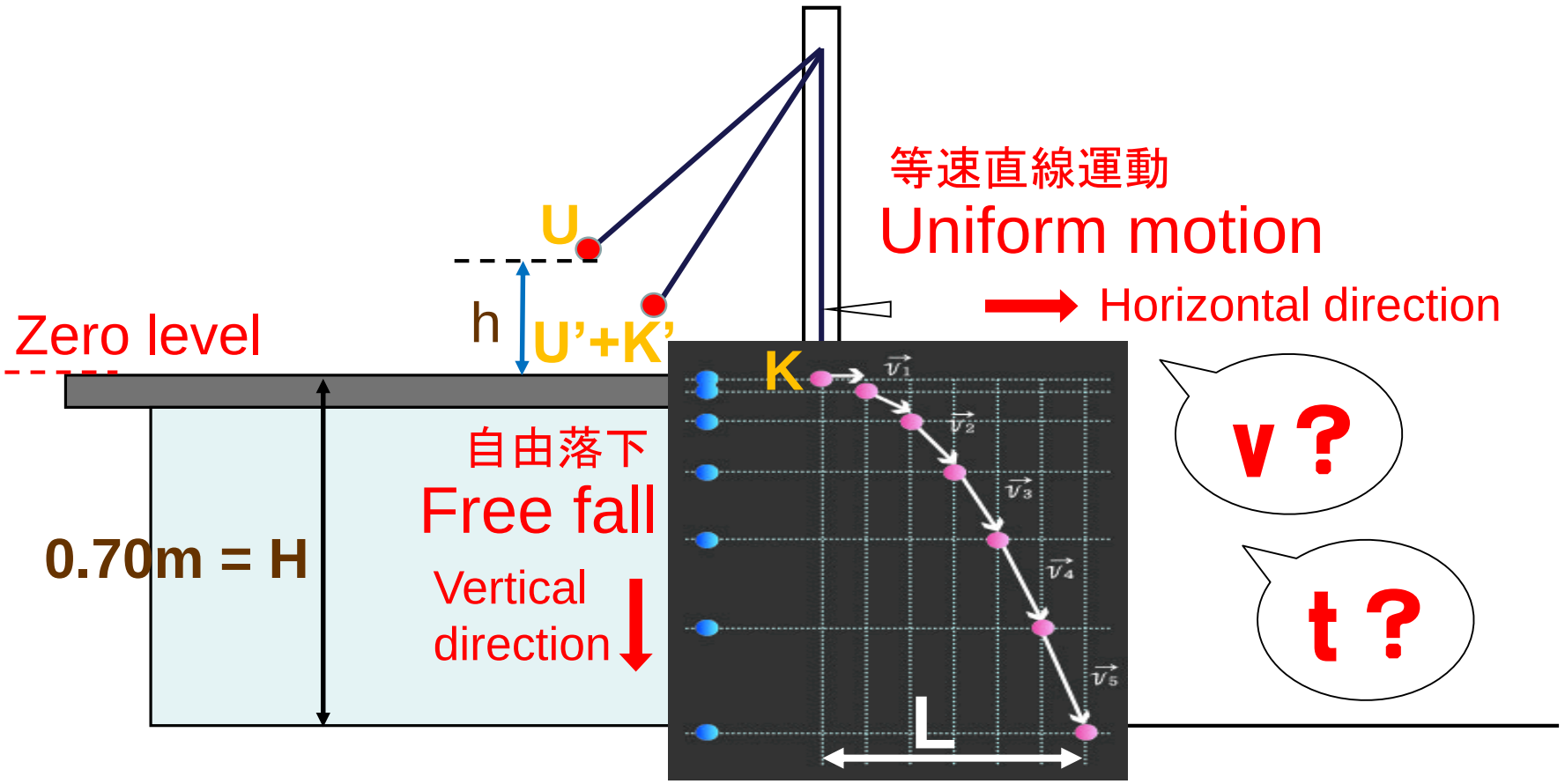
$\frac{1}{2}mv^2$

m	v	$\frac{1}{2}mv^2$
kg	? m/s	J

Kinetic energy(K) & Gravitational potential energy(U)



Kinetic energy(K) & Gravitational potential energy(U)



Equation of free fall

$$H = \frac{1}{2}gt^2$$

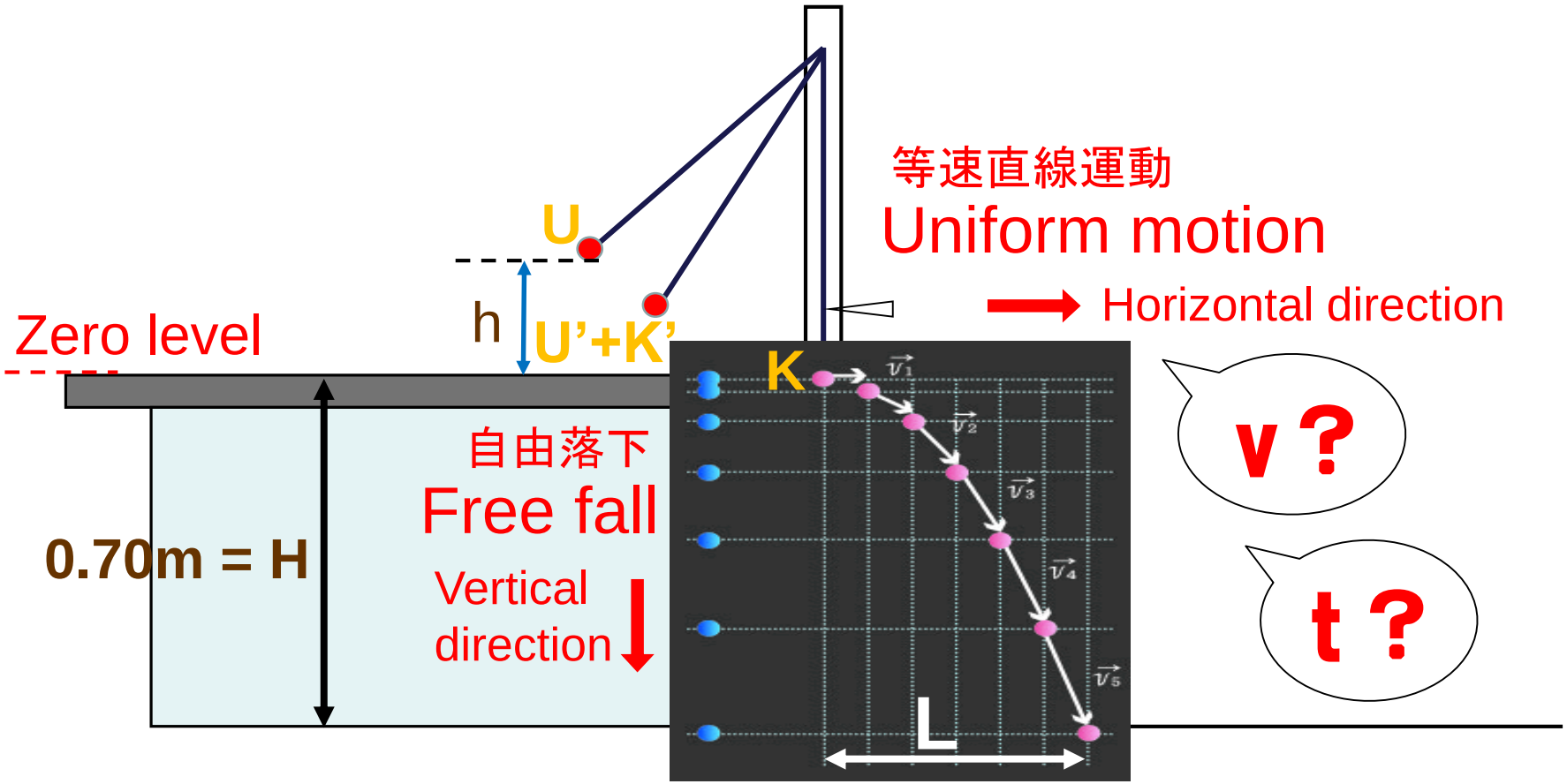
【TA's Questions＆Answers】

Page.2 E&A2 1~3

$a + b = c$	⇒	a plus b is (is equal to, equals to) c.
$a - b = c$	⇒	a minus b is c.
$a \times b = c$	⇒	a times b is b.
$\frac{a}{b} = c$	⇒	a divided by b is c. or a over b is c.
$\frac{2}{15}$	⇒	two fifteenths or two over fifteen
a^2	⇒	a squared or a to the power of two
a^3	⇒	a cubed or a to the power of three
$\sqrt{a}$	⇒	the square root of a
$\sqrt[3]{a}$	⇒	the cube root of a
$a \geqq b$	⇒	a is greater than or equal to b
$a < b$	⇒	a is less than b

式 : expression
代入する : substitute
方程式を解く : solve
x と y の関数 : a function of x and y

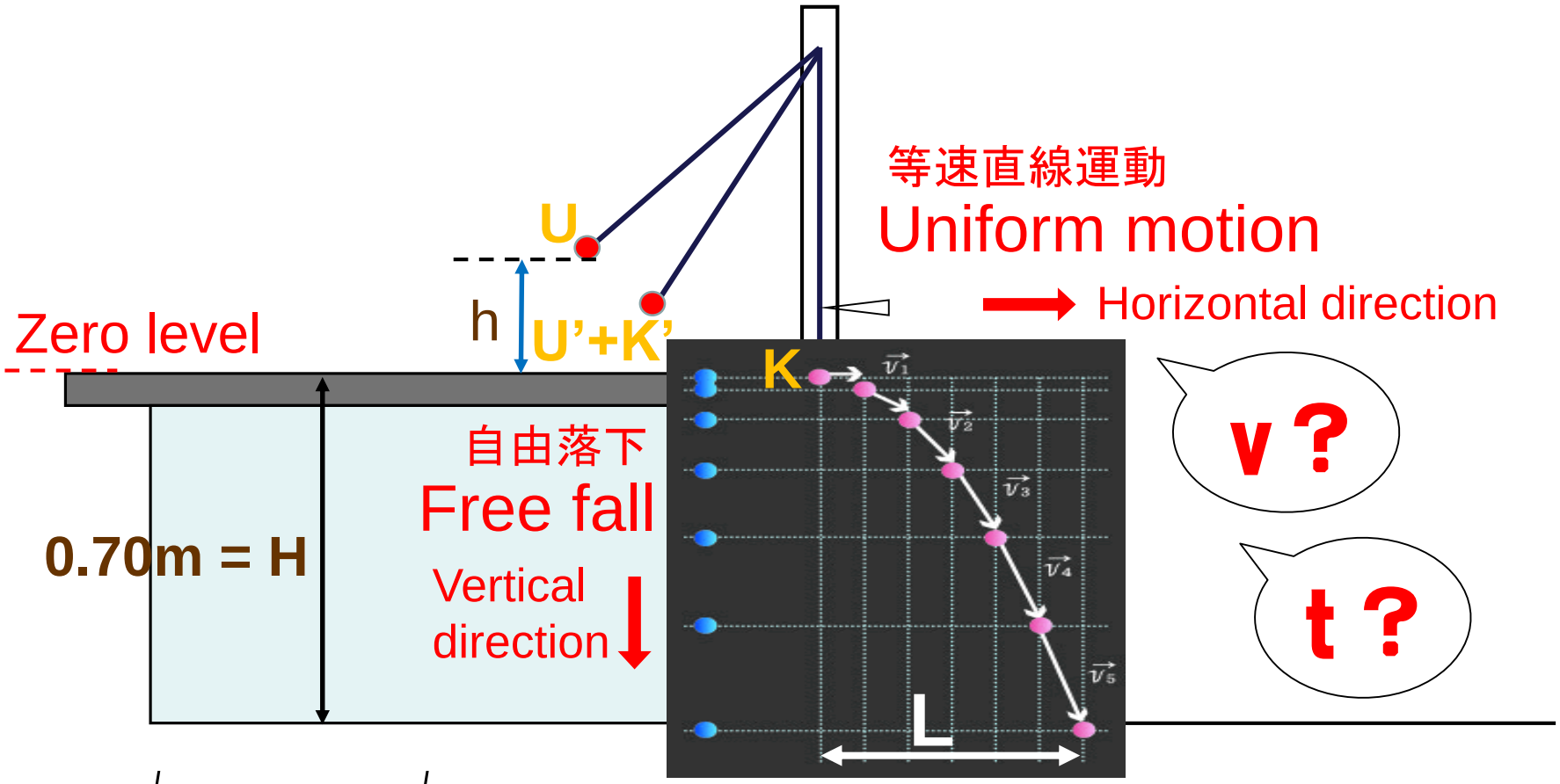
Kinetic energy(K) & Gravitational potential energy(U)



Equation of free fall

$H = \frac{1}{2}gt^2$ $t = \sqrt{2H/g} = \sqrt{2 \times 0.70/9.8} = 0.378$ [s]

Kinetic energy(K) & Gravitational potential energy(U)



$t = \sqrt{2H/g} = \sqrt{2 \times 0.70/9.8} = 0.378$ [s]

$V = L/t = L/0.378$ [m/s]

Experiment with TA

Results

Group **1～2, 5～6** Big ball

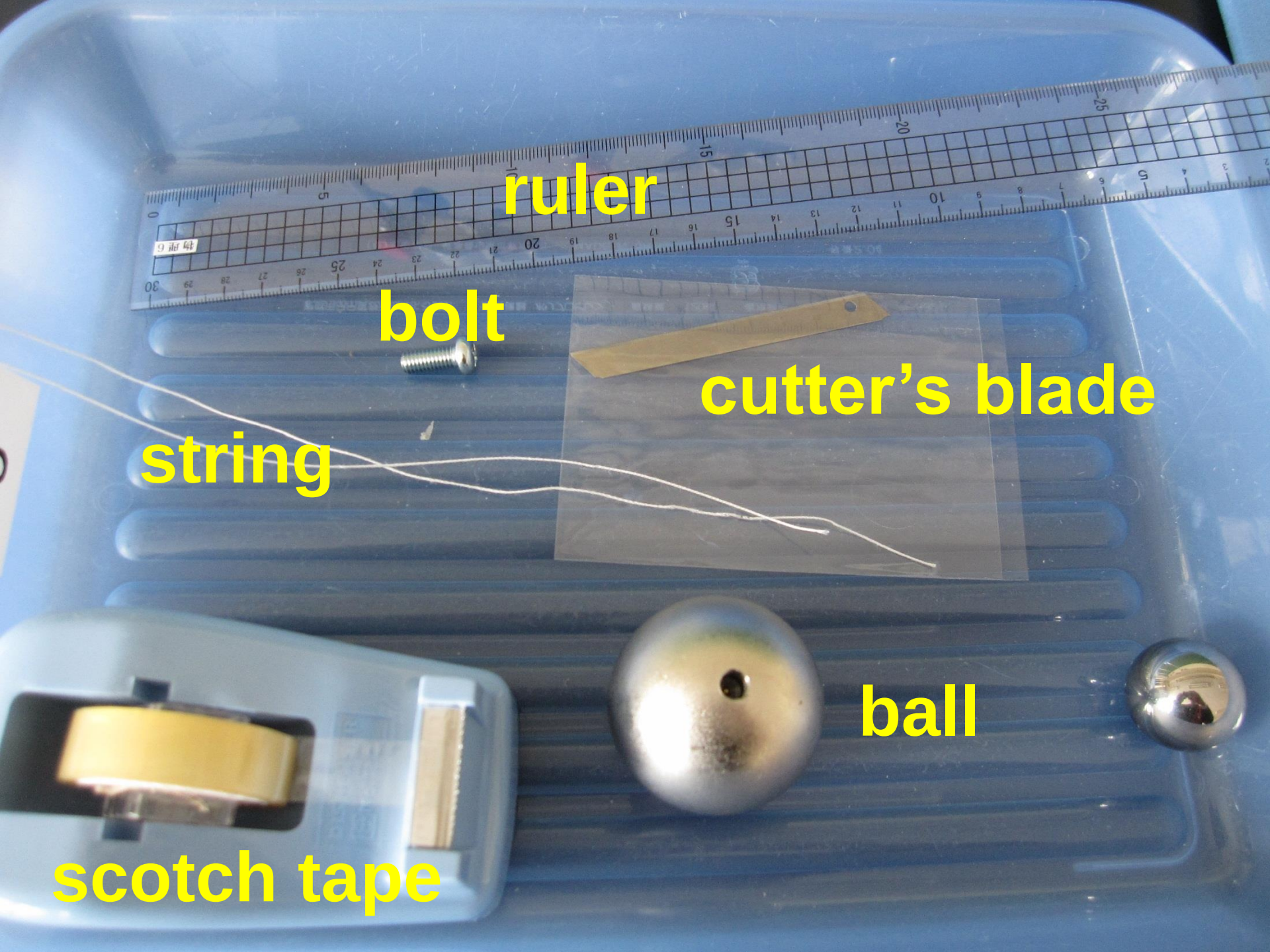
Group **3～4, 7～8** Small ball

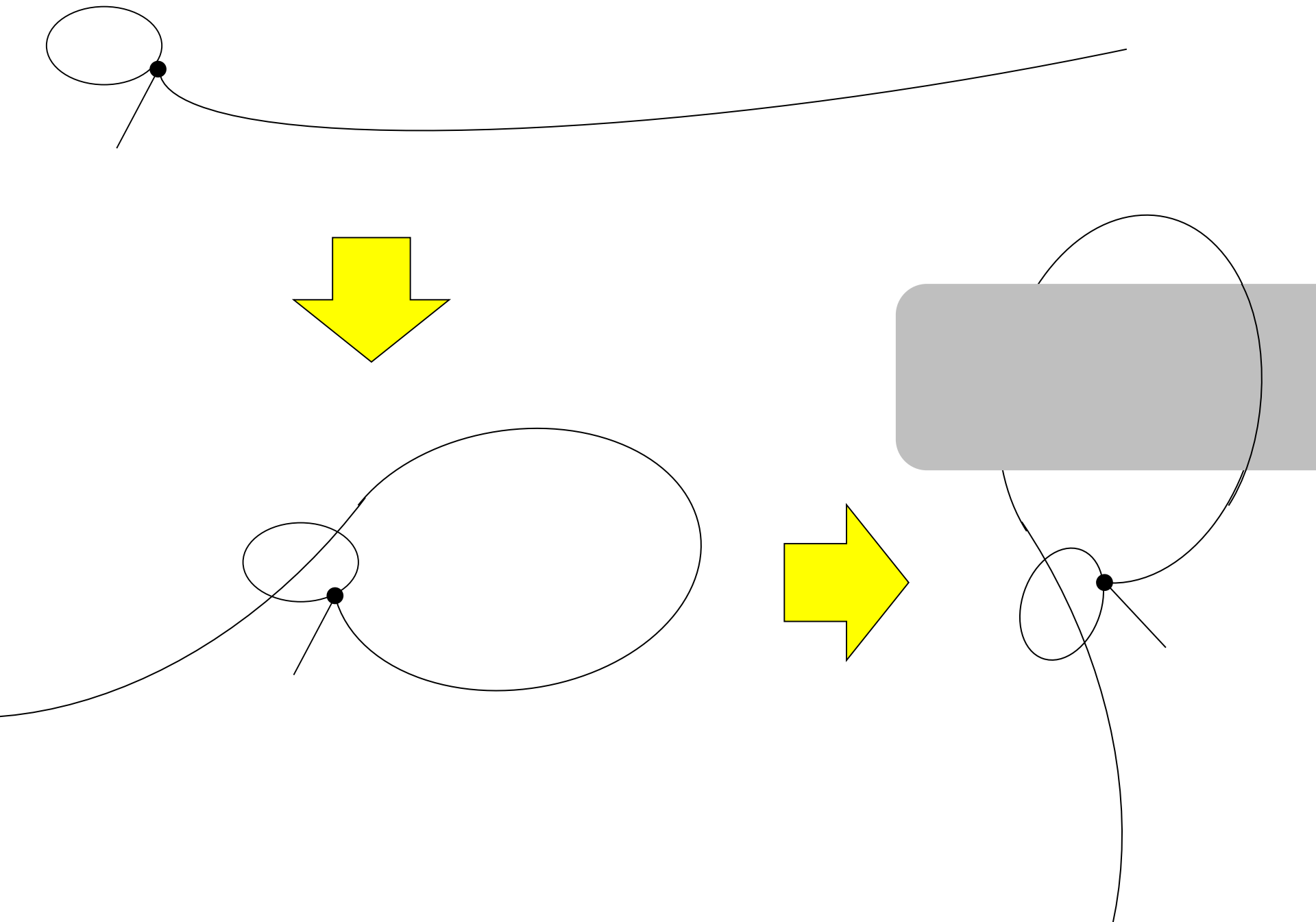
	m[kg]	h[m]	U[J] mgh	L[m]	V[m/s] $\frac{L}{0.378}$	v^2	K[J] $\frac{1}{2}mv^2$
Group 1	大	0.20					
Group 2	大	0.20					
Group 3	小	0.20					
Group 4	小	0.20					
Group 5	大	0.15					
Group 6	大	0.15					
Group 7	小	0.15					
Group 8	小	0.15					

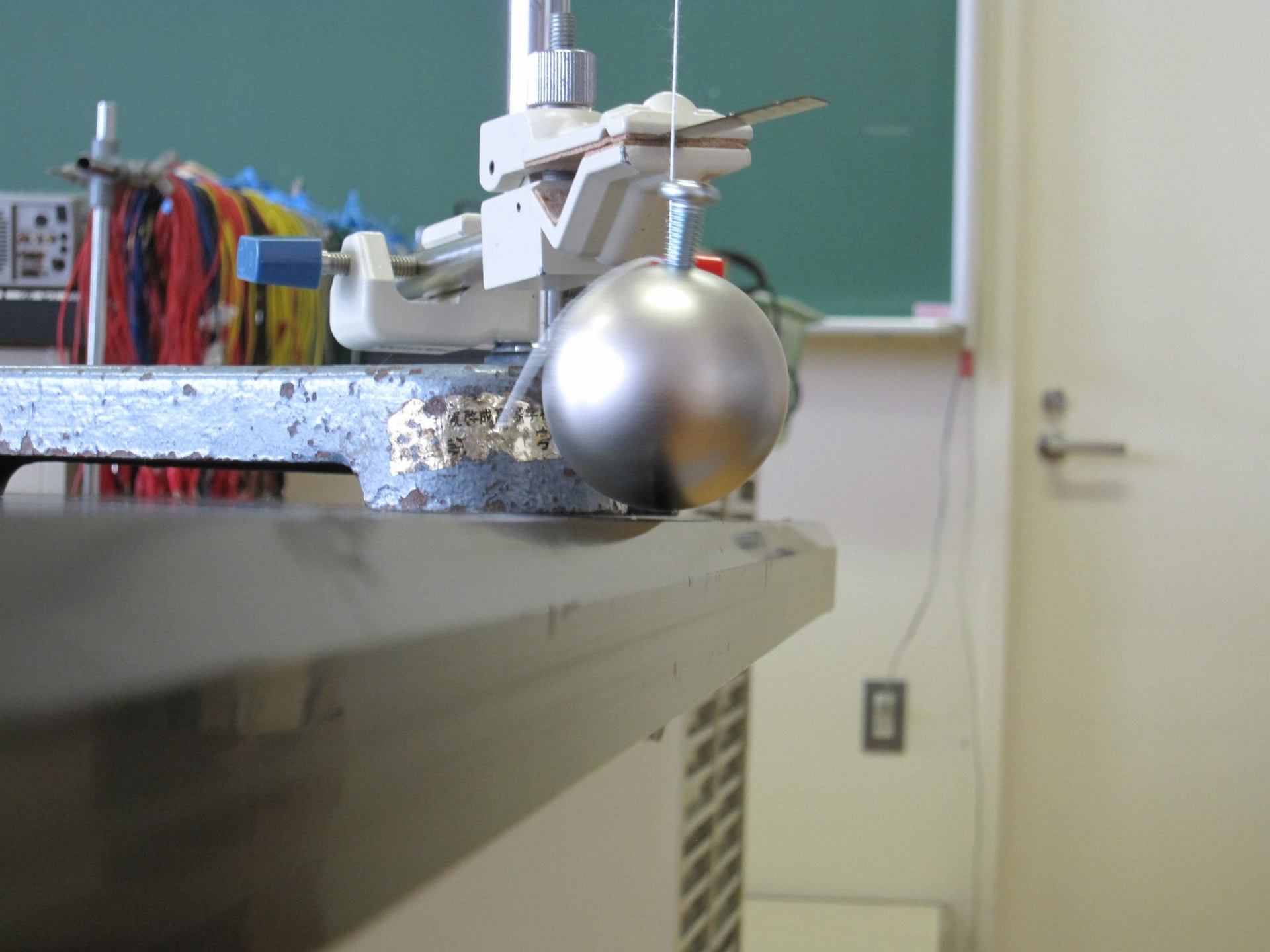
Exercise & Activity 3

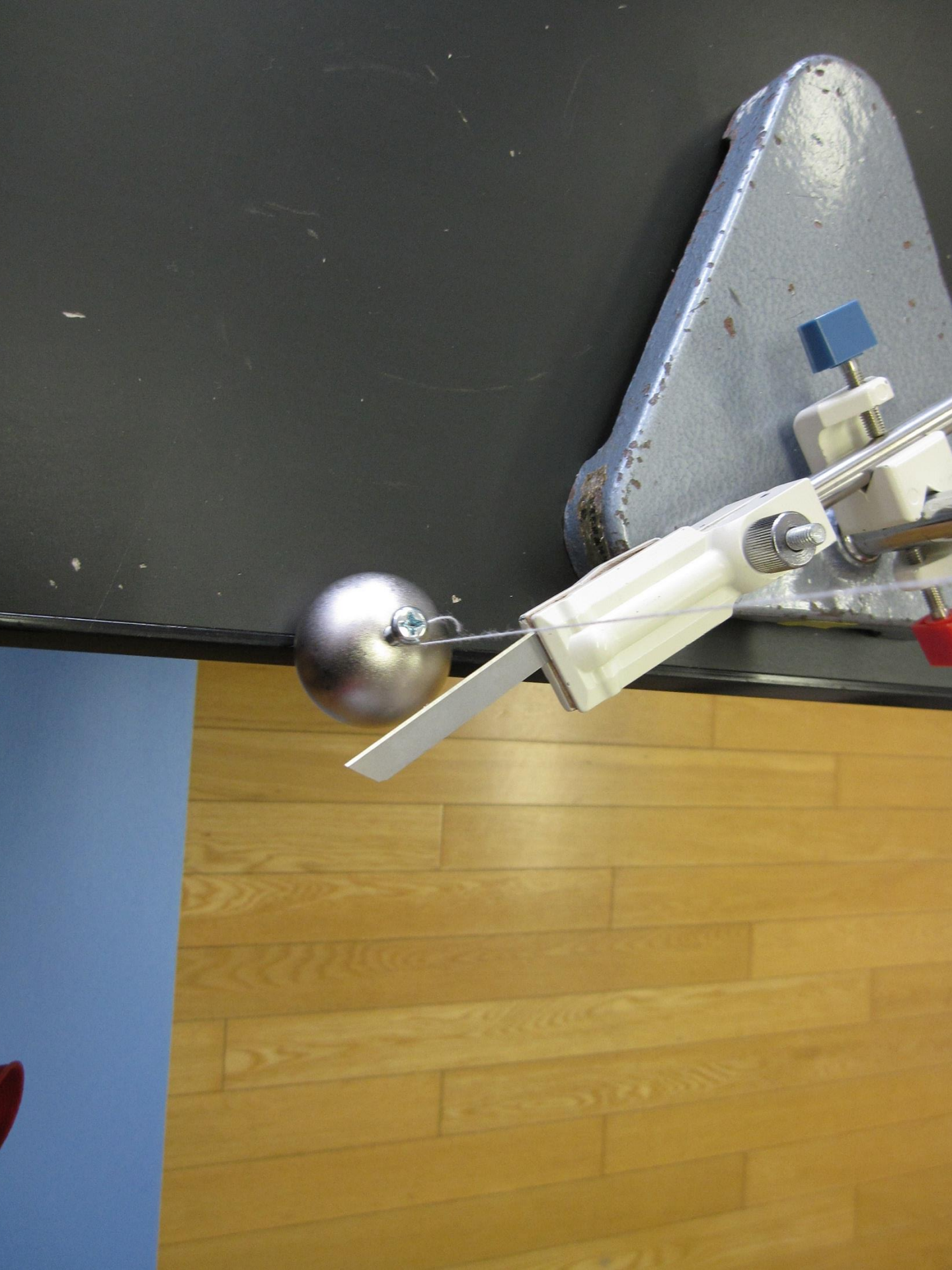
Create a table in which to record your data, then start the experiment.

Trial	m[kg]	h[m]	**U[J]**	L[m]	v[m/s]	v^2	**K[J]**
1							
2							
3							
4							
5							
Average							

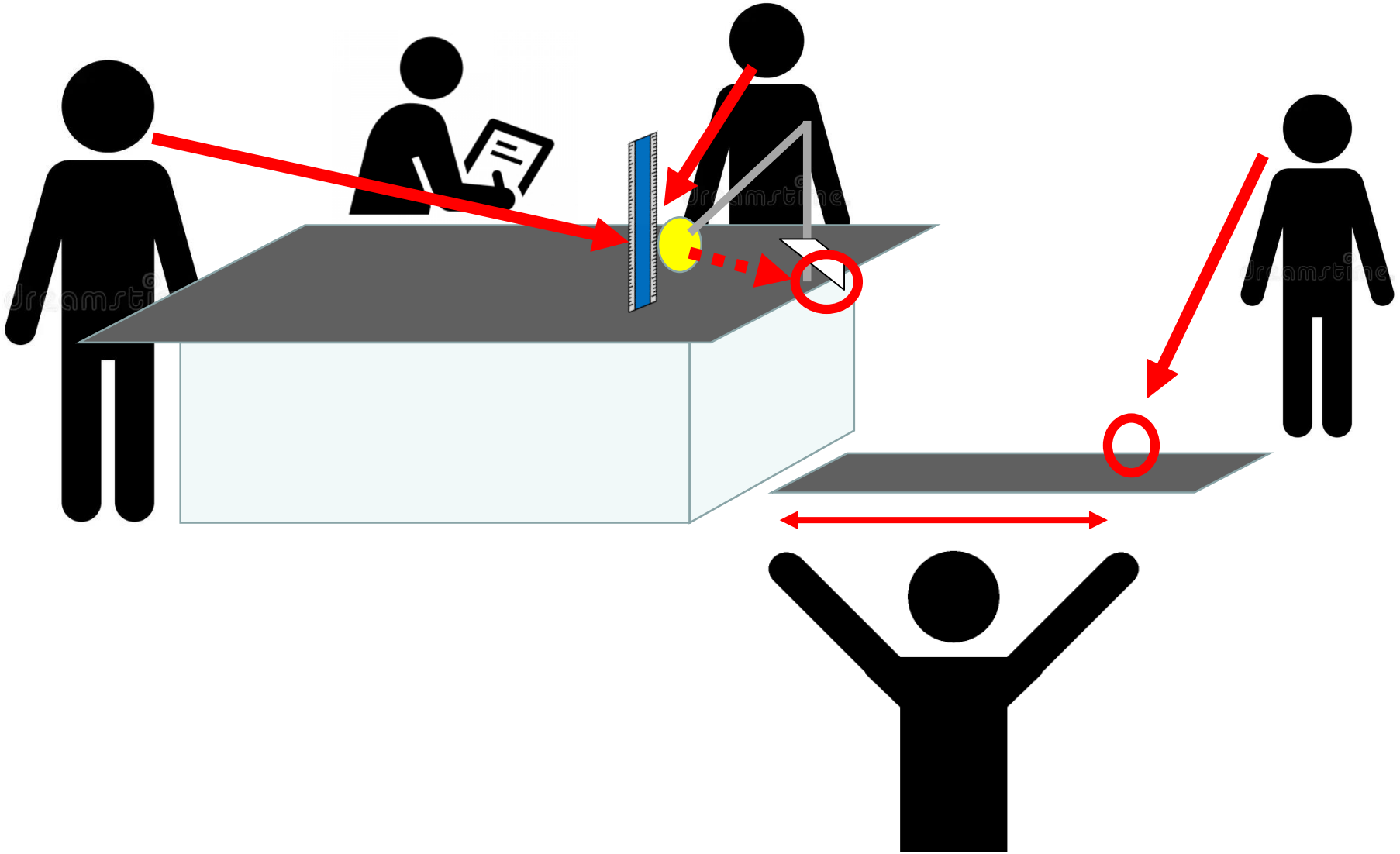

ruler
bolt
cutter's blade
string
ball
scotch tape

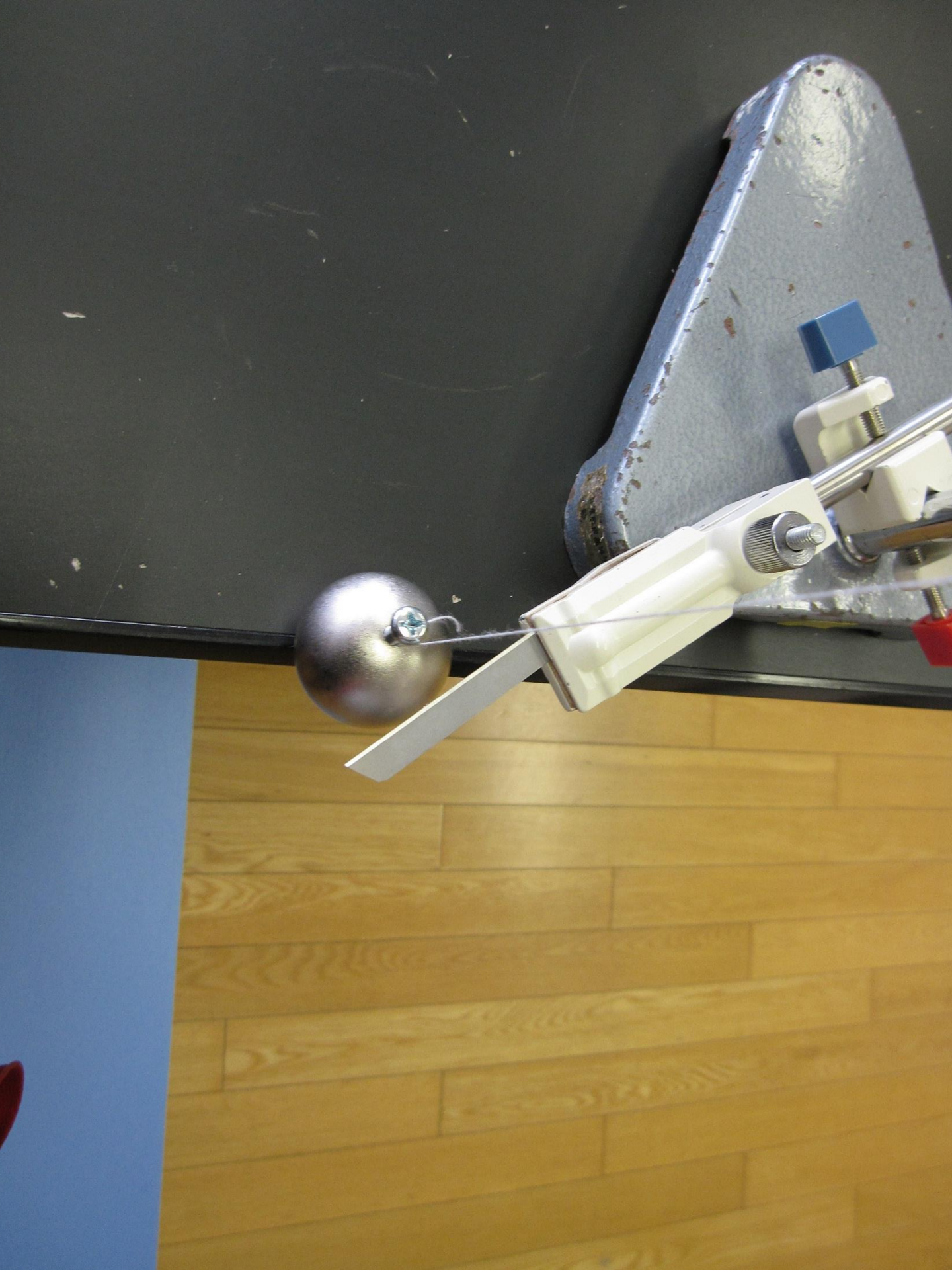






Teamwork





Exercise & Activity 3

Create a table in which to record your data, then start the experiment.

Trial	m[kg]	h[m]	U[J]	L[m]	v[m/s]	v^2	K[J]
1							
2							
3							
4							
5							
Average							

Results

Group **1～2, 5～6** Big ball

Group **3～4, 7～8** Small ball

	m[kg]	h[m]	U[J] mgh	L[m]	V[m/s] $\frac{L}{0.378}$	v^2	K[J] $\frac{1}{2}mv^2$
Group 1	大	0.20					
Group 2	大	0.20					
Group 3	小	0.20					
Group 4	小	0.20					
Group 5	大	0.15					
Group 6	大	0.15					
Group 7	小	0.15					
Group 8	小	0.15					

Results

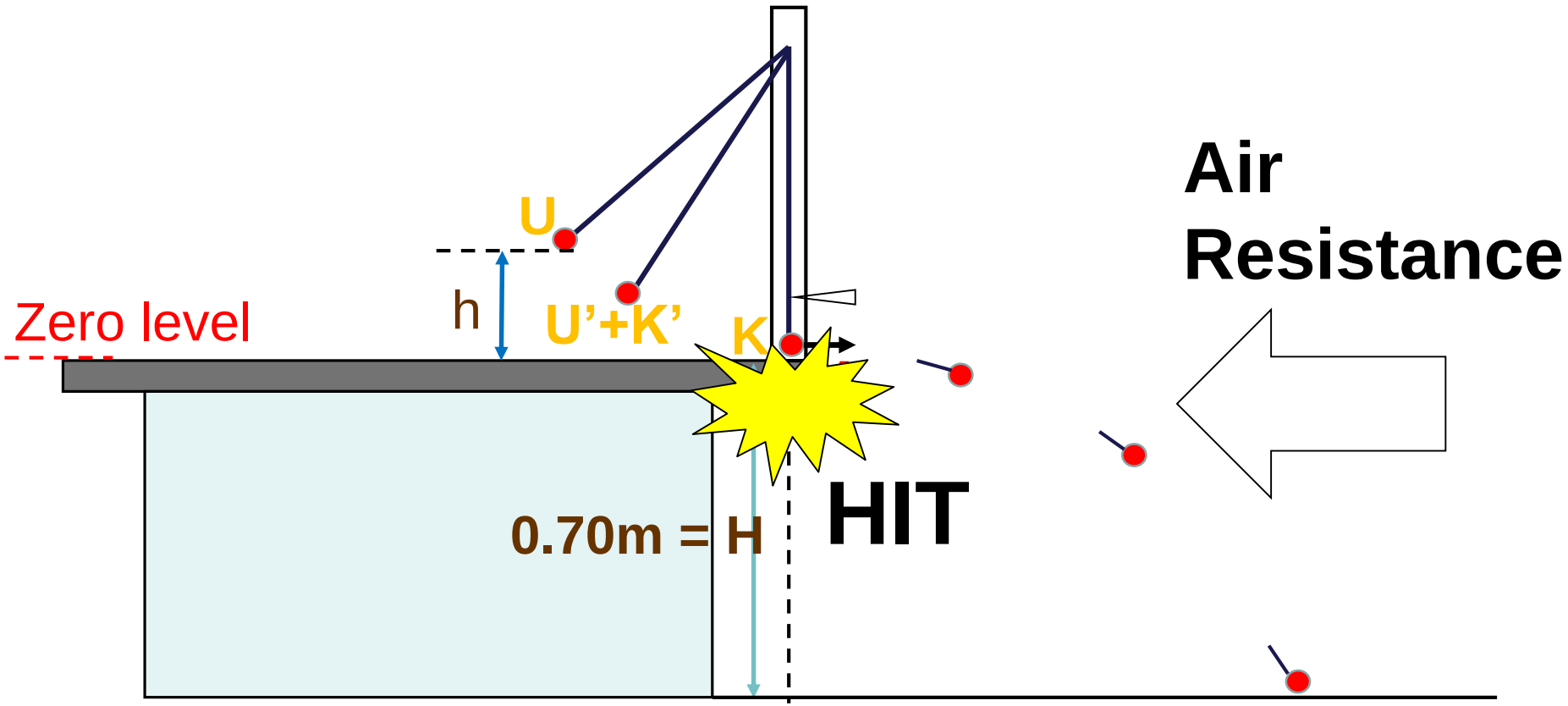
Jan. 2022

Group 1～2, 6～7 Big ball

Group 3～5, 8～10 Small ball

	m[kg]	h[m]	U[J] mgh	L[m]	V[m/s] $V = \frac{L}{0.405}$	v^2	K[J] $\frac{1}{2}mv^2$
Group 1	0.36	0.20	**0.70**	0.75	1.84	3.38	**0.61**
Group 2	0.36	0.20	**0.70**	0.77	1.89	3.57	**0.64**
Group 3	0.36	0.20	**0.70**	0.80	1.96	3.85	**0.69**
Group 4	0.067	0.20	**0.13**	0.80	1.98	3.90	**0.13**
Group 5	0.067	0.20	**0.13**	0.79	1.95	3.80	**0.13**
Group 6	0.359	0.15	**0.53**	0.65	1.59	2.54	**0.46**
Group 7	0.359	0.15	**0.53**	0.65	1.59	2.54	**0.46**
Group 8	0.07	0.15	**0.10**	0.57	1.41	1.98	**0.07**
Group 9	0.07	0.15	**0.10**	0.69	1.70	2.90	**0.10**
Group 10	0.07	0.15	**0.10**	0.69	1.70	2.90	**0.10**

Kinetic energy(K) & Gravitational potential energy(U)



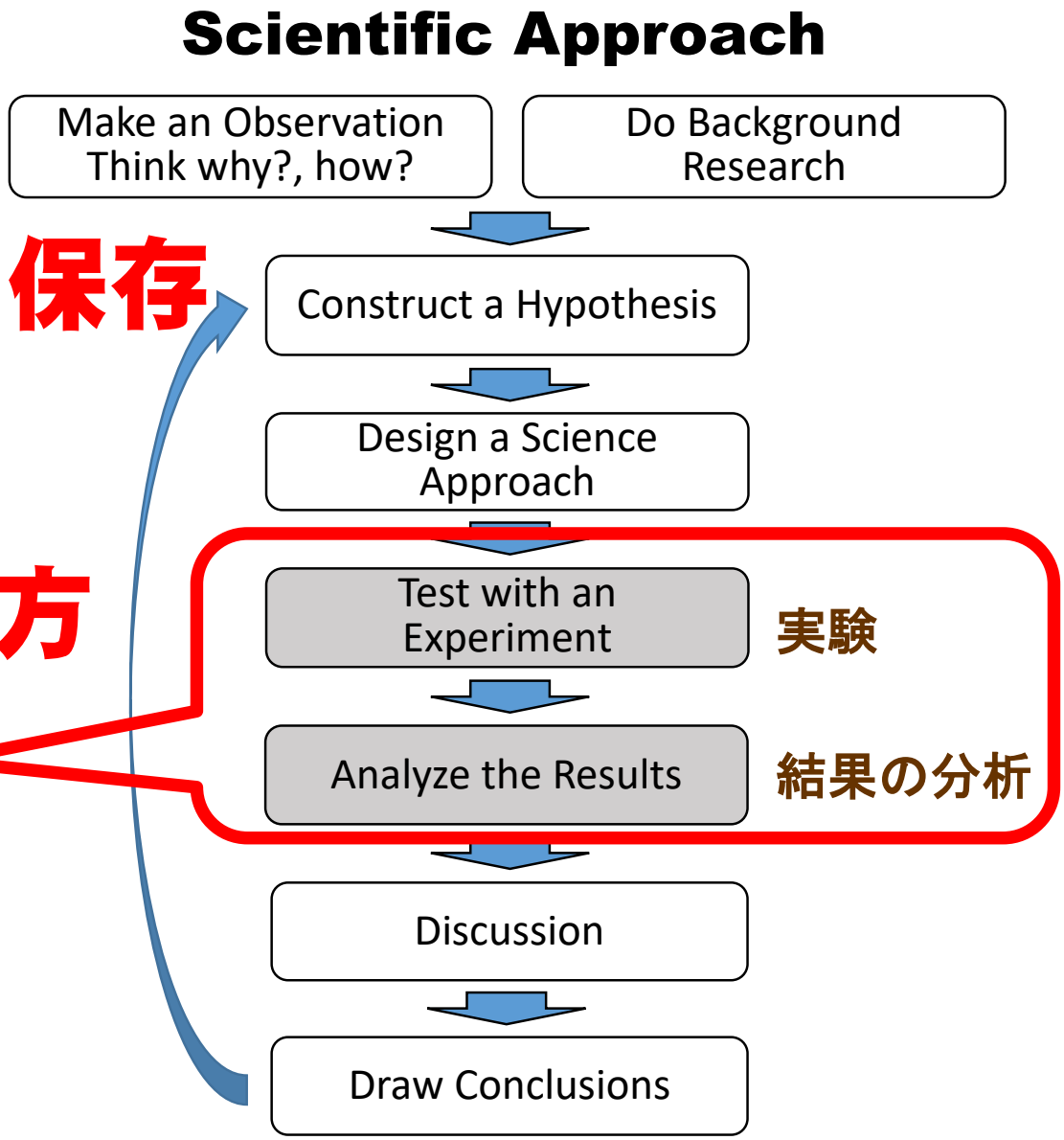
The amount of gravitational potential energy at the top of the swing
is almost equal to the amount of kinetic energy at the bottom of the swing.

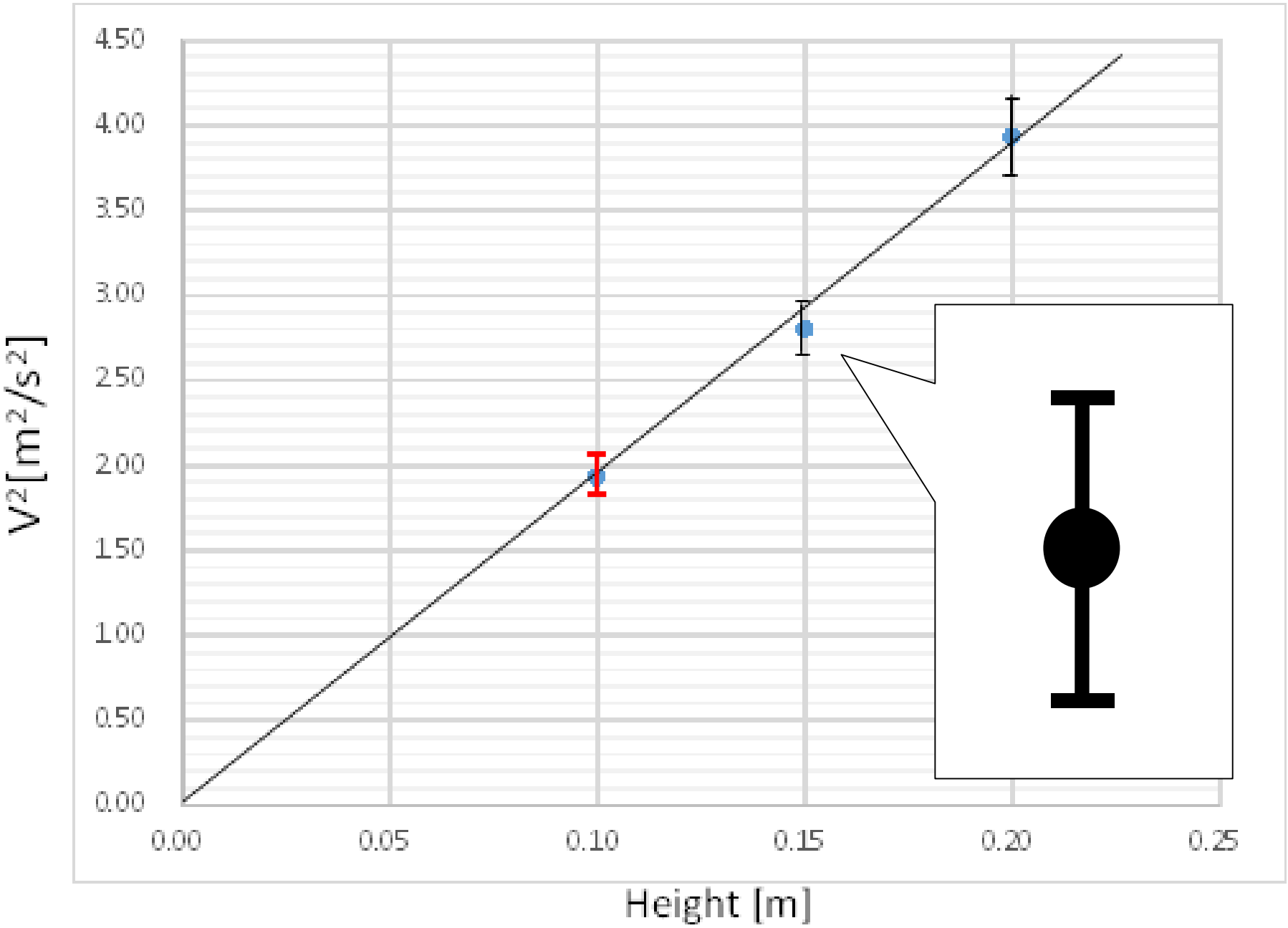
今日のポイント

①エネルギーの保存

②データの扱い方

グラフの表現




4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
$V^2[m^2/s^2]$
0.00
0.05
0.10
0.15
0.20
0.25
Height [m]

Error bar

represents the uncertainty or variation of each point

不確実性　ばらつき

Table1. Relationship between Height and v^2 (N=10)

h [m]	V^2 [m^2/s^2]										average [m^2/s^2]	SD
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th		
0.10	2.04	1.88	1.99	1.96	1.96	2.10	1.93	1.54	1.90	2.02	1.93	0.15
0.15	2.79	2.76	2.82	2.34	2.89	2.86	2.89	2.86	2.89	2.92	2.80	0.17
0.20	4.20	3.69	4.04	3.50	4.12	3.72	3.88	3.96	4.08	4.12	3.93	0.23

1.93 + 0.15 = 2.08

Average + SD

Average 1.93

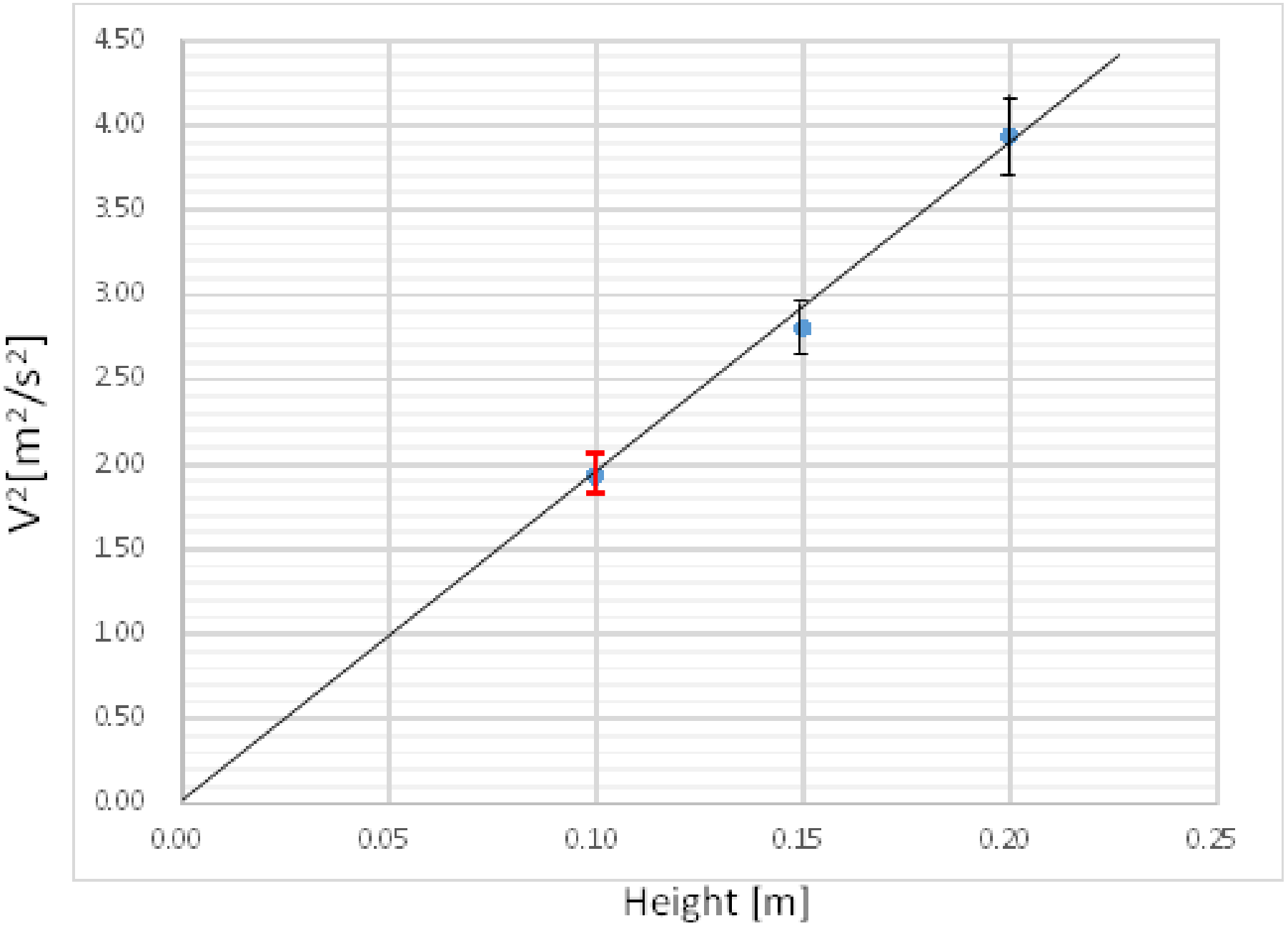
Average - SD

1.93 - 0.15 = 1.78

標準偏差

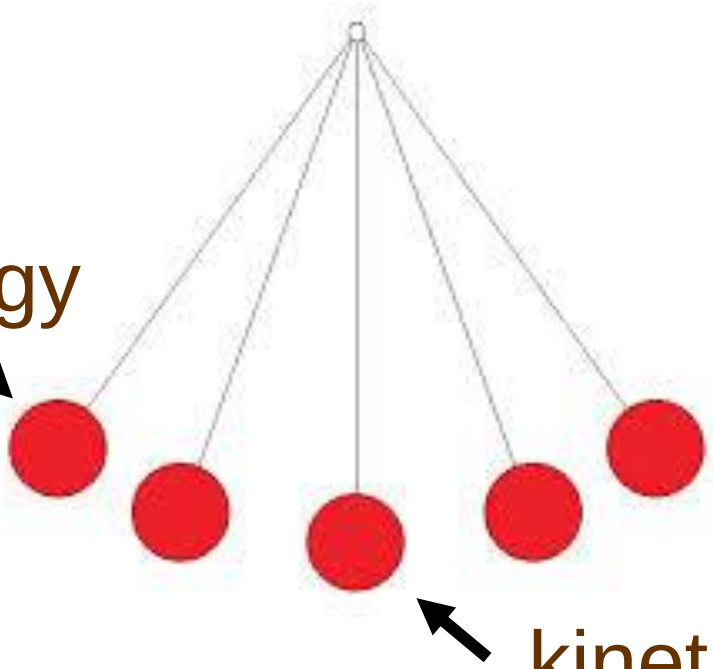
Standard deviation(SD)

$$= \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2}$$


4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
$V^2[m^2/s^2]$
0.00
0.05
0.10
0.15
0.20
0.25
Height [m]

Conclusion

potential energy



kinetic energy

Conservation of mechanical energy

Presentation Exercise

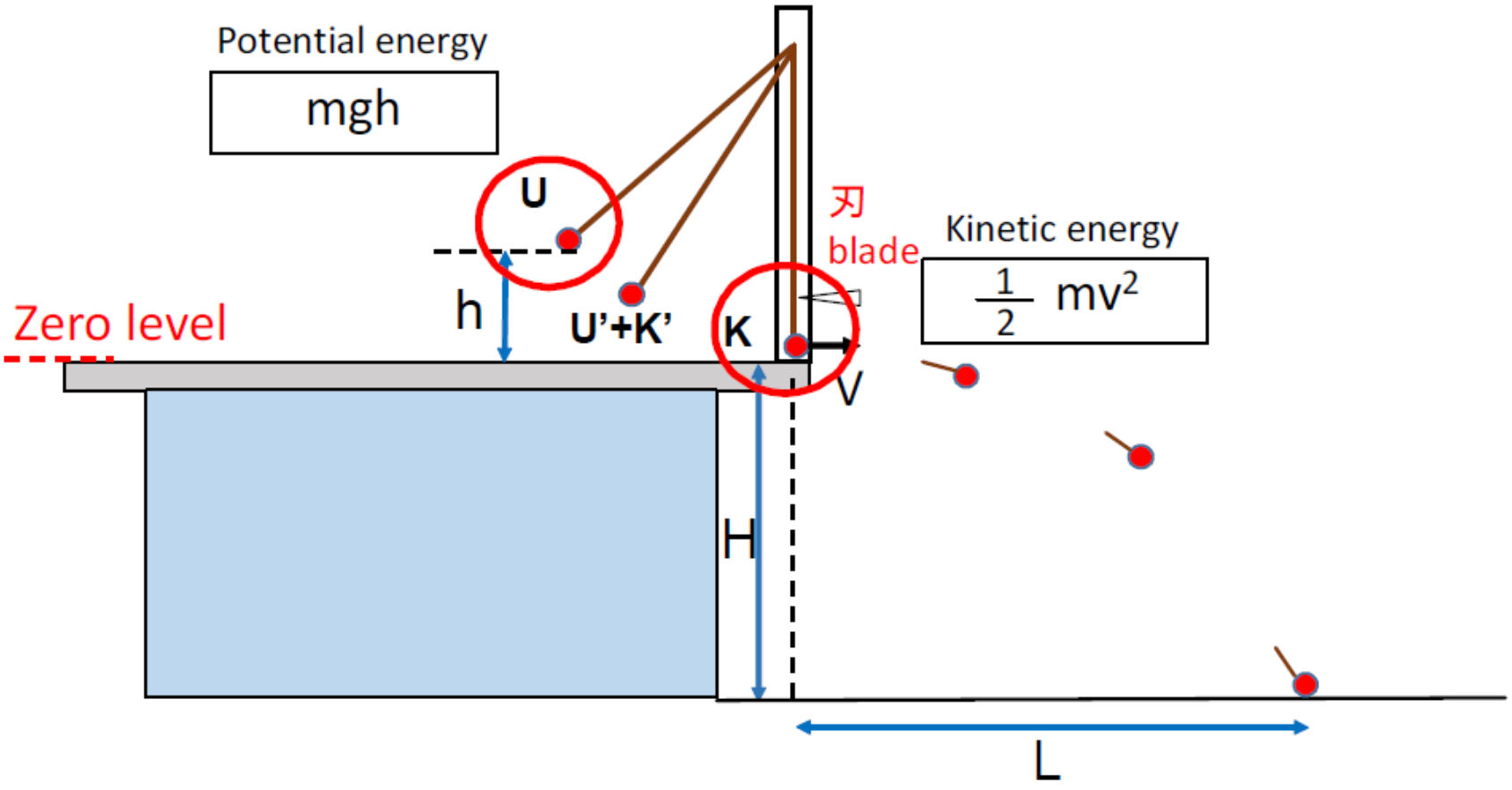
The Relationship between Kinetic Energy and Gravitational Potential Energy

Aim of research

To confirm experimentally whether mechanical energy is conserved.

Methods

Kinetic energy(E_k) & Gravitational potential energy(E_p)



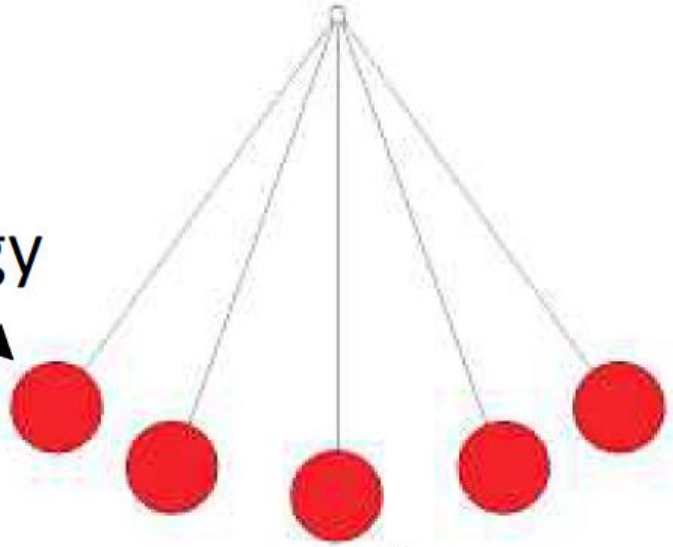
Results

$$V = \frac{L}{0.405}$$

	m[kg]	h[m]	U[J] mgh	L[m]	V[m/s]	v^2	K[J] $mv^2/2$
Group 1	0.36	0.20	0.70	0.75	1.8	3.4	0.61
Group 2	0.36	0.20	0.70	0.77	1.9	3.6	0.64
Group 3	0.36	0.20	0.70	0.80	2.0	3.9	0.69
Group 4	0.067	0.20	0.13	0.80	2.0	3.9	0.13
Group 5	0.067	0.20	0.13	0.79	2.0	3.8	0.13
Group 6	0.36	0.15	0.53	0.65	1.6	2.5	0.46
Group 7	0.36	0.15	0.53	0.65	1.6	2.5	0.46
Group 8	0.067	0.15	0.10	0.64	1.6	2.5	0.084
Group 9	0.067	0.15	0.10	0.69	1.7	2.9	0.10
Group 10	0.067	0.15	0.10	0.69	1.7	2.9	0.10

Conclusion

potential energy



kinetic energy

Conservation of mechanical energy

Thank you very much!