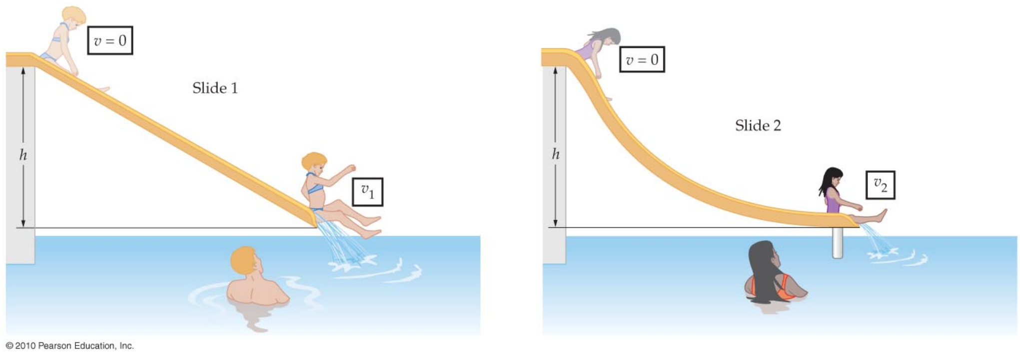
11th Physics 4 Work and Energy

2017-18



The concept of force is one of the foundations of physics. Equally fundamental, though less obvious, is the idea that a force times a the displacement through which it acts is also an important physical quantity. We referto this quantity as the ***work*** done by a force.

Now, we all know what work means in everyday life: We get up in te morning and go to work, or we "work up a sweat" as we hike a mountain trail. Later in the day we eat lunch, which gives us the "***energy***" to continue working or to continue our hike. In this packet we give a precise physical difinition of work, and show how it is related to another important physical quantity – the energy of motion, or ***kinetic energy***.

One of the greatest accomplishments of physics is the concept of energy and its conservation. To realize, for example, that there is an important physical quantity that we can neither see nor touch is an impressive leap of the imagination. Even more astonishing, however, is the discovery that energy comes in a multitude of forms, and that the sum total of all these forms of energy is a constant. The universe, in short, has a certain amount of energy, and that energy simply ebbs and flows from one form to another, with the total amount remaining fixed.

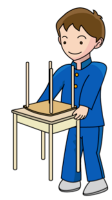
In this packet, we focus on ***the conservation of energy***, the first "conservation law" to be studied. Though only a handful conservation laws are known, they are all of central importance in physics. Not only do they give deep insight into the workings of nature, they are also practical tools in problem solving. Many problems that would be difficult to solve using Newton's laws can be solved with ease using the principle of energy conservation. (James S. Walker, "Physics", 2010 Pearson Education Inc.)

Use 9.80 m/s² as the gravitational acceleration rate, *g*, in the following problems.

1．　Work

$$W = F * d\cos\theta \quad [\,J\,] \qquad (1)$$

[Q1] Which is “work” in Physics sense?
(a)　Carrying desks from the classrooms to the gym to prepare for Zenya-sai.
(b)　Standing with buckets full of water for one hour in a passage because I slept in class.
(c)　Writing a lab report through the night.


(a)


(b)


(c)

[Q2] A boy pushes a 45 kg box with a constant force of 35 N through a displacement 23 m, as shown in the figure.　Find the work done by the force.

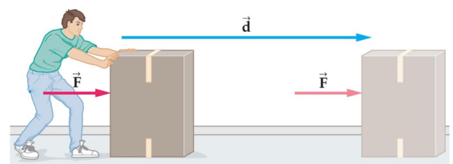


Fig. 2

[Q3] An intern pushes a 72-kg patient on a 15-kg gurney, producing an acceleration of 0.60 ms2.　(a) How much work does the intern do by pushing the patient and gurney through a distance of 2.5m? Assume the gurney moves without friction.　(b) How far must the intern push the gurney to do 140 J of work?

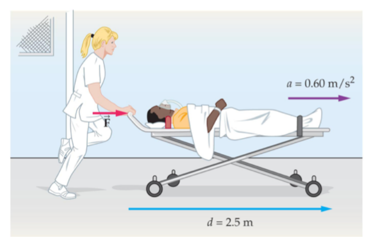


Fig. 3

[Q4] A person pulls a 25 kg suitcase with a strap with a force of 33 N at an angle of 30° from the direction of motion through a displacement of 55 m, as shown in the figure.　Find the work done by the force.

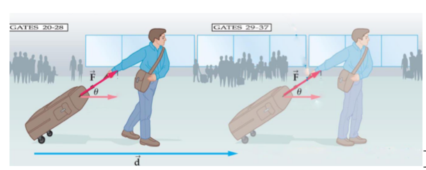
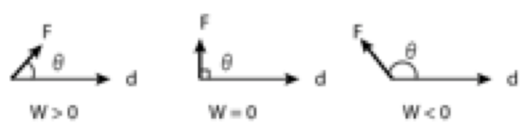
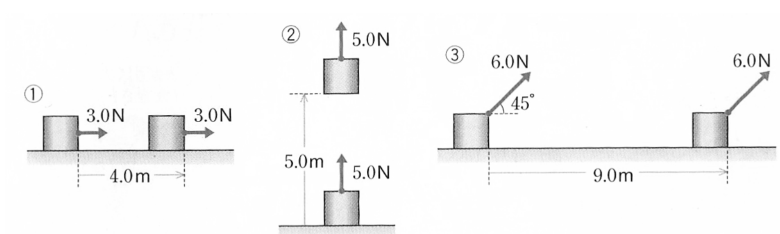


Fig. 4



[Q5] A body is moving with a constant force as shown.　Find the work done by the force.



[Q6] In a gravity escape system (GES), and enclosed lifeboat on a large ship is deployed by letting it slide down a ramp and then continuing in free fall to the water below. Suppose a 4970-kg lifeboat slides a distance of 5.00 m on a ramp, dropping through a vertical height of 2.50 m. How much work does gravity do on the boat?

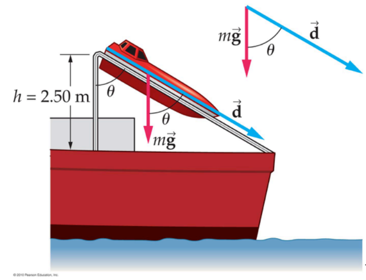


Fig. 6

[Q7] You want to load a 34 kg box into the back of a truck by sliding the box up a loading ramp, as shown in the figure. The height of the truck, h, is 1.5 m, the distance of the lamp is 4.4 m. (a) Assuming the box slides on the ramp with out friction, find the magnitude of the force required and the work done by the force. (b) Find the magnitude of the force and the work when you lift the box directly to the truck without using the ramp.

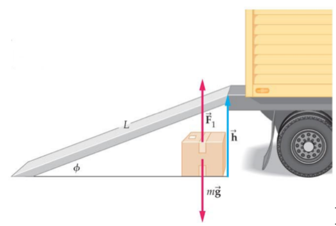


Fig.7

[Q8] To lift a 6000 kg elephant to the height of 1.0 m, a lever is used, where L_1 = 2.0 m and L_2 = 20 m. Compare the forces and works required between the cases using the lever and not using the lever.

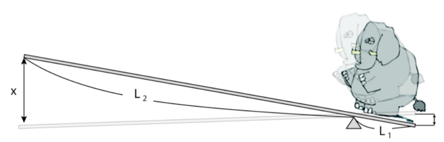


Fig. 8

[Q9] There are three kind of pulleys to lift a mass m [kg] to the height of h [m]. Compare the forces and works required assuming the friction is negligible.

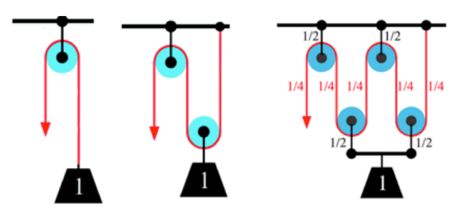
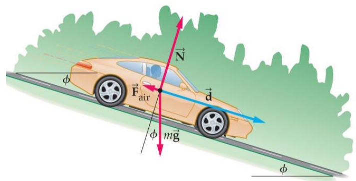


Fig. 9 A B C



2. Total Work　　　　Cases when more than one force acts on an object.

$$\sum W = W_1 + W_2 + \cdots + W_n = \sum W_n$$

$$= F_{total} d \cos\theta \qquad (2)$$

[Q10] A car of mass m coasts down a hill inclined at an angle α below the horizontal. The car is acted on by three forces: (i) the normal force exerted by the road, (ii) a force due to air resistance, and (iii) the force of gravity. Find the total work done on the car as it travels d along the road.

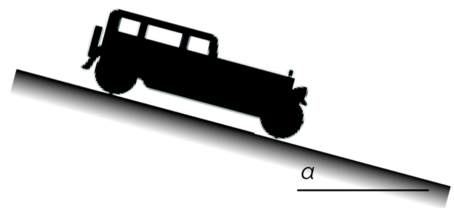
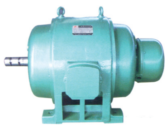


Fig. 10

[Q11] [Q12] Consider the car described in Q10. Calculate the total work done on the car using $W_{total} = F_{total} \cdot d \cos\theta$.

[Q12] Calculate the total work done on a 1550-kg car as it coasts 20.4 m down a hill with $\alpha = 5.00°$. Let the force due to air resistance be 15.0 N.



3. Power

$$P = \frac{W}{t} \qquad [W] \qquad (3)$$

[Q66] An electric motor can lift a 15 kg box vertically a distance 22 m for 26 s22. Find the power of this motor.

Fig. 56

[Q67] To pass a slow-moving truck, you want your fancy 1.30 x 10^3-kg car to accelerate from 13.4 m/s to 17.9 m/s in 3.00 s. What is the minimum power required for this pass?

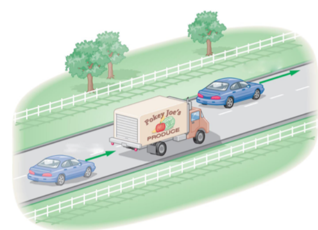


Fig. 57

Fig. 58

[Q68] You raise a bucket of water from the bottom of a deep well. If your power output is 108 W, and the mass of the bucket and the water in it is 5.00 kg, with what speed can you raise the bucket? Ignore the weight of the rope.

4. Kinetic Energy

$$K = \frac{1}{2}\, m\, v^2 \qquad [\mathrm{J}] \qquad (3)$$

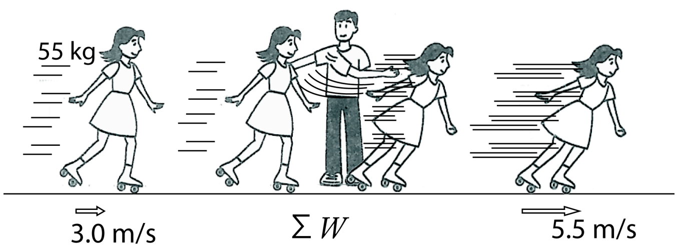
Work-Energy Theorem

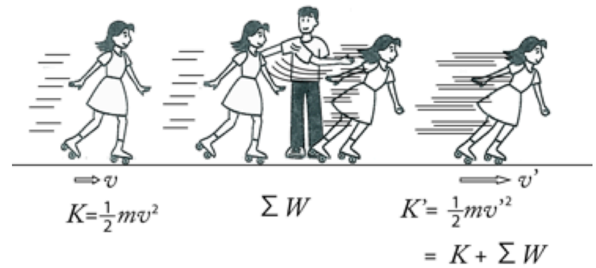
"The total work done on an object is equal to the change in its kinetic energy"

$$\sum W = \Delta K = K' - K = 1/2\; mv'^2 - 1/2\, mv^2 \qquad (4)$$

K, v : *Before* $K',\ v'$: *After*

[Q15] A 55 kg skater is moving on a horizontal plane with a speed of 3.0 m/s. An instructor pushes her and then her speed increases to a speed of 5.5 m/s. (a) Find the work done during this change. (b) What kinds of forces exert on her?





[Q16] A car of 1400 kg is moving at 36 km/h. (a) Find the kinetic energy of the car. (b) By what multiplicative factor does the kinetic energy of the truck increase if its speed is doubled?

[Q17] A truck moving at 15 m/s has a kinetic energy of 4.2×10^5 J. What is the mass of the truck?

[Q18] How much work is required for a 69 kg sprinter to accelerate from rest to 2.5 m/s?

[Q19] A 4.10-kg box of books is lifted vertically from rest a distance of 1.60 m with a constant, upward applied force of 52.7 N. Find (a) the work done by the applied force, (b) the work done by gravity, and (c) the final speed of the box.

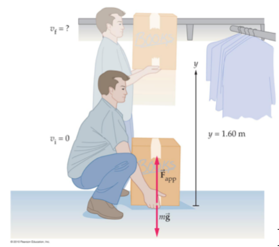


Fig. 19

[Q20] Solve Q19 using the equation motion.

(Work done by friction)

[Q22] A 1.0 kg body is moving on a horizontal rough plane. The body passes at point A with a speed of 3.0 m/s and then at point B with a speed of 2.0 m/s. The distance between A and B is 0.50 m. (a) Find the work done by the kinetic frictional force between A and B. (b) Find the magnitude of the kinetic frictional force. (c) Find the coefficient of kinetic friction.

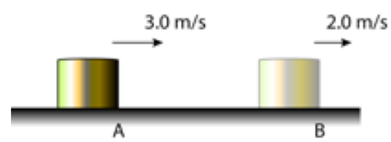


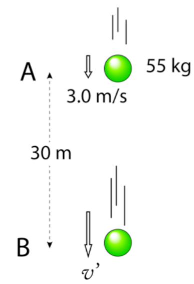
Fig. 22

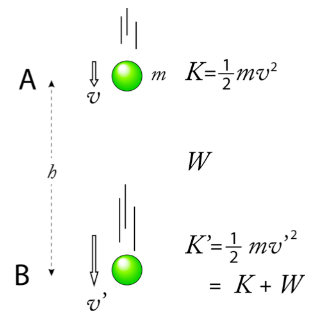
(Work done by gravity)

[Q23] A body with a mass 55 kg is falling. Its speed is 3.0 m/s at A.

(a) Find the speed v' [m/s] at B, the point 30 m below A, using the equation about free fall.

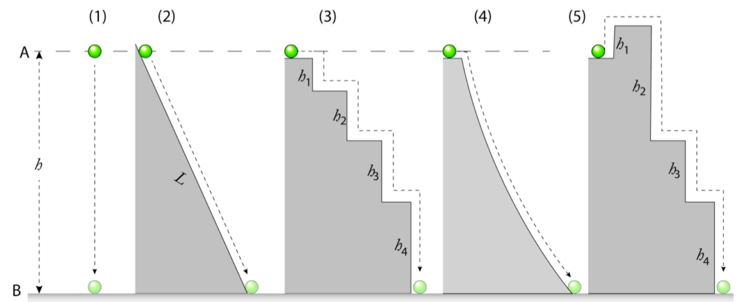
(b) Find the speed at B using the Work-Energy Theorem.



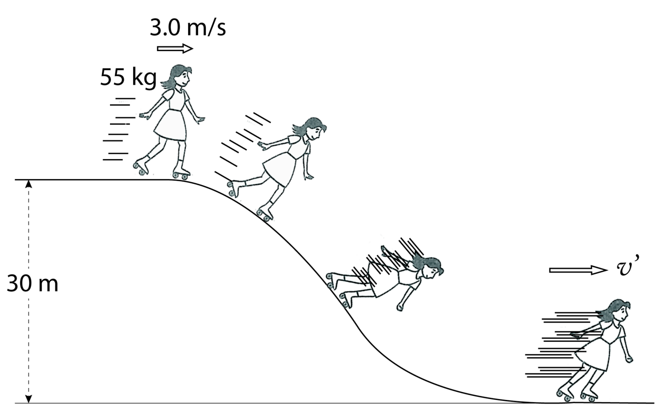


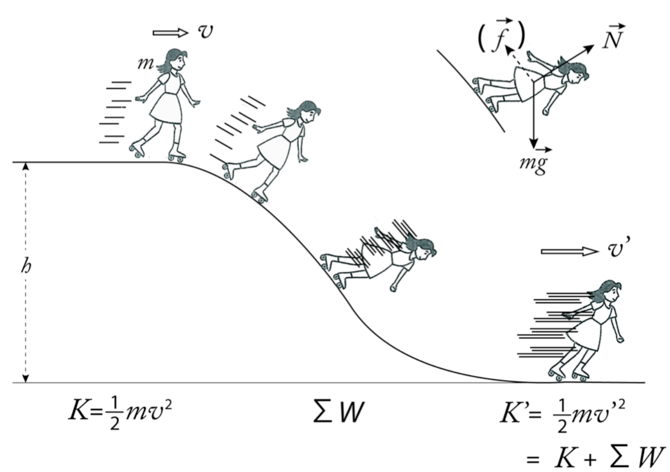
[Q24] (a) A body with a mass m [kg] moves from A to B, the point, h [m] below A. Find the work done by gravity in the cases, (1) ~ (5).

(b) What can you conclude about the work done by gravity?



[Q25] A 55 kg skater with a speed of 3.0 m/s on a hill slides down through a slope, then her speed increases to v'. (a) What kinds of forces exert on her? (b) Find v'.





5. Gravitational Potential Energy

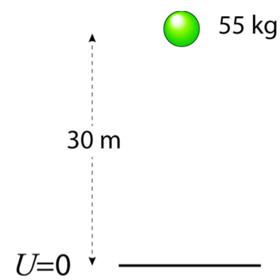
Gravitational Potential Energy $U = mgh$ [J] (5)

(We are free to choose $U = 0$ anywhere)

Work done by a Conservative Force and Potential Energy

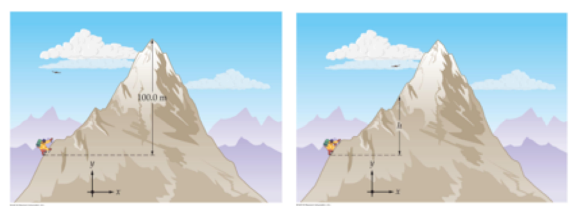
$$\Delta U \equiv U' - U \equiv -W_c \quad (6)$$

[Q33] (a) Find the gravitational potential energy of a 55 kg body when it is 30 m high from the ground. Let U = 0 be at the ground.
(b) Find the gravitational potential energy from the work done by gravity.



[Q34] By what multiplicative factor does the gravitational potential energy of a body increase if its mass is doubled?

[Q35] An 82.0 kg climber is in the final stage of the ascent of 4301-m-high Pikes Peak. What is the change in gravitational potential energy as the climber gains the last 100.0 m of altitude? Let U = 0 be (a) at sea level or (b) at the top of the peak.



(Food energy and potential energy)

[Q36] A candy bar called the Mountain Bar has a calorie content of 212 kcal, which is equivalent to the energy of 8.87×10^5 J. If an 81.0 kg mountain climber eats a Mountain bar and magically converts it all to potential energy, what gain of altitude would be possible?

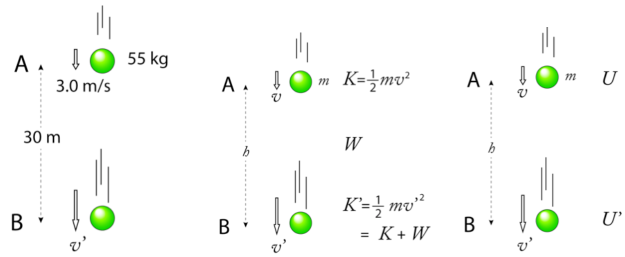
6. Conservation of Mechanical Energy 力学的エネルギー保存則 －1

(In the system with gravity as an effective force and without friction)

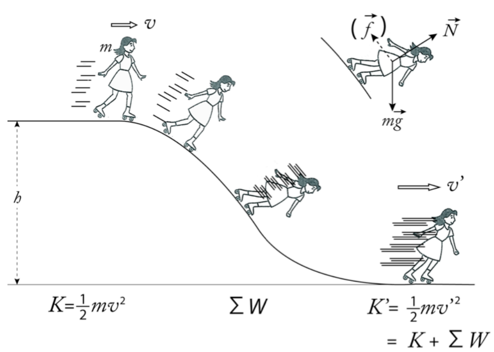
$$E = U + K = constant \qquad (8)$$

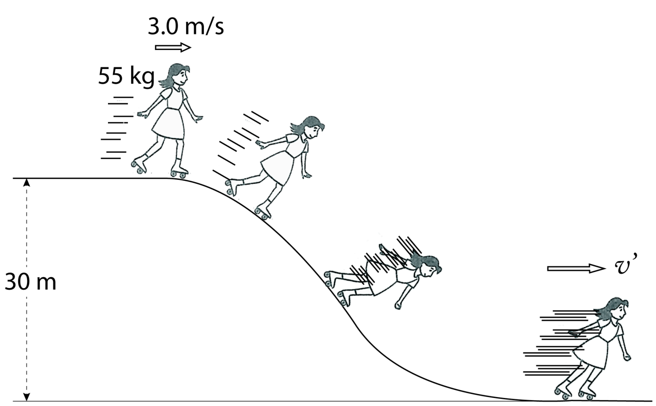
$$E \;=\; mgh \quad + \quad \frac{1}{2}\, m\, v^2 \quad = constant$$

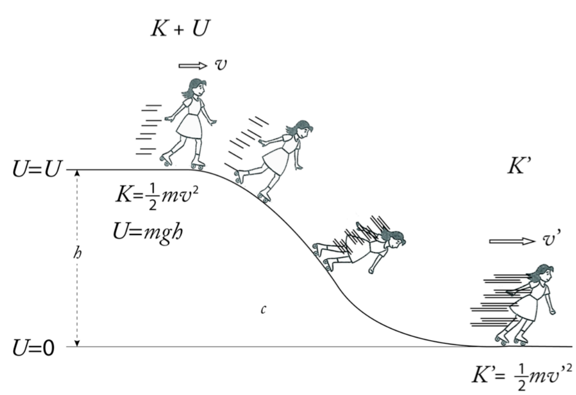
[Q23] A body with a mass 55 kg is falling. Its speed is 3.0 m/s at A. (a) Find the speed v'[m/s] at B, the point 30 m below A, using the equation about free fall. (b) Find the speed at B using the Work-Energy Theorem. (c) Find the speed at B using the conservation law of mechanical energy.



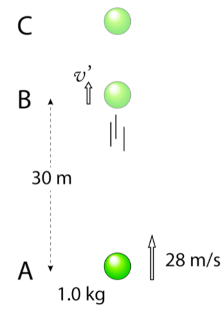
[Q25] A 55 kg skater with a speed of 3.0 m/s on a hill slides down through a slope, then her speed increases to v'. (a) Find v' using the Work-Energy Theorem. (b) Find v' the conservation law of mechanical energy.



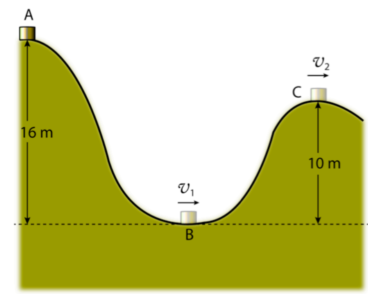




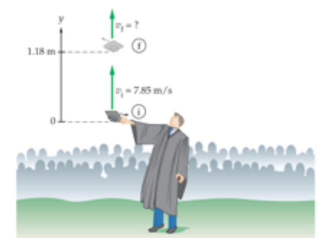
[Q41] A 1.0 kg mass is thrown upward with an initial speed of 28 m/s. (a) Find the speed of the mass when it reaches the height of 30 m. (b) Find the maximum height the mass can reach.



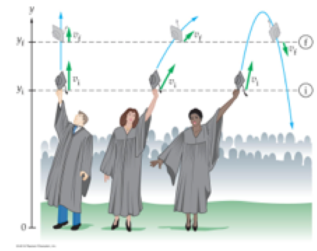
[Q42] In the diagram, a block starts from rest at A, slides down along a frictionless track to the bottom B, and goes up to the point C. (a) Find the speed at the point B. (c) Find the speed at the point C, assuming the air resistance if negligible.



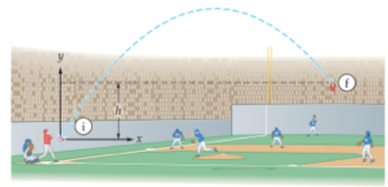
[Q43] At the end of a graduation ceremony, graduates fling their caps into the air. Suppose a 0.120-kg cap is thrown straight upward with an initial speed of 7.85 m/s, and their frictional force can be ignored. (a) Use kinematics to find the speed of the cap when it is 1.18 m above the release point. (b) Use conservation of mechanical energy to find the speed of the cap when it is 1.18 m above the release point.



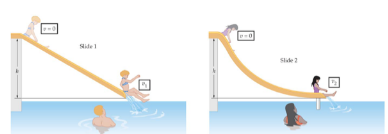
[Q44] If the initial speed vi and the release point yi is assumed to be constant, how does the speed of the cap change above 1.18 m depending on the path as shown?



[Q45] In the bottom of the ninth inning, a player hits a 0.15-kg baseball over the outfield fence. The ball leaves the bat with a speed of 36 m/s, and a fan in the bleachers catches it 7.2 m above the point where it was hit. Assuming frictional forces can be ignored, find (a) the kinetic energy of the ball when it is caught and (b) its speed when caught.



[Q46] Swimmers at a water park can enter a pool using one of two frictionless slides of equal height. Slide 1 approaches the water with a uniform slope; slide 2 dips rapidly at first , then levels out. Which slide gives faster speed at the water?



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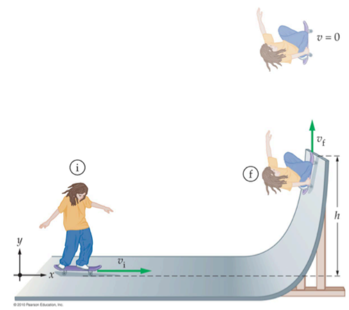
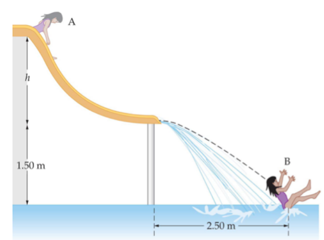
[Q47] A 55-kg skateboarder enters a ramp moving horizontally with a speed of 6.5 m/s and leaves the ramp moving vertically with a speed of 4.1 m/s.
(a) Find the height of the ramp, assuming no energy loss to frictional forces.
(b) What is the skateboarder's maximum height above the bottom of the ramp?



[Q48] The water slide shown in the figure ends at a height of 1.50 m above the pool. The ending part is horizontal. If the person starts from rest at point A and lands in the water at point B 2.50 m far from the end of the slide, what is the height h of the water slide? (Assume the water slid is frictionless.)



7. Work done by a force exerted on a spring

Work done by an **external force** during a displacement from the equilibrium to **x**. $W_{external} = 1/2\,kx^2$ [J]

Work done by an **elastic force** during a displacement from the equilibrium to **x**. $W_{elastic} = -1/2\,kx^2$ [J]

[Q49] (a) A constant force F acting through a distance d does a work W = Fd. Note that Fd is also equal to the shaded area between the force line and the x axis in Fig.1. Consider a force that has the value F_1 from x=0 to x=x_1 and a different value F_2 from x = x_1 to x=x_2 as shown Fig. 2. Find the total work.

(a) Find how to obtain the work done by a variable force shown in Fig. 3.

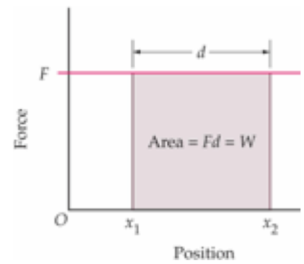


Fig.1

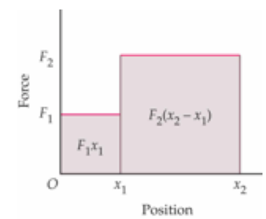


Fig. 2

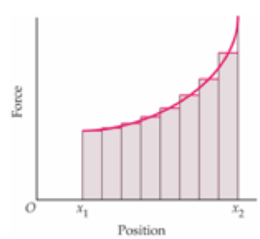
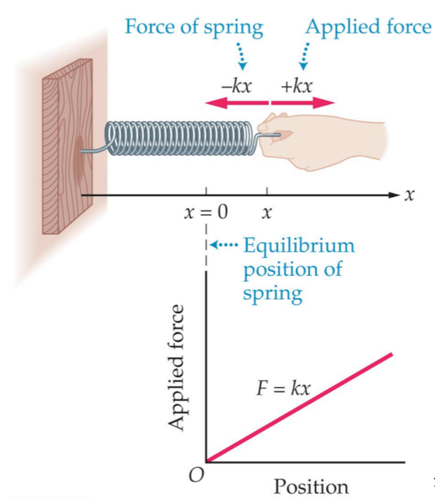
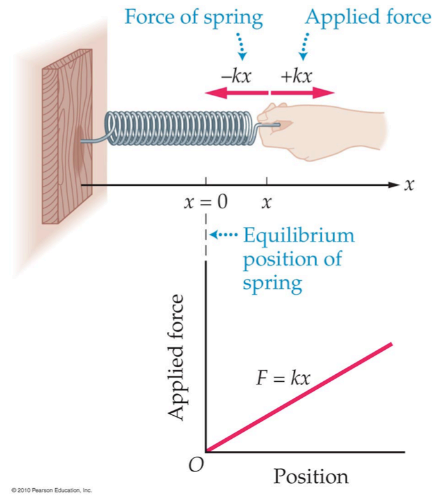


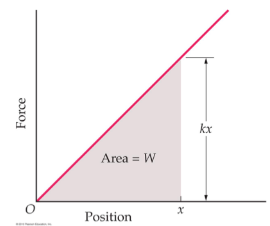
Fig. 3

[Q50] In a spring having a force constant k shown in the figure, find the work done by an applied force in shrinking a spring from a stretched position x=d to the equilibrium position x=0. Also find the work done by the elastic force of the spring.



[Q51] In a spring having a force constant k shown in Fig. d, find the work done by an applied force in stretching a spring from x=0 (equilibrium) to the general position x. Also find the work done by the elastic force of the spring.





[Q52] A pinball has a spring with a force constant k = 405 N/m. Find the work required to compress 3.00 cm.

8. Elastic Potential Energy

Elastic Potential Energy $U = 1/2\,kx^2$ [J] (7)

[Q53] (a) In a spring having a force constant k shown in Fig. 1, find the work done by the elastic force of the spring in stretching a spring from x=0 (equilibrium) to the general position x. (b) Also find the elastic potential energy at x=x.

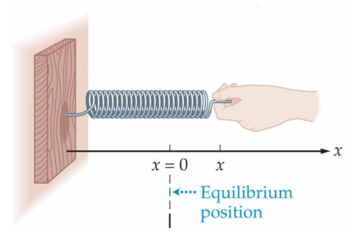
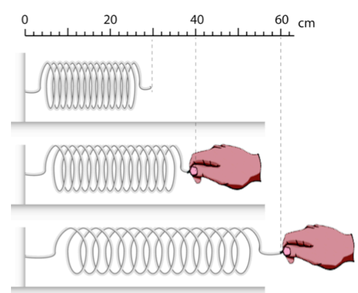
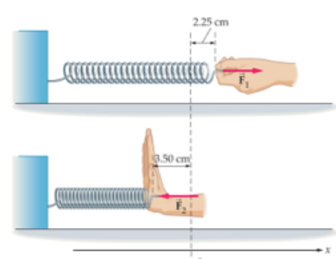


Fig.1

[Q54] A spring has a force constant k = 40 N/m and an original length of 40 cm. (a) Find the elastic potential energy when it is stretched to 40 cm. (b) Find the work required to stretch from 40 cm to 60 cm. ばね定数 40 N/m、自然長が 30 cm のばねがある。



[Q55] When a force of 120.0 N is applied to a certain spring, it causes a stretch of 2.25 cm. What is the potential energy of this spring when it is (a) compressed by 3.50 cm or (b) expanded by 7.00 cm?



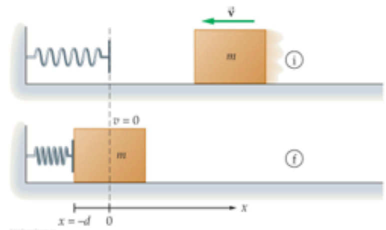
9. Conservation of Mechanical Energy

(In the system with elastic force as an effective force and without friction)

$$E = U + K = constant \qquad (8)$$

$$E = \frac{1}{2}\,k\,x^2 + \frac{1}{2}\,m\,v^2 = constant$$

[Q60] A 1.70-kg block slides on a horizontal, frictionless surface until it encounters a spring with a force constant of 955 N/m. The block comes to rest after compressing the spring a distance of 4.60 cm. Find the initial speed of the block.



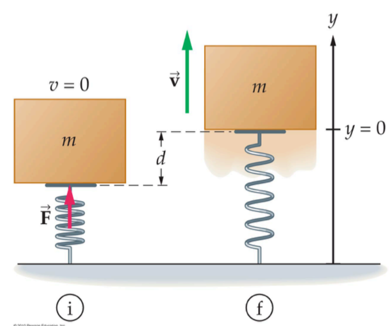
10. Conservation of Mechanical Energy

(In the system with gravity and elastic force as effective forces and without friction)

$$E = U + K = constant \qquad (8)$$

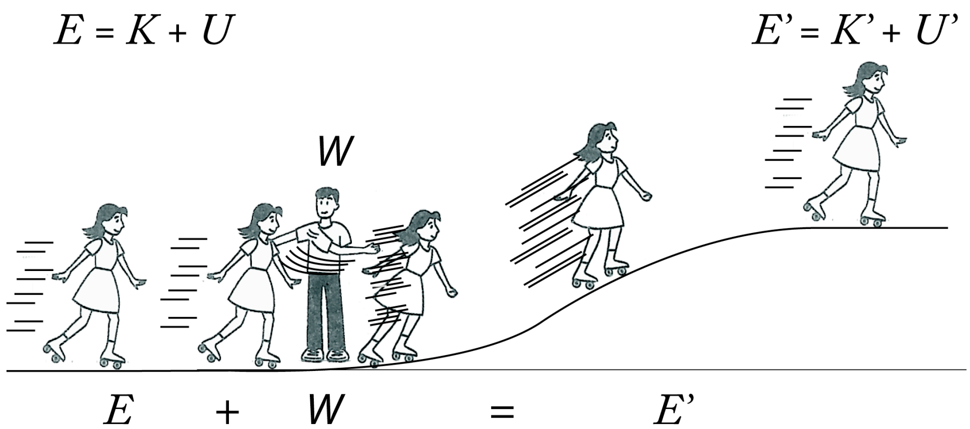
$$E = mgh + \frac{1}{2}\,k\,x^2 + \frac{1}{2}\,m\,v^2 = constant$$

[Q61] When a force of 44.0 N is applied to a certain spring, it causes a stretch of 4.60 cm. A 1.85 kg block is placed on the spring, as shown in the figure. Initially the spring is compressed 4.32 cm and the block is at rest. When the block is released, it accelerated upward. Find the speed of the block when the spring has returned to its equilibrium position.

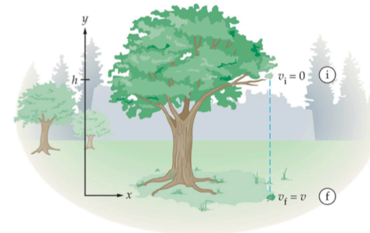


11. **Work done by Non-Conservative Force and Mechanical Energy**

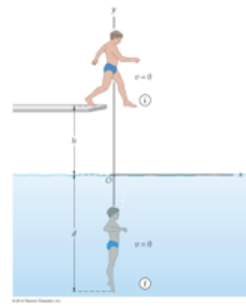
$$W_{nc} = \Delta E = E' - E \qquad (9)$$



[Q62] Deep in the forest, a 19.5 g leaf falls from a tree and drops straight to the ground. Its initial height was 7.89 m and its speed on landing was 1.50 m/s. Find the frictional force that acted on the leaf while it was falling.



[Q63] A 95.0 kg diver steps off a diving board and drops into the water 3.00 m below. At dome depth d below the water's surface, the diver comes to rest. If the non-conservative work done on the diver is Wnc = − 5120 J, what is the depth, d?

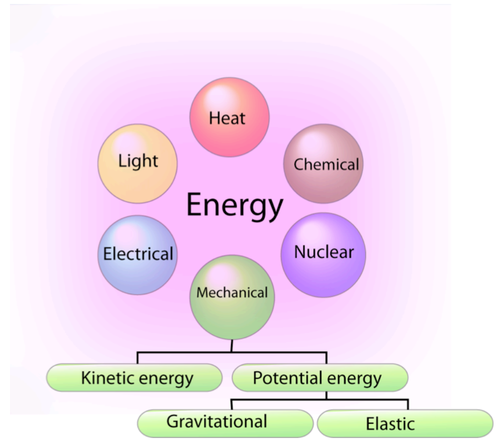


[Q64] A block of mass m_1 = 2.40 kg is connected to a second block of mass m_2 = 1.80 kg, as shown here. When the blocks are released from rest, they move through a distance d = 0.500 m, at which point m2 hits the floor. Given that the coefficient of kinetic friction between m_1 and the horizontal surface is μ' =0.450, find the speed of the blocks just before m_2 lands.

4. Energy

"Energy Is the Ability to Do Work."

Energy can be found in a number of different forms. It can be chemical energy, electrical energy, heat (thermal energy), light (radiant energy), mechanical energy, and nuclear energy. Energy can be changed in one form to another. In the beginning, we will study about mechanical energy that can be either kinetic energy or potential energy. Concerning potential energy, we will study two types, gravitational potential energy and elastic potential energy of a spring.

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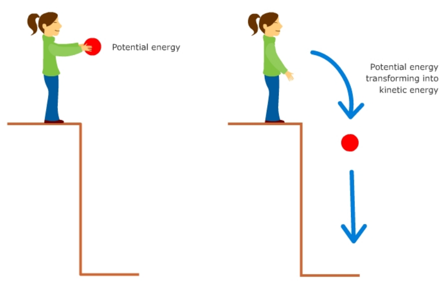

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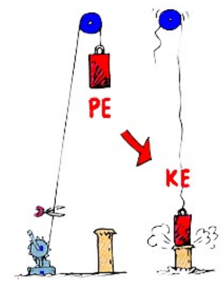

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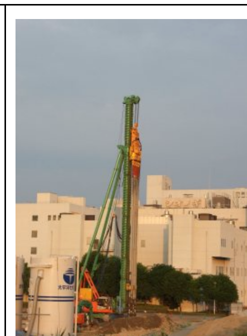
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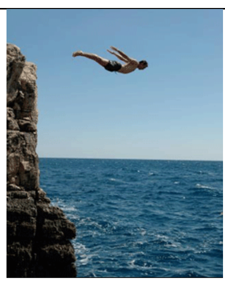
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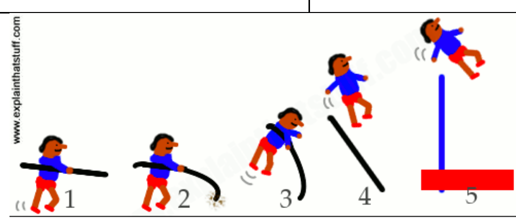


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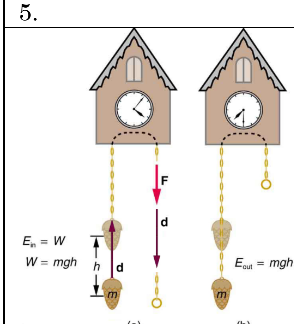

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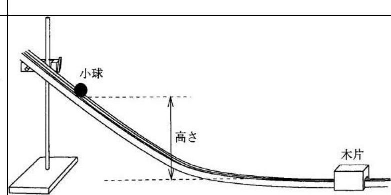

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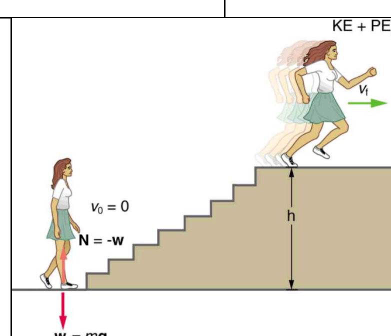

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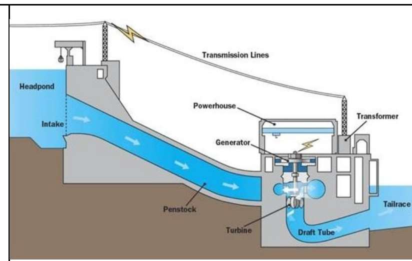

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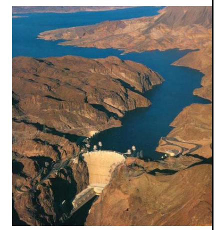

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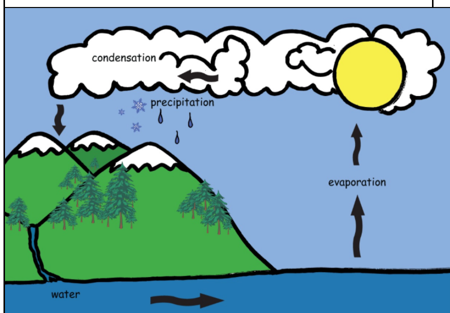

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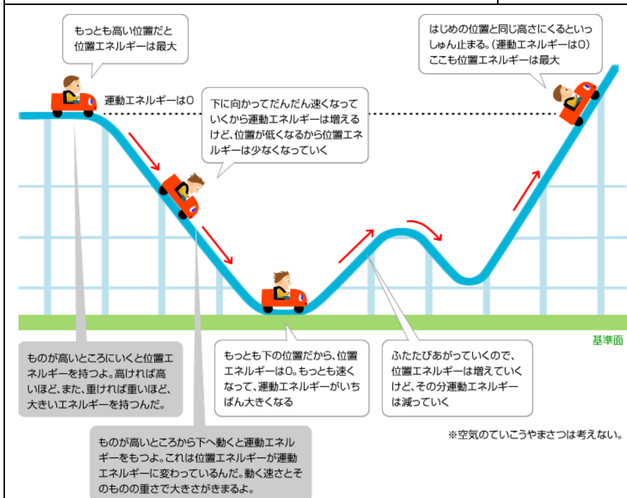

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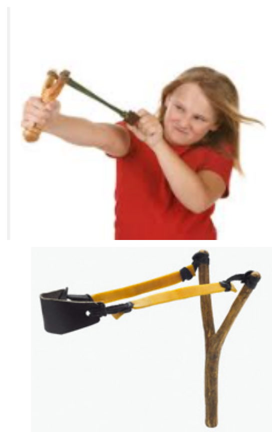

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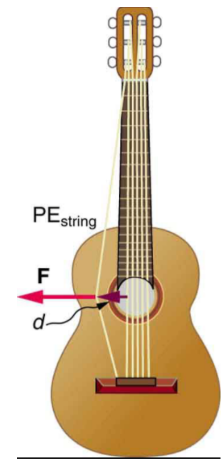

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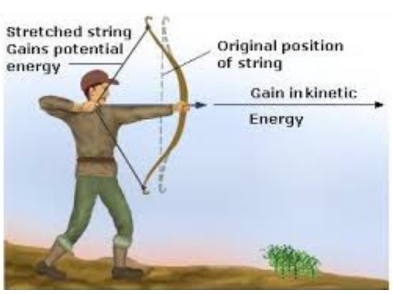

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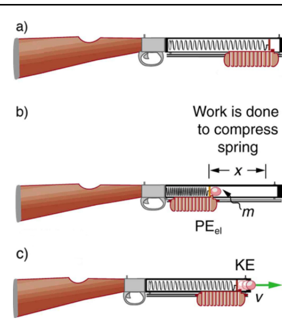

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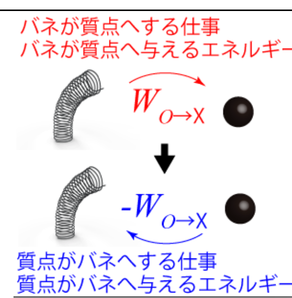

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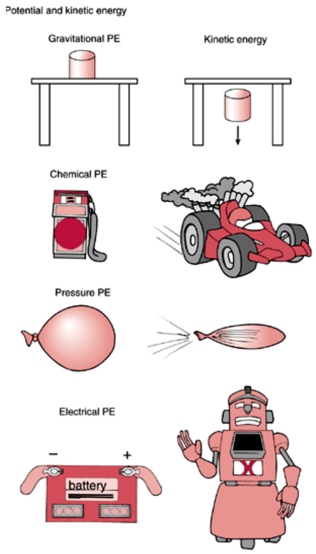
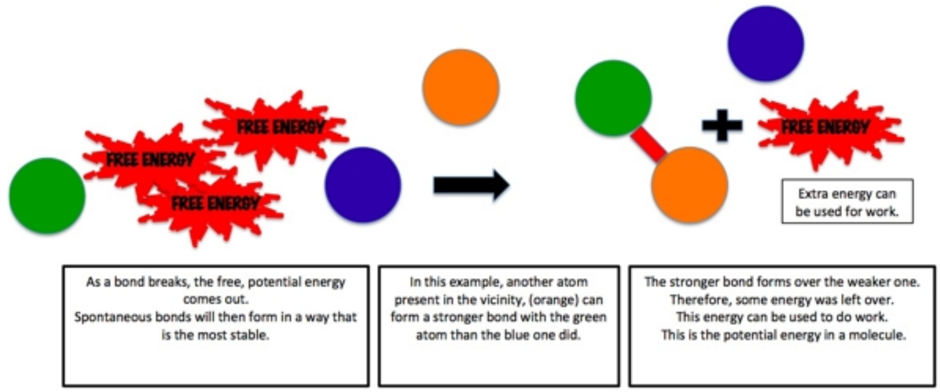
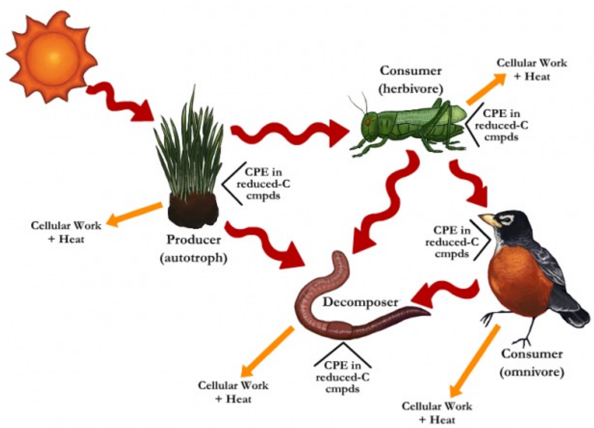

Potential and kinetic energy
Gravitational PE
Kinetic energy
Chemical PE
Pressure PE
Electrical PE
battery
−
+

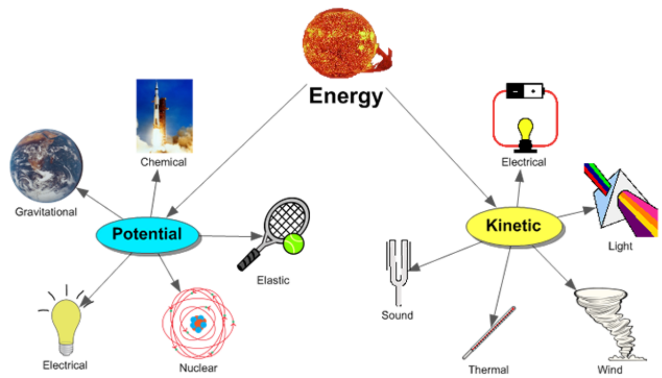
27.


FREE ENERGY
FREE ENERGY
FREE ENERGY
FREE ENERGY
Extra energy can be used for work.
As a bond breaks, the free, potential energy comes out. Spontaneous bonds will then form in a way that is the most stable.
In this example, another atom present in the vicinity, (orange) can form a stronger bond with the green atom than the blue one did.
The stronger bond forms over the weaker one. Therefore, some energy was left over. This energy can be used to do work. This is the potential energy in a molecule.

28.

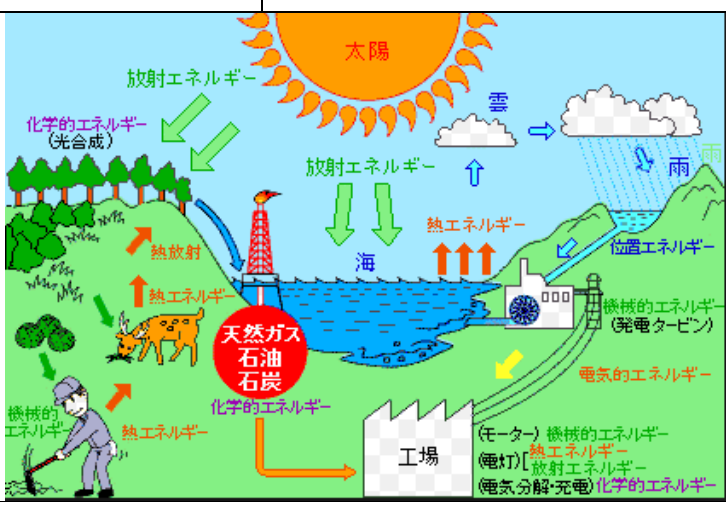

Consumer (herbivore)
Cellular Work + Heat
CPE in reduced-C cmpds
CPE in reduced-C cmpds
Cellular Work + Heat
Producer (autotroph)
CPE in reduced-C cmpds
Decomposer
Consumer (omnivore)
CPE in reduced-C cmpds
Cellular Work + Heat
Cellular Work + Heat

29.


Energy
Chemical
Gravitational
Potential
Elastic
Electrical
Nuclear
Electrical
Kinetic
Light
Sound
Thermal
Wind

30.

31.


太陽
放射エネルギー
化学的エネルギー
(光合成)
雲
放射エネルギー
雨
熱エネルギー
熱放射
位置エネルギー
海
熱エネルギー
天然ガス
石油
石炭
機械的エネルギー
(発電タービン)
電気的エネルギー
機械的
エネルギー
熱エネルギー
化学的エネルギー
工場
(モーター) 機械的エネルギー
(電灯)[熱エネルギー
放射エネルギー
(電気分解·充電) 化学的エネルギー

Temperature and Heat

Equations

$Q = C\Delta T = mc\Delta T$

- Q : Heat [J] [or cal]
- C : Heat Capacity [J/K] [or cal/K]
- c : Specific Heat [J/(kg・K) [cal/(kgK)
- m : Mass [kg]
- ΔT: Temperature change [K] ($\Delta T = T' - T$)

$Q = mL$

- L: Latent Heat [J/kg]

$Q = \Delta U + W$

- Q: Heat gained from outside [J]
- ΔU: Increase of Internal Energy [J]
- W: Work done to outside [J]

$p \cdot V$ =constant Boyle's Law (T = constant)

p : Pressure [Pa], V: Volume [m^3]

$\frac{V}{T}$ = constant Charles's Law (p = constant)

T: Temperature [K]

$$e = \frac{W}{Q_1} \times 100 = \frac{Q_1 - Q_2}{Q_1} \times 100 \ [\%]$$

- e : Efficiency
- W: Work done by Engine
- Q1: Heat added to Engine
- Q2: Exhaust Heat

1 cal = 4.186 J

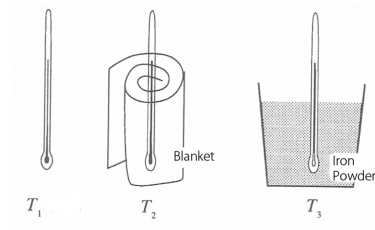
T [K] = t [℃] +273.15, F = 1.8C + 32

Specific Heat 比熱 c [J/kgK]	
Water	4186
Ice	2090
Steam	2010
Oil	1970
Copper	387
Ceramic	1090
Glass	837
Aluminum	900
Lead	128

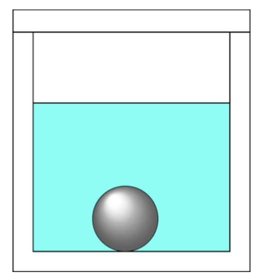
	Latent Heat of Fusion L_f [J/kg]	Latent Heat of Vaporization L_v [J/kg]
Water	3.35 x 10^5	22.6 x10^5
Ethanol	1.08 x 10^5	8.55 x10^5

1. Temperature and Heat

[Q1] Which results in the highest and lowest temperature?



[Q2] What temperature on the Kelvin scale corresponds to (a) 0℃; (b) 20℃; (c) What temperature on the Celsius scale corresponds to 70K? (d) What temperature on the Fahrenheit scale corresponds to 20℃?



2. Transfer of heat

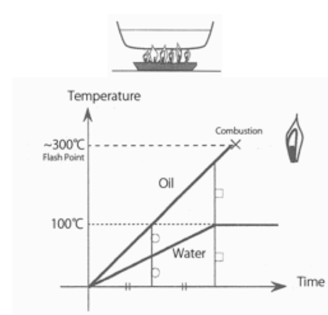
[Q3] A block of iron is dropped into a barrel of water having a temperature of 50℃. What flow of heat will take place if the temperature of the iron is (a) 40℃; (b) 50℃; (c) 60℃.

3. Heat capacity

[Q4] The heat capacity of 1.00 kg of water is 4186 J/K. What is the temperature change of the water if (a) 505 J of heat is added to the system, or (b) 1010 J of heat is removed?

4. Specific heat

[Q5] The specific heat of water is 4186 J/kgK whereas that of vegetable oil is 1970 J/kgK and its flash point is about 300℃. Why do you think fires sometimes happen at kitchen?

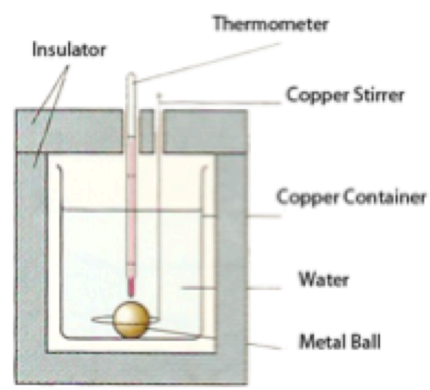


[Q6] Suppose 550 g of water at 32℃ are poured into a 210 g aluminum can with an initial temperature of 15℃. Find the final temperature of the system, assuming no heat is exchanged with the surroundings. A specific heat of water is 4186[J/kg K]

[Q7] Find a temperature when a water (10[℃], 30[g]) and a hot water (70[℃]60[g]) are mixed. A specific heat of water is 4186[J/kg K]

[Q8] A 235 g lead ball at a temperature of 84.2℃ is placed in a calorimeter containing 177 g of water at 21.5℃. Find the equilibrium temperature of the system.

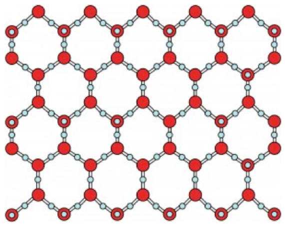
[Q9] In the calorimeter as shown, the total weight of copper container and copper is 120g. When a 100 g block of metal with an initial temperature of 98.0℃ is dropped into a the container holding 180 g of water at 20.0℃, the final equilibrium temperature becomes 24.2℃. What is the specific heat of the metal? Use 380 J/kg・K as the specific heat of copper.

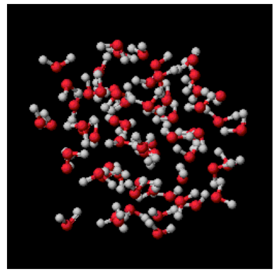


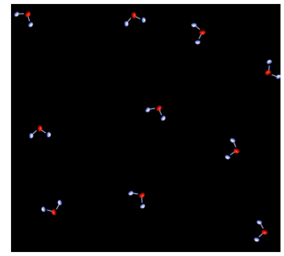
5．Temperature and Molecular Motion

[Q10] Matter consists of moving particles (atoms or molecules) which can interact more or less strongly with one another. Explain about temperature, heat transfer and phase changes using this model.


Snowflake


Molecular structure of ice


Molecular structure of water


Molecular structure of water vapor

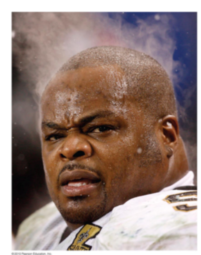
6．Evaporation

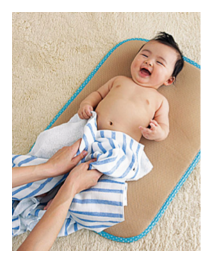
[Q11] (a) Is it effective in decreasing temperature to sprinkle water?

(b)　Why are Japanese traditional houses cooler?

(c)　Which is cooler, in the shade of house or in the shade of tree?　Why?

(d) Which method is effective for cooling a watermelon with water?

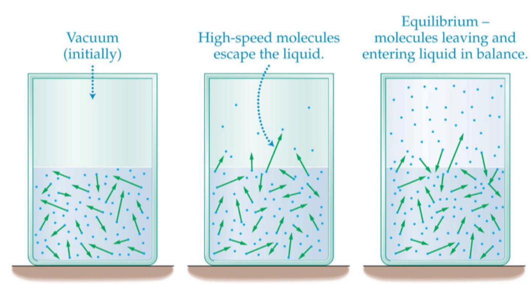




(e) How does evaporation help to cool us when we exercise or work up a sweat?

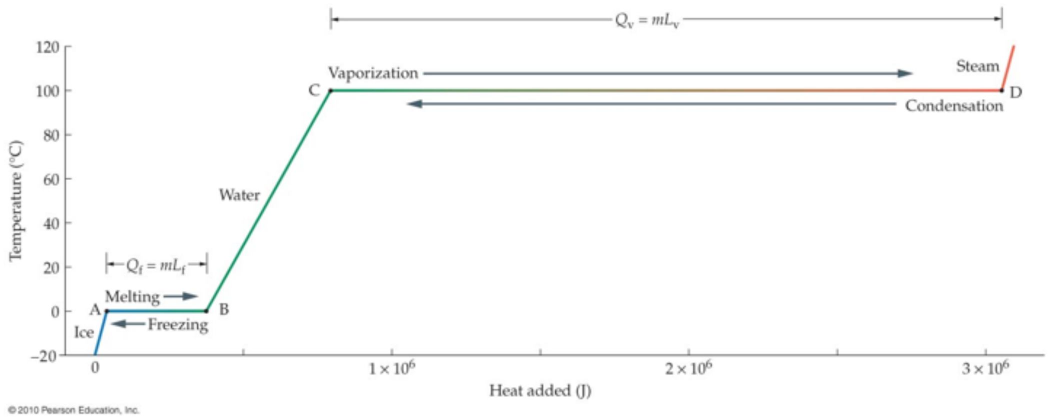
(f) Why does a chilly feeling happen after a bath?

[12] Evaporation of water occurs even in a room temperature.　Explain how it does using a molecular model.



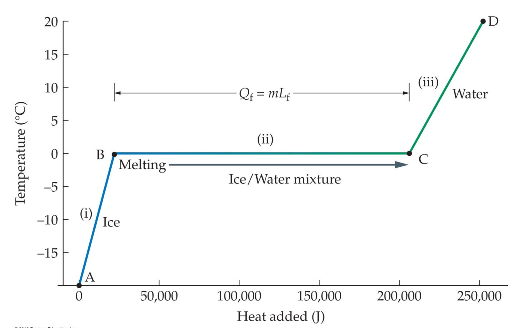
7． Latent heats

[Q19]The flowing figure show the relation between the temperature of 1.000 kg of water and the heat added or removed. Explain the behavior.



[Q20] Both water at 100℃ and steam at 100℃ can cause serious burns. Is a burn produced by steam likely to be (a) more serious than, (b) less serious than, or (c) the same as a burn produced by water?

[Q21] Find the heat energy required to raise the temperature of 0.550 kg of ice from −20.0℃ to water at 20.0℃; that is from point A to point D in the figure.



[Q22] To make steam, you add 5.60 x 10^5 J of heat to 0.220 kg of water at an initial temperature of 50.0℃. Find the final temperature of the steam.

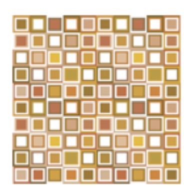
[Q23] 15℃ water(2000[g]) changes to 70℃ hot water(2190[g]) when 100℃ steam is added into it. Find a heat of vaporization of water.

[Q24] An ice (0℃) is added to water (300[g],50℃), and ice melts and the temperature becomes 43℃. Find the weight of the ice.

8. Heat Conduction

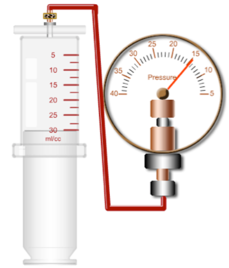
[Q39] Explain about the three mechanisms of heat exchange in the following story: The Sun warms the Earth from 150 million km of empty space. As the sunlight strikes the ground and raises its temperature, the ground-level air gets warmer and begins to rise, producing a further exchange of heat. If you walk across the ground in bare feet, you will feel the warming effect of heat entering your body.

[Q40] You get up in the morning and walk barefoot from the bedroom to the bathroom. In the bedroom you walk on carpet, but in the bathroom the floor is tile. Does the tile feel (a) warmer, (b) cooler, or (c) the same temperature as the carpet? Explain why.



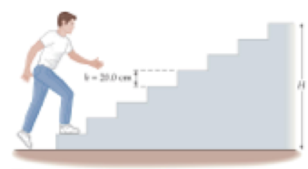
９． Gas Laws

[Q56] A syringe includes air with a volume of 16 cm^3 and a pressure of 1.0 x 10^{5}Pa. After the head is closed, the volume is expanded to 20 cm^3. Assuming the system is always at the same temperature, find the new pressure in the syringe.

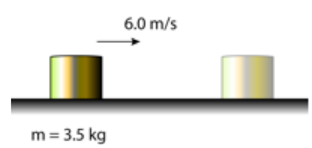


[Q57] A syringe, where its head is closed, includes air of 10 cm^3 at 27℃. The syringed is warmed to let the volume be 12 cm^3 under the same pressure. Find the new temperature.

１０． Heat and Mechanical Energy

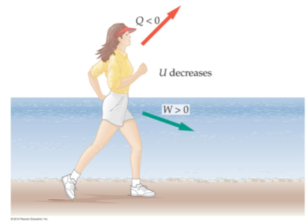


[Q35] A 74.0 kg person drinks a thick, rich 141 Cal (= 141 kcal) milkshake. How many stairs must this person climb to work of the shake? Let the height of a stair be 20.0 cm.



[Q36] When a body is slid on a horizontal surface with an initial speed of 6.0m/s, it stops soon due to friction. (a) How much heat is generated during the motion? (b) How much temperature can the heat elevate for 10 g water?

１１． Internal energy



[Q37] (a) Jogging along the beach one day, you do 4.3 x 10^5 J of work and give off 3.8 x 10^5 J of heat.　What is the change in your internal energy?　(b) Switching over to walking, you give off 1.2 x 10^5 J of heat and your internal energy decreases by 2.6 x 10^5 J.　How much work have done while walking?

１２． Work and Internal Energy

[Q58] In Fig.1, a piston is pushed downward rapidly to ignite bits of paper in the cylinder. In Fig. 2, a piston is pulled rapidly to generate cloud inside a flask that contains a small amount of water.　Explain these phenomena.

Fig. 1

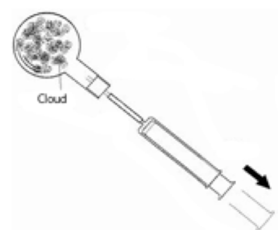
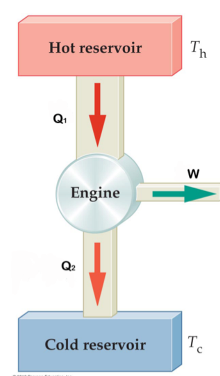


Fig. 2

１３． Heat Engine　　熱機関

[Q60] A heat engine takes in the heat of 2.1 x 10^3 J and performs work of 2.0 x 10^2 J to outside.　Find the efficiency.

[Q61] A heat engine with an efficiency of 24.0% performs 1250 J of work.　(a) Find the heat absorbed from the hot reservoir.　(b) Find the heat given off to the cold reservoir.



11th Physics 4 Work and Energy 2017-18

1. Work 仕事
   joule ジュール
   Principle of Work 仕事の原理
   Loading Ramp 傾斜路、斜面
   Lever てこ
   Movable Pulley 動滑車
   Power 仕事率
2. Kinetic Energy 運動エネルギー
3. Potential Energy 位置エネルギー
   Gravitational Potential Energy 重力による位置エネルギー
   Elastic Potential Energy 弾性エネルギー
4. Conservation of Mechanical Energy 力学的エネルギーの保存の法則

1. Temperature 温度
   Heat 熱
   Thermal Equilibrium 熱平衡

2. Heat (amount) 熱量
   Heat Capacity 熱容量
   Specific Heat 比熱
   Latent Heat 潜熱

3. Thermal Motion 熱運動
   Heat Conduction 熱伝導

4. The First Law of Thermodynamics 熱力学第 1 法則
   Internal Energy 内部エネルギー
   Ideal Gases 理想気体
   Boyle's Law ボイルの法則
   Charles's Law シャルルの法則
   Thermal Processes of Gasses
   気体の変化と内部エネルギー

5. Electric energy 電気エネルギー
   Joule's Law ジュールの法則
   Joule Heat ジュール熱

6. Energy Conversion エネルギーの変換
   Conservation of Energy エネルギーの保存則
   Efficiency of a Heat Engine 熱機関の効率