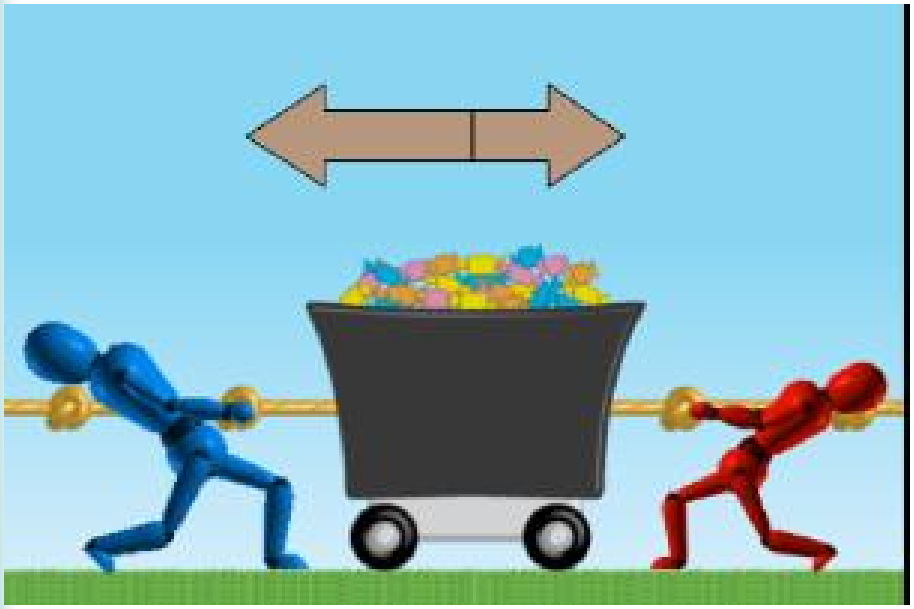
UNIT 5

FORCES



Activity I.

Learn the words and phrases

applied force – *прикладена сила*	surface – *поверхня*
balanced force – *зрівноважена сила*	tension – *розтягнення, пружність, напруга*
friction – *тертя*	time lag – *затримка в часі*
net force – *рівнодійна сила*	to exert – *напружувати , справляти (тиск)*
spring force – *сила пружності*	to involve – *втягувати, призводити до*
overall force – *сумарна сила*	to maintain – *підтримувати, зберігати*
beam – *промінь, пучок променів*	to suspend – *вішати, підвішувати*

Activity II.

Study the words and phrases. Translate the sentences paying attention to the words and phrases in bold.

***Power** (n)* 1) сила; міць 2) енергія; потужність 3) могутність, сила, влада 4) можливість 5) право, повноваження 6) держава 7) двигун, машина 8) *мат.* степінь; порядок (*кривої*) 9) *опт.* сила збільшення; 10) продуктивність	***Power (v)*** 1) пускати в хід *або* рух; 2) служити привідним двигуном; 3) оснащувати силовим двигуном; 4) живити (*електро*) енергією; 5) підтримувати; надихати ***Powered** (adj)* **–** механізований ***Powerful** (adj)* – сильний, потужний ***Powerless** (adj)* – кволий, слабкий

ЗАПАМ'ЯТАЙ!

Українському іменнику сила відповідають англійські power, energy, force, might, strength, vigour. Найбільш загальне значення має ***power;*** *такі ж відтінки має* ***energy;*** *Слово* ***force*** *означає сила для здолання опору, протидії;* ***might*** *– міць;* ***strength*** *- пасивна сила;* ***vigour*** *- фізична або розумова сила (для живих істот або живої природи)*

electric power – електроенергія
supernational powers – надприродні сили
to come to power – прийти до влади
stopping power – гальмуюча здатність
electrical power factor – коефіцієнт потужності
nuclear power – атомна енергія
the power of wind – сила вітру
healing power – лікувальні можливості
mean power – середня потужність

Activity II.

Study the words and phrases. Translate the sentences paying attention to the words and phrases in bold.

1. They are threatening to use military **power** to resolve the conflict. 2. The president was removed from **power** in the recent uprising. 3. It's in your **power** to change the way things are done here. 4. The Sun' s energy **powers** these forests for half of the year 5. He's studying the healing **powers** *of* various plants. 6. The car's engine yields more **power** while using less fuel. 7. Do you know how many watts of **power** your refrigerator uses per day? 8. He lost the **power** of thinking or understanding. 9. Nuclear **power** plants are dangerous, not to mention nuclear weapons. 10. He needed a lot of **power** to hit the ball out of the stadium.11. After the pylons collapsed, this town was without **power** for a few days.12. If you're struggling to pay your **power** bill, we can help! 13. The **power** supply cord or plug has been damaged. 14. The good thing is that we are not **powerless**. 15. He is in a **power** save mode. 16. Eighty-three percent of household lamps are now **powered** by solar energy.

Activity III.

Insert the right word*: power, strength, force, might, vigour*

1. Do you have … to run 10 kilometres? 2. That motor doesn't have enough … . 3. The … of tsunami destroyed hundreds of houses last year. 4. You have to push the door with all your … to open it. 5. … is an interaction between two bodies that maintains or changes the motion of a body. 6. The … of a permanent magnet can be expressed in the same terms as that of an electromagnet. 7. The … of the ocean has inspired many artists. 9. Examples of direct contact … include the friction of car tires on a road, or the air resistance on a moving car. 10. With renewed … the chorus began again. 11. The … of the ocean has inspired many artists.

$$\text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Force} \cdot \text{Displacement}}{\text{Time}}$$

$$\text{Power} = \text{Force} \cdot \frac{\text{Displacement}}{\text{Time}}$$

$$\boxed{\text{Power} = \text{Force} \cdot \text{Velocity}}$$

Activity IV.

Read and translate the text:

Every day we are using forces. A force is basically push and pull. When you push and pull you are applying a force to an object. A force can change the shape, size, speed and direction of an object. A force can even stop a moving object. For an example when a ball is coming your way and then you push it away. The motion of the ball is changed because you applied a force. Force is a vector quantity which means it has both magnitudes as well as direction. Forces can be either **contact** or **non-contact**. Contact force is a force which is applied by actually touching the body.

There are different types of contact forces - normal force, friction, applied force, air resistance, and tension.

- the ***normal force*** is exerted on an object by any surface with which it is in contact. The adjective normal means that the force always acts perpendicular to the surface of contact, no matter what the angle of that surface.
- the ***friction force is the force*** that resists the sliding or rolling of one object over another. It can be helpful and it allows you to let you walk without sliding. The heavier an object is the more friction it has.
- the ***tension force*** occurs when objects are stretched. Tension usually happens in ropes, cables, strings and chains.
- the ***air resistance force*** acts upon objects as they travel through the air. This force opposes the motion of the object in the air.
- the ***spring force*** is the force exerted by a compressed or stretched spring upon any object which is attached to it. Here the magnitude of the spring force is directly proportional to the amount of stretch or compression of the spring.
- the ***applied force*** is when someone is applying a force to an object, for example a person pushes the car. The applied force is the force exerted on the car by the person.

Activity IV.

Read and translate the text:

Non contact force is present in our daily lives and can be experienced in many aspects. It acts on the physically separated objects and differs from the contact force in the sense that physical contact is not involved here. It is interesting to note that origin of all contact forces can be traced to non-contact forces. The examples of non-contact forces are gravitational force, electric force, magnetic force.

Similarities:

- Both contact and non contact forces can be represented by vectors
- Both involve attraction between the objects

Differences:

Considering the size and the direction of all the forces acting on an object allows you to predict changes in the object's motion. When more than one force acts on an object, the result is a cumulative effect of all those forces. The overall force acting on an object when all the forces are combined is called the ***net force***. If the net force on an object is zero, the forces acting on the object are balanced.

Contact Forces	Non contact Forces
Force arises due to the contact between two different objects	Force arises due to the attraction between two objects there is no contact between the objects
This force takes immediate effect after the applied force	There is a time lag between the applied force and the effect of this force
There is no field associated with a contact force.	There is always a field associated with a non-contact force

Activity IV.

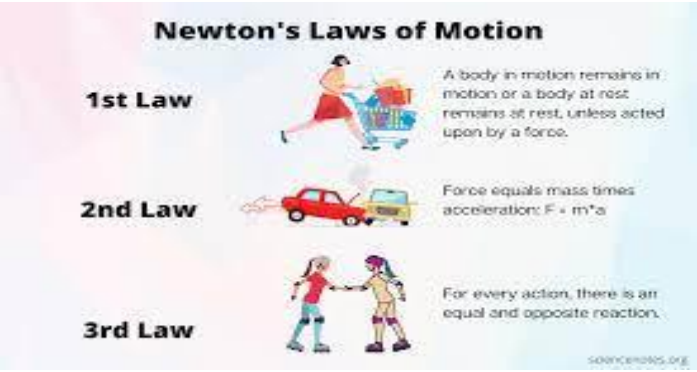
Read and translate the text:

Balanced forces are equal in size and opposite in direction. That is, the motion of the object does not change. For example, a diver standing on a diving platform is affected by different forces. Gravity pulls the diver down towards the pool, but the diving platform pushes him up. These two forces balance each other and as a result, the diver stays on the platform. If the diver steps off the end of the platform, however, the force of the platform no longer balances the force of gravity. The ***unbalanced force*** causes the diver to accelerate into the water. Only an unbalanced force can change the motion of an object.

Newton's laws

Newton's laws of motion are three physical laws which provide relationships between the forces acting on a body and the motion of the body. The laws form the basis for classical mechanics and Newton himself used them to explain many results concerning the motion of physical objects.

Newton's laws are a set of physical doctrines that describe the motion of objects as well as the field of classical mechanics. They have completely changed mankind's understanding of the universe.



Activity IV

Newton's first law of motion (usually called the law of inertia):

Every object or body continues to be in its state of rest or of motion unless acted upon by an external unbalanced force. This is universally used as a definition of inertia. If there is no net force resulting from unbalanced forces acting on an object (if all the external forces cancel each other out), the object will maintain a constant velocity. This object will remain at rest if this velocity is zero. If an additional external force is applied, the velocity will change.

Newton's second law of motion:

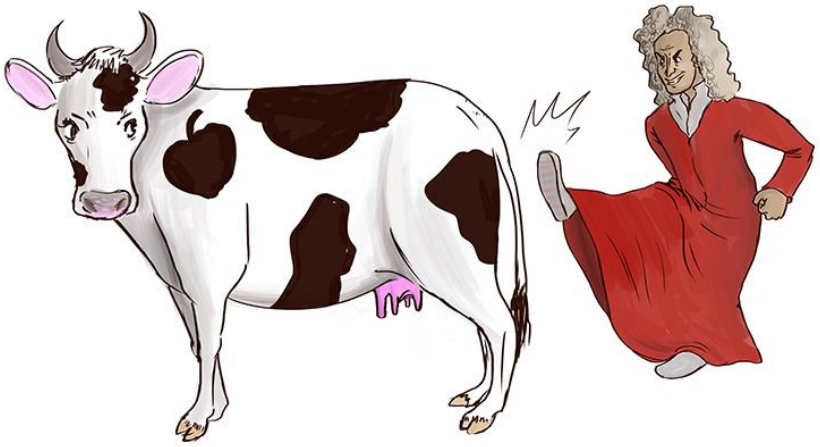
The rate of change of momentum of a body is equal to the force applied to that body, and is in the direction of the force. The acceleration of an object is directly proportional to the force applied to that object, in the direction of the force. This law is expressed by the equation,

F = ma where '**F**' stands for the net force that is acting on an object. If this body of mass '**m**' has an acceleration '**a**' (change in velocity with time), then the net force '**F**' acting upon that object is the product of its mass and acceleration. This body also undergoes acceleration during its movement. In simpler words, the acceleration produced by a particular force acting on a body is directly proportional to the magnitude of the force, and inversely proportional to the mass of the body.

Newton's third law of motion:

Every action has an equal and opposite reaction. In other words, the mutual actions of two bodies upon each other are always equal, and are directed to their contrary parts. If a force is applied by an object 'X' upon another object 'Y', then the latter will also exert an equal and opposite force on the former one. When a shooter fires his gun, he experiences a sudden recoil of the gun. This 'kick' felt by the shooter is the reaction force, which acts upon the firearm. This force is equal in magnitude to the force that pushes forward the bullets.

HOW TO REMEMBER NEWTON'S LAWS OF MOTION



Here's an easy way to remember Newton's three laws of motion:

1st Law

One day Newton was walking by a field when he saw a cow grazing.

He kicked the cow and because it hurt her (inertia) she walked a few metres.

With this he concluded:

A thing will not change its state of motion or rest unless an external force acts on it.

HOW TO REMEMBER NEWTON'S LAWS OF MOTION

2nd Law

He kicked the cow again and the cow screamed MAAAAA.

With this he concluded:

A force applied is equal to mass times acceleration.

$$F = ma$$

HOW TO REMEMBER NEWTON'S LAWS OF MOTION

3rd Law

Newton kicked the cow for a third time, but this time the cow kicked Newton back with an equal and opposite force. And then kicked him with the other leg to remind you that in every interaction forces are found in pairs.

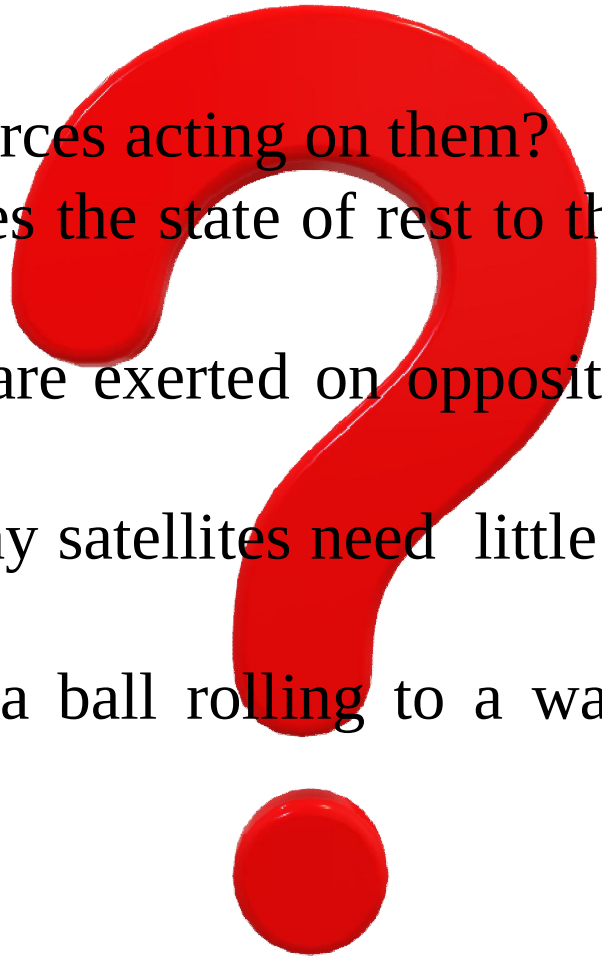
With this he concluded:

For every action, there is an equal and opposite reaction. In every interaction, forces are found in pairs.

Activity V.

Answer the questions:

1. What is a force? Can you name 5 different forces?
2. What is the main difference between contact and non-contact forces?
3. How do forces affect motion?
4. How do things move if there are no forces acting on them?
5. How do we call a force which changes the state of rest to the state of motion of an object?
6. What happens when unequal forces are exerted on opposite sides of an object?
7. Which of Newton's Laws explains why satellites need little fuel to stay in orbit?
8. Which of Laws is demonstrated by a ball rolling to a wall then stopping?
9. What is the net force?
10. What is inertia?



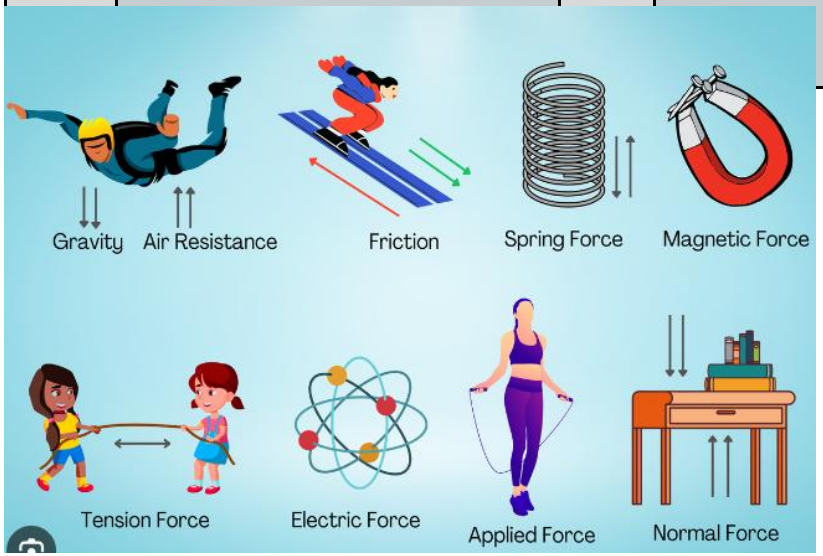
Activity VI.

Decide whether each of the following statements is 'true' or 'false'

1. When a force is applied on the object it cannot bring about a change in the shape of an object.
2. The magnetism is the force with which the earth, moon, or other massively large object attracts another object towards itself.
3. All objects upon earth experience a force of gravity that is directed "upward" towards the center of the earth.
4. A normal force is exerted vertically between two objects that are in contact with each other.
5. The force of air resistance is often observed to oppose the motion of an object.
6. The tension force is directed along the length of the wire and pulls equally on the objects on the opposite ends of the wire.
7. If a person is pushing a desk across the room, then there is a normal force acting upon the object.
8. A force which is not opposed by a force of equal magnitude and acting in the exact opposite direction hence leading to motion of object is called unbalanced force.
9. Unbalanced forces lead to acceleration of an object.
10. The magnitude and direction of the net force does not affect the resulting motion.
11. An object that is not accelerating or decelerating has no net forces acting on it.
12. A stationary object has no forces acting on it.
13. The only way to slow down a moving object is to apply a net force to it.
14. When an object is stationary, all of the forces acting on it are balanced.

Activity VII. *Match the definitions with words:*

1.	centripetal force	a.	the frictional force on two bodies in motion relative to one another
2.	kinetic frictional force	b.	the frictional force on two bodies at rest
3.	static frictional force	c.	the force, directed toward the center of a circle, which causes uniform circular motion
4.	tension force	d.	the force felt by a rope or cable that transmits another force
5.	frictional force	e.	the force caused by two bodies in direct contact that is perpendicular to the plane of contact
6.	normal force	f.	the force caused by the electrical interaction between two bodies in direct contact that is parallel to the plane of contact and in the opposite direction of the motion of one object relative to the other.

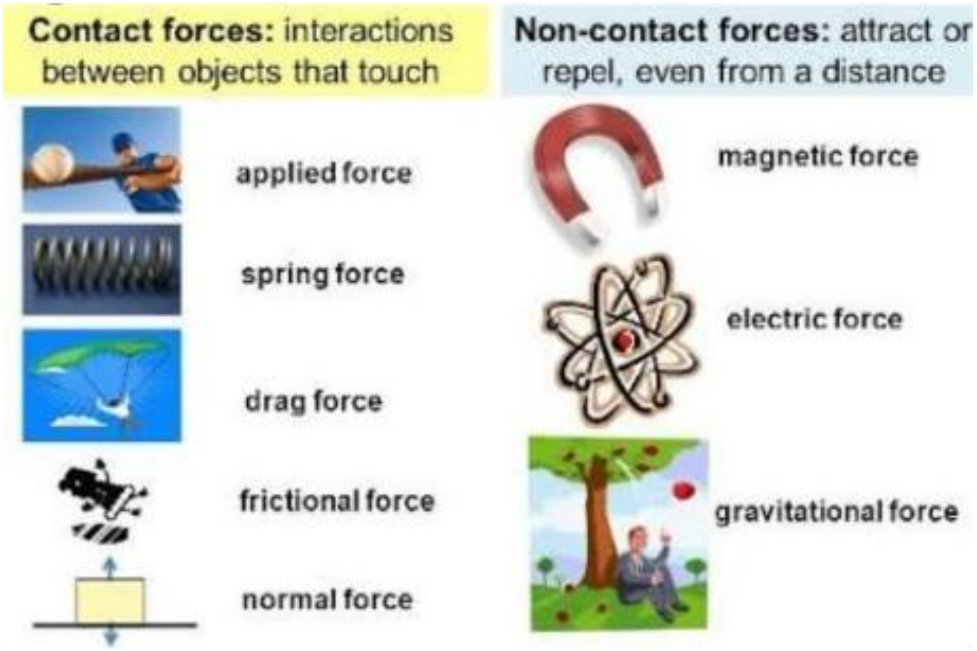


ACTIVITY VIII.

Whenever there is an interaction between two objects, there is a force acting upon each of the objects. When the interaction ceases, the two objects no longer experience the force. Forces only exists as result of an interaction. In the following situations, identify the agent exerting the force and the object on which it acts. State the effect of the force in each case.

№	Situation	Agent	Object	Effect
1.	Squeezing a piece of lemon between the fingers to extract its juice			
2.	Taking out paste from a toothpaste tube			
3.	A load suspended from a spring while its other end is on a hook fixed to a wall			
4.	An athlete making a high jump to clear the bar at a certain height			

Decide what type of forces are applied in the following examples:



- ☐ A person is pushing a desk across the room
- ☐ Hitting a ball with a bat
- ☐ A goalkeeper saving a goal
- ☐ Hockey player flicking a ball
- ☐ Free fall of feather towards earth
- ☐ A skydiver
- ☐ Falling of rain drops on earth
- ☐ Iron pins being attracted when in the vicinity of a magnet without any physical contact.

Activity X.

Choose the correct answer:

1. A wagon is being pulled in a straight line. The forces exerted on the wagon are balanced. The wagon …
a. speeds up. b. slows down. c. moves with a constant speed.
2. A wagon is being pulled in a straight line. The forces exerted on the wagon are unbalanced in the direction opposite to its motion. The wagon …
a. speeds up. b. slows down. c. moves with a constant speed.
3. A ball is rolling to the east. It is given a quick kick to the north. After the kick the ball
a. keeps rolling to the east. b. rolls only to the north c. keeps rolling but changes its direction.
4. You push a box on a smooth, smooth ice rink. Imagine the ice is frictionless. Which statement is true
a. the box speeds up. b. the box moves at a constant speed. c. the box slows down.
5. A change to an objects motion is caused by...
a. balanced forces b. unbalanced forces c. acceleration
6. A force is described as...
a. a push only. b. a pull only. c. a push or a pull.
7. The amount of force needed to move an object is measured in...
a. Newtons b. grams c. seconds
8. Which of Newton's Laws describes the amount of force applied to accelerate an object's mass?
a. newton's first law b. newton's second law c. newton's third law
9. Why is it difficult to scoot a bed from one end of the room to the other
a. deceleration b. friction c. gravity
10. What is inertia?
a. the opposing force of gravity b. another name for unbalanced forces
c. the tendency of an object to continue doing what it is currently doing.

Activity XI.

Pay attention to the following facts:

1. At first, young Newton was not very good in his studies. One day, he was beaten by a school bully in his class. Enraged, he challenged that boy in a fight and won. But, young Newton was still not satisfied with this, he wanted to teach him a lesson in the academic field as well and so he focused more on his studies. This was an important moment in Newton's life as it set the foundation for his future academic success and historic discoveries.
2. Newton wrote more about religion and the Bible than about astronomy, mathematics or physics. He studied the Bible mainly to extract scientific information. In 1704, Newton wrote a manuscript, which contained different scientific notes based on the Holy Bible. One of his most fascinating observations in the manuscript was a prediction that Earth will end in 2060!
3. One of the interesting facts about Sir Isaac Newton is his deep interest in Alchemy. He wrote around 169 books dealing with this mysterious science and its characteristics. He also experimented with alchemy using various elements like lead and mercury. Isaac Newton's aim was to find the Philosopher's Stone and the Elixir of Life through his experiments. During his experiments, Newton suffered from lead poisoning during his alchemical experiments!
4. During his college years, Isaac Newton was more interested in the concepts of modern astronomers and thinkers such as Kepler, Galileo, and Copernicus than what was taught in the college's curriculum, The college's teachings were mainly based on Aristotle's ideas and teachings.
5. It was seen that, a majority of discoveries were made by Newton in his early to mid-twenties, but weren't published until many years later. Many arguments resulted because of this action.
6. The first flight to Moon was possible only because of Newton's profound discoveries about the movement of planets and the speed of light.

Activity XII.

Find English equivalents

directly proportional _____

acceleration produced by a particular force _____

to remain at rest _____

external force _____

equal forces _____

mercury _____

the vector sum of all the forces _____

stationary objects _____ _____

frictionless _____

Activity XIII.

Find Ukrainian equivalents:

коефіцієнт пропорційності _____

зовнішня сила _____

рівнодійна діючих сил _____

сила прикладена до тіла _____

інерційні властивості об'єкта _____

під дією сили_____

інерціальні системи відліку _____

кінцеве прискорення _____

сумарна сила _____

Activity XIV.

Applications of law:

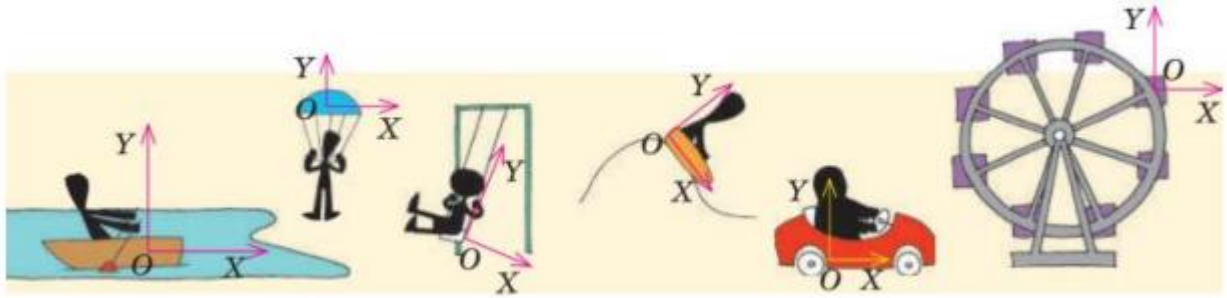
1^{st} law	2^{nd} law	3^{rd} law

- ☐ A soccer ball will not move until a player kicks it
- ☐ If air is let out of a balloon quickly, air pushes down & balloon goes up
- ☐ It takes less force to push a bike than a motorcycle
- ☐ In a plane taking off you feel pushed back into your seat
- ☐ Someone crashes their bike into a rock & is thrown over it to the ground

Activity XV.

***Translate into English*:**

1. Всяке тіло зберігає стан спокою або рівномірного прямолінійного руху до тих пір, поки дія інших тіл не виведе його із цього стану. 2. Дві матеріальні точки діють один на одного з силами, які числено рівні і направлені в протилежні сторони вздовж прямої, яка з'єднує ці точки. 3. Однаковий вплив по-різному змінює рух різних тіл. 4. Однакова дія приводить до різного прискорення різних тіл. 5. Під дією сили тіло змінює свою швидкість не миттєво, а поступово, тобто здобуває кінцеве прискорення, яке тем менше, чим більше маса. 6. Здатність тіла зберігати свою швидкість називається інертністю. 7. Інерціальні системи відліку відіграють особливу роль не тільки в механіці, але й в інших розділах фізики, тому що згідно із принципом відносності Ейнштейна математичний запис будь-якого фізичного закону повинен мати той самий вид у всіх системах відліку. 9. Неінерціальними системами є системи, що рухаються прямолінійно з прискоренням відносно інерціальних систем (кабіна ліфта, ракета) або обертаються (карусель, Земля).



WORD STUDY

1W. Learn the following speech patterns. Make your sentences with the following patterns

A.

1) None of us knew **whether or not** there would be a meeting.
2) She is in doubt **whether or not** to accept a new job.
3) You'll stay here **whether you like** it or not.

B.

1) Some people do not have confidence **when using** computers.
2) He often feels sleepy while watching TV or **after eating** a meal.
3) She is a terror **when roused**.
4) **When shaped** the diamond should be faceted.

2W. Match the antonyms.

Verbs		Nouns	
1. increase	a. keep	1. wholesale	a. vendor
2. push	b. sell	2. shrinkage	b. retail
3. buy	c. go up	3. customer	c. likeness
4. drop	d. decrease	4. subscriber	d. growth
		5. distinction	e. publisher

WORD STUDY

3W. Study the pattern and translate the sentences:

Виділювальна конструкція It is .... that служить для виділення окремих членів речення:

It is/was ... that/when/who/whom ...

It was the first experiment *that* was successfully performed.

Це був перший успішно проведений експеримент.

It was that chance *that* gave them the opportunity to show the positive results.

Саме це шанс дав їм можливість показати позитивні результати.

1. It is with the help of the radio that we get the news. 2. It was the Ukrainian scientist who created a car that runs on compressed air. 3. It was Einstein who gave a new conception of time, space and gravitation. 4. It was his brother who received an award from the European scientific and industrial chamber. 5. It was yesterday when we discussed the plan. 6. It is the force of gravity that keeps the planets around the sun. 7. It was last week when we performed the experiment. 8. It was Einstein who gave a new conception of time, space and gravitation. 9. It is in this article that you will find the necessary data. 10. The work was difficult, and it was only due to your help that I could finish it.

WORD STUDY

4W. Choose the correct word and fill in the blanks:

(to) improve improvement

1. Your work shows considerable … .
2. I would like to … my German.
3. Your English is getting better, but there is still room for … .

(to) benefit beneficial

1. He had the …. of a first-class education.
2. The fall in prices will be …. to our business.
3. He is most likely …

technology technological technologist

1. The system uses advanced …. computer and satellite .
2. We witness the rapid …. pace of change.
3. A specialist in technology is called … .
4. We use the latest … .

5W. In the sentences below complete each word with a prefix chosen from thefrom the following list: de- re- un-post -mal-- dis-over- mis-pre

1. We hope the bus won't be……rowded. 2. The proposal for the new bridge is …. acceptable. It is turned down.3. The phone company will …. connect your telephone soon. You didn't pay your phone-bill. 4. Do you think the mayor will be …. elected for a second time? 5.The province was …. populated after the war. 6. After he got a Ph.D. in Chemistry, he did ...doctoral work at Oxford University. 7.The author was angry because he was …. quoted in the newspaper. 8. He took ...cautions against burglary by installing an alarm. 9. No compromise was reached. The discussion ended up with most people in …. agreement. 10. The tourist guide promised the tourists that they would get a ……fund if they did not like the trip.11. You have …. spelled too many words.12. He added a…... script at the end of the letter.

Text 1

ADDITIONAL READING PASSAGE

Everyday Applications of Newton's First Law

There are many applications of Newton's first law of motion. Have you ever observed the behavior of coffee in a coffee cup filled to the rim while starting a car from rest or while bringing a car to rest from a state of motion? Coffee "keeps on doing what it is doing." When you accelerate a car from rest, the road provides an unbalanced force on the spinning wheels to push the car forward; yet the coffee (that was at rest) wants to stay at rest. While the car accelerates forward, the coffee remains in the same position; subsequently, the car accelerates out from under the coffee and the coffee spills in your lap. On the other hand, when braking from a state of motion the coffee continues forward *with the same speed and in the same direction*, ultimately hitting the windshield or the dash. Coffee in motion stays in motion.

Have you ever experienced inertia in a car while it is breaking to a stop? The force of the road on the locked wheels provides the unbalanced force of the road on the locked wheels provides the unbalanced force to change the car's state of motion, yet there is no unbalanced force to change your own state of motion. Thus, you continue in motion, sliding along the seat in forward motion. A person in motion stays in motion with the same speed and in the same direction ... Unless acted upon by the unbalanced force of a seat belt. Yes! Seat belts are used to provide safety for passengers whose motion is governed by Newton's laws. The seat belt provides the unbalanced force that brings you from a state of motion to a state of rest. Perhaps you could speculate what would occur when no seat belt is used.

Blood rushes from your head to your feet while quickly stopping when riding on a descending elevator. The head of a hammer can be tightened onto the wooden handle by banging the bottom of the handle against a hard surface. A brick is painlessly broken over the hand of a physics teacher by slamming it with a hammer. To dislodge ketchup from the bottom of a ketchup bottle, it is often turned upside down and thrusted downward at high speeds and then abruptly halted.

UNIT VI

GRAVITATION

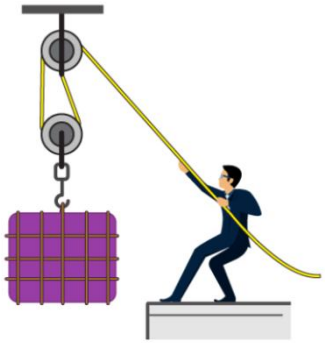
Activity I.

Learn the words and phrases

attractive force – *сила тяжіння*	free fall – *вільне падіння*
conclusion – *висновок*	downward – *спрямований вниз*
gravitational fields – *гравітаційні поля*	upward – *спрямований вниз*
gravitational force – *гравітаційна сила*	tide – *морський приплив, відлив*
gravitational constant – *гравітаційна стала*	mutual attraction – *взаємне тяжіння*
directly proportional – *прямопропорційний*	straight-line distance – *відстань по прямій*
inversely proportional – *оберненопропорційний*	to exert a gravitational pull – *притягувати*

Activity II.

Study the words and phrases. Translate the sentences paying attention to the words and phrases in bold.

Force *(n)* 1) сила, міць 2) дієвість; дійсність 3) насильство, примус 4) збройний загін; (військове) з'єднання; (the Force) поліція; (*pl*) війська; збройні сили 5) смисл, резон; значення 6) *фіз*. зусилля, сила	***Force*** *(v)* 1) змушувати, примушувати 2) застосовувати силу, брати силою; 3) насилувати, силувати; 4) робити (що-небудь) через силу; перенапружувати 5) прискорювати (крок, хід) 6) тех. нагнітати, форсувати (режим роботи); ***Forced*** *(adj)* 1) примусовий 2) форсований 3) змушений 4) штучний 

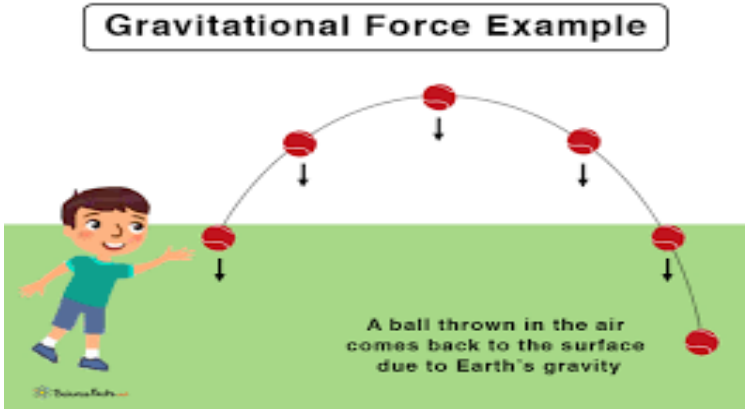
ЗАПАМЯТАЙ!

1) to come to force – *прийти до сили;*
2) to exert force – прикладáти сúлу
3) composition of forces – *векторна сума сил*
4) centrifugal force – *доцентрова сила*
5) electromotive force – *напруга*
6) weak force carrier particle – *квант слабкого поля*
7) weak force – *слабка взаємодія*
8) to distribute force – *розподіляти силу*

Activity II.

Study the words and phrases. Translate the sentences paying attention to the words and phrases in bold.

1.The **force** of gravity is invariably distributed throughout the volume of a body. 2. Don't **force** your idea on others. 3 Physicists use the newton, a unit of the International System (SI), for measuring **force**. 4. The plane had to make a **forced landing** because one of the engines failed. 5. The new driving regulations are going **to be brought into force** later this year. 6. Treaties signed by the State and **in force** are part of the national law. 7. This unification model predicts the existence of these two new **force** particles, which should act a lot like the weak **force**, only weaker. 8. First of all, walking across hot coals doesn't take **force** of mind, it takes **force** of physics. 9. I forgot my key, so I had **to force** a window. 10. The army has seized power **by force**.



Activity III.

Read and translate the text:

There is a popular story that Newton was sitting under an apple tree, when the fall of an apple, on his head, made him sit down and think. It was this thinking that led him to the Universal Law of Gravitation. Newton, upon observing an apple fall from a tree, might have started thinking along the following lines: the apple had been accelerated, since its velocity had hanged from zero (when it was hanging on the tree) and had attained a definite finite value when it hit the ground. By Newton's second Law, there must be a force that had acted on the apple and caused it to get accelerated. Let's call this force "gravity", and the associated acceleration the "acceleration due to gravity". Now imagine an apple tree that is twice as high. Again, we expect the apple to be accelerated toward the ground, so this suggests that this force, that we have called gravity, reaches to the top of the tallest apple tree.

Sir Isaac's Innovative Idea

It was here that the world got to witness Newton's truly brilliant insight: if the force of gravity reaches to the top of the highest tree, might it not reach even farther; in particular, might it not reach all the way to the orbit of the Moon! Then, the orbit of the Moon, about the Earth, could be a consequence of the gravitational force; the acceleration due to this force could change the velocity of the Moon in just such a way that it followed an orbit around the earth. To calculate the force of gravity on the Moon, one must also know how much weaker it was at the Moon's distance.

Activity III.

Read and translate the text:

Newton showed that if gravity at a distance R was proportional to 1/R (varied like the "inverse square of the distance"), then the decrease in the acceleration, due to this force, compared to its value (g) measured at the Earth's surface, would indeed correctly predict the orbital period T of the Moon. Newton went further and proposed that the force of gravitation (gravity) was a "universal" force, and that it is the Sun's gravity that 'hold's the planets in their orbits. He was then able to show that Kepler's laws were a natural consequence of this "inverse square law". Today all calculations, of the orbits of planets and satellites, are based essentially on it.

$$F = m \times a$$

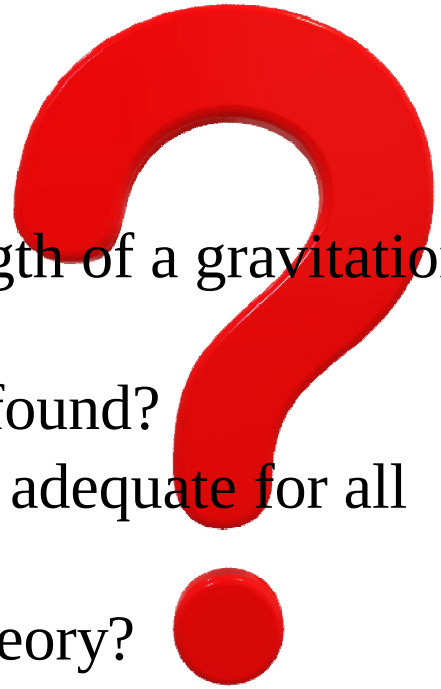
Newton's Universal law of gravitation

Sir Isaac Newton compared the acceleration of the moon to the acceleration of objects on earth. Taking the gravitational forces as the basic cause in each case, Newton was able to draw an important conclusion about the dependence of the force of gravitation upon distance. This comparison led him to conclude that the force of gravitational attraction, between the Earth and other objects, is inversely proportional to the distance separating the earth's center from the object's center. However, distance is not the only variable affecting the magnitude of a gravitational force. Consider Newton's famous equation

Activity IV.

Answer the questions:

1. What is gravity?
2. What causes gravity?
3. Why isn't there gravity in space?
4. In what way do physicists characterize the strength of a gravitational field?
5. How can the strength of a gravitational field be found?
6. Is Newton’s mathematical description of gravity adequate for all gravitational fields?
7. What is one of the predictions of the General Theory?
8. Have gravitational waves been detected?
9. What law suffices for calculating gravitational forces in most situations?
10. What is the weight of a 40kg child on the Earth?



Activity V.

Decide whether each of the following statements is 'true' or 'false'

1.Some objects in the universe that have mass exert a gravitational pull, or force, on every other mass.

2. The Moon's gravitational pull keeps our planet **orbiting** the Sun.

3. The earth's gravity is a long distance force which reaches far into space and keeps satellites in orbit.

4. The moon has less amounts of gravity then the earth does so if you were to go on the moon you would bounce and float rather than walk.

5. Free fall is motion in the Earth's gravitational field when different forces act on the object.

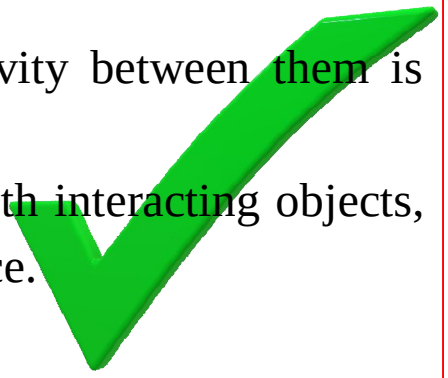
6. When your weight or height increase or decrease your body mass changes shape.

7. All objects fall towards the earth with a constant acceleration due to the gravitational pull of the Sun.

8.If we lived in a world where there was no air resistance, the A4 sheet of paper and the tennis ball would reach the ground at the same time.

9. If the mass of both of the objects is doubled, then the force of gravity between them is quadrupled;

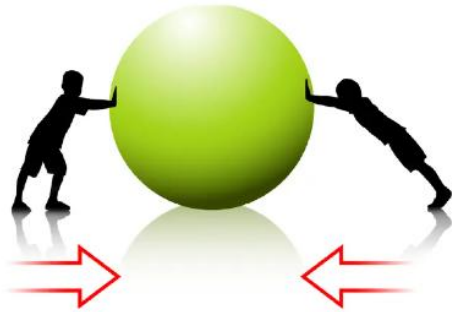
10. Since the gravitational force is directly proportional to the mass of both interacting objects, more massive objects will attract each other with a greater gravitational force.



Activity VI.

Match the definitions with words:

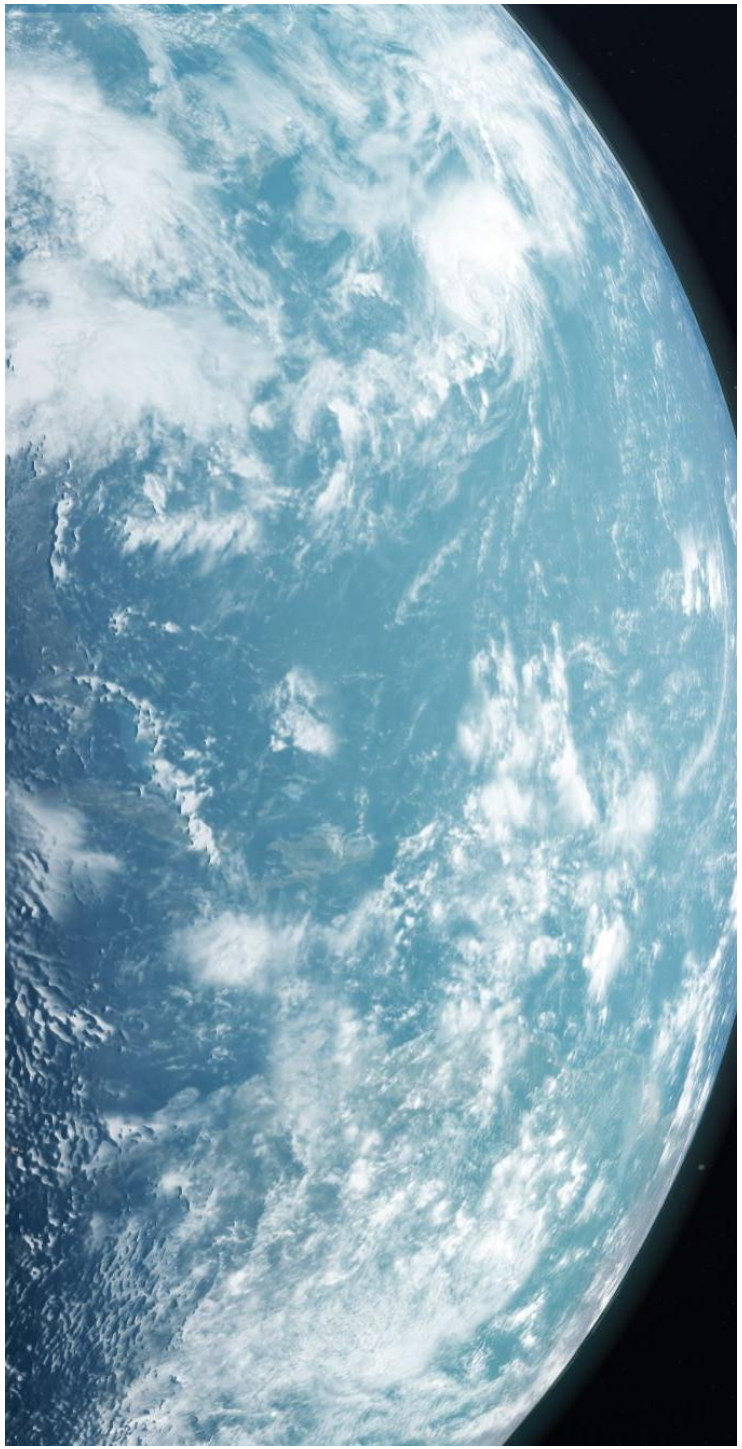
1.	mass	a.	is a region of space in which a mass experiences a force.
2.	weight	b.	is a region of space in which a mass experiences a gravitational force.
3.	weightlessness	c.	is motion in the Earth's gravitational field when no other forces act on the object.
4	tide	d.	the mutual attraction between all masses in the universe.
5.	gravitation	e.	the quantity of matter contained in a body is called its mass.
6.	free fall	f.	the force with which a body is attracted towards the center of the earth
7.	gravitational field	g.	the state when the apparent weight of a body becomes zero
8.	field	h.	the periodic rise and fall of the sea level under the gravitational pull of the moon



ACTIVITY VII.

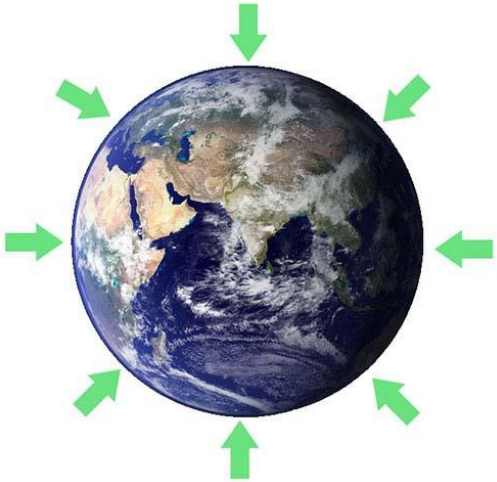
PAY ATTENTION TO THE FOLLOWING FACTS:

1. Of all the four fundamental forces - the electromagnetic force, the gravitational force, the strong force, and the weak force - gravity is the weakest.
2. Magnets can both attract and repel, but gravity only works in one direction. It compels massive objects to come together but cannot be reversed to force them apart.
3. Gravity isn't evenly spread on Earth. This is because Earth isn't a perfect sphere. The mass of Earth also isn't even. This means that gravity can vary slightly in different places.
4. In the whole universe, black holes have the biggest gravitational pull.
5. In the absence of gravity, the Sun would throw hot gases, and within a few minutes, it would just explode, destroying the whole Solar System.
6. Fishes also use the gravitational pull of the Earth to remain below the water's surface. Fishes' heads have calcium carbonate deposits pulled down by gravity and help them remain underwater.
7. Because Mars has a lower gravity than Earth, a person weighing 200 pounds on Earth would only weigh 76 pounds on Mars.
8. As astronauts stay in space, they grow taller by 2 in (5.08 cm) due to the lack of gravity. However, as they return to Earth, they are back to normal size as the Earth's gravity reverses the growth.
9. The highest known acceleration voluntarily experienced by a human is 46.2 g by g-force pioneer John Stapp.
10. In zero gravity, a candle's flame is round and blue.



Activity VIII.

Choose the correct answer:



1. What is gravity?

a) Newtons first law
b) the force that objects exert on each other because of their masses
c) the downward pull on the Earth
d) the friction that an object has put on it

2. The force of gravitation exists

everywhere in the universe
on the surface of earth only
inside the earth only
up to the surface of moon only

3. An astronaut on the Moon simultaneously drops a feather and a hammer. The fact that they land together shows that:

a) no gravity forces act on a body in a vacuum
b) the acceleration due to gravity on the Moon is less than on Earth
c) in the absence of air resistance all bodies at a given location fall with the same acceleration

4. G = 0 on the Moon. Of the following where would the weight of an object be the least?

a) at the north pole
b) at the equator
c) at the center of Earth
d) at the south pole

5. When a fruit falls from a tree

a) only the earth attracts the fruit
b) only the fruit attracts the earth
c) both the earth and the fruit attract each other
d) the fruit and the earth repel each other

Activity VIII.

Choose the correct answer:

6. Earth exerts a gravitational force on the Moon, keeping it in its orbit. The reaction to this force, in the sense of Newton's third law, is:

a) the centripetal force on the Moon b) the nearly circular orbit of the Moon

c) the gravitational force on Earth by the Moon d) the tides due to the Moon

7. The earth moves about the sun in an elliptical orbit. As the earth moves closer to the sun, which of the following best describes the earth-sun system's moment of inertia?

a) it is zero b) it decreases c) it increases d) it remains constant e) none of the above choices are valid

8. Which of the following statements is true of a satellite orbiting the earth on a circular path?

a) it moves with constant speed and acceleration of zero magnitude.

b) it moves with constant velocity and acceleration of constant magnitude.

c) it moves with variable velocity and acceleration of zero magnitude.

d) it moves with constant speed and acceleration of constant magnitude.

9. The escape velocity of a spaceship from a planet depends on

a) the mass of the planet and the mass of the spaceship. b) the mass and the diameter of the planet.

c) the mass of the planet only. d) the diameter of the planet only.

10. An artificial satellite of Earth releases a bomb. Neglecting air resistance, the bomb will:

a) strike Earth under the satellite at the instant of release

b) strike Earth under the satellite at the instant of impact

c) strike Earth ahead of the satellite at the instant of impact

d) strike Earth behind the satellite at the instant of impact

e) never strike Earth

11. An astronaut in an orbiting spacecraft feels "weightless" because he:

a) is beyond the range of gravity b) is pulled outward by centrifugal force

c) has no acceleration d) has the same acceleration as the spacecraft

Activity IX.

Find Ukrainian equivalents

mutual attraction _____

its influence is taken for granted _____

to express in mathematical terms _____

the law of universal gravitation _____

is directly proportional _____

is inversely proportional _____

experimental measurements _____

it can be found by equating _____

when applied to large masses _____

is adequate for weak gravitational fields _____

in terms of acceleration _____

is denoted by “g” _____

Activity X.

Find English equivalents:

пропорційний _____

рух небесних тіл _____

прискорення _____

час вільного падіння _____

вага тіла _____

невагомість _____

сила тяжіння _____

виміри _____

падіння тіл за відсутності опору повітря _____

спростовувати _____

Activity XI.

Translate into English

Спостерігаючи падіння тіл, можна помітити, що «важкі» тіла падають звичайно швидше, ніж «легкі». Наприклад, монета падає набагато швидше, ніж паперовий кружок. Ще в давнину Арістотель стверджував, що легкі тіла мають властивість падати повільніше, ніж важкі. Це переконання вважалося правильним понад дві тисячі років, поки його не спростував італійський учений Галілей, що перейшов від спостережень до дослідів.

Якщо Арістотель має рацію, то тіла рівної маси повинні падати однаково. Перевіримо на досліді: чи так це? Відпустимо з однієї й тієї ж висоти аркуш паперу й зроблену з такого ж аркуша паперову грудку. Аркуш падає набагато повільніше від грудки, хоча їхні маси однакові. Виходить, тіла рівної маси не обов'язково падають однаково – дослід спростовує це положення Арістотеля, а це значить, що воно неправильне.

Галілей припустив, що в ідеальній ситуації – якби опору повітря не було зовсім – всі тіла падали б однаково. Щоб перевірити своє припущення, Галілей кинув з Пізанської вежі одночасно кулю й гарматне ядро. Хоча їхні маси відрізняються в багато разів, куля та ядро впали практично одночасно, підтвердивши припущення Галілея.

Падіння тіл за відсутності опору повітря називають вільним падінням. Отже, при вільному падінні всі тіла падають однаково. Виміри показали, що при вільному падінні швидкість тіла щосекунди збільшується на 9,8м/с.

WORD STUDY

1W. Learn the following speech patterns. Make your sentences with the following patterns

A.

1) Supercomputers are very expensive such that ordinary customers cannot afford them.
2) In her eyes there was a fear **such that** she could not say a word.
3) The damage was **such that** it would cost too much money to repair.
4) The baby is **such** a cutie **that** everyone likes her.

B.

1) He didn’t show a flicker of interest **in what** I was saying to him.
2) If you cannot have the best, make the best **of what** you have.
3) He asked me for my advice **on what** he should do.
4) I was in doubt **about what** to do.

C.

1) I’ll meet you in the city, **that is**, I will if the trains are running.
2) I’ve always enjoyed my work – **that is**, I did until this new manager arrived.
3) Uncomplicated computer interface **that is** truly easy to use.
4) **That’s** it then. There’s nothing more we can do.

D.

1) Probably she was right **after all**.
2) I’m sorry but we’ve decided not to come **after all**.
3) She shouldn’t be working so hard – she is 70, **after all**.
4) I’m not ambitious. **After all**, money isn’t everything.

WORD STUDY

2W. Choose the word that best completes each sentence.

1. I don't find this story (amusing/amused). 2.I must have the mixer (fixing/fixed). 3.My room is a mess: I really must get it (tidying/tidied) up. 4. I would stay at home after such a (tiring/tired) day. 5.Uncle Frank has a gentle old horse (naming/named) Pete on his farm. 6. Can you smell something (burning/burned)? 7. He opened the letter with (shaking/shaken) fingers. 8. She had rather a (pleasing/pleased) look on her face. 9. Deeply (shocking/shocked) I left them. 10. When (answering/answered) your question yesterday, I forgot this fact. 11. He walked along the road with his collar (turning/turned) up, hands in pockets. 12. I didn't enjoy the party because I was (boring/bored) there. 13. Why not throw away the (breaking/broken) umbrella, we are not likely to repair it. 14. She didn't pay any attention to the (ringing/rung) telephone. 15. Don't you think your hair needs (cutting/cut)? 16. Can you think of the name of an animal (beginning/begun) with "B"?

3W. Give the opposites of the following words

Single, the simplest, general-purpose, accept, in a sequence, specified, to be loaded into, to complete, output, difficult, considerable, multiple, advanced, complexity, inability, advantage, overcome, concurrent, rapid.

WORD STUDY

4W. Choose the right word.

complex — complicated — sophisticated

1. Knowledge-based systems are widely used now in the diagnosis and control of … dynamic systems. 2. To justify his concept, the speaker resorted to highly … reasoning. 3. The sequence of tenses can be observed in … sentences only. 4. The surgical operation was … by the patient being very weak. 5. … set of measures was applied

Translate into English choosing the right word.

1. Студент успішно впорався з цим завданням, хоча спочатку воно здалося йому надто складним. 2. Складним називають об'єкт, що складається з багатьох взаємозалежних елементів. 3. Щоб спростувати або підтвердити цю гіпотезу, треба провести серію складних експериментів. 4. Мого товариша доставили до лікарні зі складним переломом. 5. Хоча комп'ютер є складним пристроєм, його можна спрощено розглядати як пристрій, що складається з процесора, пам'яті, мережі зв'язку та пристроїв введення-виведення.

practice — practise

1. We need to put these ideas into … . 2. To learn English well you have to … . 3. He always … politeness. 4. To be good at it, you need to … year after year, and for your whole life. 5. It was with difficulty that he was induced to stoop from speculation to … .

Translate into English choosing the right word.

1. Постійна практика вдосконалює вміння людини в будь-якій галузі. 2. Спробуймо займатися програмуванням разом. 3. Я надаю перевагу практичному аналізу та перевірці різних наукових припущень. 4. Моєму братові ніколи не подобалося займатися англійською мовою. 5. Працювати, навчаючись на третьому курсі — це звичайна практика серед студентів нашого університету.

WORD STUDY

5W. Translate and learn the word combinations with the word mind. Make your own sentences with them:

USAGE:

1. Дієслово, яке йде після mind, завжди вживається у формі герундія, e. g.: Do you mind my helping you? Ви не будете заперечувати, якщо я допоможу вам?; Do you mind helping me? Ви не відмовитеся допомогти мені? До цієї групи дієслів належать також to avoid, to delay, to enjoy, to imagine, to finish, to excuse, to postpone.
2. У значенні заперечувати дієслово to mind вживається переважно в заперечних і питальних реченнях, e.g.: Do you mind my smoking? – No, I don't mind a bit. Ви не заперечуєте, якщо я закурю? – Ніскільки.
3. У значенні остерігатися, берегтися дієслово to mind вживається у наказових реченнях, e.g.: Mind the steps! Обережно, тут сходинка! 4. Зворот never mind! часто вживається у відповідь на вибачення або вдячність, e.g.: Excuse my being late! – Never mind. Вибачте, що запізнився. – Нічого, будь ласка.

1. To keep in **mind** 2. To read smb's mind **mind.** 3. To have a **mind** to do smth . 4. To get smth into one's **mind 5.** Don't **mind** me. 6. To be in sound **mind.** 7. To change one's **mind.** 8. To be in a good state of **mind. 9.** To be in two **minds.**

Confusion of Mass and Weight

The force of gravity acting upon an object is sometimes referred to as the **weight** of the object. Many students of physics confuse weight with mass. The **mass** of an object refers to the amount of matter that is contained by the object; the weight of an object is the force of gravity acting upon that object. Mass is related to how much *stuff* is there and weight is related to the pull of the Earth (or any other planet) upon that *stuff*.

The mass of an object (measured in kg) will be the same no matter where in the universe that object is located. Mass is never altered by location, the pull of gravity, speed or even the existence of other forces. For example, a 2-kg object will have a mass of 2 kg whether it is located on Earth, the moon, or Jupiter; its mass will be 2 kg whether it is moving or not ; and its mass will be 2 kg whether it is being pushed upon or not.

On the other hand, the weight of an object (measured in Newton) will vary according to where in the universe the object is. Weight depends upon which planet is exerting the force and the distance the object is from the planet. Weight, being equivalent to the force of gravity, is dependent upon the value of **g** - the gravitational field strength. On earth's surface **g** is 9.8 N/kg. On the moon's surface, **g** is 1.7 N/kg. Go to another planet, and there will be another **g** value. Furthermore, the g value is inversely proportional to the distance from the center of the planet. So if we were to measure **g** at a distance of 400 km above the earth's surface, then we would find the **g** value to be less than 9.8 N/kg.

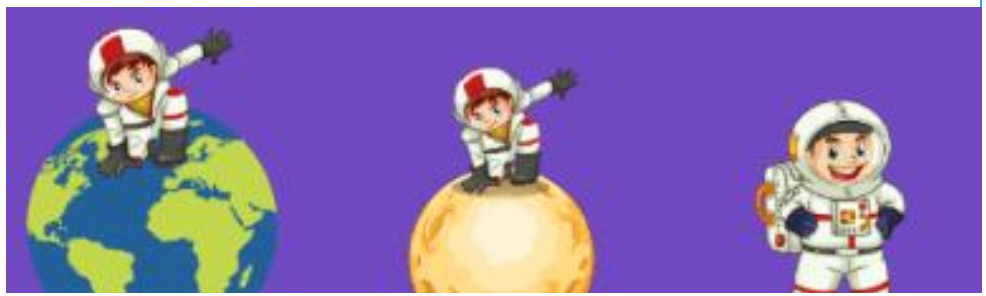
Always be cautious of the distinction between mass and weight.

ADDITIONAL READING PASSAGE

Activity I ***Divide the sentences into two groups*****:**

Mass	Weight

a) It is the amount of matter contained in the object;
b) It is constant throughout the universe;
c) It is the force with which an object is pulled towards the Earth;
d) It can never be equal to zero;
e) It is a scalar quantity;
f) It is a vector quantity;
g) It varies from place to place as g varies;
h) SI unit of … is Newton.



Text 2

ADDITIONAL READING PASSAGE

Newton’s law of gravitation accounts for ocean tides

High and low tides are partly due to the gravitational force exerted on Earth by its moon. The tides result from the difference between the gravitational force at Earth’s surface and at Earth’s center. A full explanation is beyond the scope of this text, but we will briefly examine this relationship.

The two high tides take place at locations on Earth that are nearly in line with the moon. On the side of Earth that is nearest to the moon, the moon’s gravitational force is greater than it is at Earth’s center (because gravitational force decreases with distance). The water is pulled toward the moon, creating an outward bulge. On the opposite side of Earth, the gravitational force is less than it is at the center. On this side, all mass is still pulled toward the moon, but the water is pulled least. This creates another outward bulge. Two high tides take place each day because when Earth rotates one full time, any given point on Earth will pass through both bulges.

The moon’s gravitational force is not the only factor that affects ocean tides. Other influencing factors include the depths of the ocean basins, Earth’s tilt and rotation, and friction between the ocean water and the ocean floor. The sun also contributes to Earth’s ocean tides, but the sun’s effect is not as significant as the moon’s is. Although the sun exerts a much greater gravitational force on Earth than the moon does, the difference between the force on the far and near sides of Earth is what affects the tides.