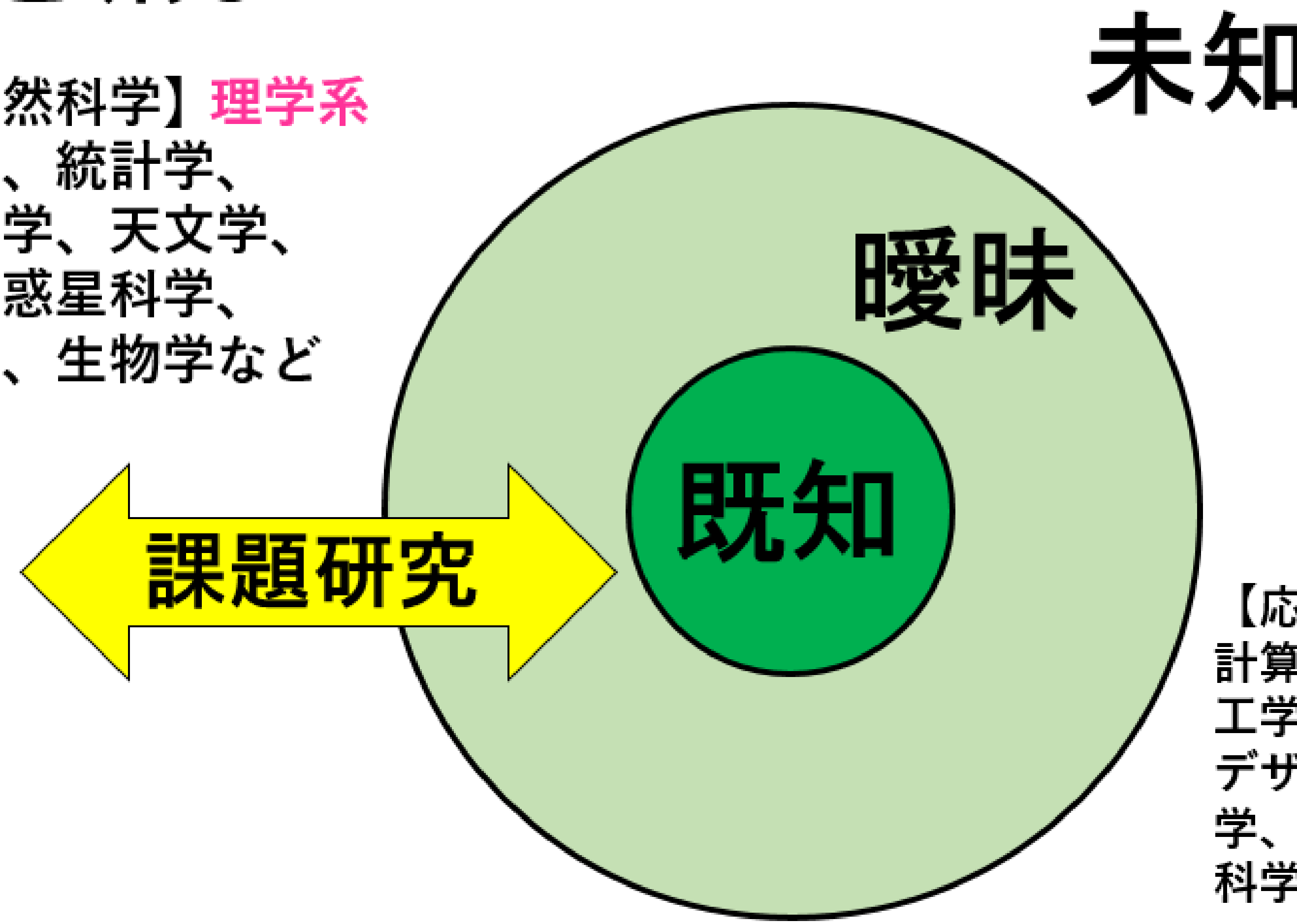
Science English

Data Analysis “Conservation of mechanical energy”

Pre - training

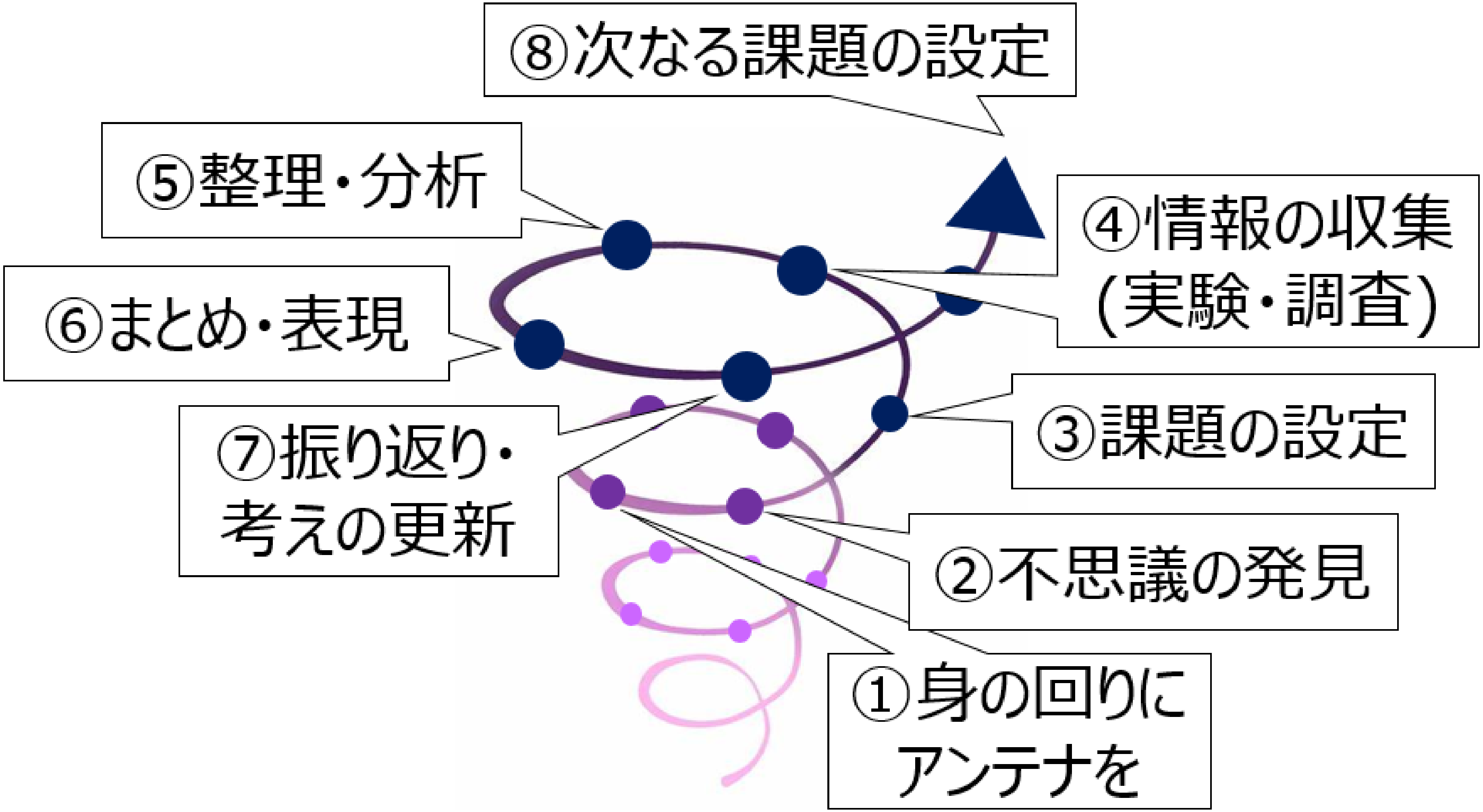
課題研究

【自然科学】理学系
数学、統計学、
物理学、天文学、
地球惑星科学、
化学、生物学など



工学系
農学系
医療系
【応用科学】
計算機科学（工学）、
工学、建築学、
デザイン学、農学、医
学、歯学、薬学、健康
科学など

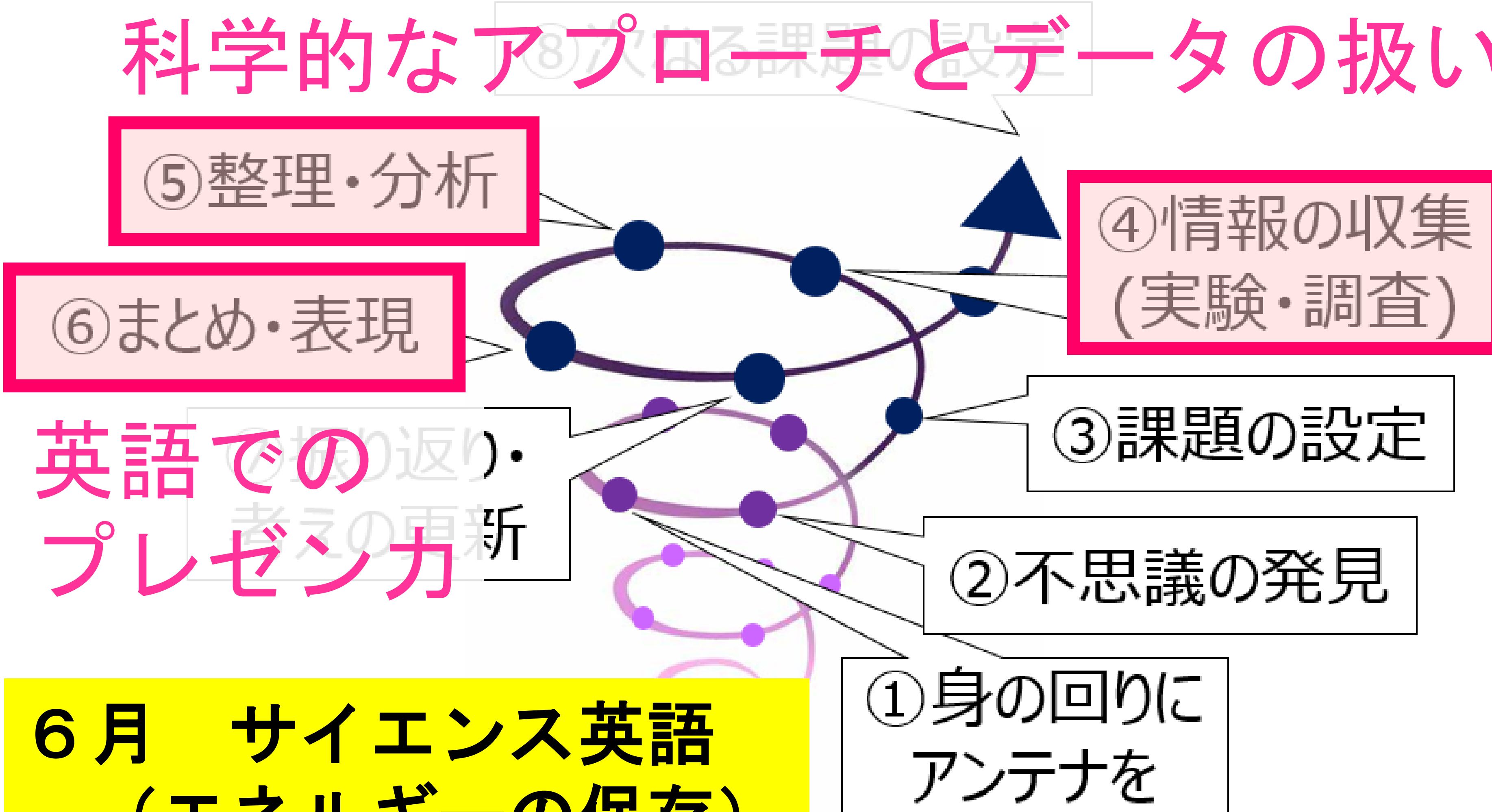
探究の過程



⑧次なる課題の設定
⑤整理・分析
④情報の収集
(実験・調査)
⑥まとめ・表現
③課題の設定
⑦振り返り・
考えの更新
②不思議の発見
①身の回りに
アンテナを

探究の過程

科学的なアプローチとデータの扱い



英語での
プレゼン力

６月　サイエンス英語
（エネルギーの保存）
７月　事後学習

サイエンス英語Ｉ事前学習

１　なぜ英語？
２　２時間の進め方
３　Conservation of mechanical energy
４　科学英単語

● 考える

どうして英語で科学を学ぶ授業があるの？

英語でのプレゼン力を鍛えるのはなぜ？

● 考える

研究者にとって
英語力が必須だから

とある理系学部の学生の６年

大学１～３年生

・教養科目や専門科目の授業
・実験・演習、課外研修
・３年に研究室に配属

大学４年生

・卒業研究（**文献調査**、実験、データ解析、論文や発表資料作成）
・大学院進学準備

大学院１年生

・大学院専門科目
・修士研究
・**国内外での学会発表**

大学院２年生

・修士研究・**修士論文**
・**国内外での学会発表**
・**学術誌への論文投稿**
・就職・進学準備

学術論文

Eur. J. Entomol. 106: 171–178, 2009
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ISSN 1210-5759 (print), 1802-8829 (online)

Genetic and physiological variation among sexual and parthenogenetic populations of *Asobara japonica* (Hymenoptera: Braconidae), a larval parasitoid of drosophilid flies

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Key words. *Asobara japonica*, climatic adaptation, COI, cold tolerance, diapause, *Drosophila*, oviposition preference, parasitism, preimaginal period, genetic variation

Abstract. We studied variations in genetic, physiological, and ecological traits, and the phylogenetic relationship among sexual and parthenogenetic populations of *Asobara japonica*, a larval parasitoid of drosophilid flies, in order to understand how they adapt to local environments and have differentiated. The strain from Iriomote-jima (IR) differed from other Japanese strains in the nucleotide sequences of its cytochrome oxidase subunit I (COI) and in not undergoing diapause and having a shorter preimaginal period and a higher adult tolerance of cold. The strains other than IR showed a low level of nucleotide variation in COI but varied in their mode of reproduction; the strains from the Ryukyu Islands were sexual, whereas those from the main islands of Japan and Ogasawara were parthenogenetic. In addition, strains from higher latitudes generally showed a high incidence of diapause, although there were some exceptions. On the other hand, preimaginal period and adult cold tolerance varied little among the strains excluding IR, and pupal cold tolerance, oviposition preference and incidence of parasitism varied little among the strains including IR. Evolution and environmental adaptations in this species are discussed, particularly focusing on parthenogenetic populations.

INTRODUCTION

Parthenogenetic lineages are often considered as evolutionary dead ends, and their low potential to respond to rapid environmental changes is thought to be one of the factors leading to their extinction (Maynard Smith, 1978). However, recent studies have shown that parthenogenetic lineages of some organisms, such as aphids, are genetically more variable than expected (reviewed by Lushai & Loxdale, 2002) and have a substantial potential for rapid adaptive changes (Loxdale & Lushai, 2003; Lushai et al., 2003; Wilson et al., 2003; Castagnone-Sereno, 2006). Such genetic variability and adaptive potential could allow a parthenogenetic lineage to adapt to diverse environments following geographic and habitat expansion, resulting in geographic and ecological differentiation. However, genetic variability is not the only mechanism generating genetic differentiation in parthenogenetic populations. Repeated evolution of parthenogenesis in sexual populations would also result in the genetic differentiation among parthenogenetic populations (Cenis, 1993; Semblat et al., 1998; Castagnone-Sereno, 2006). It is possible to discriminate between these two processes of genetic differentiation by molecular phylogenetic analyses of parthenogenetic and sexual populations (Cenis, 1993; Semblat et al., 1998; Vorwerk & Fornech, 2007; Schwander & Crespi, 2009). Such phylogenetic analyses might also provide an estimate of when and where parthenogenesis evolved.

In this paper, we study variations in diapause traits, preimaginal period, cold tolerance, and host use among sexual and parthenogenetic populations of *Asobara japonica* Belokobylskij (Hymenoptera: Braconidae) in order to understand how they adapt to local environments. In addition, their phylogenetic relationship is analysed using nucleotide sequences of their mitochondrial cytochrome oxidase subunit I (COI) in order to understand how they have differentiated. The study species is a larval-pupal parasitoid of drosophilid flies (Diptera) occurring from Sapporo (cool-temperate region) to Iriomote-jima (subtropical region), and its populations on the main islands are parthenogenetic whereas those on the Ryukyu Islands are sexual (Mitsui et al., 2007). Thus, the parthenogenetic populations of this species are widely distributed unlike those of many other multicellular parthenogenetic organisms that are restricted to marginal environments (Peck et al., 1998). Widely distributed sexually-reproducing insects often show geographic variation in life-history traits, stress tolerance, or host use as a result of their adaptations to local environmental conditions (Danilevskii, 1965; Tauber et al., 1986; Danks, 1987; Roff, 1992; Kraaijeveld & van del Wel, 1994). In contrast, little is known about how widely distributed parthenogenetic populations vary geographically and adapt to local conditions.

In this study, some geographic strains were crossed in order to determine the extent to which they are geneti-

* Corresponding author

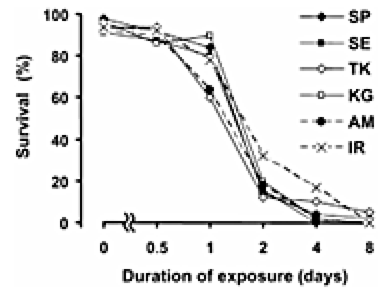


Fig. 4. Percentage survival of pupae of the different strains of *Asobara japonica* that were exposed to 0°C for various periods.

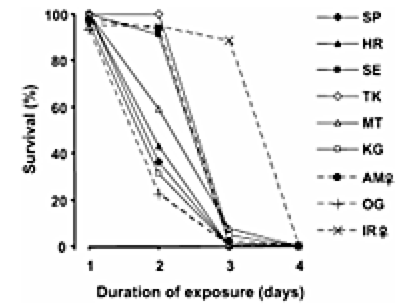


Fig. 5. Percentage survival of adult females of the different strains of *Asobara japonica* that were exposed to 0°C for various periods.

DISCUSSION

The Iriomote-jima (IR) population of *Asobara japonica* differs in its COI nucleotide sequence from northern populations. In addition, it does not diapause and has a faster preimaginal development, and its adults have a higher tolerance of cold. It is also reported that most populations and species of insects occurring in subtropical regions like the Iriomote-jima strain do not diapause or only weakly do so and develop faster (Masaki, 1961; Danilevskii, 1965; Tauber et al., 1986; Danks, 1987; Kimura, 1988; Shimizu & Kawasaki, 2001; Kato, 2005; Shiota & Kimura, 2007). However, it is unknown why the adults of the IR population have a higher tolerance of cold. It may be related to the lack of diapause. Since the IR population does not diapause, adults of this population could emerge in winter. A high tolerance of cold may lower its mortality in winter, even though temperatures on Iriomote-jima do not fall below 0°C (Hirai et al., 2000). In contrast, tolerance of cold in the adult is not necessary in the northern populations because they overwinter in prepupal diapause.

Furthermore, there seems to be weak asymmetrical sexual isolation between the IR and AM strains. The morphological and genetic distinction between populations from Iriomote-jima and Amami-oshima is also documented for a number of other animals and insects (Kimoto & Gressitt, 1966; Ohta, 1998). Such results suggest that these two regions have been geographically separated for a long time.

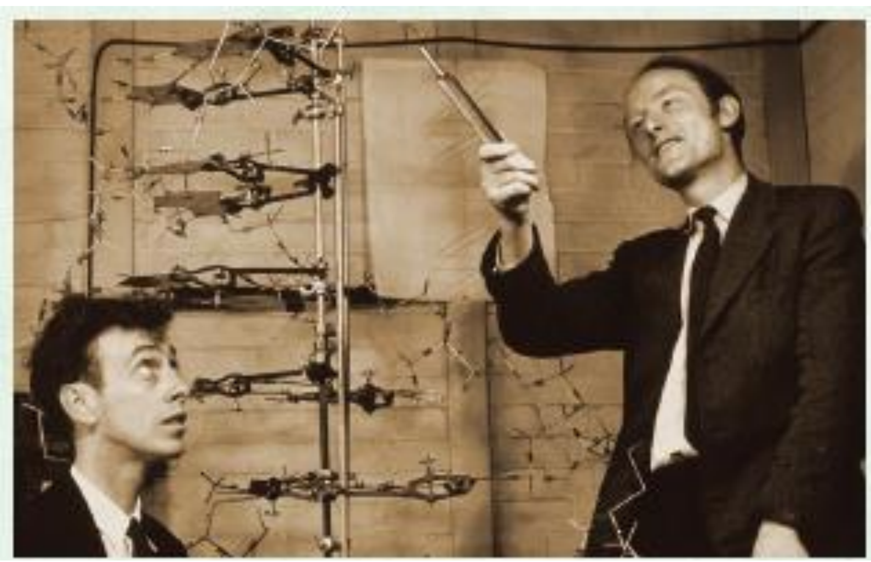
The *A. japonica* populations from the Ryukyu Islands, including Iriomote-jima, reproduce sexually whereas those from Ogasawara and the main islands of Japan are parthenogenetic (see Mitsui et al., 2007). However, there is no or very little differentiation in the COI nucleotide sequences of the sexually reproducing populations from the central Ryukyu Islands (Amami-oshima, Okinoerabu-jima and Kume-jima) and parthenogenetic populations from Ogasawara and the main islands of Japan. This suggests that parthenogenesis in this species has evolved recently.

The strains other than IR entered prepupal diapause when reared under short daylengths and low temperatures. As observed in many temperate insects (Danilevskii, 1965; Tauber et al., 1986; Danks, 1987) the incidence of diapause was usually higher in strains from higher latitudes, although there were exceptions (the SP and OG strains). Even so, it is unclear whether there is geographic variation in the critical daylength for diapause induction in this species, although it is commonly observed in temperate insects (Danilevskii, 1965; Tauber et al., 1986; Danks, 1987). Thus, *A. japonica* may adapt to local climatic conditions not by changing the critical daylength but the incidence of diapause.

Table 4. Percentages of drosophilid larvae oviposited by the TK, AM and IR strains of *Asobara japonica* in the oviposition preference test.

	TK		AM		IR		
	N	Oviposition (%)	N	Oviposition (%)	N	Oviposition (%)	χ^2-test
D. takahashii	22	81.8	25	96.0	30	93.3	$P = 0.202$
D. lacteicornis	21	85.7	28	85.7	30	86.7	$P = 0.317$
D. bipectinata	30	83.3	30	96.7	30	96.7	$P = 0.084$
D. ficusphila	30	86.7	30	86.7	30	80.0	$P = 0.713$
D. albomicans	27	0	30	0	30	0	–
D. ruberrima	26	19.2	24	12.5	30	3.3	$P = 0.167$

研究成果を巡る研究者の競争



国際的な
共同研究体制

北海道大学
GI-CoRE
国際連携研究教育局

北海道大学の強み・特色を活かした国際連携研究・教育の推進と、
部局が独自に進める国際連携研究・教育の支援を実現する

国際連携研究教育局とは
About GI-CoRE

Global Institution for Collaborative Research and Edu

国際連携研究教育局（GI-CoRE）は、北海道大学の
める国際連携研究・教育の支援を目的とし、世界ト
織です。

Consortium for the Control of Zoonoses

To integrate research activity toward the goal of "control of zoonoses", we have established the "Consortium for the Control of Zoonoses" wherein all unit members meet together and exchange information through collaboration with leading international researchers in the following research units; The University of Melbourne, University College Dublin and King Abdullah University of Science and Technology, and Hokkaido University.

国際連携教育教育局GI-CoRE
Webページより

札幌啓成理数科の３年

高校１年生

サイエンス英語Ⅰ

・英語で科学を学ぶ授業
・英語プレゼン練習

高校２年生

サイエンス英語Ⅱ

・研究内容から英語
　ポスター作成

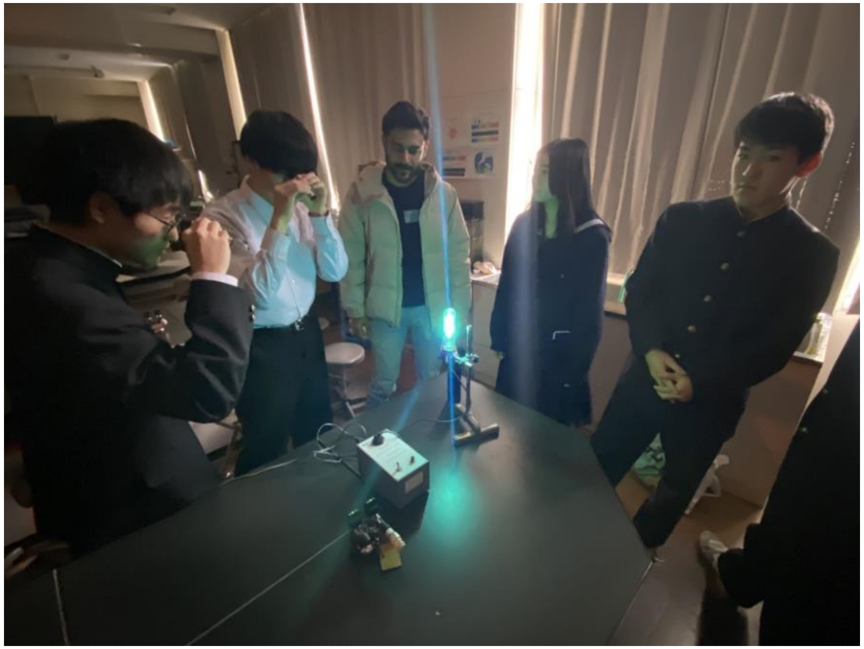
Global Science Workshop in Hokkaido

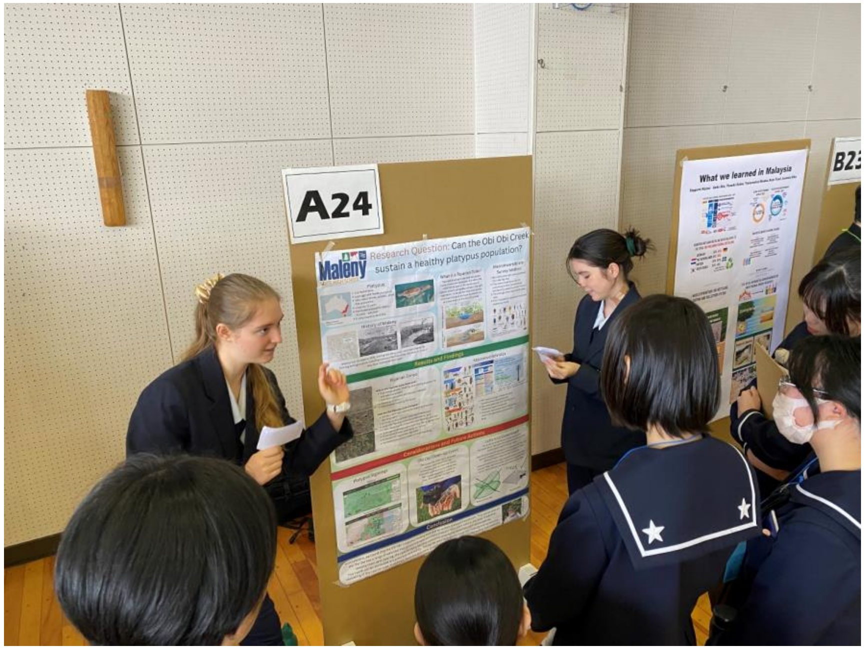
・道内高校生や海外生徒に
　英語ポスター発表

高校３年生

論文作成

・一部英語にて




A24
Maleny
Research Question: Can the Obi Obi Creek sustain a healthy platypus population?
What we learned in Malaysia
B23

サイエンス英語Ｉ事前学習

１　なぜ英語？
２　２時間の進め方
３　Conservation of mechanical energy
４　科学英単語

Science English

Data Analysis “Conservation of mechanical energy”

サイエンス英語Ⅰ

1) English Activity Part

↓

2) Science Experiment Part

↓

3) English Presentation Exercise

● 考える

この２時間をどのように
取り組みますか？

①・・・
②・・・
③・・・

この２時間をどのように取り組みますか？

①日本語禁止
②ＴＡとたくさん
　おしゃべり
③科学的な視点も

サイエンス英語Ｉ事前学習

１　なぜ英語？
２　２時間の進め方
３　Conservation of mechanical energy
４　科学英単語

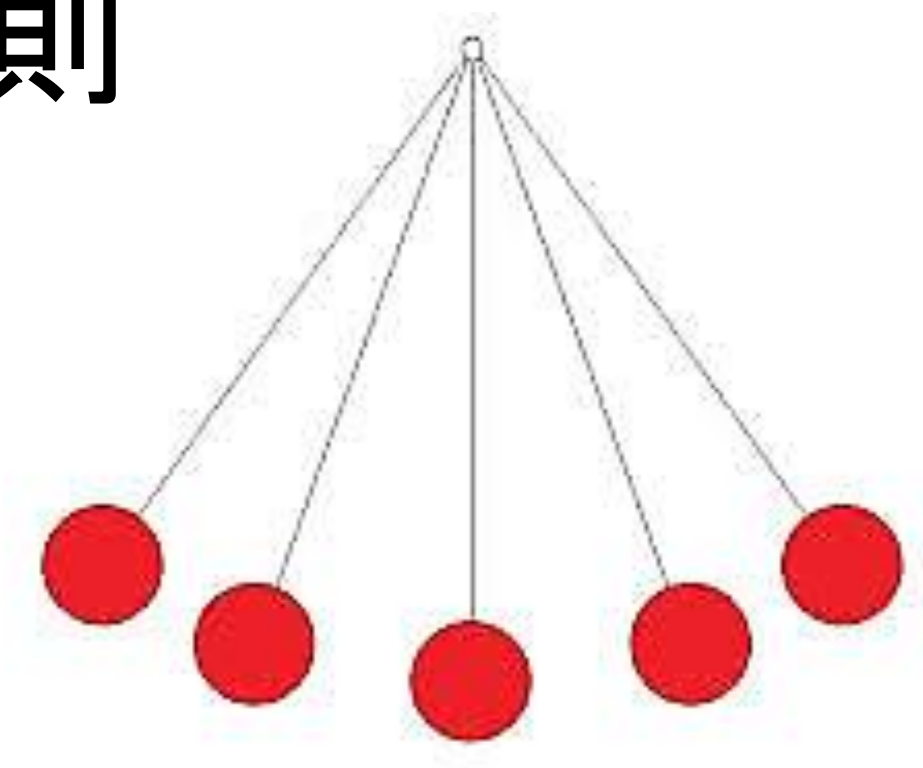
Science English

Data Analysis "Conservation of mechanical energy"

● 考える

力学的エネルギー保存の法則

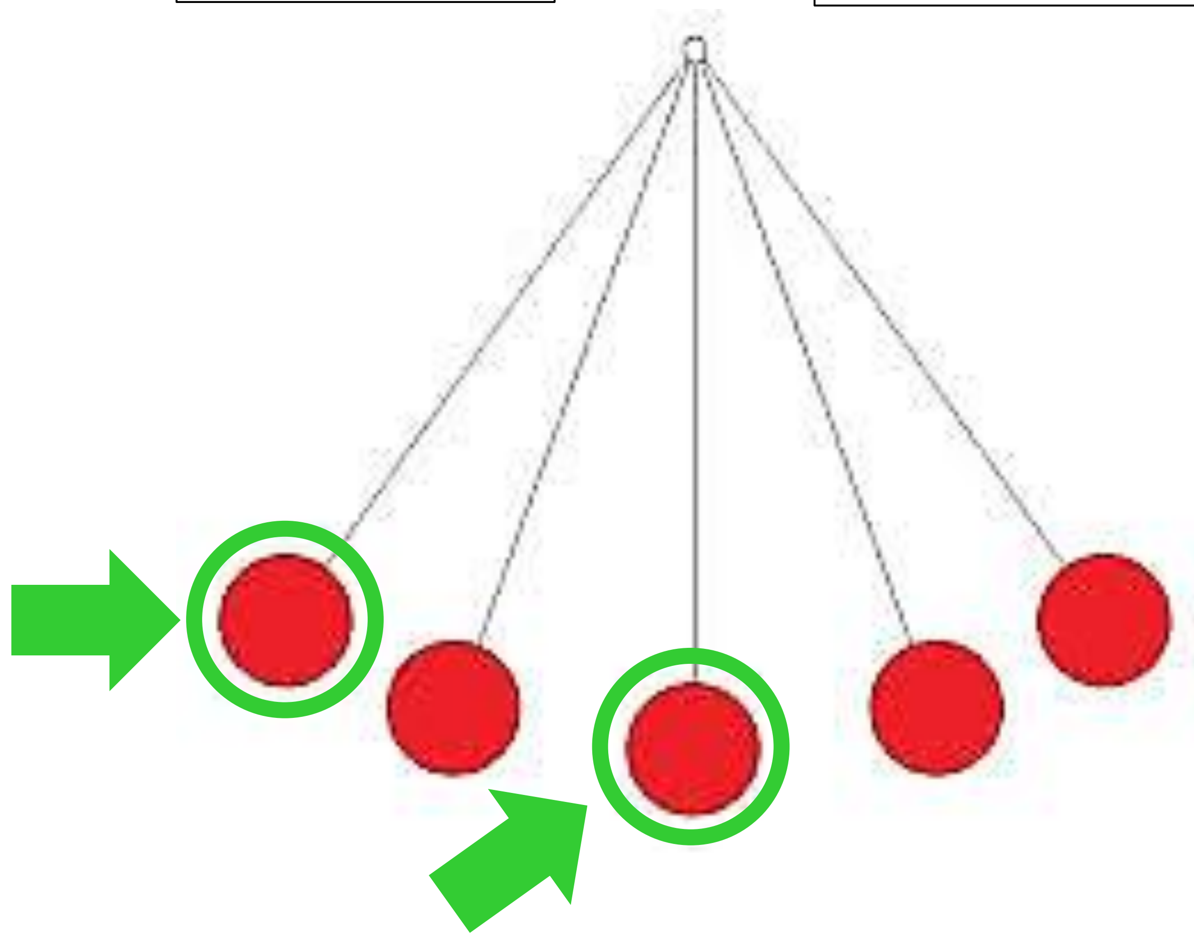
とは？



力学的エネルギー保存の法則

（ある条件下で）力学的エネルギーは常に一定に保たれる

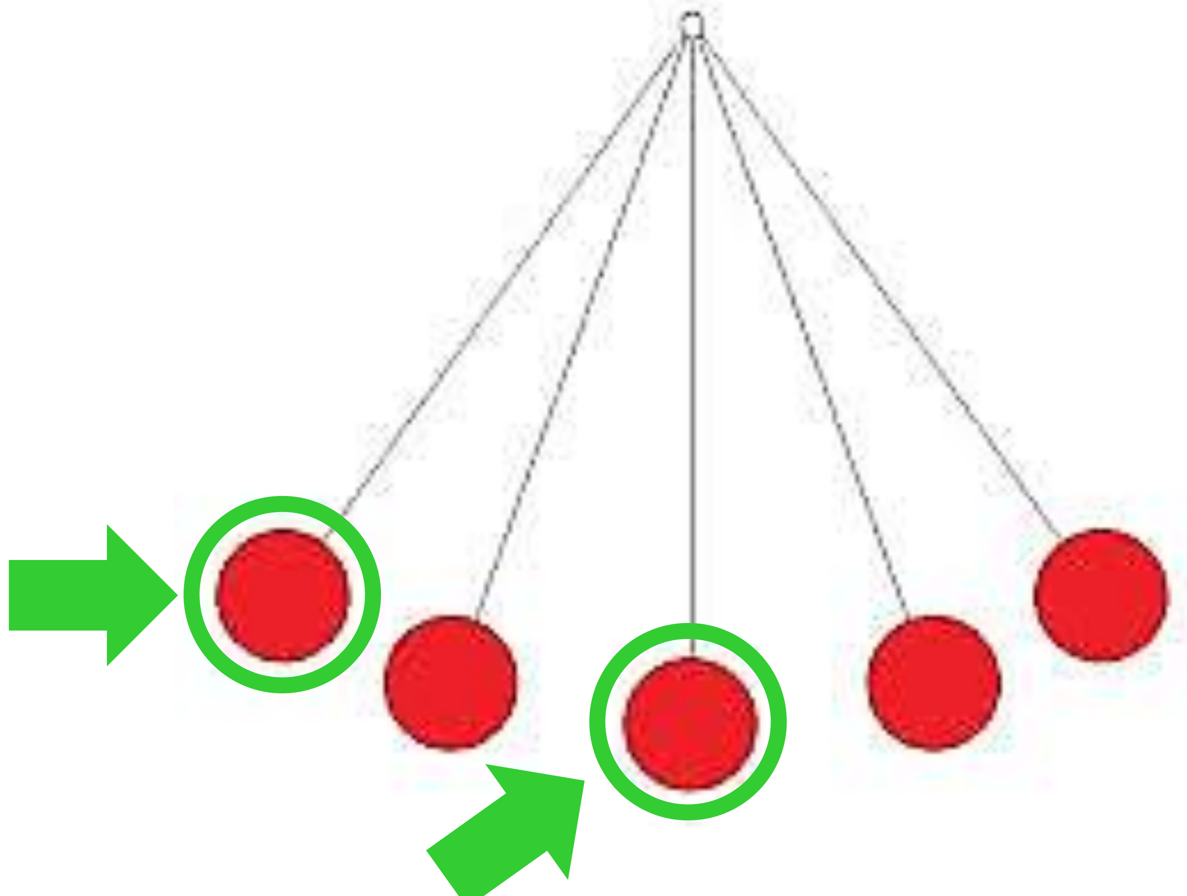
力学的エネルギー	＝	エネルギー	＋	によるエネルギー



力学的エネルギー保存の法則

（ある条件下で）力学的エネルギーは常に一定に保たれる

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**



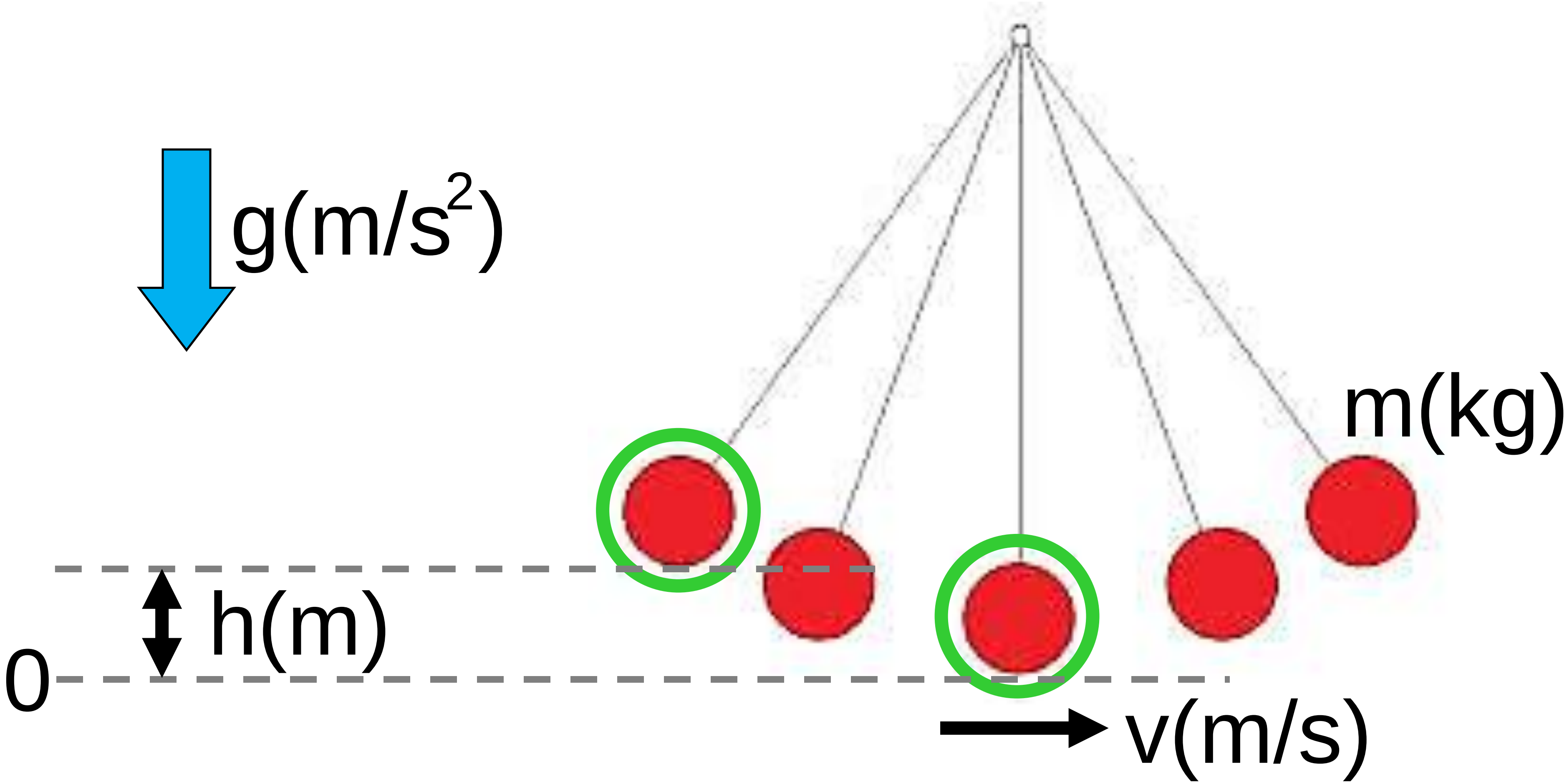
$$\boxed{\text{運動エネルギー}} = \frac{1}{2} \times \underset{(\mathrm{kg})}{\text{質量}} \times \underset{(\mathrm{m/s})}{\text{速度}}^{2}$$

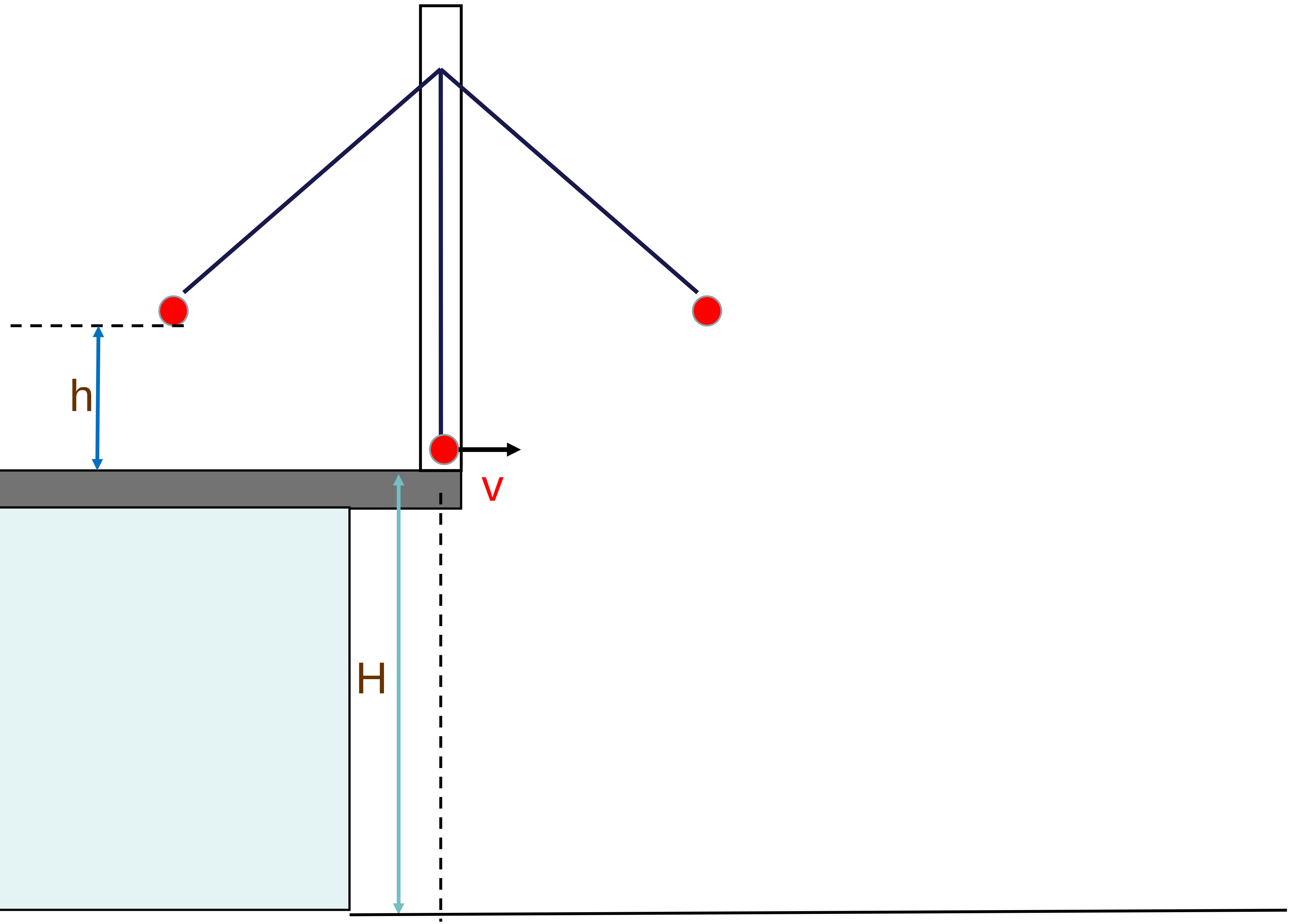
$$\boxed{\text{重力による位置エネルギー}} = \underset{(\mathrm{kg})}{\text{質量}} \times \text{重力加速度}(\mathrm{m/s^2}) \times \underset{(\mathrm{m})}{\text{高さ}}$$

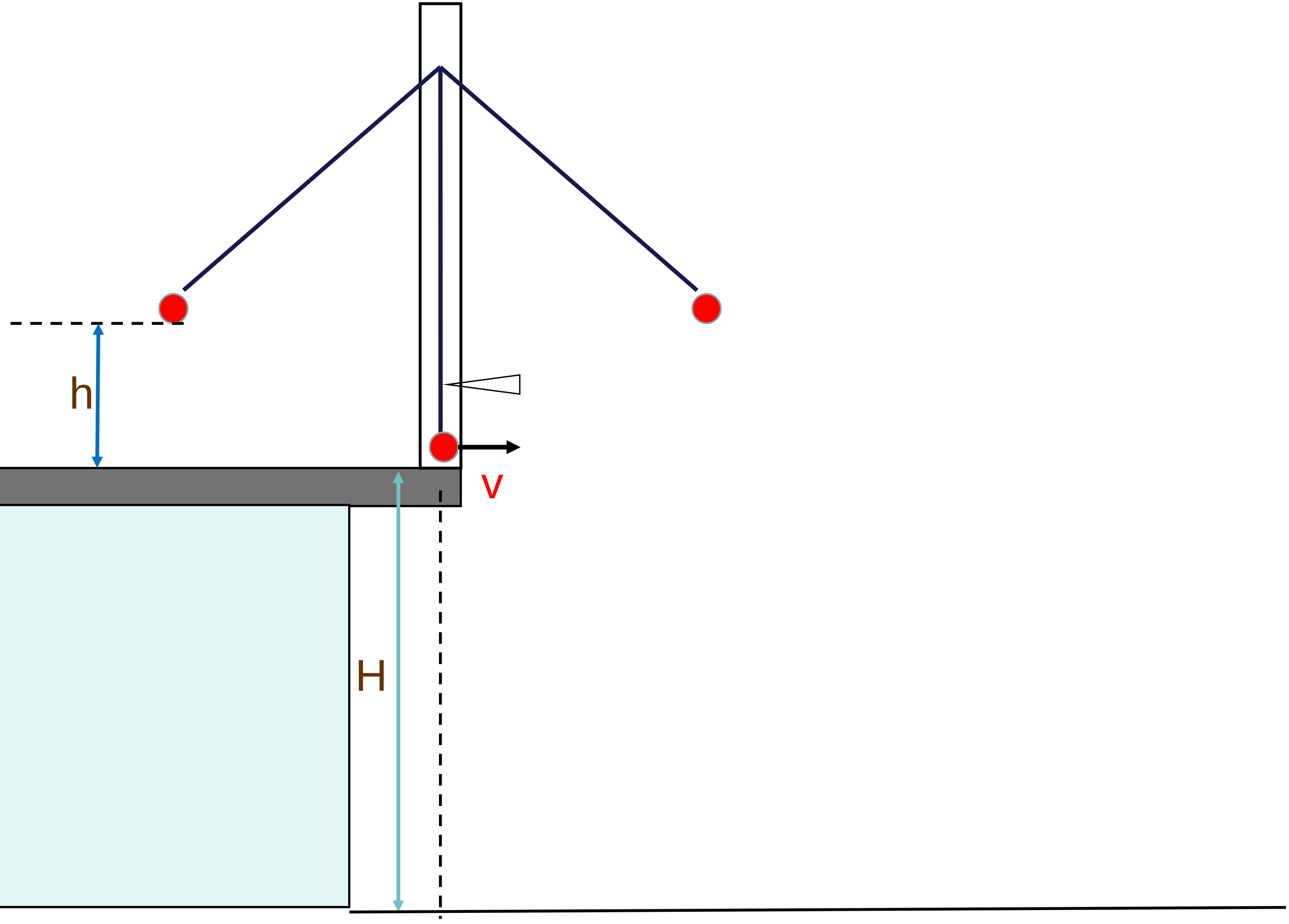
力学的エネルギー保存の法則

（ある条件下で）力学的エネルギーは常に一定に保たれる

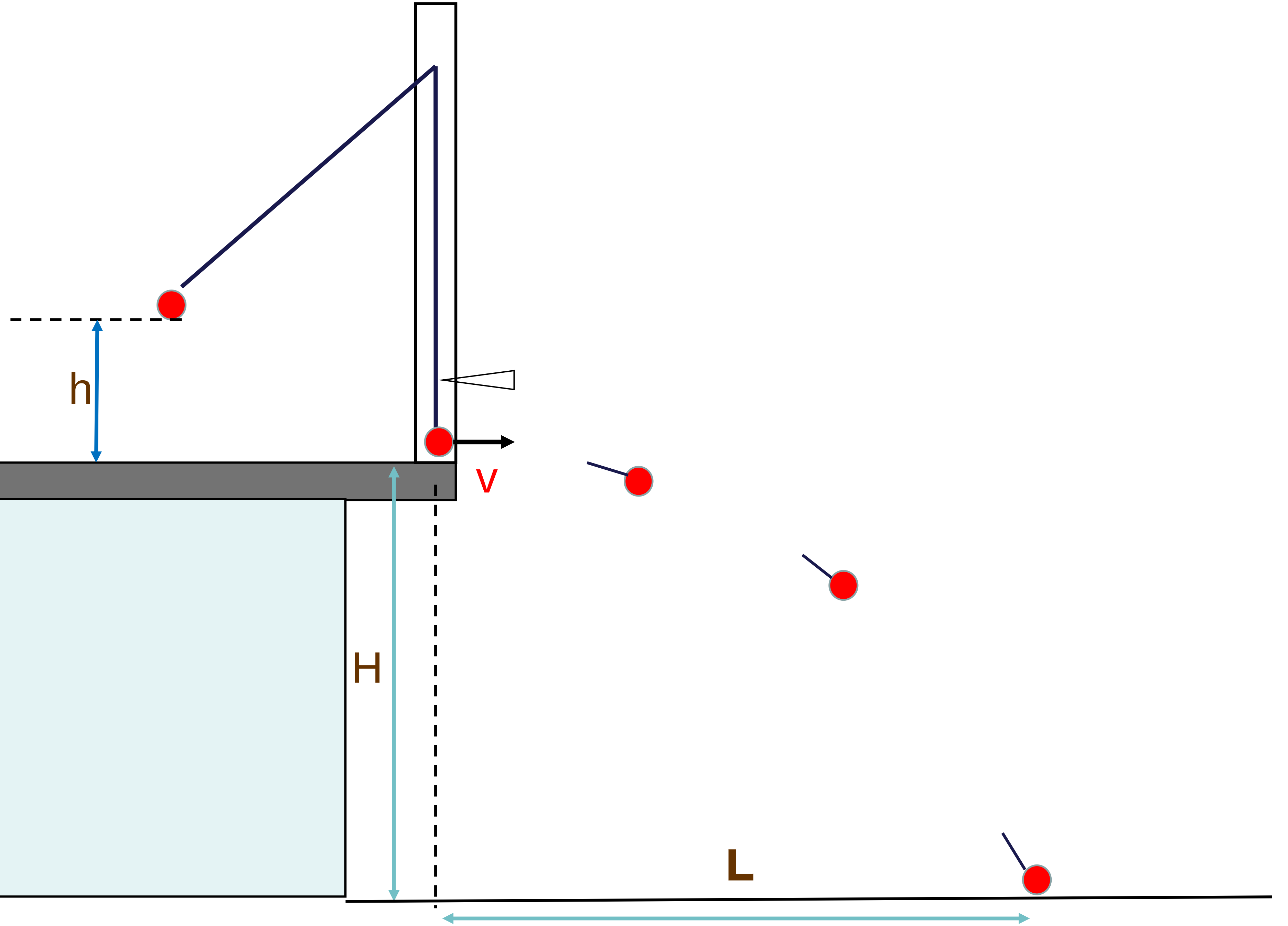
力学的エネルギー	**＝**	**運動エネルギー**	**＋**	**重力による位置エネルギー**

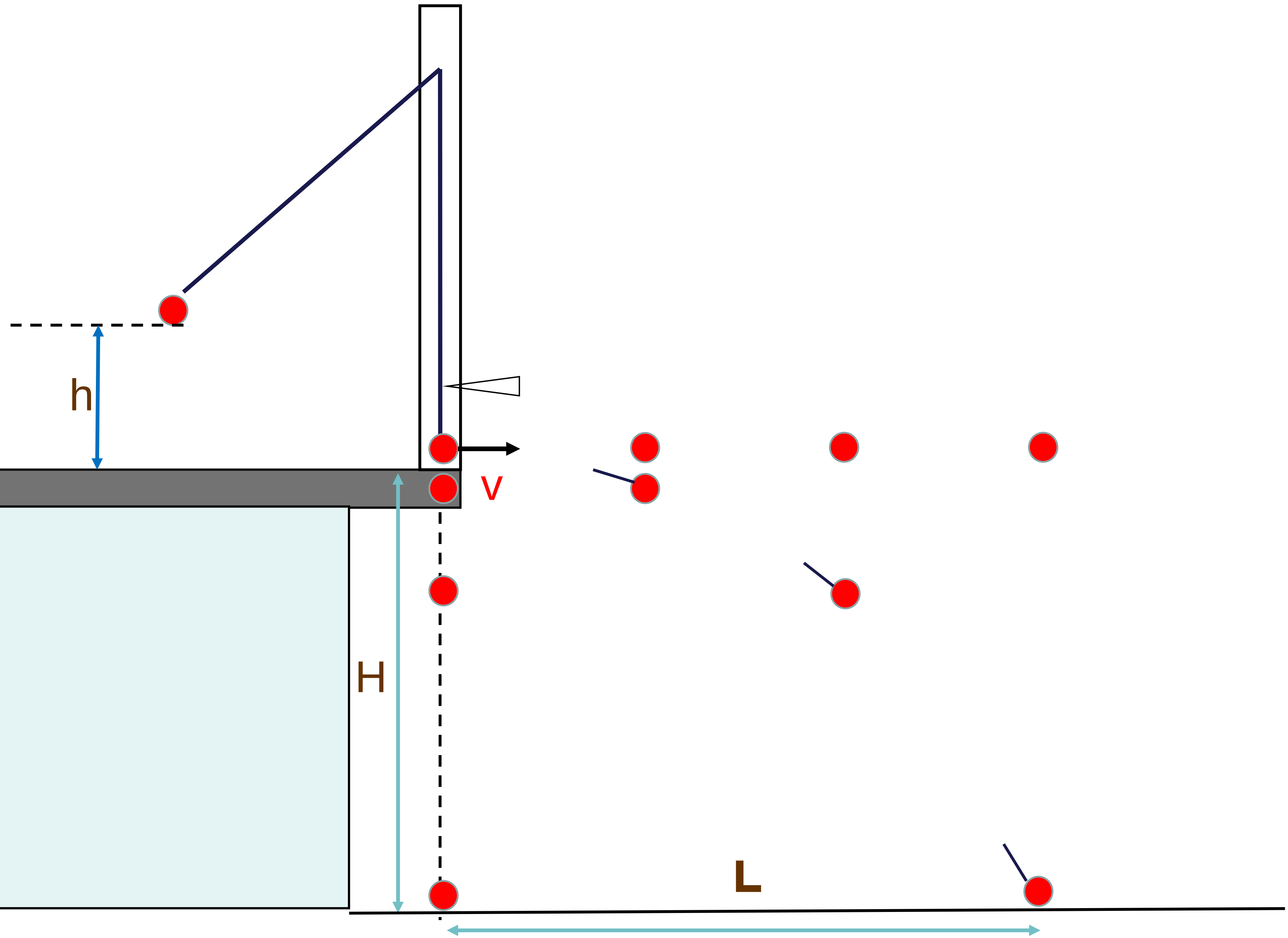



h
v
H

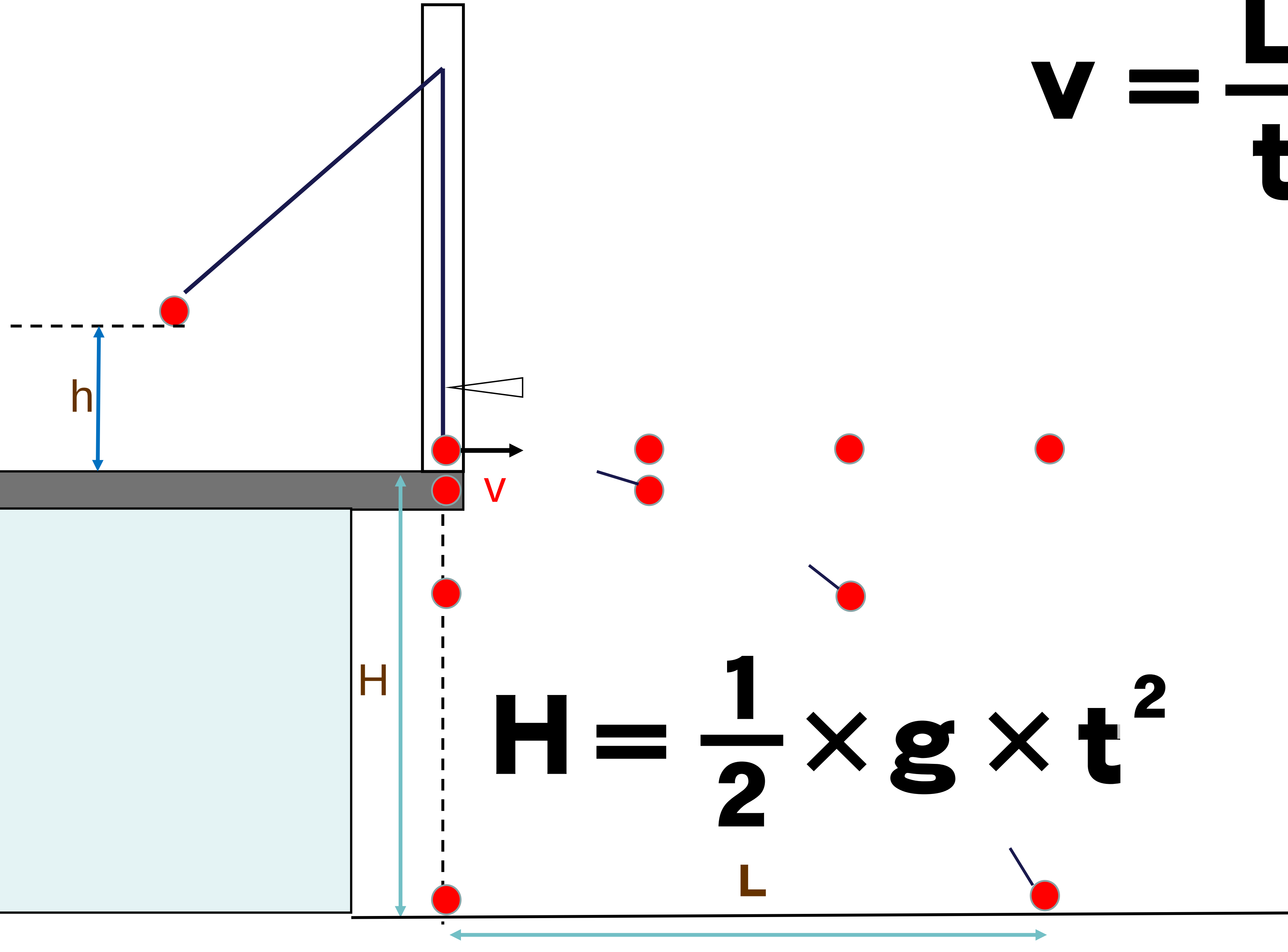


h
v
H


h
v
H
L


h
v
H
L

$$v = \frac{L}{t}$$



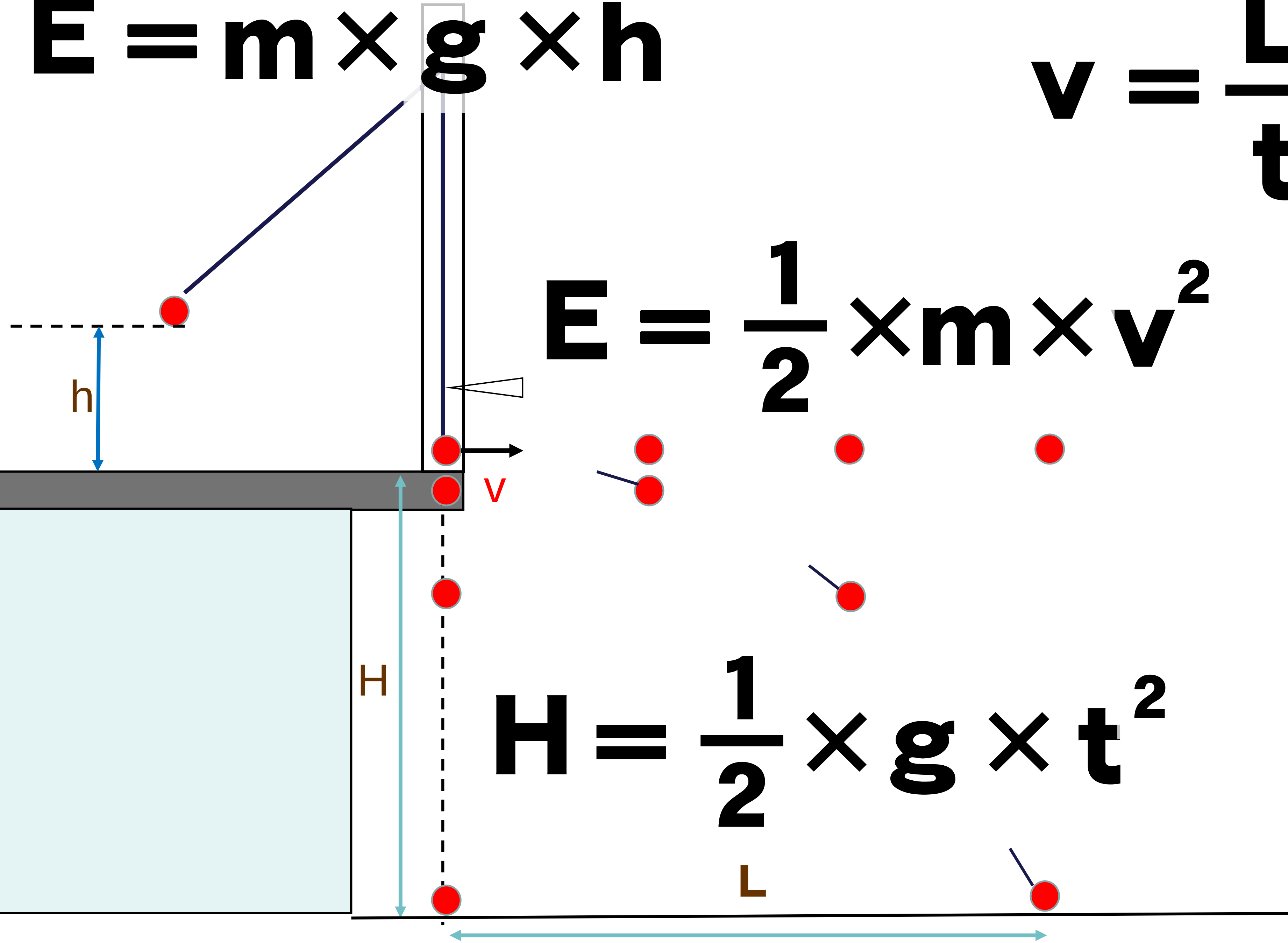
$$H = \frac{1}{2} \times g \times t^2$$

$$E = m \times g \times h$$

$$v = \frac{L}{t}$$

$$E = \frac{1}{2} \times m \times v^2$$

$$H = \frac{1}{2} \times g \times t^2$$



サイエンス英語Ｉ事前学習

１　なぜ英語？
２　２時間の進め方
３　Conservation of mechanical energy
４　科学英単語

サイエンス英語Ⅰ

1) English Activity Part

⇩

2) Science Experiment Part

⇩

3) English Presentation Exercise

Scientific Terminology

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

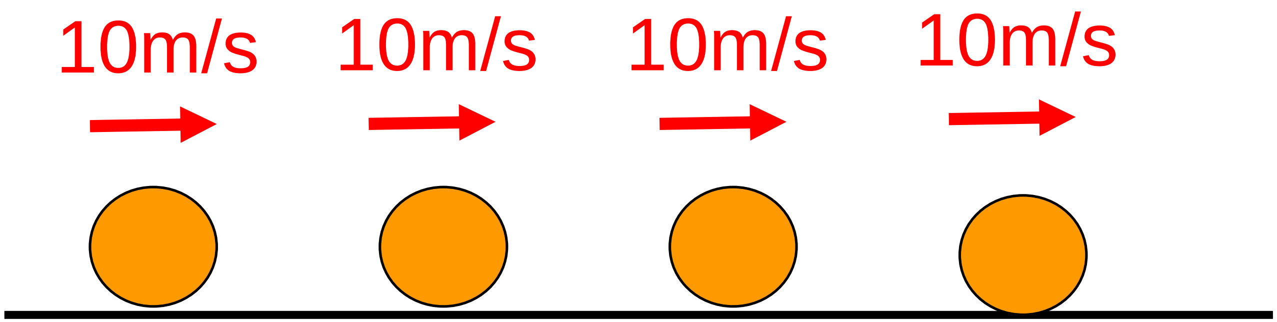
速度

40km/h

the speed of something in a particular direction

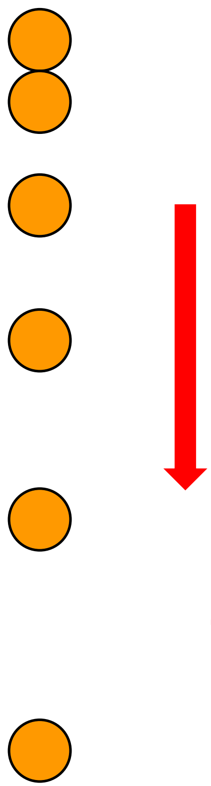
Uniform motion

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



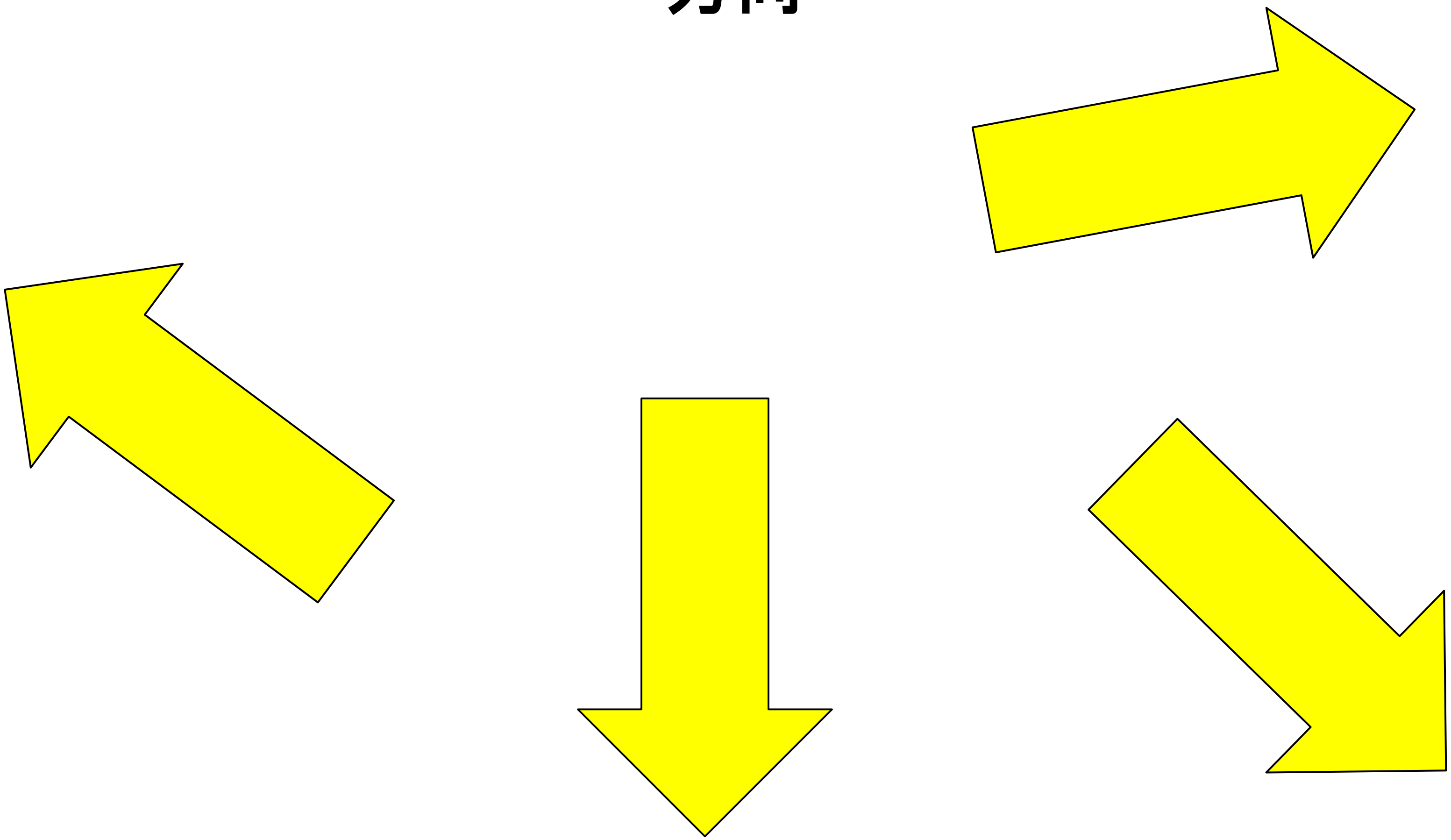
重力加速度

$g = 9.8 m/s^2$

the acceleration due to gravity

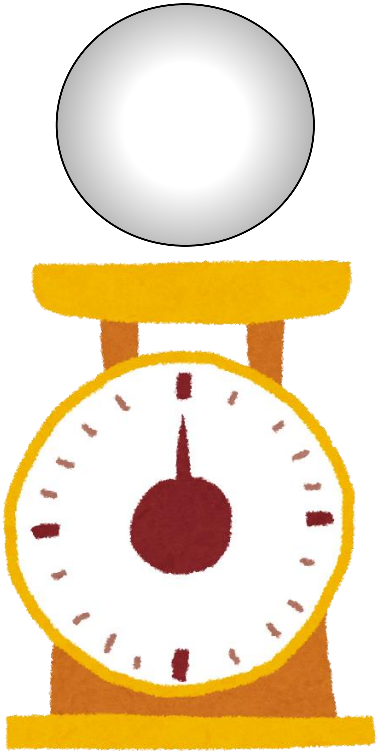
Direction

方向



Mass

質量



Unit

単位

重力加速度(m/s^2)

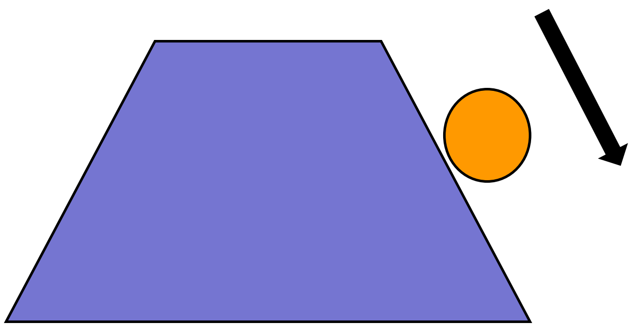
速度(m/s)

質量(kg)

高さ(m)

Kinetic energy

運動エネルギー

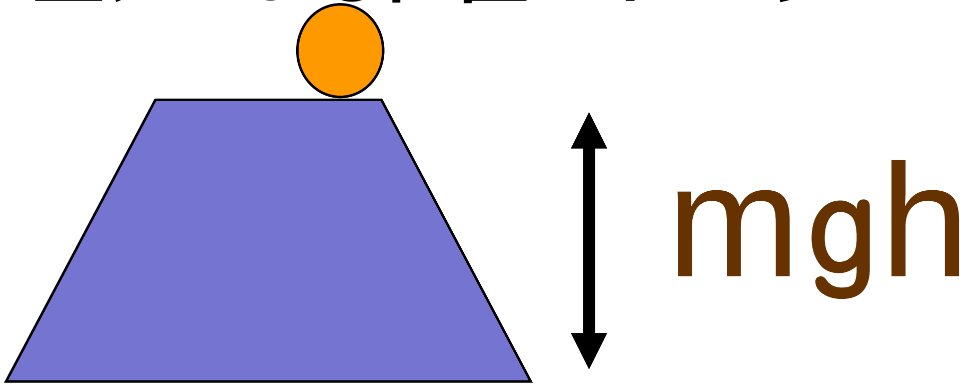


$$\frac{1}{2}\, m\, v^2$$

the energy an object has because it is in motion

Gravitational potential energy

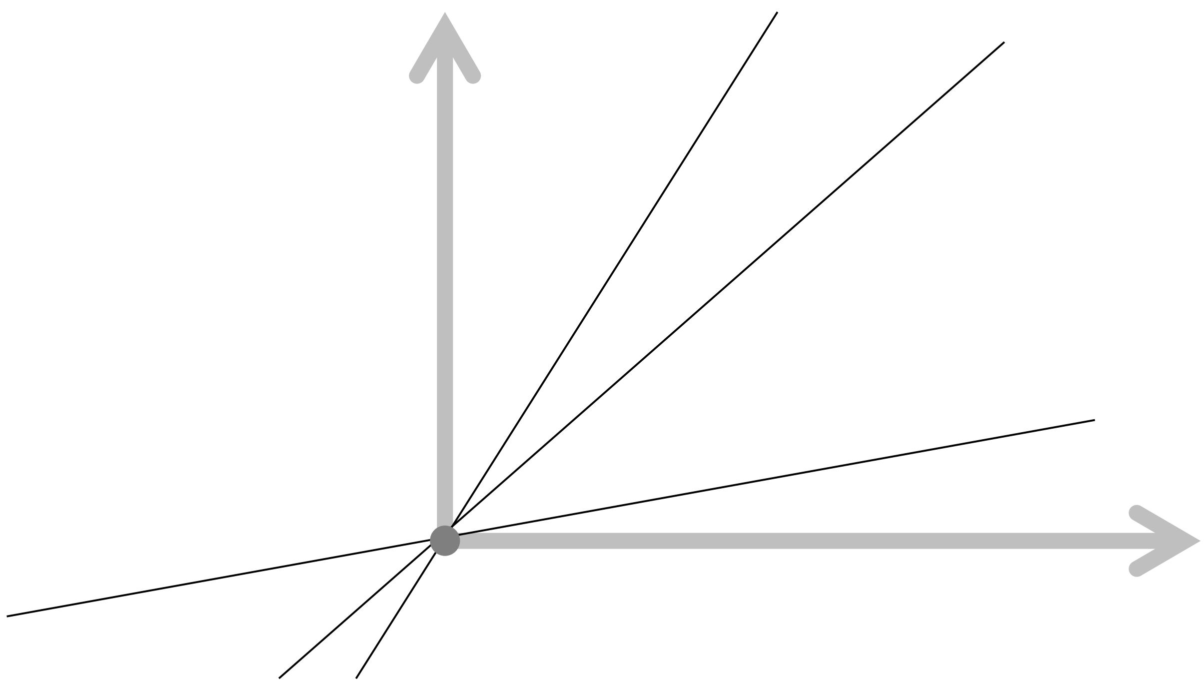
重力による位置エネルギー



the energy stored in an object because of its posit

be proportional to

比例する



Conservation of mechanical energy

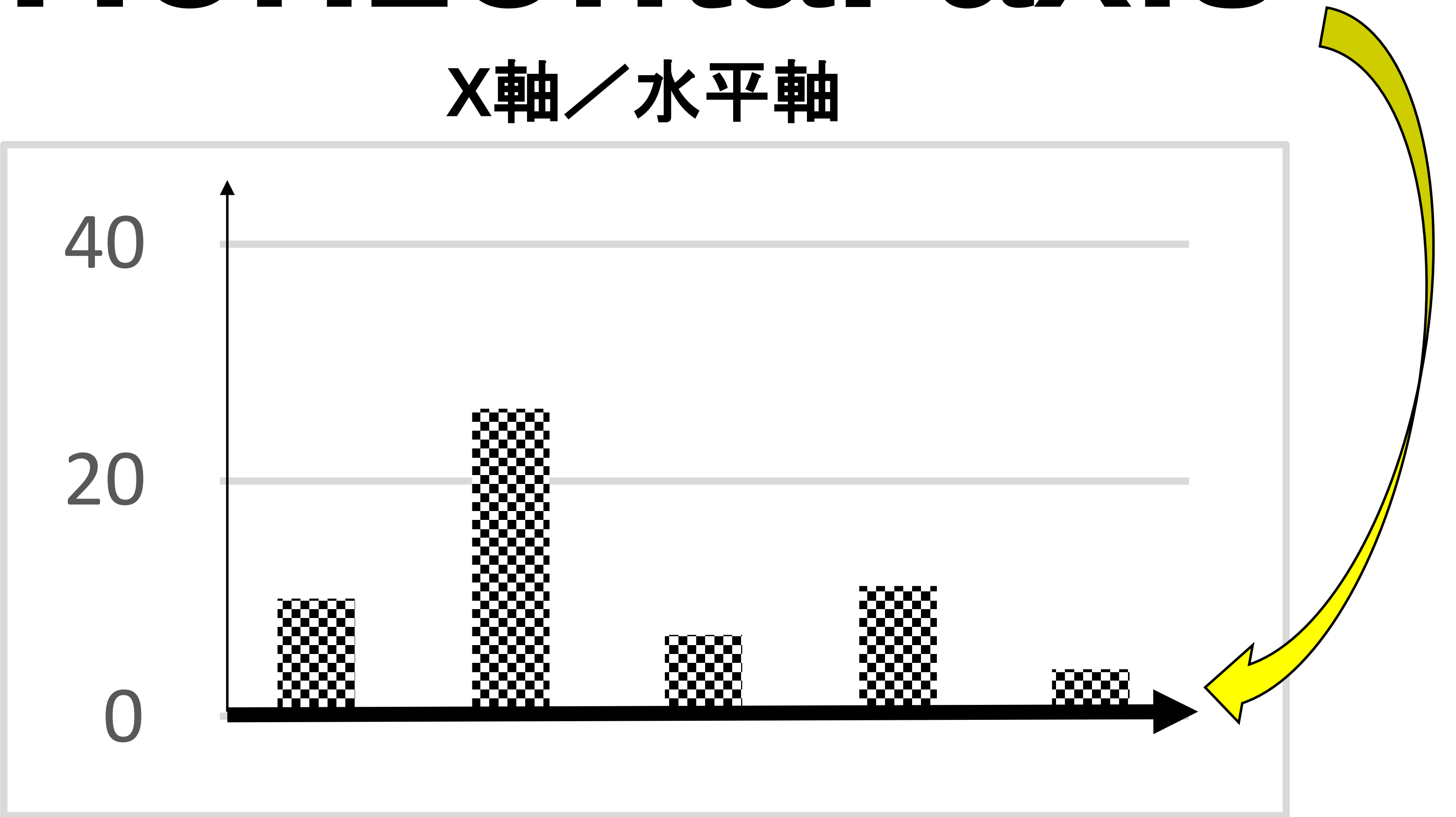
力学的エネルギー保存の法則

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

the total mechanical energy in a system remains constant

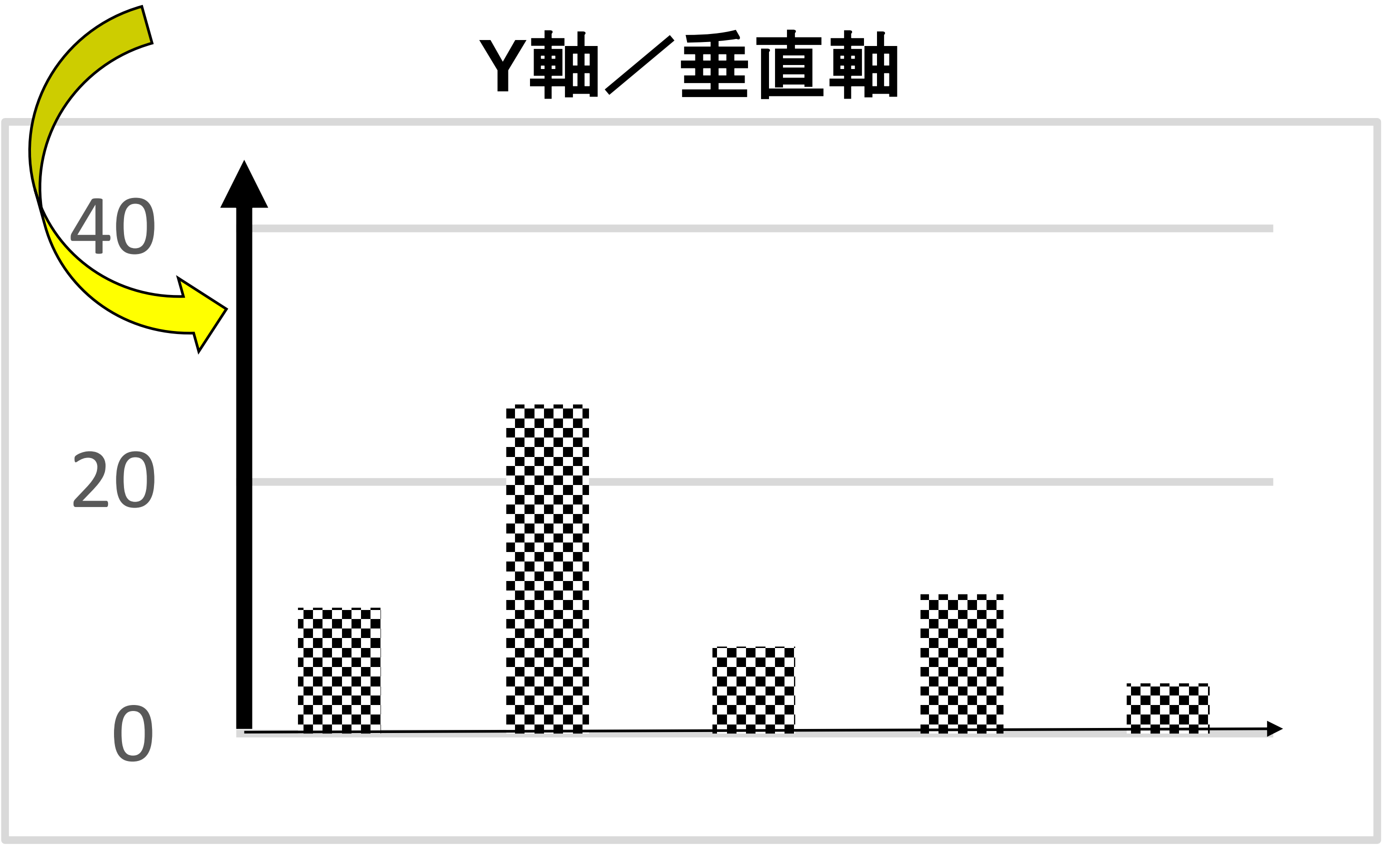
Horizontal axis

X軸／水平軸



Vertical axis

Y軸／垂直軸



Presentation Exercise

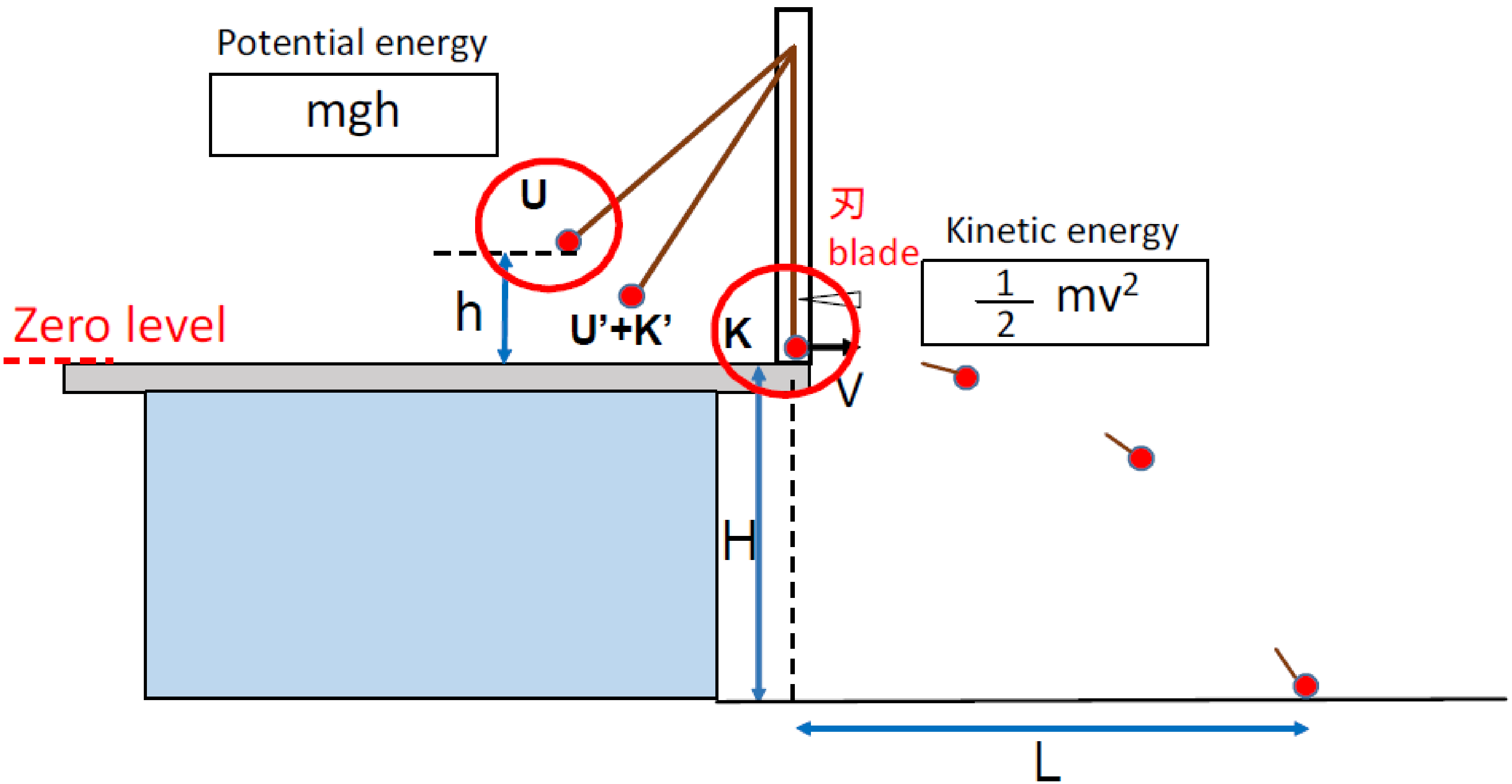
The Relationship between Kinetic Energy and Gravitational Potential Energy

Aim of research

To confirm experimentally whether mechanical energy is conserved.

Methods

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



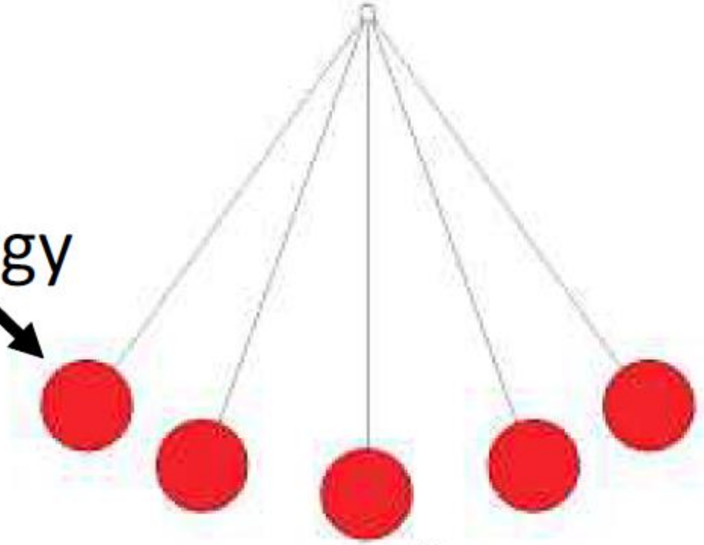
Results

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

	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!