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НАВЧАЛЬНІ ЗАВДАННЯ

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Навчальні завдання для розвитку професійного мовлення з дисципліни «Іноземна мова за професійним спрямуванням /англійська/» для студентів напряму підготовки 6.050601 «Теплоенергетика» / Н. Ф. Осецька, А. Т. Літвінчук, Рівне: НУВГП, 2014, – 38 с.

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Вступ

Навчальні завдання призначені для студентів другого етапу навчання напряму підготовки 6.050601 «Теплоенергетика».

Матеріал складається з оригінальних текстів, які відображають комплекс основних понять, з якими стикаються студенти напряму підготовки «Теплоенергетика», і які готують студентів до читання і розуміння оригінальної англомовної літератури за фахом.

Дані навчальні завдання складаються з чотирьох уроків. Кожен урок містить текст, словник-мінімум, пояснення найскладніших для перекладу словосполучень, виразів чи окремих речень. Текст призначений для вивчаючого читання. Також текст при бажанні можна використовувати для аудіювання.

В навчальних завданнях дається велика кількість різноманітних вправ, спрямованих на удосконалення навичок словотворення, а також повторення і закріплення граматичного і лексичного матеріалу.

Закріплення лексичних одиниць, що згруповані в словниках-мінімумах, забезпечується їх багаторазовим повторенням в текстах і вправах до уроків.

Підбір сучасних навчальних, актуальних для сьогодення та цікавих в інформативному плані текстів, а також система вправ, яка включає новітні досягнення педагогічної науки і відповідає стандартам Типової програми з англійської мови для професійного спілкування, дають можливість, на нашу думку, досягти основної практичної мети навчання – сформувати у студентів загальні та професійно орієнтовані комунікативні мовленнєві компетенції.

Lesson 1. Energy

Topical Vocabulary

ability	здатність
amount	об'єм
apply	застосовувати
appreciate	цінувати
bat	битка
capacity	потужність, здатність
consider	вважати
convert	перетворювати
entire	весь, цілий
eventually	зрештою
exist	існувати
expand	збільшуватись
force	сила
fossil fuels	викопне паливо
infinite	безконечний
interaction	взаємодія
interchangeable	взаємозамінний
joule	джоуль
movement	рух
nutrition	харчування
object	предмет
particle	частка
perform	виконувати
phenomenon	явище
property	властивість
purpose	мета
relationship	зв'язок
require	вимагати
stove	плита
subtle	тонкий
transfer	передача
universe	всесвіт
various	різний
velocity	швидкість

Read and translate the text:

What is Energy?

I like to go for runs, and when I do, I think of energy. When I run, I also think about matter. Matter is anything that has mass and takes up space. Energy and matter are everywhere, and everything is composed of energy and matter. Energy, however, is more abstract, as you can't really see it. Nonetheless, energy has been around since the beginning of time. In fact, theory holds that energy existed before matter. According to the Big Bang Theory, the universe began when an infinite amount of energy suddenly began to expand. Energy cooled as it expanded, and, as it cooled down enough, the particles were able to come together and form matter eventually, giving rise to the universe as we know it today. It can be said that the universe is composed of two interchangeable properties: energy and matter. Energy can be converted into matter and matter can be converted into energy.

Okay, so what is energy? Energy is usually defined as the capacity or ability to perform work. I'm sure you can appreciate the fact that energy is needed to do work, but what's work? Work can be defined as the movement of mass when a force is applied to it. In other words, work is done when a force moves some object some distance. Simply put, work requires energy, and energy spent performs work.

Where Does Energy Come From?

Now that we know what energy is, let's consider where it comes from. The answer to this question is really pretty simple. Energy comes from matter. Now you know why we've been talking about these two properties of energy and matter. This makes sense when we examine the definition of work. Work can be defined as the transfer of energy to or from matter. In fact, the total amount of energy contained within matter is directly proportional to the mass. Additionally, energy can be transferred from one system to another.

So what's a system? A system is a collection of objects organized into a whole – or, to put it another way: whatever you are considering as the whole for the purpose of a study. Let's talk about a few examples of systems. For example, you can consider the entire universe as a system. You may consider the universe as a system for the purpose of studying the relationship between different galaxies within the universe. Another example of a system could be your body. You may consider the human body as a system for the purpose of studying the interaction between the various organs that make up your body.

Energy transfer from one system to another can be as simple as moving a mass from one system to another system. For example, when a lion eats a zebra, the energy contained within the mass of the zebra is transferred into the mass of the lion – or, perhaps, a whole bunch of lions. On the other hand, energy transfer can be more complex. When energy is transferred from one system to another system by some means other than movement of mass, the second system will change as a result of work done to it.

Let's look at an example of that. We've all heated water on a stove, or perhaps we've watched somebody else do that. When we heat the water on the stove, energy is transferred from the heated element of the stove into the water. As that energy is transferred, the water molecules are forced to move faster. Similarly, a system may transfer energy to another by coming into direct contact with it. When a boy who plays baseball hits the ball, that ball goes pretty far. In this example of energy transfer, the energy of motion in the bat is transferred into the baseball, which, in turn, now has energy of motion as well.

In the physics world, energy is measured in units that we call joules. This is important because you'll see this unit attached to numbers as a measurement of how much energy there is in a system. In other fields, such as industry and nutrition, energy may be measured in different units. For example, in industry kilowatt-hours are used as a measure of energy. In nutrition, calories are used as a measure of energy. You've probably heard of calories before; in fact, if you look at any wrapping paper or box of food, it's required by law that the amount of energy contained within that food be expressed in terms of calories.

Why is Energy Necessary?

Hopefully you now have a better understanding of what energy is and where energy comes from. Let's shift gears here a bit. Now let's talk about the significance of energy as it exists in nature. As energy is defined as the capacity to do work, we can appreciate that energy is needed in order to move anything in nature. This can be as obvious as energy derived from the burning of fossil fuels to move your car, or it can be as subtle as energy derived from the breakdown of nutrients by our cells to do work. For example, our muscle cells have to break down nutrients to obtain energy that is necessary to contract. That contraction of the muscle is the work performed by the muscle, and the energy needed for that work comes from the breakdown of nutrients within the muscle cell. In either case, energy is released when some mass is broken down. Once released, energy, in turn, can be used to perform work. As we've talked about before, energy is everywhere. Throughout the universe, energy is released from matter and used to perform work.

Examples of Types of Energy

Let's shift gears again. Now let's talk about different types of energy. There are various types of energy. One example of an energy type is thermal energy. Thermal energy is the internal energy of a system as a result of its temperature. We discussed this a little bit before when we talked about heating a pot of water on the stove. That heated pot of water has a certain temperature, which is a reflection of the internal energy contained within the water. That's thermal energy.

Another type of energy is mechanical energy. Mechanical energy is the energy of an object as a result of its location or motion. A good example of mechanical energy might be water held back behind a dam. There it has a certain position. Then the water moves over the dam. Now that water has motion. So that's a good example of a system containing mechanical energy – water moving over a dam.

It's really important, however, to keep in mind that all energy, regardless of the type, is still simply the capacity to do work. Any form of energy may be transferred into another form of energy. For example, let's go back to the dam. Water flowing over a dam has energy of motion, and that energy of motion is used to generate electrical energy. When these energy transformations occur, the total amount of energy remains the same. It is important to note as well that what we may call 'man-made' energy is simply energy that has been transferred from nature to some man-made source.

Lesson Summary

Let's summarize. In review, energy is the capacity to do work and work is accomplished when a force moves an object. Energy is measured in units referred to as joules. Energy is necessary within systems in order to do work within that system. Finally, energy exists in different forms and energy can be transformed from one form of energy into another form of energy.

Exercise 1. Translate the following word combinations.

1. accumulate more matter; **2.** more difficult to run; **3.** you can't really see it; **4.** since the beginning of time; **5.** theory holds; **6.** Big Bang Theory; **7.** infinite amount of energy; **8.** form matter; **9.** give rise **10.** interchangeable properties; **11.** ability to perform work; **12.** appreciate the fact; **13.** in other words; **14.** move some object some distance; **15.** let's consider; **16.** in fact; **17.** directly proportional; **18.** transfer from one system to another; **19.** to put it another way; **20.** consider as the whole; **21.** interaction between the various organs; **22.** make up human body; **23.** energy transfer from one system to another; **24.** on the other hand; **25.** molecules are forced to move faster; **26.** measure of energy; **27.** wrapping paper; **28.** it's required by law; **29.** to express in terms of calories; **30.** shift gears; **31.** in order to; **32.** contraction of the muscle; **33.** in either case; **34.** in turn; **35.** reflection of the internal energy; **36.** to keep in mind; **37.** man-made energy.

Exercise 2. Choose the correct preposition.

1. Everything is composed … energy and matter.
a) of; *b) to;* *c) in;* *d) since.*

2. Energy has been around … the beginning of time.
a) of; *b) to;* *c) in;* *d) since.*

3. … fact, theory holds that energy existed before matter.
a) of; *b) to;* *c) in;* *d) since.*

4. According … the Big Bang Theory, the universe began when an infinite amount of energy suddenly began to expand.
a) of; *b) to;* *c) in;* *d) since.*

5. The universe is composed … two interchangeable properties: energy and matter.
a) of; *b) to;* *c) in;* *d) since.*

6. Energy can be converted … matter and matter can be converted into energy.
a) of; *b) to;* *c) in;* *d) into.*

7. … other words, work is done when a force moves some object some distance.
a) of; *b) to;* *c) in;* *d) since.*

8. The answer … this question is really pretty simple.
a) of ; *b) to;* *c) in;* *d) since.*

9. Energy comes … matter.

a) from; *b) to;* *c) within;* *d) for.*

10. The total amount of energy contained … matter is directly proportional to the mass

a) from; *b) to;* *c) within;* *d) for.*

11. Students have studied the relationship between different galaxies … the universe.

a) from; *b) to;* *c) within;* *d) for.*

12. … the other hand, energy transfer can be more complex.

a) on; *b) to;* *c) within;* *d) for.*

13. When we heat the water on the stove, energy is transferred from the heated element of the stove … the water.

a) from; *b) into;* *c) on;* *d) for.*

14. In the physics world, energy is measured … units that we call joules.

a) in; *b) to;* *c) within;* *d) for.*

15. Energy is needed … order to move anything in nature.

a) from; *b) to;* *c) within;* *d) in.*

16. Once released, energy, … turn, can be used to perform work.

a) from; *b) in;* *c) within;* *d) for.*

17. Water flowing … a dam has energy of motion, and that energy of motion is used to generate electrical energy.

a) over; *b) to;* *c) within;* *d) for.*

Exercise 3. Match the terms to their definitions.

1.	Matter	**1.**	is the energy of an object as a result of its location or motion.
2.	The Big Bang theory	**2.**	is a quantity which indicates how hot or cold the body is.
3.	Energy	**3.**	is the internal energy of a system as a result of its temperature.
4.	Work	**4.**	is the transfer of energy to or from matter.
5.	A system	**5.**	states the universe began when an infinite amount of energy suddenly began to expand.
6.	Joule	**6.**	are fuels formed by natural processes such as anaerobic decomposition of buried dead organisms.
7.	Thermal energy	**7.**	is a collection of objects organized into a whole.

8.	Mechanical energy	**8.**	is a device that measures temperature or temperature gradient using a variety of different principles.
9.	Fossil fuels	**9.**	is the unit for measuring the energy.
10.	The temperature of a body	**10.**	is the capacity or ability to perform work.
11.	A thermometer	**11.**	anything that has mass and takes up space.
12.	A temperature gradient	**12.**	is a physical quantity that describes in which direction and at what rate the temperature changes the most rapidly around a particular location.

Exercise 4. Answer the questions.

1. What is matter?
2. Are energy and matter everywhere?
3. Everything is composed of energy and matter, isn't it?
4. How did the universe begin?
5. What properties is the universe composed of?
6. What is energy?
7. What is work?
8. What does the work require?
9. Where does energy come from?
10. What are the peculiarities of energy?
11. What's a system?
12. Is it difficult to transfer energy from one system to another?
13. What units is energy measured in?
14. What is the significance of energy?
15. Where does the energy exist in nature?

Exercise 5. Read the text.

Much of the world uses the Celsius scale (°C) for most temperature measurements. It has the same incremental scaling as the Kelvin scale used by scientists, but fixes its null point, at 0°C = 273.15 K, approximately the freezing point of water (at one atmosphere of pressure). The United States uses the Fahrenheit scale for common purposes, a scale on which water freezes at 32°F and boils at 212°F (at one atmosphere of pressure).

For practical purposes of scientific temperature measurement, the International System of Units (SI) defines a scale and unit for the thermodynamic temperature by using the easily reproducible temperature of the triple point of water as a second reference point. The reason for this choice is that, unlike the freezing and boiling point temperatures, the temperature at the triple point is independent of pressure (since the triple point is a fixed point on a two-dimensional plot of pressure vs. temperature). For historical reasons, the triple point temperature of water is fixed at 273.16 units of the measurement increment, which has been named the Kelvin in honor of the Scottish physicist who first defined the scale. The unit symbol of the Kelvin is K.

Absolute zero is defined as a temperature of precisely 0 Kelvin's, which is equal to −273.15 C or −459.67 F.

Exercise 6. Compare different temperature scales.

Exercise 7. Speak about.

1. Energy.
2. Matter.
3. Work.
4. Big Bang Theory.
5. Energy transfer from one system to another.
6. Energy measuring units.
7. Significance of energy.
8. Different types of energy.

Self-assessment test

Choose the correct answer.

1. Matter is anything that has … and takes up space.
a) mass; *b) matter;* *c) energy;* *d) space.*

2. Energy and matter are everywhere, and everything is composed of … and matter.
a) mass; *b) matter;* *c) energy;* *d) space.*

3. … , however, is more abstract, as you can't really see it.
a) mass; *b) matter;* *c) energy;* *d) space.*

4. Nonetheless, energy has been around since the … of time.

a) begin; b) began; c) beginning; d) is beginning.

5. In fact, theory holds that energy … before matter.

a) existed; b) began; c) expanded; d) composed.

6. According to the Big Bang Theory, the universe began when an … amount of energy suddenly began to expand.

a) existed; b) finite; c) definite; d) infinite.

7. The particles were able to come together and form matter eventually, giving … to the universe as we know it today.

a) rise; b) rose; c) raised; d) rising.

8. It can be said that the universe is composed of two … properties: energy and matter.

a) existed; b) interchangeable;
c) expanded; d) composed.

9. Energy can be converted into matter and matter can be … into energy.

a) defined; b) converted; c) appreciate; d) applied.

10. Energy is usually defined as the capacity or … to perform work.

a) possibility; b) converted; c) ability; d) applied.

11. I'm sure you can a … the fact that energy is needed to do work.

a) to know; b) to use; c) appreciate; d) applied.

12. Work can be defined as the movement of mass when a force is … to it.

a) application; b) converted; c) apply; d) applied.

13. In other words, work is done when a force moves some … some distance.

a) subject; b) object; c) matter; d) part.

14. … put, work requires energy, and energy spent performs work.

a) easy; b) simply; c) sample; d) simple.

15. Work can be defined as the … of energy to or from matter.

a) change; b) transfer;
c) transform; d) example.

16. In fact, the total amount of energy contained within matter is … proportional to the mass.

a) directly; b) direct;
c) reverse; d) indirect.

17. It is a well-known fact that a system is a collection of objects … into a whole.

a) organization; b) is organized;
c) system; d) organized.

18. For example, you can consider the entire … as a system.

a) universal; *b) universe;*
c) university; *d) example.*

19. You … consider the universe as a system for the purpose of studying the relationship between different galaxies within the universe.

a) can; *b) may;* *c) have to;* *d) must.*

20. Energy transfer from one system to another … be as simple as moving a mass from one system to another system.

a) can; *b) should;*
c) is; *d) may.*

21. We've all heated water on a stove, or perhaps we … somebody else do that.

a) watch; *b) have watched;* *c) look;* *d) saw.*

22. When we heat the water on the stove, energy is transferred from the … element of the stove into the water.

a) hot; *b) heat;* *c) heated;* *d) heating.*

23. As that energy is transferred, the water molecules … forced to move faster.

a) are; *b) be;* *c) was;* *d) were.*

24. Similarly, a system may transfer energy to another by … into direct contact with it.

a) comes; *b) has comet;* *c) coming;* *d) came.*

25. Nick … to play baseball and he's really pretty good at it.

a) loves; *b) loving;* *c) has loved* *d) going.*

26. When a boy hits the ball, that ball goes … far.

a) handsome; *b) cute* *c) so;* *d) pretty.*

27. In the physics world, energy is measured … units that we call joules.

a) at; *b) in;* *c) after;* *d) since.*

28. In other fields, such as industry and nutrition, energy may be … in different units.

a) measure; *b) measured;*
c) is measured; *d) measuring.*

29. … , in industry kilowatt-hours are used as a measure of energy. In nutrition, calories are used as a measure of energy.

a) for example; *b) example;*
c) at instance; *d) instance.*

30. Hopefully you now have a better … of what energy is and where energy comes from

a) understanding; *b) measured;*
c) significance; *d) obvious.*

Lesson 2. Kinetic Energy to Potential Energy: Relationship in Different Energy Types

Topical Vocabulary

arrangement	оформлення
beam	промінь
bond	зв'язок
burn	горіти
calculate	обчислювати
contain	містити
convert	перетворювати
couple	пара, декілька
dependent upon	залежний
device	пристрій
directly proportional	прямо пропорційний
due to	завдяки
equation	рівняння
exist	існувати
explore	досліджувати
force	сила
friction	тертя
gasoline	бензин
illuminate	освітлювати
likewise	подібно, також
lever	важіль
motion	рух
release	вивільняти
result in	призводити до
resume	підсумок
roll	котити
shape	вигляд, форма
spring	пружина
squared	в квадраті
state	стан

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store	запасати
surface	поверхня
tire	шина
top	верх
transmit	передавати
trap	капкан
understand	розуміти
variable	змінний
velocity	швидкість

Read and translate the text:

Kinetic Energy to Potential Energy: Relationship in Different Energy Types

Energy gets things done. Energy warms the surface of our planet and blows the wind through our hair. Energy contracts muscles and transmits signals within our brain. Energy illuminates the lights in our homes and moves cars down the road. Energy is usually defined as the ability to do work. Scientists have learned how to change energy from one form into another to make our lives more comfortable. Energy exists in different forms, such as heat, motion, light, chemical and sound. While there are different forms of energy, all the different forms can be put into two categories. One category would be kinetic energy. That's energy of motion. The other category is potential energy. That's energy stored in an object due to its position.

What is Kinetic Energy?

Let's first explore kinetic energy. Kinetic energy of an object is the energy it contains due to movement. If an object is at rest, it doesn't have kinetic energy. If it's moving, then it has kinetic energy. It's pretty simple!

The amount of kinetic energy of an object is dependent upon two variables, one being the mass of the object, the other being the speed or the velocity of the object. Let's look at an equation that will help us calculate kinetic energy and understand the relationship of these variables. Here it is:

$$Kinetic\ Energy = \frac{mass \times velocity^2}{2}$$

Therefore, kinetic energy is directly proportional to both the mass of the object and the square of its speed. This is important because small changes in speed will result in larger changes in kinetic energy. For example, if a car moves twice as fast as another, it will contain four times as much kinetic energy. That is assuming that both cars have the same mass - or even if you talk about the same car and it moves twice as fast, it will also have four times as much kinetic energy.

What is Potential Energy?

Now that we have explored kinetic energy, let's now take a look at potential energy. Potential energy is stored in an object when work is done on that object. Work is done when a force moves an object some distance to a new position. In other words, potential energy is stored in a system when something is moved from its natural resting state.

Let's look at an example of potential energy. A mouse trap contains potential energy when the lever is forced into its set position. Within the mouse trap, the potential energy is stored specifically within the spring. When the trap is tripped, the potential energy is released from the spring when the trap resumes its original shape and then perhaps catches a mouse. Potential energy can be stored in other devices as well, such as tires on your car, the shock absorbers on your car and even wrecking balls that are used to tear down buildings. Metal beams that are used to construct buildings also contain potential energy.

At a much smaller level, potential energy is stored in chemicals. This chemical potential energy is related to the arrangement of the chemicals. The arrangement may be a result of bonds that hold an individual chemical together, or the arrangement could be the arrangement of different chemicals that are existing together within a system. Let's look at a couple of examples. Gasoline is a chemical. That's obviously what we use to run our automobiles. When gasoline is burned, these bonds within the gasoline are broken, and that releases potential energy. Likewise, our bodies break down food chemicals to release energy.

What is The Relationship between Kinetic and Potential Energy?

Now let's explore the relationship between kinetic and potential energy. It's difficult to discuss kinetic or potential energy alone because they're so tightly related and even dependent upon each other. In fact, the only way any kinetic energy will exist is if it is released from a formerly stored energy, which is potential energy. Likewise, kinetic energy is needed in order to store potential energy in any system. For example, people use potential energy in food to contract muscles that are needed to ride a bike. In this example, the potential energy from food is converted into kinetic energy, the energy of motion of the bicycle. The kinetic energy of biking can then be converted into other forms. If the person rides the bike to the top of a hill, the kinetic energy of motion is then converted into potential energy stored in the bike at the top of the hill. The potential energy stored in the bike at the top of the hill can be used to roll the bike down the hill.

Lesson Summary

In review, energy is the capacity to do work, and work is accomplished when a force moves an object. Energy exists in different forms, all of which can be classified as either potential energy or kinetic energy. Potential energy is energy stored in an object due to its position or arrangement. Kinetic energy is energy of an object due to its movement - its motion. All types of energy can be transformed into other types of energy. This is true for potential and kinetic energy as well. Potential energy can be converted into kinetic energy, and kinetic energy can be converted into potential energy.

Exercise 1. Translate the following word combinations.

1. to warm the surface; **2.** contract muscles; **3.** transmit signals within brain; **4.** illuminate the lights; **5.** move cars down the road; **6.** change energy from one form into another; **7.** make lives more comfortable; **8.** exist in different forms; **9.** put into two categories; **10.** energy of motion; **11.** energy stored in an object; **12.** explore kinetic energy;. **13.** due to movement; **14.** an object is at rest; **15.** pretty simple; **16.** the amount of energy depends on; **17.** the mass of the object; **18.** the velocity of the object; **19.** the relationship of variables; **20.** directly proportional; **21.** square of speed; **22.** move twice as fast as; **23.** contain four times as much energy; **24.** natural resting state; **25.** a mouse trap; **26.** the trap is tripped; **27.** resume original shape; **28.** wrecking ball; **29.** tear down buildings; **30.** metal beams; **31.** the arrangement of the chemicals; **32.** to release energy; **33.** the relationship between energy.

Exercise 2. Choose the correct preposition.

1. Energy contracts muscles and transmits signals … our brain.

a) on; *b) to;* *c) in;* *d) within.*

2. Energy illuminates the lights … our homes and moves cars down the road.

a) on; *b) to;* *c) in;* *d) within.*

3. Scientists have learned how to change energy … one form into another to make our lives more comfortable.

a) on; b) toward; c) into; d) from.

4. Energy exists … different forms, such as heat, motion, light, chemical and sound.

a) on; b) to; c) in; d) within.

5. Energy stored in an object due … its position is potential energy.

a) on; b) to; c) in; d) within.

6. An object at rest doesn't have kinetic energy.

a) on; b) at; c) in; d) for.

7. The amount of kinetic energy of an object depends … the mass and the velocity of the object.

a) on; b) to; c) at; d) with.

8. Let's look … an equation that will help us calculate kinetic energy.

a) for; b) since; c) in; d) at.

9. If a car moves twice as fast … another, it will contain four times as much kinetic energy.

a) on; b) as; c) for; d) within.

10. Let's now take a look at potential energy.

a) on; b) to; c) in; d) at.

11. In other words, potential energy is stored in a system when something is moved … its natural resting state.

a) with; b) to; c) in; d) from.

12. The potential energy is stored specifically … the spring.

a) with; b) to; c) by; d) within.

13. Potential energy can be stored in such devices … tires on your car, the shock absorbers on your car.

a) for; b) to; c) in; d) as.

14. … a much smaller level, potential energy is stored in chemicals.

a) at; b) to; c) in; d) from.

15. When gasoline is burned, chemical bonds … the gasoline are broken.

a) till; b) to; c) in; d) within.

16. Let's explore the relationship … kinetic and potential energy.

a) as; b) between; c) in; d) because.

17. Kinetic and potential energy are tightly related and even dependent … each other.

a) since; b) at; c) for; d) upon.

18. In fact, the only way any kinetic energy will exist is if it is released … potential energy.

a) from; b) between; c) in; d) within.

19. Likewise, kinetic energy is needed in order to store potential energy … any system.

a) for; b) between; c) in; d) within.

20. The kinetic energy of biking can then be converted … other forms.

a) into; b) to; c) in; d) within.

21. If the person rides the bike … the top of a hill, the kinetic energy of motion is then converted into potential energy.

a) at; b) to; c) in; d) within.

25. The potential energy stored in the bike … the top of the hill can be used to roll the bike down the hill.

a) on; b) to; c) at; d) within.

Exercise 3. Match the terms to their definition.

1.	Energy	**1.**	is related to the arrangement of the chemicals.
2.	Potential energy	**2.**	energy of motion.
3.	Kinetic energy	**3.**	that are used to construct buildings also contain potential energy.
4.	Kinetic energy	**4.**	the ability to do work.
5.	Work is done	**5.**	can be transformed into other types of energy.
6.	Chemical potential energy	**6.**	a contrivance for catching and holding animals.
7.	Metal beams	**7.**	formal statement of the equality or equivalence of mathematical or logical expression.
8.	All types of energy	**8.**	the rate at which someone or something moves or travels.
9.	Trap	**9.**	the rate of change of position along a straight line with respect to time.
10.	Equation	**10.**	when a force moves an object some distance to a new position.
11.	Speed	**11.**	directly proportional to both the mass of the object and the square of its speed.
12.	velocity	**12.**	energy stored in an object due to its position.

Exercise 4. Fill in the gaps with the words given below.

1. Motion. 2. Joule. 3. Direction. 4. Scalar. 5. Speed. 6. Fourfold. 7. Directly. 8. Mass. 9. Object. 10. Amount. 11. Due to. 12. Vibrational. 13. Forms. 14. Kinetic.

Kinetic energy is the energy of …1… . An object that has motion – whether it is vertical or horizontal motion – has …2 … energy. There are many …3… of kinetic energy – vibrational (the energy due to …4… motion), rotational (the energy …5… rotational motion), and translational (the energy due to motion from one location to another). The …6… of kinetic energy that an …7… has depends upon two variables: the …8… (*m*) of the object and the speed (*v*) of the object.

The equation representing the kinetic energy of an object reveals that the kinetic energy of an object is …9… proportional to the square of its speed. That means that for a twofold increase in speed, the kinetic energy will increase by a factor of four. For a threefold increase in speed, the kinetic energy will increase by a factor of nine. And for a …10… increase in speed, the kinetic energy will increase by a factor of sixteen. The kinetic energy is dependent upon the square of the …11… . As it is often said, an equation is not merely a recipe for algebraic problem solving, but also a guide to thinking about the relationship between quantities.

Kinetic energy is a …12… quantity; it does not have a …13… . Unlike velocity, acceleration, force, and momentum, the kinetic energy of an object is completely described by magnitude alone. Like work and potential energy, the standard metric unit of measurement for kinetic energy is the …14… .

Exercise 5. Answer the questions.

1. What does energy do?

2. How is usually energy defined?

3. What forms does energy exist in?

4. What two categories can all the different forms of energy be put into?

5. What is kinetic energy?

6. Does an object at rest have kinetic energy?

7. What does the amount of kinetic energy of an object depend on?

8. What will help us calculate kinetic energy?

9. What is kinetic energy equation?

10. What is kinetic energy directly proportional to?
11. What is potential energy?
12. When is work done?
13. When is potential energy stored in a system?
14. What devices can potential energy be stored?
15. There is potential energy in chemicals, isn't there?
16. Why is it difficult to discuss kinetic or potential energy alone?
17. What is the only way any kinetic energy existence?
18. How do people use potential energy in food?

Exercise 6. Speak about

a) energy;
b) kinetic energy;
c) potential energy;
d) relationship between kinetic and potential energy.

Exercise 7. Give a short summary of the lesson

Self-assessment test

Choose the correct answer.

1. Energy … the surface of our planet and blows the wind through our hair.

a) warms; *b) warmed;* *c) warming;* *d) is warmed.*

2. Energy illuminates the lights in … homes and moves cars down the road.

a) our; *b) us;* *c) my;* *d) we.*

3. Energy is usually defined as the ability to do ….

a) works; *b) job;* *c) working;* *d) work.*

4. … have learned how to change energy from one form into another to make our lives more comfortable.

a) science; *b) research;* *c) scientists;* *d) scientist.*

5. Energy exists in different forms, such as …, motion, light, chemical and sound.

a) hot; *b) heat;* *c) heating;* *d) heater.*

6. While there are different forms of energy, all the different forms can … put into two categories.

a) was; *b) be;* *c) is;* *d) are.*

7. Kinetic energy of an object … the energy it contains due to movement.

a) was; *b) were;* *c) is;* *d) are.*

8. If an object is at rest, it doesn't have kinetic energy.

a) object *b) subject* *c) things* *d) objective*

9. If it's moving, then it … kinetic energy.

a) has *b) to have* *c) have* *d) had*

10. The amount of kinetic energy of an object is dependent upon two variables: the mass of the object and the velocity of the object.

a) depend; *b) dependent;*
c) depends; *d) depended.*

11. Let's look at an equation that will help us calculate kinetic energy and understand the relationship of these variables.

a) equation; *b) equations;* *c) equal;* *d) phenomenon.*

12. Kinetic energy … directly proportional to both the mass of the object and the square of its speed.

a) was; *b) were;* *c) is;* *d) are.*

13. This is important because small changes in speed will … in larger changes in kinetic energy.

a)resulted; *b) results;* *c) result;* *d) resulting.*

14. Potential energy is stored in an object when work … on that object.

a) was done; *b) did;* *c) is done;* *d) does.*

15. Work is done when a force … an object some distance to a new position.

a) moves; *b) move;* *c) moved;* *d) moving.*

16. In other words, potential energy is stored in a system when something is … from its natural resting state.

a) moves; *b) move;* *c) moved;* *d) moving.*

17. A mouse trap contains potential energy when the lever is forced into … set position.

a) it; *b) it is;* *c) it's;* *d) its.*

18. Within the mouse trap, the potential energy is stored specifically within the spring.

a) summer; *b) springs;* *c) spring;* *d) autumn.*

19. Potential energy can be stored in tires on your car, the shock absorbers on your car and even wrecking balls that are used to tear … buildings.

a) up; *b) away;* *c) aside;* *d) down.*

20. Metal beams that are used to … buildings also contain potential energy.

a) construct; *b) constructed;*
c) construction; *d) constructs.*

21. At a much smaller level, potential energy is stored in chemicals.

a) more; *b) much;* *c) most;* *d) many.*

22. … potential energy is related to the arrangement of the chemicals.

a) chemist; *b) chemistry;* *c) chemicals;* *d) chemical.*

23. The arrangement of chemicals may be a result of bonds that hold an individual chemical together.

a) must; *b) has to;* *c) could;* *d) may.*

24. Gasoline is … to run our automobiles

a) uses; *b) used;* *c) useful;* *d) user.*

25. … gasoline is burned, these bonds within the gasoline are broken, and that releases potential energy.

a) when; *b) if;* *c) until;* *d) as well*

26. Now let's explore the … between kinetic and potential energy.

a) relate; *b) relative;*
c) relationship; *d) relationships.*

27. It's difficult to discuss kinetic or potential energy alone because they're so tightly related and even … upon each other.

a) dependent; *b) depend;* *c) depended;* *d) depends.*

28. In fact, the only way any kinetic energy will exist is if it is released from a … stored energy, which is potential energy.

a) formerly; *b) formally;* *c) form;* *d) former.*

29. Kinetic energy is needed in order to … potential energy in any system.

a) stored; *b) store;* *c) use;* *d) storage.*

30. If the person rides the bike to the top of a hill, the kinetic energy of motion is then converted into potential energy … in the bike at the top of the hill.

a) eventually; *b) shortage;* *c) stored;* *d) storage.*

Lesson 3. The First Law of Thermodynamics: the law of Energy conservation

Topical Vocabulary

amalgamate	об'єднувати
ability	здатність
account	брати до уваги
appear	виявлятися
apply	застосовувати
ash	зола
breakdown	прорив
create	створювати
consider	вважати, розглядати
coast	рухатись по інерції
conservation	збереження
constant	сталий, незмінний
derive	походити
difference	різниця
discovery	відкриття
destroy	руйнувати
enter	входити
explain	пояснювати
fireplace	камін
friction	тертя
introduction	введення
internal	внутрішній
include	включати
in order to	для того щоб
input	вклад, подача
law	закон
leave	залишати, піти
loose	звільняти, випускати
lubricate	змащувати
matter	речовина
particle	частка
permit	дозволяти
perpetual	безперервний
possibly	можливо
prerequisite	передумова

provide	забезпечувати
quantity	кількість
rather	краще, швидше, переважно
release	відпустити, звільнити
remain	залишатися
soot	сажа
space	простір
stuff	предмет, матеріал, речі
windmill	вітряк
wheel	колесо

Read and translate the text

Have you ever wondered what happens to wood as it burns? It seems as if the wood may disappear into thin air. While burning wood appears to create energy and destroy the wood, neither is created or destroyed. Rather, energy and matter are changing from one form to another. Wood contains what we call chemical potential energy , which is energy stored in the bonds that hold the chemicals together. This stored energy is released in the form of heat and light when the wood is burned.

Wood also contains matter, which is anything that has mass and takes up space (volume). The matter within the wood is transformed into different matter, including ash and soot, as it burns. The total amount of energy and matter in the wood before burning is equal to the energy and matter of the ash, soot, heat, and light after burning. In other words, energy and matter are conserved both during and after the wood is burned.

This phenomenon of conservation is explained by what we call the first law of thermodynamics, sometimes referred to as the law of energy conservation. The law states energy cannot be created or destroyed. Energy can be described as the ability to do work, where work is the movement of matter when a force is applied to it. With the example of burning wood, the energy we see in the form of fire is not created out of nothing but rather comes from the energy that is stored in the wood. Likewise, the wood is not destroyed but rather is converted into ash and soot.

In order to better understand the law of energy conservation, we need to consider the fact that it applies to systems. A system is simply a collection of component parts that make up a whole. Burning wood is a system that includes the wood, heat, ash, and soot. The universe is the largest system that we know of, and it includes all matter and all energy, including the burning wood that we're talking about. There're other examples of small systems. For example, you can consider your body as a system. When you're cooking, you can consider a pot of water on the stove as a system as well.

Now that we have a good understanding of systems, let's consider the difference between an open and a closed system and discuss the law of energy conservation as it applies to each. A closed system is a system in which no matter or energy is allowed to enter or leave. The first law of thermodynamics tells us that the amount of energy within any closed system is constant – it doesn't change.

An open system, on the other hand, allows stuff to come in and go out, like burning wood in a fireplace. Here, you can add wood to the fireplace and light it with a match from, say, your pocket. Heat, ashes, and soot can leave the fireplace as the fire burns. In other words, energy and mass can enter and leave a system as long as they come from a system or leave to go to another system. It's important to note, however, that the total mass and energy in our universe remains constant.

Since most systems are not closed, the law of energy conservation can be rephrased to say that the change in the internal energy of the system is equal to the difference between the amount of energy coming in minus the amount of energy going out. In other words, the amount of energy in a system can change, but only if it comes from another system or goes to another system.

At any rate, systems, whether they're open or closed, do not create or destroy energy. Rather, energy can enter from one system and leave to another. Energy that enters a system must either be stored there or leave. A system cannot expend more energy than it contains without receiving additional energy from an external source.

Application of the First Law of Thermodynamics

Now that we understand that energy is conserved within a system, let's consider some practical applications of the law. In other words, what does it do for me? How does understanding the law of conservation help us out?

Have you ever heard of a perpetual motion machine? Such a machine would continue to work without any input of energy. No such machine has ever been built, and according to the energy conservation law, such a machine never will be. Every machine requires the continual input of energy in order to keep working. The type of energy providing the input can vary, including the sun for solar energy, wind to move a windmill, water flowing over the dam, the breakdown of chemicals like gasoline to run our automobiles, or the breakdown of chemicals in the food we eat to pedal a bike. A really good bike can coast on level ground for a long time, but it's eventually going to come to a stop unless someone pedals the bike.

So how does the law of energy conservation help us explain why machines will stop working if no energy is put into the system? At first, the law of energy conservation may seem to not apply to machines because we're having to constantly add energy. So it seems as if energy's not being conserved. But, on the contrary, the law absolutely applies, and, in fact, it applies to all machines and all systems.

Any time a machine works, some energy is lost to what we call friction . Friction is heat generated by moving objects in contact with each other. No matter how well-lubricated the wheels of a bike, for example, every bike will lose energy to friction as it moves. This energy lost to friction has got to come from somewhere according to the law of energy conservation, and indeed it does. It comes from the energy of the system - in this case, the system is the coasting bike. Eventually, all the energy of the coasting bike is going to be lost to friction and the bike will come to a stop. You see? The law applies.

The law of energy conservation applies to all matter and energy in every system, no matter what the conditions. As it is a law, we assume it to be true in all cases, even if our observations don't seem to match up with the law. If they don't, we assume that we're not accounting for some form of energy. This assumption has helped us to discover new forms of energy.

Lesson Summary

The amount of energy and mass in the universe is constant. It's been the same since the beginning of time. Energy can be changed from one form to another, but it cannot be created or destroyed. Energy can be moved from one system to another, but it cannot be created out of nothing. Likewise, a system cannot destroy energy; rather, energy can be transferred to another system.

All machines, whether they're man-made or natural, require a source of energy in order to continue working. As long as this energy is supplied, the machine can continue working. When the source of energy is removed, however, the machine will eventually stop. The machine stops due to friction. Friction, again, is the heat generated due to moving objects in contact with each other. This principle is referred to as the first law of thermodynamics or the law of energy conservation, the law applies to all systems both large and small, and, again, it states that energy cannot be created or destroyed.

Exercise 1. Translate the following word combinations.

1. thin air; **2.** create energy; **3.** change from one form to another; **4.** to be stored in the bonds; **5.** hold the chemicals together; **6.** in the form of heat and light; **7.** the total amount of energy and matter; **8.** in other words; **9.** the first law of thermodynamics; **10.** energy conservation; **11.** energy can neither be created nor destroyed; **12.** the movement of matter; **13.** a force is applied; **14.** to be created out of nothing; **15.** ash and soot; **16.** in order to; **17.** a collection of component parts; **18.** make up a whole; **19.** a pot of water; **20.** an open and a closed system; **21.** to be allowed to enter or leave; **22.** the amount of energy within any closed system; **23.** on the other hand; **24.** to light it with a match from your pocket; **25.** it is important to note; **26.** remain constant; **27.** since most systems are not closed; **28.** at any rate; **29.** additional energy; **30.** an external source; **31.** perpetual motion machine; **32.** according to the law; **33.** input of energy; **34.** solar energy; **35.** pedal the bike.

Exercise 2. Choose the correct preposition.

1. Have you ever wondered what happens … wood as it burns?

a) to; *b) in;* *c) during;* *d) after.*

2. Stored energy is released … the form of heat and light when the wood is burned.

a) to; *b) in;* *c) during;* *d) after.*

3. The total amount of energy and matter in the wood … burning is equal to the energy and matter of the ash, soot, heat, and light after burning.

a) at; *b) before;* *c) during;* *d) after.*

4. In other words, energy and matter are conserved both … and after the wood is burned.

a) on; *b) in;* *c) during;* *d) after.*

5. This phenomenon of conservation is explained by what we call the first law of thermodynamics, sometimes referred to … the law of energy conservation.

a) before; *b) as;* *c) during;* *d) after.*

6. … order to better understand the law of energy conservation, we need to consider the fact that it applies to systems.

a) to; *b) in;* *c) during;* *d) after.*

7. The universe is the largest system that we know …, and it includes all matter and all energy.

a) between; *b) about;* *c) of;* *d) after.*

8. Let's consider the difference between an open and a closed system and discuss the law of energy conservation … it applies to each.

a) from; *b) as;* *c) during;* *d) at.*

9. A closed system is a system … which no matter or energy is allowed to enter or leave.

a) on; *b) about;* *c) in;* *d) after.*

10. An open system, … the other hand, allows stuff to come in and go out, like burning wood in a fireplace.

a) out; *b) into ;* *c) on;* *d) after.*

11. You can add wood to the fireplace and light it … a match from your pocket.

a) for; *b) about;* *c) with;* *d) from.*

12. The total mass and energy … our universe remains constant.

a) on; *b) after;* *c) in;* *d) before.*

13. … other words, the amount of energy in a system can change.

a) on; *b) about;* *c) in;* *d) after.*

14. … any rate, systems, whether they're open or closed, do not create or destroy energy.

a) with; *b) about;* *c) in;* *d) at.*

15. Perpetual motion machine would continue to work … any input of energy.

a) between; *b) at;* *c) without;* *d) after.*

16. No such machine has ever been built, and according … the energy conservation law, such a machine never will be.

a) below; *b) to;* *c) in;* *d) after.*

17. The law of energy conservation helps us explain why machines will stop working if no energy is put … the system.

a) on; *b) into;* *c) in;* *d) from.*

18. … first, the law of energy conservation may seem to not apply to machines because we're having to constantly add energy.

a) since; *b) at;* *c) in;* *d) for.*

19. But, … the contrary, the law absolutely applies, and, in fact, it applies to all machines and all systems.

a) on; *b) for;* *c) above;* *d) from.*

20. This energy lost to friction has got to come … somewhere according to the law of energy conservation.

a) between; *b) about;* *c) to;* *d) from.*

21. It comes from the energy of the system - … this case, the system is the coasting bike.

a) from; *b) in;* *c) during;* *d) after.*

22. The law of energy conservation applies … all matter and energy in every system, no matter what the conditions.

a) on; *b) at;* *c) to;* *d) for.*

23. As it is a law, we assume it to be true in all cases, even if our observations don't seem to match … with the law.

a) as; *b) from;* *c) up;* *d) for.*

24. If they don't, we assume that we're not accounting … some form of energy.

a) on; *b) from;* *c) in;* *d) for.*

25. Energy can be changed … one form to another, but it cannot be created or destroyed.

a) from; *b) at;* *c) into;* *d) for.*

26. Energy can be moved from one system … another, but it cannot be created out of nothing.

a) on; *b) at;* *c) in;* *d) to.*

27. All machines, whether they're man-made or natural, require a source of energy in order to continue working.

a) for; *b) about;* *c) during;* *d) in.*

28. As long … this energy is supplied, the machine can continue working

a) at; *b) since;* *c) as;* *d) after.*

Exercise 3. Arrange the synonyms into pairs.

A. 1. wonder; **2.** create; **3.** to vary; **4.** type; **5.** vice-versa; **6.** cold; **7.** heat; **8.** space; **9.** amount; **10.** equal; **11.** originate; **12.** movement; **13.** for example; **14.** since; **15.** include; **16.** large; **17.** to enter;

18. destroy; **19.** small; **20.** to leave; **21.** to remain; **22.** important; **23.** say; **24.** application; **25.** to work; **26.** require; **27.** eventually; **28.** to begin; **29.** constant; **30.** to add.

B. 1. volume; **2.** quantity; **3.** the same; **4.** build; **5.** ruin; **6.** think; **7.** little; **8.** to start; **9.** come from; **10.** warmth; **11.** great; **12.** to stay; **13.** kind; **14.** go out; **15.** tell; **16.** usage; **17.** to run; **18.** to need; **19.** to differ; **20.** from; **21.** on the contrary; **22.** cool; **23.** to come in; **24.** motion; **25.** for instance; **26.** consist of; **27.** at least; **28.** continuous; **29.** essential; **30.** to plus.

Exercise 4. Arrange the antonyms into pairs.

A. 1. disappear; **2.** create; **3.** released; **4.** including; **5.** equal; **6.** before; **7.** light; **8.** the first; **9.** conservation; **10.** ability; **11.** better; **12.** simple; **13.** the largest; **14.** good; **15.** closed; **16.** to enter; **17.** constant; **18.** to come in; **19.** unimportant; **20.** total; **21.** minus; **22.** stored; **23.** external; **24.** practical; **25.** to continue; **26.** output; **27.** work; **28.** to stop; **29.** heat; **30.** false.

B. 1. changeable; **2.** to leave; **3.** bad; **4.** the smallest; **5.** complex; **6.** worse; **7.** disability; **8.** consumption; **9.** the last; **10.** dark; **11.** after; **12.** unequal; **13.** exclude; **14.** stored; **15.** destroy; **16.** appear; **17.** open; **18.** theoretical; **19.** to stop; **20.** internal; **21.** expend; **22.** plus; **23.** part; **24.** important; **25.** to go out; **26.** idle; **27.** cold; **28.** true; **29.** to continue; **30.** input.

Exercise 5. Match the terms to their definition.

1.	Matter	**1.**	the largest system that we know of, and it includes all matter and all energy.
2.	The law of energy conservation	**2.**	more energy than it contains without receiving additional energy from an external source.
3.	A system	**3.**	a system in which no matter or energy is allowed to enter or leave.
4.	The universe	**4.**	heat generated by moving objects in contact with each other.
5.	A closed system	**5.**	allows stuff to come in and go out.
6.	The first law of thermodynamics	**6.**	energy stored in the bonds that hold the chemicals together.

7.	An open system	**7.**	the ability to do work.
8.	A system cannot expend more energy	**8.**	would continue to work without any input of energy.
9.	A perpetual motion machine	**9.**	the movement of matter when a force is applied to it.
10.	Friction	**10.**	cannot be created or destroyed.
11.	The law of energy conservation applies	**11.**	the amount of energy within any closed system is constant.
12.	Chemical potential energy	**12.**	a collection of component parts that make up a whole.
13.	Energy	**13.**	to all matter and energy in every system, no matter what the conditions.
14.	Work	**14.**	anything that has mass and takes up space (volume).

Exercise 6. Fill in the gaps.

The …1… of energy and …2… in the …3… is constant. It's been the same …4… the beginning of time. Energy can be …5… from one …6… to another, but it cannot be created or …7… . Energy can be moved from one …8… to another, but it cannot be created out of …9…. Likewise, a system cannot destroy energy; rather, energy can be …10… to another system.

All machines, whether they're …11… or natural, require a …12… of energy …13… order to continue working. As long …14… this energy is supplied, the machine can continue working. When the source of energy is removed, however, the machine will …15… stop. The machine stops …16… friction. …17… is the heat …18… due to moving objects in contact with each other. This principle is referred …19… as the first law of thermodynamics or the …20… , the law applies to …21… systems both large and small, and, again, it states that energy cannot be …22… or destroyed.

1. since; **2.** changed; **3.** form; **4.** system; **5.** amount; **6.** transferred; **7.** as; **8.** friction; **9.** generated; **10.** mass; **11.** source; **12.** Law of energy conservation; **13.** created; **14.** to; **15.** in; **16.** eventually; **17.** all; **18.** destroyed; **19.** man-made; **20.** nothing; **21.** universe; 22. due to.

Exercise 7. Answer the questions:

1. Can energy and matter change from one form to another?

2. What is chemical potential energy?,

3. What form is stored energy released in?

4. What is the phenomenon of conservation explained by?

5. What does the first law of thermodynamics state?

6. What is a system?

7. What is the largest system that we know of?

8. What system is called open?

9. What system is called a closed one?

10. Can any system expend more energy than it contains without receiving additional energy from an external source?

11. What is a perpetual motion machine?

12. How does the law of energy conservation help us explain why machines will stop working if no energy is put into the system?

13. The law of energy conservation applies to all matter and energy in every system, doesn't it?

Exercise 8. Retell the text.

Self-assessment test

Choose the correct answer.

1. Energy and matter … changing from one form to another

a) has; *b) was;* *c) do;* *d) are.*

2. Wood contains chemical potential energy , stored in the bonds that … the chemicals together.

a) hold; *b) held;* *c) holding;* *d) holds.*

3. This stored energy is released in the form of heat and light when the wood is … .

a) burn; *b) burned;* *c) burning;* *d) burns.*

4. Wood also contains matter, which is anything that … mass and takes up space (volume).

a) have; *b) has had;* *c) has;* *d) had.*

5. The matter within the wood is transformed into different matter, … ash and soot, as it burns.

a) is included; *b) included;* *c) including;* *d) includes.*

6. In other words, energy and matter are conserved … during and after the wood is burned.

a) second; b) both; c) two; d) another.

7. A lot of … are explained by what we call the law of energy conservation.

a) phenomenon; b) phenomena;
c)phenomenons; d) phenomen.

8. The law states energy … be created or destroyed.

a) can't; b) can; c) could; d) may.

9. Energy can … described as the ability to do work.

a) are; b) is; c) be; d) was.

10. Work is the movement of matter when a force is applied to ….

a) its; b) their; c) it's; d) it.

11. In order to better understand the law of energy conservation, we need to consider the fact … it applies to systems.

a) that; b) this; c) when; d) which.

12. A system is a collection of component parts that … up a whole.

a) makes; b) made; c) making; d) make.

13. The universe is … known system.

a) the largest; b) largest; c) large; d) larger.

14. A closed system is a system in … no matter or energy is allowed to enter or leave.

a) when; b) what; c) where; d) which.

15. The first law of thermodynamics tells us that the amount of energy within any closed system … change.

a) do; b) don't; c) doesn't; d) isn't.

16. An open system allows stuff to … in and go out.

a) come; b) comes; c) coming; d) came.

17. It's important to note, that the total mass and energy in our … remains constant.

a) universes; b) university; c) universal; d) universe.

18. In other words, the amount of energy in a system can change, but only if it comes from another system or goes to another system.

a) hold; b) held; c) holding; d) holds.

19. Systems … create or destroy energy.

a) are; b) does not; c) do not; d) is.

20. Energy that enters a system must … be stored there or leave.

a) either; b) neither; c) nor; d) or.

21. … you ever heard of a perpetual motion machine?

a) had; b) did; c) do; d) have.

22. A perpetual motion machine would continue to work without … input of energy

a) any; *b) no;* *c) some;* *d) anything.*

23. Every machine requires the continual input of energy in order to … working.

a) keep; *b) keeps;* *c) kept ;* *d) keeping.*

24. Any time a machine works, … energy is lost to what we call friction.

a) something; *b) no;* *c) some;* *d) anything.*

25. The law of energy conservation applies to … matter and energy in every system

a) whole; *b) each;* *c) every;* *d) all.*

Lesson 4. The Second Law of Thermodynamics: the Law of Entropy

Topical Vocabulary

additional	додатковий
automobile	автомобіль
begin	починати
boundary	межа
case	випадок
consume	споживати
convert	перетворювати
chaotic	хаотичний
dam	дамба
decrease	зменшувати
effort	зусилля
entropy	ентропія
eternal	вічний
existence	існування
expanse	простір, збільшення
experience	зазнавати, переживати, досвід
implication	залучення, причетність
increase	збільшувати
internal combustion engine	двигун внутрішнього згорання
invent	винаходити
kick	ударяти
level	рівень

location	розташування
man-made	штучний
natural	природний
object	предмет
occur	відбуватися
quality	якість
release	звільнення, відпускати
research	досліджувати, ретельний пошук
scale	зважувати, шкала, масштаб
scientist	вчений
single	один, єдиний
spontaneous	мимовільний
spread	поширювати
suggest	пропонувати
survive	вижити
vast	простір, величезний
wonder	запитувати себе, цікавитись

Національний університет
водного господарства
та природокористування

Read and translate the text

Second Law of Thermodynamics: Law of Entropy

Do you ever wonder how the universe came into existence? The Big Bang theory tells us that the universe began as an infinite amount of energy exploded and began to spread into the universe as we know it today. Alright, that's great, but what's energy? Energy is simply the ability to do work, and work is the movement of something by some force.

At the beginning of time, all the energy in the universe was contained in a single relatively small location. This intense concentration of energy represented a massive amount of what we call potential energy, where potential energy is stored energy due to its location or position, and it is now equal to the total amount of energy in the universe today. As time goes on, the energy has spread over the vast expanse of our universe.

On a much smaller scale, a reservoir of water held back by a dam contains potential energy, as its location gives it the potential to flow over the dam. In each case, the stored energy, once released, spreads out and does so without any applied effort or force. In other words, the release of potential energy is a spontaneous process. A spontaneous process is simply a process that occurs without the need for additional energy. Another way of putting that is that it happens automatically once you give it a little bit of a kick. As the energy spreads out, some of it is converted into usable energy and gets the work done that we need. The rest of the energy is converted into unusable energy, simply referred to as heat.

As our universe continues to spread out, it contains less and less useful energy. As less useful energy is available, less work can get done. As water flows over a dam, it contains less useful energy as well. This decrease in useful energy over time is referred to as entropy, where entropy is the amount of unusable energy in a system, and a system is simply a collection of objects that make up a whole.

Entropy can also be referred to as the amount of randomness or chaos in a system – less organization. As usable energy decreases over time, disorganization and chaos increase. Thus, as stored potential energy is released, not all of it is converted into usable energy. All systems experience this increase in entropy over time. This is very important to understand, and this phenomenon is referred to as the second law of thermodynamics.

As you may have guessed, the second law of thermodynamics follows the first law of thermodynamics, which is commonly referred to as the law of energy conservation, and it states that energy can't be created and it can't be destroyed. In other words, the amount of energy in the universe, or any system, is constant. The second law of thermodynamics is commonly referred to as the law of entropy, and it holds that energy becomes less usable over time. Therefore, while the quantity, based on the first law, of energy remains the same, the quality of energy decreases over time, based on the second law.

Application of the Second Law of Thermodynamics

How does understanding the second law of thermodynamics help us? The implications of the second law of thermodynamics are as extensive as the boundaries of our universe. The universe is constantly losing usable energy and becoming more chaotic – less organized. This would suggest that the universe is not eternal but rather has an end, both in space and time.

At a much smaller level, the springs of an old clock must be wound in order for the clock to tick and to tock. The wound springs contain a lot of stored potential energy, and that energy is used over time to make the clock work – that's what moves the hands of the clock. However, not all the potential energy is converted into usable energy. Some of that energy is lost in the form of heat – heat is unusable energy. If no one's available to wind up the clock, it won't be able to do any work again.

Let's now consider a biological example. Our bodies are systems. As long as we can consume energy, our bodies can do the work that's needed to survive and reproduce. Eventually, however, our bodies become less organized and more chaotic. Structure and function eventually give way to entropy. Nobody lives forever, and, just like the universe, our lives have an end.

However, scientists are constantly researching for ways to slow down entropy, both in man-made and natural systems. A good example of that is the internal combustion engine that makes our automobiles move. They're far more efficient now than they were when they were first invented.

Lesson Summary

The first law of thermodynamics reminds us that the amount of energy in a system is constant. It has been the same since the beginning of time. Energy can be changed from one form to another, but it cannot be created or destroyed. That's the first law.

The second law of thermodynamics tells us that entropy increases in a system as the potential energy is converted into usable energy for work. In other words, all systems, both natural and man-made, will eventually fall apart

Exercise 1. Translate the following word combinations.

1. come into existence; **2.** infinite amount of energy; **3.** to spread into the universe ; **4.** at the beginning of time; **5.** intense concentration; **6.** vast expanse of the universe; **7.** flow over the dam; **8.** without any applied effort; **9.** spontaneous process; **10.** the need for additional energy; **11.** a little bit of a kick; **12.** unusable energy; **13.** decrease in useful energy over time; **14.** make up a whole; **15.** randomness in a system ; **16.** the quantity of energy; **17.** quality of energy; **18.** the implications of the law; **19.** as extensive as the boundaries of our universe; **20.** the universe is eternal; **21.** both in space and time; **22.** a much smaller level; **23.** the springs of a clock; must **24.** tick and tock; **25.** the hands of the clock; **26** consume energy; **27.** to do the work that's needed to survive; **28.** become less organized; **29.** give way to entropy; **30.** live forever; **31.** like the universe; **32.** to like the universe; **33.** ways to slow down entropy; **34.** man-made and natural systems; **35.** the internal combustion engine .

Exercise 2. Match the synonyms.

A. 1. begin; **2.** great; **3.** tell; **4.** amount; **5.** movement; **6.** place; **7.** reservoir; **8.** additional; **9.** effort; **10.** take place; **11.** convert; **12.** quantity; **13.** commonly; **14.** total; **15.** go on; **16.** border; **17.** to be based; **18.** man-made; **19.** researcher; **20.** to do;

B. 1. change; **2.** occur; **3.** force; **4.** extra; **5.** container; **6.** quantity; **7.** state; **8.** exiting; **9.** motion; **10.** start; **11.** location; **12.** continue; **13**. whole; **14.** usually; **15.** amount; **16.** artificial; **17.** to be founded; **18.** boundary; **19.** to make; **20.** scientist.

Exercise 3. Match the antonyms.

A. 1. begin; **2.** infinite; **3.** simple; **4.** force; **5.** small; **6.** narrow; **7.** spread out; **8.** unusable; **9.** cold; **10.** larger; **11.** with; **12.** continue; **13.** less; **14.** useful; **15.** decrease; **16.** whole; **17.** order; **18.** spend; **19.** changeable; **20.** destroy; **21.** gain; 22. die; **23.** external; **24.** near; **25.** natural.

B. 1. massive; **2.** store; **3.** vast; **4.** smaller; **5.** without; **6.** usable; **7.** hot; **8.** finish; **9.** finite; **10.** complicated; **11.** weakness; **12.** chaos; **13.** increase; **14.** conserve; **15.** create; **16.** lose; **17.** survive; **18.** man-made; **19.** internal; **20.** far; **21.** stop; **22.** part; **23.** more; **24.** stable; **25.** useless.

Exercise 4. Choose the correct preposition.

1. At the beginning of time, all the energy … the universe was contained in a single relatively small location.

a) at; b) since; c) to; d) in.

2. Potential energy is stored energy due … its location.

a) at; b) since; c) to; d) in.

3. As time goes on, the energy has spread … the vast expanse of our universe.

a) over; b) since; c) to; d) from.

4. … each case, the stored energy spreads out without any applied effort or force.

a) in; b) for; c) to; d) on.

5. ... other words, the release of potential energy is a spontaneous process.

a) at; b) at; c) to; d) in.

6. Some of the energy is converted … usable energy.

a) with; b) into; c) to; d) in.

7. The decrease … useful energy over time is referred to as entropy.

a) with; b) into; c) to; d) in.

8. All systems experience this increase … entropy over time.

a) over; b) into; c) in; d) out.

9. The first law of thermodynamics is commonly referred … as the law of energy conservation.

a) with; b) into; c) to; d) in.

10. The implications of the second law of thermodynamics are as extensive … the boundaries of our universe.

a) among; b) as; c) for; d) from.

11. At a much smaller level, the springs of an old clock must be wound in order … the clock to tick and to tock..

a) from; b) for; c) till; d) as.

12. Some of the energy is lost … the form of heat.

a) with; b) into; c) to; d) in.

13. As long as we can consume energy, our bodies can do the work that's needed to survive and reproduce.

a) as; b) since; c) on; d) likewise.

14. Structure and function eventually give way … entropy.

a) with; b) into; c) to; d) in.

15. Scientists are constantly researching … ways to slow down entropy, both in man-made and natural systems.

a) at; b) for; c) before; d) to.

Exercise 5. Match the term to its definition.

1.	Energy	**1.**	the amount of unusable energy in a system.
2.	Work	**2.**	is the movement of something by some force.
3.	A system	**3.**	the ability to do work.
4.	Potential energy	**4.**	the amount of energy in the universe, or any system, is constant.
5.	A spontaneous process	**5.**	energy becomes less usable over time.

6.	Heat	**6.**	stored energy due to its location or position.
7.	Entropy	**7.**	a collection of component parts that make up a whole.
8.	The first law	**8.**	a process that occurs without the need for additional energy.
9.	The second law	**9.**	unusable energy.

Exercise 6. Answer the questions.

1. Do you know how the universe came into existence?

2. What does the Big Bang theory tell us about the beginning of the universe?

3. What's energy?

4. Where was all the energy in the universe contained at the beginning of time?

5. What do we call potential energy?

6. What process is called a spontaneous one?

7. What is heat?

8. Why does our universe contain less useful energy?

9. What is entropy?

10. What do we call a system?

11. When do disorganization and chaos increase?

12. The amount of energy in any system, is constant, isn't it?

13. What does the second law of thermodynamics state?

14. How does understanding the second law of thermodynamics help us?

15. Is it possible to convert all the potential energy into usable energy?

16. What are scientists constantly researching for?

Exercise 7. Look through the text concerning 4 laws of thermodynamics.

Thermodynamics states a set of four laws that are valid for all systems that fall within the constraints implied by each. In the various theoretical descriptions of thermodynamics these laws may be expressed in seemingly differing forms, but the most prominent formulations are the following:

• Zeroth law of thermodynamics: *If two systems are each in thermal equilibrium with a third, they are also in thermal equilibrium with each other.*

• The physical content of the zeroth law has long been recognized. For example, Rankine in 1853 defined temperature as follows: "Two portions of matter are said to have equal temperatures when neither tends to communicate heat to the other." Maxwell in 1872 stated a "Law of Equal Temperatures". By the time the desire arose to number it as a law, the other three had already been assigned numbers, and so it was designated the *zeroth law*.

• First law of thermodynamics: *The increase in internal energy of a closed system is equal to the difference of the heat supplied to the system and the work done by it:* $\Delta U = Q - W$

• The first law of thermodynamics asserts the existence of a state variable for a system, the internal energy, and tells how it changes in thermodynamic processes. The law allows a given internal energy of a system to be reached by any combination of heat and work. It is important that internal energy is a variable of state of the system whereas heat and work are variables that describe processes or changes of the state of systems.

• Second law of thermodynamics: *Heat cannot spontaneously flow from a colder location to a hotter location.*

• The second law of thermodynamics is an expression of the universal principle of dissipation of kinetic and potential energy observable in nature. The second law is an observation of the fact that over time, differences in temperature, pressure, and chemical potential tend to even out in a physical system that is isolated from the outside world.

• Third law of thermodynamics: *As a system approaches absolute zero the entropy of the system approaches a minimum value.*

The third law of thermodynamics is a statistical law of nature regarding entropy and the impossibility of reaching absolute zero of temperature. This law provides an absolute reference point for the determination of entropy. The entropy determined relative to this point is the absolute entropy. Alternate definitions are, "the entropy of all systems and of all states of a system is smallest at absolute zero," or equivalently "it is impossible to reach the absolute zero of temperature by any finite number of processes".

Exercise 8. Guess the number of the law and prove your answer.

1. The … law of thermodynamics is a version of the law of conservation of energy, adapted for thermodynamic systems. The internal energy of an isolated system is constant and energy can be transformed from one form to another, but cannot be created or destroyed.

2. The … law of thermodynamics states that the entropy of an isolated system never decreases, because isolated systems spontaneously evolve towards thermodynamic equilibrium – the state of maximum entropy. Equivalently, perpetual motion machines of the second kind are impossible.

3. The … law is an empirically validated postulate of thermodynamics, but it can be understood and explained using the underlying quantum statistical mechanics, together with the assumption of low-entropy initial conditions in the distant past.

4. The … law of thermodynamics is sometimes stated as follows: The entropy of a perfect crystal at absolute zero is exactly equal to zero.

5. The … law of thermodynamics states that if two systems are each in thermal equilibrium with a third system, they are also in thermal equilibrium with each other.

Exercise 9. Define four laws of thermodynamics.

Self-assessment test

Choose the correct answer.

1. The Big Bang … tells us that the universe began as an infinite amount of energy.

a) theory; *b) law;* *c) statement;* *d) truth.*

2. Work is the … of something by some force.

a) movement; *b) motion;*
c) move; *d) travel.*

3. At the beginning of time, all the energy in the universe was contained in a single … small location.

a) relatively; *b) relative;* *c) relatives;* *d) relation.*

4. Potential energy is stored energy due to its … or position.

a) location; *b) local;* *c) locality;* *d) localize.*

5. As time goes on, the energy has spread over the vast expanse of our … .

a) universe; *b) universal;* *c) university;* *d) unique.*

6. On a much smaller … a reservoir of water held back by a dam contains potential energy.

a) location; *b) scale;* *c) map;* *d) place.*

7. The stored energy, once released, spreads out and does so without any … effort or force.

a) application; *b) applied;*
c) apple; *d) apply.*

8. In other words, the release of potential energy is a … process.

a) chaotic; *b) spontaneous;*
c) chaos; *d) rule.*

9. A spontaneous process is simply a process that occurs without the need for … energy.

a) add; *b) additional;*
c) additive; *d) adjective.*

10. As the energy spreads out, some of it is converted into … energy.

a) useful; *b) usable;*
c) use; *d) useless.*

11. As our universe continues to spread out, it contains … useful energy.

a) lesser; *b) little;* *c) less;* *d) least.*

12. As water flows over a dam, it contains less useful energy as ... .

a) good; *b) will* *c) well;* *d) wells.*

13. This decrease in useful energy over … is referred to as entropy.

a) season; *b) period;* *c) time;* *d) years.*

14. Entropy is the … of unusable energy in a system,

a) mass; *b) weight;* *c) amount;* *d) quality.*

15. A system is a … of objects that make up a whole.

a) collective; *b) collect;* *c) collection;* *d) list.*

16. Entropy can also be referred to as the amount of … in a system.

a) collection; *b) order;* *c) knowledge;* *d) chaos.*

17. As usable energy decreases over time, disorganization and … increase.

a) collection; *b) order;* *c) knowledge;* *d) chaos.*

18. Not all of released potential energy it is converted into usable ….

a) amount; *b) stock;* *c) resource;* *d) energy.*

19. All systems experience this increase in entropy over time.

a) witness; *b) follow;* *c) oversee;* *d) experience.*

20. This … is referred to as the second law of thermodynamics.

a) *phenomena;* b) *phonetics;*
c) *phenomens;* d) *phenomenon.*

21. The second law of thermodynamics … the first law of thermodynamics.
a) *explain;* b) *moderate;* c) *follows;* d) *use.*

22. The first law of thermodynamics … that energy can't be created and it can't be destroyed.
a) *countries;* b) *towns;* c) *states;* d) *prove.*

23. In other words, the amount of energy in the universe … constant.
a) *will;* b) *be;* c) *is;* d) *were.*

24. The … law of thermodynamics holds that energy becomes less usable over time.
a) *next;* b) *the first;* c) *second;* d) *last.*

25. While the quantity of energy remains the same, the … of energy decreases over time.
a) *quality;* b) *amount;* c) *quality;* d) *range.*

26. The implications of the second law of thermodynamics … as extensive as the boundaries of our universe.
a) *were;* b) *are;* c) *was;* d) *is.*

27. The universe is constantly … usable energy and becoming more chaotic – less organized.
a) *loose;* b) *loosing;* c) *looking;* d) *lost.*

28. It is known that the universe is not .. but rather has an end, both in space and time.
a) *large;* b) *eternal;* c) *endless;* d) *special.*

29. … bodies are systems.
a) *we;* b) *our;* c) *us;* d) *them.*

30. However, scientists are constantly researching for ways to slow down entropy, both in man-made and … systems.
a) *artificial;* b) *natural;* c) *vital;* d) *usual.*