The following publication and all events within the Adventurous Maths and Science project realised in the Erasmus + programme were prepared by the following teachers of I Liceum Ogólnokształcące im. 14 Pułku Powstańców Śląskich in Wodzisław Śląski, Šiaulių Lieporių gimnazija and Istituto di Istruzione Superiore Leonardo da Vinci Maccarese – Fiumicino.

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LESSON PLAN 1

CHEMISTRY

Topic: Identification of organic substances in fruit and vegetables.
Grade: 9th
Tasks:
1. Use of iodine to determine starch in vegetables and fruits.
2. Ways to recognise that honey, sour cream have no additives.
3. Determine which foods contain more protein.

Lesson progress:

Lesson Parts	**Teacher Activities**	**Student Activities**	**Notes**
Introductory part.	Lesson topic announced. Revision on organic materials.	Students listen.	Discussions on what is needed to perform.
Determination of starch, using iodine in vegetables, food.	Explanations on how to find starch in fruits, vegetables according to color reactions.	Carrot, apple, potato, cucumber are cut, and iodine is applied. Dropping iodine on starch powder and flour.	Drop iodine on filter paper and starch. This is the control color of iodine. After application of iodine, the product, if starch is present, changes its colour into blue.
How to recognize that, honey, sour cream have no additives.	Sometimes manufacturers can use moisture-binding agents, for example, well-known starch. It should be known that such honey and cream quickly become sour.	Whether there is starch in honey, can be determined by the same way as looking for it in the curd, in liquid dairy products: drop iodine on honey sample and, if the sample changes its colour into blue, starch is present.	
Protein determination in food.	Add sodium hydroxide solution (approximately equal to the present solution) to the tested solution, followed by a little copper (II) sulfate $CuSO_4$.	Investigating: buckwheat, manna, barleycorn, milk, Greek yoghurt, egg whites, potato juice.	After the reaction, if the colour turns violet, then protein is present. The brighter the color, the more protein is present.

End of the lesson.	Summarizing the lesson, discussing the results.	Students make self-assessment of the performed work.	Discussion, conversation, evaluation.

LESSON PLAN 2

CHEMISTRY

TOPIC:

Characteristic reactions of chromate and dichromate ions – laboratory classes.

AIMS:

Student:

- analyses the durability of chromate and dichromate ions depending on the environment;
- makes correct observations from experience;
- constructs correct conclusions from experience;
- saves correctly molecular and ionic reaction equations;
- uses correctly the solubility table;
- uses equipment and chemical reagents skillfully

LESSON PROGRESS:

I. Introduction

A reminder of OHS principles in the laboratory and the principles of using chemical reagents.

Getting to know the work plan:

- performance of the experiment;
- taking notes in a notebook;
- restoring order at the workplace

II. Beginning

Presentation of the topic of experiments.

1. STABILITY OF CHROMATE (A) AND DICHROMATE IONS (B) DEPENDING ON THE ENVIRONMENT

Description of the experiment:

To 2 tubes containing a potassium dichromate solution should be added - to the first a small amount of sulfuric acid (VI), to the second - potassium hydroxide. The same experiment should be performed by adding the acid and base to 2 tubes containing potassium chromate.

Student's tasks:

- performance of the experiment;
- observation record;
- formulation of conclusions regarding ion stability;
- recording of reaction equations in molecular and ionic form.

1.Diagram of the experiment:

A B

2.Observations

A……
……..

B……
……..

3.Conclusions:

A……
……..

B……
……..

4.Reaction equations:

- molecular

A……

B……

- ionic

A……

B……

2. RECEIVING SPARINGLY SOLUBLE CHROMATE SALTS

Description of the experiment:

To 2 tubes containing a potassium chromate solution, add a small amount of solutions: to the first aluminum chloride, to the second - barium nitrate (V).

Students tasks:

- performance of the experiment;
- observation record;
- formulation of conclusions based on a solubility table;
- recording of reaction equations in molecular and ionic form.

1.Diagram of the experiment:

A B

2.Observations

A……
……..

B……
……..

3.Conclusions:

A……
……..

B……
……..

4.Reaction equations:

- molecular

A……

B……

- ionic

A……

B……

3. TEST OF OXIDIFYING PROPERTIES OF POTASSIUM DICHROMATE IN THE PRESENCE OF SODIUM (III) NITRATE IN THE ACIDIC ENVIRONMENT

Description of the experiment:

A small amount of sulfuric acid (VI) should be added to the test tube with a potassium dichromate solution followed by a solution of sodium nitrite (III)

Student's tasks:

- performance of the experiment;
- observation record;
- formulation of conclusions based on a solubility table;
- recording of reaction equations in molecular and ionic form.

1.Diagram of the experiment:

2.Observations:

..……

……..

3.Conclusions:

..……

……..

4.Reactions equations:

- molecular

..……

- ionic

..……

III. Final part

Summary of students' work.

Cleaning workstations.

METHODS:

- laboratory work.

MATERIALS:

- laboratory equipment: test tubes;
- chemical reagents: solutions of potassium dichromate, potassium chromate, sulfuric acid (VI), potassium hydroxide, aluminum chloride, (V) barium nitrate, sodium nitrate (III).
- solubility tables

LESSON PLAN 3

MATHEMATICS

PHYSICS

1. TOPIC: **Projectile Motion**
2. AIMS

2.0. Principal aim is to understand the projectile motion in two dimensions without taking air resistance into account.

2.A. After the lesson the student should know:

- the equations of projectile motion in 2 dimensions
- what is the horizontal range of the projectile

2.B. After the lesson student will be able to:

- calculate the horizontal range of the projectile
- write the equation of the path curve of the projectile

3. METHODS discussion, demonstration
4. MATERIALS computer, GeoGebra program, Kahoot, chalk, blackboard.
5. PROCEDURE
    1. WARM-UP
        - Describe the motion of the ball on a horizontal plane.

- Teacher will throw the projectile. What two factors would affect projectile motion - angle, initial velocity?
- Hammer throw example.

2. REALISATION
   - An object is fired from the ground at 30 m/s at an angle of 30 degrees with the horizontal.
   - Calculate the horizontal and vertical components of the initial velocity.
   - Calculate the coordinates of the object.
   - Write the equation of the path curve.
   - What is the horizontal range of the projectile?
   - Visualisation with GeoGebra.

3. FOLLOW-UP
   - Kahoot test
   - Homework

6. WORKSHEETS

1. Find the inclination of the straight line with slope 2.

2. Find the slope of the straight line with inclination $\alpha = 60°$.

3. Find the equation of a straight line given a point A(1, 2) on it and an angle $\alpha = 30°$ between the line and the positive x-axis.

4. Eliminate the parameter t from the equations $x=2t-3$, $y=5-3t$ and describe the resulting function in the form $y = ax + b$ $y = ax + b$.

5. Transform the parametric equations of the straight line into the slope-intercept equation $y = ax + b$ $y = ax + b$:

a) $x = 2 - 3t, y = 1 - 2t, t \in R$ $x = 2 - 3t, y = 1 - 2t, t \in R$

b) $x = mt, y = nt - k, t \in R$ $x = mt, y = nt - k, t \in R$

6. Eliminate the parameter t from the equations and describe the resulting function in the form $y = ax^2 + bx + c$ $y = ax^2 + bx + c$.

a) $x = 20t, y = 5t - 4t^2$ $x = 20t, y = 5t - 4t^2$

b) $x = t \cdot \cos\alpha, y = t \cdot \sin\alpha - \frac{t^2}{2}$ $x = t \cdot \cos\alpha, y = t \cdot \sin\alpha - \frac{t^2}{2}$

7. Prove the following trigonometric identities:

a) $\tan\alpha \cdot \cos\alpha = \sin\alpha$ $\tan\alpha \cdot \cos\alpha = \sin\alpha$

b) $\tan\alpha \cdot \cos^2\alpha = \sin 2\alpha$ $\tan\alpha \cdot \cos^2\alpha = \sin 2\alpha$

8. Sketch the graphs of the following functions:

a) $y = \sin 2\alpha$ $y = \sin 2\alpha$

b) $y = 3\sin 2\alpha$ $y = 3\sin 2\alpha$

9. Graph the following quadratic function $f(x) = -2x^2 + 3x$ $f(x) = -2x^2 + 3x$. Find the maximum value and the roots.

10. Solve quadratic equations:

a) $x^2 - 4x = 0$ $x^2 - 4x = 0$

b) $x \cdot \sqrt{2} - \frac{x^2 \cdot \pi}{2} = 0$ $x \cdot \sqrt{2} - \frac{x^2 \cdot \pi}{2} = 0$

c) $x \cdot \tan\alpha - \frac{x^2 \cdot g}{2v^2 \cos^2\alpha} = 0$ $x \cdot \tan\alpha - \frac{x^2 \cdot g}{2v^2 \cos^2\alpha} = 0$

11. Find the length of the x and y components of vector v if is at an angle of 30° above the x-axis and has a magnitude of 40 km/h.

12. Find the length of the v_x v_x and v_y v_y components of vector $v = 100\,m/s$ $v = 100\,m/s$.

REALISATION NOTES:

Velocity components: $v_x = v \cdot \cos\alpha$ $v_x = v \cdot \cos\alpha$, $v_y = v \cdot \sin\alpha$ $v_y = v \cdot \sin\alpha$

Coordinates: $x = v \cdot t \cdot \cos\alpha$ $x = v \cdot t \cdot \cos\alpha$, $y = v \cdot t \cdot \sin\alpha - \frac{g \cdot t^2}{2}$ $y = v \cdot t \cdot \sin\alpha - \frac{g \cdot t^2}{2}$

Trajectory: $y = x \cdot \tan\alpha - \frac{g}{2 \cdot v^2 \cdot \cos^2\alpha} \cdot x^2$ $y = x \cdot \tan\alpha - \frac{g}{2 \cdot v^2 \cdot \cos^2\alpha} \cdot x^2$

Range: $z = \frac{v^2 \cdot \sin 2\alpha}{g}$ $z = \frac{v^2 \cdot \sin 2\alpha}{g}$

HOMEWORK PROBLEM

A ball kicked at an initial velocity of 50 m/s reaches a horizontal distance of 150 meters.

- What is the size of angle between initial velocity and the ground?
- What is the maximum height reached by the ball?

KAHOOT TEST QUESTIONS

1. While the projectile is in flight, the velocity:

   A. remains constant

   B. decreases, then increases

   C. decreases, then remains the same

   D. increases, then decreases.

2. We fire two similar projectiles with the same velocity. The first at an angle of 45° with the horizontal and the second with an angle of 60° with the horizontal. The first one has:

   A. longer horizontal range
   B. shorter horizontal range
   C. the same horizontal range as the second
   D. not enough data

3. Vector $v = \sqrt{2}$ $v = \sqrt{2}$ is at an angle of 45° with the horizontal. Its v_x v_x and v_y v_y components are:

   A. 1 and 1
   B. 2 and 0
   C. 0 and 2
   D. 2 and 2

4. The x axis intercepts for function $f(x) = x - \frac{x^2}{25}$ $f(x) = x - \frac{x^2}{25}$ are

   A. 5 and -5
   B. 25 and -25

C. 0 and 5
D. 0 and 25

5. Function $y = \frac{\sqrt{3}}{2}\sin 2\alpha$ $y = \frac{\sqrt{3}}{2}\sin 2\alpha$ its maximum value for

A. $\alpha = 30^o$ $\alpha = 30^o$
B. $\alpha = 45^o$ $\alpha = 45^o$
C. $\alpha = 60^o$ $\alpha = 60^o$
D. $\alpha = 90^o$ $\alpha = 90^o$

6. A straight line with inclination $\alpha = 45°$ to the positive x-axis and passing trought point (0, 0) has equation

A. $y = x + 45$ $y = x + 45$
B. $y = x + \frac{\sqrt{2}}{2}$ $y = x + \frac{\sqrt{2}}{2}$
C. $y = \frac{\sqrt{2}}{2}x$ $y = \frac{\sqrt{2}}{2}x$
D. $y = x$ $y = x$

LESSON PLAN 4

MATHEMATICS

Grade level	3rd year of Secondary school - Grade 11
Subject	Mathematics

Title	**Angle Bisector as a Locus. The Incenter of a triangle**

Topic	The interior bisector of an angle is the locus of the interior points of an angle, equidistant from its sides. The interior bisectors of a triangle meet at a point equidistant from the sides of the triangle, called incenter, which is the center of the inscribed circle in the triangle.
Objectives	● Familiarizing with the notion of the locus, the set of all points satisfying some certain condition; ● Learning that the angle interior bisector is the locus of the angle interior points, equidistant from the sides of the angle; ● Knowing that the all three interior triangle bisectors meet at a single point, called the incenter, equidistant from the sides of triangle; ● Learning digital investigative techniques, especially dynamic geometry such as moving points and objects, changing positions and sizes, etc. ● Be able to apply their knowledge to construct the interior bisectors and the incenter of any triangle.
Resources	*Links to the interactive worksheets: Interactive Worksheet 1 – Angle Bisector:* *https://www.geogebra.org/classic/ynsurrx3* *Interactive Worksheet 2 – The Incenter:* *https://www.geogebra.org/classic/rbmgswq6*
Materials/Technology Uses	students will need a computer or laptop or their own mobiles
Step 1	*Introduction of the theme and the working methods.* The topic and goals are announced, and the interactive worksheets are described. The angle bisector definition and construction modalities are recapitulated;
Step 2	*Individually investigate the bisector concept using Interactive Worksheets 1 and 2.*
Step 3	*Observation, front-to-class dialogue, verification of the notes required in the interactive worksheets.*
Step 4	*Construct the interior bisectors and the incenter of any triangle.*

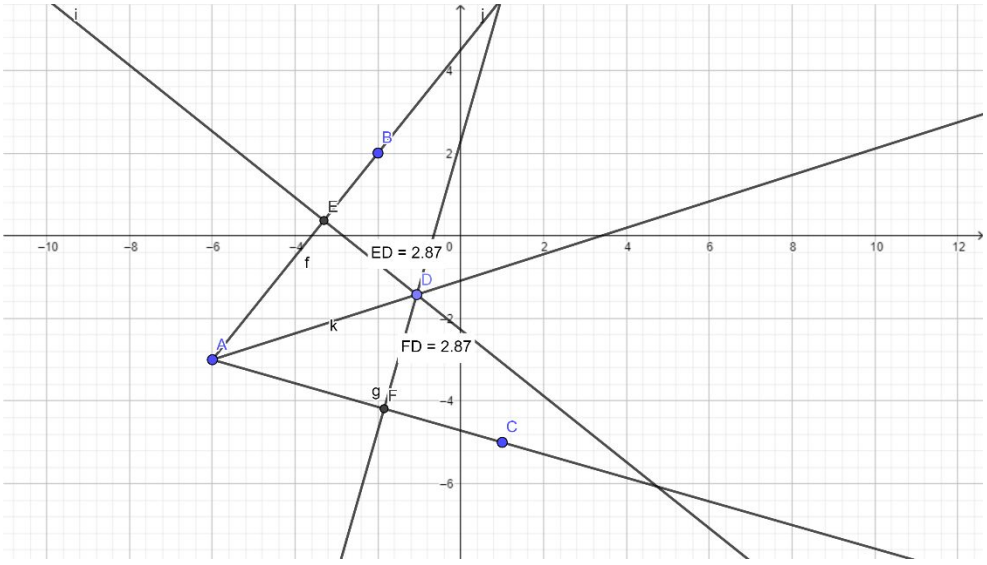


Figure 1 Worksheet 1- Angle bisector

https://www.geogebra.org/classic/ynsurrx3

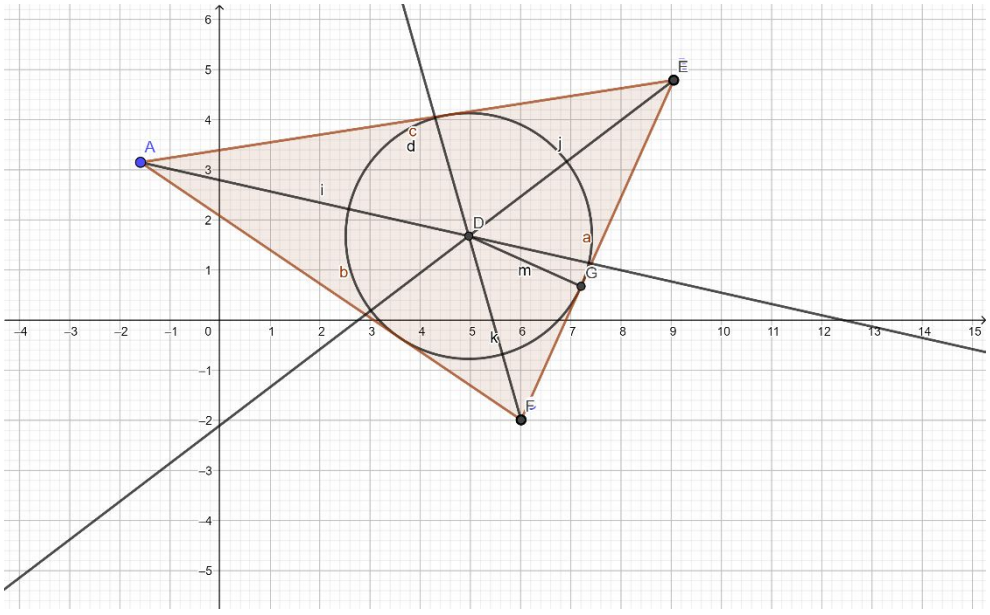


Figure 2 Worksheet 2 - Incenter of a triangle

https://www.geogebra.org/classic/rbmgswq6

LESSON PLAN 5

MATHEMATICS

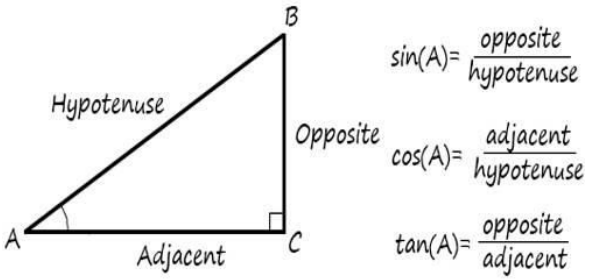
USING TRIGONOMETRY RATIOS FOR RIGHT-ANGLED TRIANGLES

Objectives of the lesson

- define the ratios sine, cosine and tangent with reference to a right-angled triangle.
- use the trig ratios to solve problems involving triangles.
- Use trigonometric (sine, cosine and tangent) functions to model and solve problems;

Introduction of the new material

Definition of the three ratios of sides in a right angled triangle



Given a triangle, students will analyse what parts of the triangle are given. Find out what trigonometric ratios are they going to use.

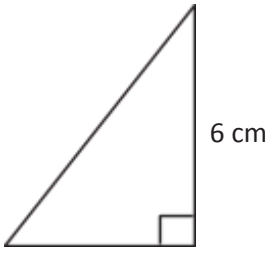
Apply the formulas given to them.

Using sine, cosine or tangent students should be able to solve the problem.

Using the calculator students should be able to find the angle (One word of warning: most calculators operate with angles measured in one of two ways, degrees or radians. You need to make sure the calculator is operating with the correct measurement of the angle)

Example 1

Consider the right-angled triangle shown in Figure. Suppose we wish to find the length of the hypotenuse



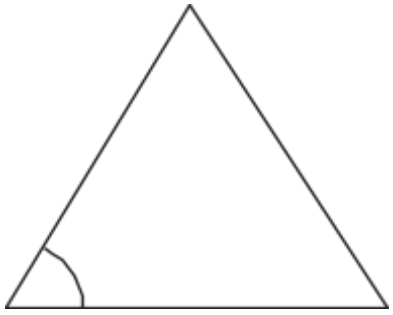
We know the adjacent side is 6 cm. We want to know the hypotenuse, x, say. The ratio which links these is the cosine.

$$6 = x \cos 35^\circ$$

$$\cos 35^\circ = \frac{6}{x}$$

$$x = 7.3246$$

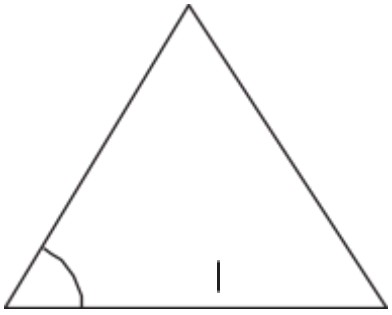
Example 2



10m

In this Example consider the isosceles triangle shown in Figure. Suppose we wish to find the marked angle.

In this Example there does not appear to be a right-angle. In questions like this you must look to introduce a right-angle for yourself. If we divide the isosceles triangle in half, we can form a



right-angle as shown in Figure

α H

This is read as "α is the angle whose cosine is $\frac{5}{12}$ $\frac{5}{12}$"

The calculator will have a button marked $\cos^{-1}$ in order to do this calculation. Check that you can use it correctly to find $\alpha = \cos^{-1}\left(\frac{5}{12}\right)\left(\frac{5}{12}\right) = 65.3757^\circ == 65.4^\circ$ (1 d.p.). So, the required angle has been shown to be 65.4◦.

Tasks

1. The angle of elevation of the top of a tree from a point on the ground 10 m from the base of the tree is 28°. What is the height of the tree (to 1 decimal place)?
2. Using a surveying instrument 1.6 m high, the angle of elevation of the top of a tower is measured to be 55° from a point 6 m from the base of the tower. How high is the tower (to 1 decimal place)?
3. The angle of elevation of the top of a 20 m high mast from a point at ground level is 34°. How far is the point from the foot of the mast (to 1 decimal place)?
4. An isosceles triangle has base 8 cm and sloping sides both with length 10 cm. What is the base angle of this triangle (to the nearest degree)?
5. A right-angled triangle has sides 5, 12, 13. What is the size of the smallest angle in this triangle (to the nearest degree)?
6. What is the height (to 1 decimal place) of an isosceles triangle with base angle 65° and sloping sides with length 10 cm? What is the length of the base of this triangle (to 1 decimal place)?

7. One angle in a right-angled triangle is 50° and the side opposite this angle has length 5 cm. What is the length of the hypotenuse (to 1 decimal place)?

Review with kahoot:

https://create.kahoot.it/share/trigonometry-ratios-and-right-angled-triangles/813dc02c-04d5-4d52-bb5c-8eecd5720ea4

LESSON PLAN 6

MATHEMATICS

EXPONENTIAL FUNCTION

Objectives of the lesson.

After you learn the definition and features of exponential function, you will draw a graph. Then, you will revise graph transformations and solve exponential variation tasks. Using exponential function's features, you will be able to solve simple practical and mathematical content exercises.

Introduction of the new material.

Definition. Function, that can be expressed by formula f(x) = a^x , when a > 0 and a $\neq$ 1 is called exponential function.

We are analyzing two cases:

1) f(x) = a^x , when a > 1, x ϵ R

E.g. f(x) = 2^x. Let's draw a graph of the function.

Apibrėžtis. Funkcija, kurią galima išreikšti formule f(x) = a^x

kai a > 0 ir a ≠1, vadinama rodikline funkcija.

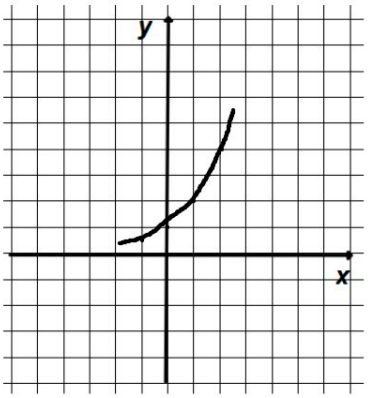
X	-1	0	1	2	3
y					

Nagrinėsim du atvejus:

1. $f(x) = a^x$ **kai a>1 x∈R**

$$f(x) = 2^x$$

1.Sudarome lentelę;
2. Nubrėžiame grafiką;
3. Užrašome savybes.



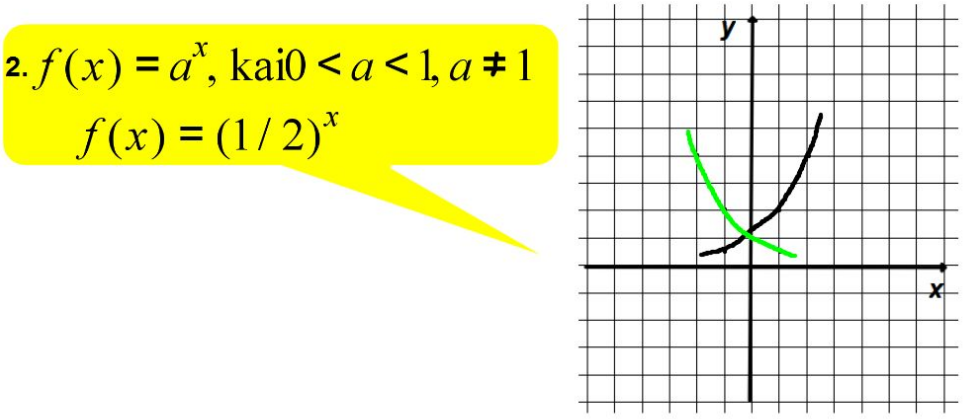
Identify features using a graph:

1. What is the domain set? (Set of *x* values)
2. What is the codomain set? (Set of *y* values)
3. Is the function increasing or decreasing?
4. Find a point where the graph touches *y*-axis. Does the graph have a mutual point with *x*-axis?

2) f(x) = a^x , when 0 < a < 1, x ϵ R

E.g. f(x) = $(\frac{1}{2})^x$. Let's draw a graph.

X	-1	0	1	2	3
y					



Identify features using a graph: symmetrical

5. What is the domain set? (Set of *x* values)
6. What is the codomain set? (Set of *y* values)
7. Is it an increasing or decreasing function?
8. Find a point where the graph touches *y*-axis. Does the graph have a mutual point with *x*-axis?

Conclusion. Functions' f(x) = 2^x and f(x) = $(\frac{1}{2})^x$ graphs are symmetrical to *y*-axis.

Let's revise graph transformations.

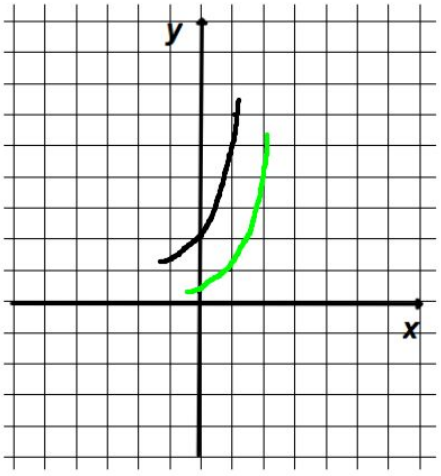
Tasks.

1. Draw graphs of function f(x) = $5^x + 1$ and f(x) = 5^{x-1}

Atlikite užduotis:

1.Nubraižykite funkcijų grafikus

$f(x) = 5^x + 1,\ f(x) = 5^{x-1}$



2. Draw graphs of equation $2^x = \frac{8}{x}$ and indicate the amount of answers.
3. Which of these points A(0;1), B(-1;1/9) and C(-2;1/18) belong to graph of function $f(x) = 3^{2x}$?

The use of exponential function.

Exponential variability. There are common actions found in nature, technologies and economy. While these processes are in progress, certain quantities can increase or decrease during every time unit by the same amount of times. This kind of change is called exponential variability.

Tasks.

E.g. There are 25 bacteria in the tube. Each day the amount of them becomes twice as big. Write a formula of how many bacteria there will be x days later.

E.g. There is a 2000 € deposit in the bank. It pays 2,5% of compound annual interest. How big the deposit will be 6 years later?

E.g. Under favourable conditions, the amount of bacteria increases three times per hour. Write a formula of the dependence of bacteria amount from time t .

E.g. Every day the amount of bacteria in the tube decreases by half. How many germs there would be after 1 day; 4 days; 10 days; n days, if at the beginning there were 1000 of them?

E.g. 20% of petrol evaporates from tank in one week. If the initial amount of petrol is V^0, how much of it will be left after 2 weeks; 3 weeks; t weeks?

E.g. The price of used workshop equipment decreases by 5% every year. How much will the equipment, bought for 12000 €, will cost in 8 years?

E.g. A farmer borrowed 20000 €. Write a formula, which calculates the amount of debt together with interest, when annual interest rate is 10%. When will the debt with interest make up 32210,2 €?

LESSON PLAN 7

ENGLISH

Grade level	3rd year of Secondary school - Grade 11
Subject	English

Title	The Birth of the Nation
Topic	The gradual settlement and colonization of Great Britain
Objectives	Students ● will be able to carry out a research project and share their finding with the rest of the class

	• will be able to use the information gathered through research and apply it to their thing link visual presentation
Resources	Print: English textbook Non Print: Websites
Materials/Technology Uses	students will need a computer or laptop or their own mobiles not only to do research , but also to create their thing link.
Step 1	Students are introduced to the study of the gradual settlement and colonization of Great Britain
Step 2	Have students work in groups of two or three and let them browse the sites and look for information about one of the population invading Great Britain (Romans, Anglo-Saxons, Vikings, Normans..)
Step3	Ask the students to download the ThingLink app
Step 4	Students work together to create a ThingLink adding a background image selected from folders or taken from any website. Students can choose a title for their interactive image and add content.
Step 5	Students present the research information to classmates through ThingLink

Refer to link below:

https://padlet.com/germana_catania61/3A

LESSON PLAN 8

ENGLISH

A Film Review

Objectives:

Students will know the requirements for a film review and will be able to write one when working in groups.

Methods:

Brainstorming ideas, interactive tasks, creative writing in groups.

Materials:

Handouts, interactive tasks (attached to the lesson plan).

Procedure:

Warm-up:

A class discussion on recently seen films and features that make a good/bad film;

Description of six films belonging to different genres (a Smart board activity).

Realization:

Analysis of six tips for a film review (a Smart board activity);

Handouts: a gap filling task on useful vocabulary for a film review;

Handouts: a task on how to write a film review - general requirements;

Matching definitions for useful vocabulary (a Smart board activity);

Ordering parts of a film review (a Smart board activity).

Follow-up:

Teamwork: writing a film review following the requirements and using useful vocabulary;

Film review presentations to the class.

Feedback:

Assessment of personal progress: In this lesson I learned…/I need more practice in…

LESSON PLAN 9
PHYSICS

TOPIC: Mechanical waves.

AIMS

- **DIDACTIC:**
  - Introduction of the concept of mechanical wave and the concepts of physical quantities that describe it;
  - Demonstration of the propagation of a mechanical wave in various centers;
  - Introduction of concepts: transverse wave and longitudinal wave

-EDUCATIONAL:

- Supplementing and organizing students' knowledge in a given range of material - mechanical wave;
- Awareness of the role of experiment and theory in cognition of nature and the importance of mathematics in solving physical problems;
- Developing and shaping the ability of reflective observation of phenomena occurring in the world around us

DETAILED AIMS – STUDENT:

- Knows the concept of mechanical wave and describes the mechanism of transmission of vibrations from one point of the center to another;
- Provides examples of mechanical waves occurring in the world around us;
- Demonstrates the production of waves on the rope and on the water surface;
- Uses the terms amplitude, frequency and period, speed and wavelength;
- Distinguishes between transverse and longitudinal waves, gives examples;
- Uses the mathematical relationships found in the calculations and estimates their order of magnitude;
- Solves simple computational tasks

METHODS:

- **Films, experiment;**
- **Observations;**
- **Conversation;**
- **Exercises.**

MATERIALS:

- **Film „Mechanical wave";**
- Set for demonstrations: rope, ribbon, glass bath tub, spring, tuning fork, string.
- **Exercises**

LESSON PROGRESS:

1. Organizational matters.
2. Introduction to the subject of the lesson - discussion.
3. Definition of the mechanical wave and its characteristics.
4. A demonstration of the experience illustrating the propagation of the wave in various centers (rope, ribbon, water, tuning fork).
5. Discussing the observation.
6. Film animation: "Mechanical waves".
7. Introduction and discussion of the concept of transverse and longitudinal wave.
8. A demonstration of the experience illustrating transverse and longitudinal waves (a glass bath with water, a toy spring.
9. Mathematical description of a mechanical wave - introduction of basic formulas describing: wavelength, speed, frequency $\lambda = V \cdot T$, $T = \frac{1}{\nu}$.
10. Solving simple physical tasks (attached).
11. Summing up

The activities of the teacher and students	**Remarks, use of materials**
• Introduction to the topic - discussion: What is associated with the concept of wave. • Giving the example of waves; reflection on the commonality of the given examples. • Providing the definition of a mechanical wave	As examples, waves propagating on water will be most often given; seismic waves and sound waves may also appear. If students have problems with giving examples, they should be directed accordingly. • The purpose of the discussion is to provide a common characteristic of all the mentioned examples. It is worth emphasizing that the direction of the wave motion is another thing, and the direction of the movement of the elements of the medium which has been deformed is something else. The center in which the wave propagates does not move.
A demonstration of the experiment illustrating the propagation of a wave on a rope (or hose, lines). • Discussing observations	• Example of an experiment: one end of a rope is fastened to the wall; we strain the rope and then hit it with your hand. • The deformation done with the hand during impact moves quickly along the string. • We repeat the experience, but we tie a ribbon on the rope. • We present a situation in which by moving the rope quickly, we cause several wave impulses. • We confirm with observation what we have previously said about mechanical waves. A mechanical wave is a deformation moving at a specific speed. Elements of the medium in which the mechanical wave travels are leaning out of the equilibrium position, but the center itself does not move.
Detailed explanation of the mechanism of mechanical wave propagation, using animation and computer program	• The use of, for example, the animation "Wave impulse", the board "Wave on a rope". • The use of film animation "Mechanical waves". • Based on the animation and computer program, we explain to students that the deformation of the elastic medium is related to vibrations of its individual elements. The vibration is enforced by some external force. The wave can be caused, for example, by hand movement, wind, stone falling into the water.
Observation of the wave propagating in the rope and water at different excitation frequencies.	Suggestions for experiments

• Formulation of conclusions from observations.	1. We move it slower, faster with a long rope hooked on one side. 2. We generate a wave by hitting the water surface with, for example, a pencil. We observe a change in the shape of the wave with a slower and much faster hitting. To observe the waves, we can use a flashlight, which we highlight from the bottom a vessel with water, and the resulting image is observed on the ceiling or screen of the projector. If we move the hand faster, the distances between the individual "hills" and "valleys" decrease.
Introduction of concepts and formulas describing a mechanical wave	By using film animation and information acquired by students, we first enter the values describing the mechanical wave. We note that if the propagation of the wave is related to the vibrations of the elements of the medium in which the wave propagates, the frequency f of the wave amplitude A and wave period T should be introduced. • We introduce the concept, unit and designation of the wavelength (wavelength as the smallest distance between the same out-of-balance objects of the medium in which the wave propagates). • Using computer simulation, we show that during one period the wave moves exactly one length, so the formula for the speed of wave propagation is: $v = \frac{\lambda}{T} = \lambda \cdot f$ V = λ/T or V= λ·f
Introduction and discussion of the concepts of transverse wave and longitudinal wave	Transverse wave is a wave in which the direction of vibration of the center's particles is perpendicular to the direction of wave propagation. • Use of the "transverse wave" screen. • Providing examples of transverse wave. • Longitudinal wave is a wave in which the vibrations of the center's particles are parallel to the direction of wave travel. • Use of the "Longitudinal Wave" board. Providing examples of longitudinal wave. It is worth mentioning that the sound waves propagating in the air are longitudinal waves - the mechanism of their propagation will be explained in another lesson

A demonstration of the experience illustrating the propagation of a longitudinal wave .	Example of experience We hang the long spring on a thread and squeeze it, and then release some of its first coils. Observations: Thinning or thickening of the spring coils runs along its length
Doing exercises	Solving tasks - calculations Using formulas: $V = \lambda/T$ and $V= \lambda \cdot f$ ● Exemplary exercises
Summing up	Ask students questions to check knowledge gained during the lesson ●

Film “Mechanical waves”

https://www.youtube.com/watch?v=SUhLhb__Vms

LESSON PLAN 10

BIOLOGY

The influence of various factors on seed germination

1.**CONTENT OF EDUCATION**

The student presents the structure of the seed (seed husk, endosperm, germ) and describes the conditions necessary for the germination process (temperature, water, oxygen).

• The student presents two types of seed germination - epigeic and hypogeous.

• The student analyzes the experiences made by the group of students regarding the factors affecting the germination of seeds as well as the germination rate depending on the plant species.

2. **AIMS**

STUDENT:

defines the concept of: germination;
defines the biological role of seeds;
determines the conditions necessary for the germination process;
indicates the location of backup materials in whites and unbleached seeds
it distinguishes whiting and unbleached seeds;
knows the structure of the seed;
knows the functions of the semen construction elements
it distinguishes two types of seed germination

3. **GAINING SKILLS**

STUDENT

improves teamwork skills;
gives examples of plants producing whiting and unbleached seeds;
gives examples of plants forming the largest and smallest seeds;
can determine the influence of water, temperature and light on the germination process

4. KEY COMPETENCES

• IT competences
• mathematical thinking and basic scientific and technical competences
• communicating in the mother tongue
• learning to learn
• the ability to analyze experiences and draw conclusions

5. **Stages of the lesson**

1. **Introduction:**

Familiarizing students with the subject.
A short talk about the biological role of seeds and the germination process

2. **Lesson process:**

The teacher presents an interactive illustration of "The construction of the seed". It indicates the elements of semen construction and discusses their functions.
The students and the teacher are characterized by whites and unbleached seeds.
They determine the difference in the structure of monocotyledonous and dicotyledonous plant seeds.
Students analyze the factors necessary for germination of seeds.
Students compare 2 types of germination: epigeic and hypogeous.
Students analyze the didactic film made by a group of students
„ The influence of various factors on the germination of cucumber and cress seeds "

3. **Theoretical description of the discussed phenomenon:**

The seeds remain at rest until there are no suitable conditions to start the germination process. Necessary factors include the right temperature, the presence of water and oxygen, and for some seeds (tobacco, lettuce) also light.
Germination is the first stage in the development of the plant from the seed.
Seed before harvesting gains water from the environment. The seed stock breaks under the influence of swelling.
First the root gets out and then the momentum.
Until the leaves capable of photosynthesis grow, the plant lives at the expense of nutrients stored in the seed.

Determining the purpose and object of the conducted experiments:

The purpose of the analyzed experiment was to determine the influence of light, temperature and water on the germination of cucumber and cress seeds.

Analysis of experiment (film) conducted by a group of students.

A talk about the diversity of seed forms and the influence of factors on their germination.
Explanation of the concept: germination force.
The teacher presents a set of photos "Big and small seeds"

4. **Summary:**

The teacher presents known seeds of various plant species, students recognize and name them.
Students determine the effect of various factors necessary for germination of seeds.
Analysis of repetitive tasks concerning plant physiology - types of germination

Homework

Due to the high content of nutrients, seeds are valuable food. Provide what seeds are in your daily diet

5. **Materials**

multimedia materials: photo gallery "Big and small seeds" ,, Seed construction "
a film from the experiment
multimedia materials: interactive illustration "Construction of semen"
manual, work sheets
computers connected to the Internet

6. **Methods:**

- observation
- conversation

7. **Forms of work**

- group
- individual

Films:

https://youtu.be/Kxmndh-1zCg

https://youtu.be/nECnlHSUzBU