CMA Activity database - Summary Biology

Topic	Title	Type	Driving question	Description
Ecology	Arctic hare and Arctic fox	Modeling	What is the relationship between the population of arctic foxes and arctic hares?	In this activity student study and discuss the relation between the Arctic hare and Arctic fox. The activity can be used as starting activity to explain predator-prey relationships.
Ecology	Budworms	Modeling	Is it possible to simulate a biological equilibrium?	This activity gives students the opportunity to explore the basic principles of population ecology. The model reflects a number of concepts, such as (biological) equilibrium, carrying capacity and predator pressure.
Ecology	Dissolved oxygen in water	Measurement	What is the relation between dissolved oxygen in water and the temperature?	Dissolved oxygen in water is one of the parameters which determine water quality in water body. This activity gives students some basic insights in one of the most important parameters for water quality.
Ecology	Mice population	Modeling	Which factors impact a mice population?	In this activity, students look step by step how certain factors impact the mice population. In the first part exponential growth is examined. In the second part of the activity some factors are added which limit the growth of the mice population. In this way students will progressively work towards an ecological model.
Ecology	Water quality	Measurement	What is the water quality of a pond or stream?	In this experiment students investigate a pond or stream near their school. Abiotic and biotic factors (flora and fauna) both give information about the water quality.
Human Physiology	Monitoring EKG	Measurement	Can you visualize electrical activity of the heart?	In this activity you will investigate the electrical activity of your heart using an ECG sensor. Also the effect of, for example exercising or a cup of coffee, can be examined.
Human Physiology	Electromyogram	Measurement	What is the electrical activity of a muscle?	In this investigation students visualize the activity of a muscle with an EKG sensor. Using different weights they are able to study the relation between the electrical activity of a muscle and the force.
Human Physiology	Monitoring heart rate	Measurement	What is your heart rate and how can you affect it?	In this activity students measure their heart rate in rest and after exercises. Is there an effect? Is this the same for every student?
Human Physiology	Lung volume	Measurement	What is your lung volume and capacity?	In this activity students use a spirometer to measure their lung volumes. During a normal breathing cycle a couple of lung volume types can be measured. This provides the opportunity to show students their breathing cycle and compare this with other students.
Human Physiology	Kidney function	Modeling	What is the effect of EPO and diabetes on the functioning of the kidneys?	This activity can be used to study the function of the kidneys in detail. Students can investigate the use of EPO and diabetes on the function of kidneys.This activity is based on a model and questions form a Dutch schoolexam.
Human Physiology	Human respiration	Measurement	How does exercise affect your breathing pattern?	In this activity students will study their breathing using a thermocouple sensor. They can compare their breathing with that of someone else. And examine the effect of exercise on their breathing pattern.
Human Physiology	Hypothermia	Measurement	What happens when you have hypothermia?	In this activity, students examine with simple experiment, the effects of hypothermia and the relation to the surface-volume ratio. As a result, this experiment can be used both for a discussion on temperature regulation in warm-blooded animals and the physiology around hypothermia.
Human Physiology	Alcohol Degradation	Modeling	Which factors influence the blood alcohol level in the human body?	In this activity students use a model to simulate alcohol absorption and degradation. They learn to understand the model, adjust the model and improve the model. The model is based on the Widmark formula, and widely used to calculate the BAC value.
Human Physiology	Diving response	Measurement	What causes the diving response?	In this activity students stimulate the diving reflex by measuring the heart rate before, during, and after immersing their face in water. After the diving response is visualized, students can examine which factors cause the diving reflex.

Topic	Title	Type	Driving question	Description
Human Physiology	Human perspiration	Measurement	How does the human body cool?	In this activity the evaporation process is made visible. Human perspiration and evaporation can be examined and compared.
Human Physiology	Glucose regulation	Modeling	How do insulin and glucagon regulate the blood glucose concentration	In this activity a model of the bood glucose concentration is explored. The effect of several hormones are simulated.
Human Physiology	Respiration regulation	Measurement	What is the respiratory response during and after physiological challenges?	In this activity the respiratory response is studied. Students need to know the basics of the respiratory response and the respiration physiology to understand the results of the experiment. This knowledge can be given in advance, but can also be gathered during this activity. In the latter case, it makes sense to let students read the Science Background. The difference in respiratory physiology during and after the various physiological challenges may vary per student. It makes sense to discuss this in class and link this to the CO2 and O2 concentration in the blood. Also the influence on the breath stimulus is relevant to respiratory physiology.
Animal Physiology	Animal skin	Measurement	Is it colder with your coat on?	In this activity students investigate with a simple experiments the function of fur. As an example, cotton wool is used (dry and greasy wool).
Animal Physiology	Respiration calculation	Measurement	Which invertebrates to excrete carbondioxide and use the largest amount of glucose?	In this activity students indicate carbon dioxide with calcium hydroxide and calculate the used glucose from the use oxygen
Animal Physiology	Respiration by maggots	Measurement	Do maggots respire?	In this activity students will study the respiration of maggots. Using a CO2 sensor (and optionally an O2 sensor) they measure the released CO2 in a closed container with maggots. In this activity concepts such as aerobic respiration are treated. The activity can be extended by changing the temperature of the maggots.
Plant Physiology	Photosynthesis (colour)	Measurement	Has the light color effect on the photosynthesis?	In this activity students examine the photosynthesis. Using an O2 sensor to measure the rate of photosynthesis at different colors of light. What color ensures the highest photosynthesis?
Plant Physiology	Photosynthesis for middle school	Measurement	How do plants get their energy?	In this activity students study the basic principles of photosynthesis using spinach leafs.
Plant Physiology	Photosynthesis long term	Measurement	How does photosynthesis influence the carbon dioxide and oxygen gas concentration in a long-term experiment?	In this activity photosynthesis and respiration is measured over two days. Two day-night cycles are covered and effects on the CO2 and O2 concentrations can be examined.
Plant Physiology	Respiration of plant seeds	Measurement	Respire plant seeds?	In this activity students investigate whether plants also respire. Most people know that animals respire but what about plants? By making use of germinating seeds, and a CO2 sensor, the respiration of plants seeds can be measured.
Plant Physiology	Photosynthesis (light intensity)	Measurement	Does light intensity effect photosynthesis?	In this activity students examine the photosynthesis. Using an O2 sensor to measure the rate of photosynthesis at different light intensity. How much disadvantage has a plant in the shade anyway?
Plant Physiology	Life in a pond	Modeling	What is the effect of plants, animals and light on the oxygen concentration in a pond?	In this activity students study life in a pond. From behind the computer they use an existing model to investigate the impact of plants, animals and light on the oxygen concentration in a pond. A fun activity in which respiration, photosynthesis and the influence of light are brought together.
Plant Physiology	Plant transpiration	Measurement	Can you visualize the transpiration of plants?	In this activity students investigate how much water evaporates from different kinds of plants, coming from dry or wet environments.
Research	Bad Atmosphere	Measurement	Is the quality of air different in an empty or crowded bus or metro?	With a datalogger students are going to measure a few variabels to measure the air quality in a bus, metro or train. Does the CO2 concentration change?

Topic	Title	Type	Driving question	Description
Microbiology	Ebola	Modeling	How does an ebola infection develop over time?	Our defense system is not an easy topic to understand. This model helps students to understand the topic more easily. Students can study the impact of factors such as incubation period and infection on the course of an Ebola virus infection. Through inquery based learning students learn the basics of a viral infection and important factors.
Microbiology	Sugar fermentation	Measurement	Does the sugar type affect the rate of alcoholic fermentation?	In this activity students measure the CO2 produced by yeast cells with a CO2 sensor. The rate of alcoholic fermentation of different types of sugar can be determined.
Microbiology	Effect of temperature on the fermentation	Measurement	Does the temperature affect the rate of fermentation?	In this activity students examine the affect of temperature on the fermentation rate of yeast cells. Using a gas pressure sensor the produced CO2 is measured.
Microbiology	Making yoghurt	Measurement	How does the pH rate change during the processof making yoghurt?	In this activity students make their own yoghurt. Yoghurt is a food product which is familiar to almost all students. The process of making yoghurt is less well known. Through the process of making yoghurt students discover that bacteria confert milk sugars into lactic acid.
Cell biology	Alcohol and membranes	Measurement	What effect do different alcohols have on cell membranes?	In this activity students study the (negative) effect of various alcohols on a cell membrane.

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CMA Activity database - Summary Physics

Topic	Title	Type	Driving question	Description
Motion in one direction	How to use Motion Detector	Data-logging	Can sound be used to measure distances?	In this activity students learn about "echolocation" and how sound can be used to measure distances. They use a Motion Detector and measure distances between the Motion detector and different objects; they measure how tall they are.
Motion in one direction	Graphing distance	Data-logging	How do you graph motion?	In this activity students record motion graphs. They are asked to walk in front of the Motion detector and a graph of distance vs. time is being plotted real-time on the computer or data-logger screen during their motion. Students are asked to interpret resulting graphs.
Motion in one direction	Match the graph	Data-logging	How do I have to walk to match a motion graph?	In this activity students walk in front of the motion detector to match the given distance vs. time graph
Motion in one direction	Understanding velocity	Data-logging	How to determine velocity of a moving cart?	In this activity students are asked to record the distance vs. time graph of a cart moving with a constant velocity. Based on the resulting graph they have to create the velocity vs. time graph and determine the velocity of the cart.
Motion in one direction	Graphing velocity	Data-logging	How to interpret 'velocity versus time' graphs?	In this activity students record the 'distance versus time' graph of a cart, which bounces between two limits set on a track. Such a set-up allows to record motions in two directions. The cart velocity is directly calculated and the 'velocity versus time' graph is simultaneously plotted during the cart motion. Students can directly focus on interpreting the resulting velocity graphs.
Motion in one direction	Match the graph v(t)	Data-logging	How do I have to walk to match a motion v(t) graph?	In this activity students walk in front of the motion detector to match the given velocity vs. time graph.
Motion in one direction	Understanding acceleration	Data-logging	How to determine acceleration of a moving cart?	In this activity students record distance vs. time and velocity vs. time graphs of a cart moving on an inclined track. Based on the measured data they have to determine acceleration of the cart.
Motion in one direction	Acceleration due to gravity I	Data-logging	What is acceleration due to gravity?	In this activity students use two photogates and measure the time that a ball takes to fall a distance between two photogates. They measure the distance between the photogates and calculate the acceleration due to gravity.
Motion in one direction	Acceleration due to gravity II	Data-logging	What is the relationship between the distance fallen and time of fall?	In this activity students use a free fall apparatus to measure the time of fall of a ball dropped from several different heights and find the relationship between the distance fallen and time of fall. They calculate the acceleration of gravity. In this activity NTL free-fall apparatus "Jumbo" is used (CMA art. code DM347-1F).
Motion in one direction	Analysing free fall with photo	Data Video	How to use a stroboscopic photo to analyse motion?	In this activity students analyse the motion of a freely falling ball from a stroboscopic photograph. They learn how to setup a stroboscopic image measurement and measure positions of the ball on the photo. Then they determine the velocity and acceleration of the falling ball.
Motion in one direction	Investigating velocity in free fall	Data-logging	How the velocity of a falling card depends upon the height it falls?	In this activity the time interval of the card passing through the photogate is measured. The velocity is calculated based on this measured interval and the length of the card. The emphasis of this experiment is on investigating the relationship between the velocity of the card and the distance it has fallen from rest.
Motion in one direction	Falling ball	Data Video	What is the acceleration of a freely falling ball?	In this activity students make a video analysis of a freely falling ball. They measure position the ball during its motion and determine its velocity and acceleration. To perform correct measurement students have to fist correct the perspective view of an image plane of motion; they learn how to apply the perspective correction tool of Coach
Motion in one direction	Throwing a ball	Data-logging	What is the acceleration of a ball thrown vertically upward?	In this activity students record and analyze the motion of a ball thrown straight upward. They identify different regions of the ball motion in the recorded graphs and determine the ball's acceleration.

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Motion in one direction	Moon jump	Data Video	What is the acceleration due to gravity on the Moon?	The events analysed via video measurements can be more unusual. In this activity such example is used, the jump on the Moon. Based on the video measurements of the jump students determine the acceleration due to gravity on the Moon.
Motion in one direction	Periodic motion	Data-logging	How the displacement of the spring and the mass hanging on the spring influence the period of spring oscillations?	In this activity students record position vs. time and velocity vs. time graphs of the periodical motion of a mass hanging on a spring. They interpret the resulting graphs and determine the period of the spring oscillations. They investigate how the amplitude of the spring and the mass hanging on the spring influences the period of the motion.
Forces and Newton's laws of motion	Falling shuttlecock	Data Video	What is the terminal velocity of a falling shuttlecock?	In this activity students measure the motion of the falling badminton shuttlecock in which the effects of air resistance are important and measurable. They interpret the motion graphs, estimate the terminal velocity of the shuttlecock and discuss the forces acting on the falling shuttlecock.
Forces and Newton's laws of motion	Air drag	Modeling	How does the drag force acting on a falling shuttlecock depend on its velocity?	In this activity students use the given model to describe the motion of a falling shuttlecock. In the model the drag force acting on the shuttlecock is not defined. By comparing the empirical data with the model data students find out which of the two models of air resistance, linear or quadratic drag, best describes the collected data.
Forces and Newton's laws of motion	The fall of a parachute jumper	Data-logging	How the terminal velocity of a parachute jumper depends on his mass and on a size of his parachute?	In this activity students use a model to investigate the motion of a parachute jumper. They analyse forces acting on the jumper during a jump and investigate the relationship between the terminal velocity and the mass of the jumper and diameter of the parachute. They determine a diameter of a parachute they would need for a safe jump
Forces and Newton's laws of motion	Friction	Data-logging	What is static and what is kinetic friction?	In this activity students investigate friction forces with the help of a friction block and the force sensor. A friction block is pulled from rest using a force sensor until it moves with constant velocity for a few seconds. A graph of the Force vs. time is created in real-time. The students determine the maximum static friction force and kinetic friction force.
Forces and Newton's laws of motion	Forces on cheerleaders	Data Video	What forces must be applied by the arms of the cheerleaders to keep a human tower in balance?	In this activity students measure the angles on the image and determine the forces applied by the arms of the cheerleaders.
Forces and Newton's laws of motion	Atwood's machine	Data-logging	How to determine gravitational acceleration by using Atwood's machine?	In this activity students use Atwood's machine to determine the gravitational acceleration g. Atwood's machine is made of two masses suspended over a pulley connected a photogate
Momentum and impulse	Hitting a softball	Data Video	What is an impulse experienced by the ball when it is hit with a baseball bat?	In this activity students measure on the movie showing a player hitting the softball. They measure the position of the moving ball and determine the velocity and momentum of the ball before and after the hit. Based on the impulse-momentum theorem they calculate the impulse experienced by the ball when it is hit with the bat. Having found the impulse on the ball, they calculate the force exerted by the bat on the ball.
Harmonic motion	Harmonic motion	Data-logging	What are the properties of simple and damped harmonic motion?	In this activity students measure spring oscillations using motion detector and force sensor and verify of the recorded oscillations are harmonic oscillations. Additionally they investigate the damped oscillations.

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Harmonic motion	Model of damped oscillations	Modeling	How to model damped oscillations?	In this activity students modify the given model of harmonic motion to construct a model of damped harmonic motion. Then by comparing the model data with the given experimental data they investigate which friction type (which friction formula) the best fits the friction in the experiment
Harmonic motion	Bungee jump	Data video	What is the maximal acceleration during a bungee jump?	In this activity students analyse a video clip with the bungee jump from a high crane. Students collect position and time data of the moving jumper. They analyse y(t), v(t) and a(t) graphs by looking at initial values, zero points, maximal values and slopes.
Heat and temperature	Newton's law of cooling	Data-logging	How fast an object cools down and what are the factors, which affect the rate of cooling?	In this activity students record temperature during a cooling process of hot water and check the validity of Newton's law of cooling for the collected data
Gas laws	Boyle's law	Data-logging	What is the relatioship between gas pressure and volume when temperature is kept constant?	In this activity students use the pressure sensor to measure the air pressure in the syringe depending on the volume of the air in the syringe. Based on the collected data students verify the Boyle’s law and determine the own volume of the sensor.
Gas laws	Absolute zero	Data-logging	How cold is at absolute zero?	In this activity, students measure pressures and temperatures of a gas sample, make a graph, and then extrapolate the data to determine the temperature at zero pressure. This gives them the temperature at absolute zero.
Sound	Sound waves	Data-logging	What is sound and what are sound properties?	In this activity students use the sound sensor and record sound waveforms from tuning forks.
Sound	Speed of sound	Data-logging	What is the speed of sound in air?	In this activity students determine the speed of sound in air. There are two measuring methods offered in the activity. Depending on an interface a different method can be used
Sound	Sound beats	Data-logging	What are sound beats?	In this activity students investigate concept of sound beats. They use the sound sensor and record the sound waveforms produced by two single tuning forks of different frequencies, first separate for each tuning fork and then for two tuning forks sounding simultaneously. Based on the collected data and the given assignments they discover how sound beats are created.
Sound	Human speech analysis	Data-logging	How do we recognise a human voice?	In this activity students use a sound sensor to record human voice sounds. By using signal analysis tools available in Coach they detrmine formants of the recorded speech waveforms.
Electric fields	Discharging a capacitor	Data-logging	How do capacitance and resistance values determine the time of discharging?	In this activity students use the voltage sensor to measure the potential across a capacitor as the capacitor discharges. They determine the time constant of the circuit. They investigate the effect of changing the capacitance of the capacitor and changing the resistance of the resistor on the time of discharging
Electric circuits	I(V) for a resistor	Data-logging	What is the relationship between current carried through, and voltage across a resistor?	In this activity students use the current and voltage sensors and measure the current carried through and voltage across a resistor while increasing the voltage. Students analyse the resulting graphs to discover the linear relationshop between current and voltage (Ohm’s law).
Electric circuits	Resistors in series and in parallel	Data-logging	What is the equivalent resistance for resistors connected in series and in parallel?	The goal of this experiment is to study circuits made up of two resistors in series, and two resistors in parallel, by using current and voltage sensors. Using the measured current and voltage values, equivalent resistance of series and parallel can be calculated.

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Electric circuits	I(V) for a light bulb	Data-logging	What is the relationship between current carried through and voltage across a light bulb?	In this activity students measure current carried through and the voltage across a light bulb when the voltage is varied. They discover that the relation between current and voltage is not proportional (non-ohmic materials). They calculate the resistance. By further processing the measurement data the relation between resistance (resistivity) and temperature of a bulb filament can be obtained.
Electric circuits	R(T) of a light bulb	Modeling	What is the relationship between resistance and temperature for a light bulb filament?	In this activity students use the given model and explore the relation between resistance (resistivity) and temperature of a filament (tungsten wire) like a one used in light bulbs. The data generated via model can be compared to the data collected in the experiment in which I(V) characteristic of a light bulb is recorded.
Electric circuits	Light bulb operated with AC voltage	Data-logging	At which rate does a light bulb flicker when connected to AC voltage?	In this activity students use a light sensor and record the light intensity of a light bulb operated with ac voltage. By using high frequency sampling students discover flickering of light. They determine the period and frequency of flickering and compare this value to the frequency of the ac voltage.
Electric circuits	Light intensity and AC voltage	Data-logging	How does frequency of AC voltage influence the light intensity of a light bulb?	In this activity students use a light sensor to record the light intensity of a light bulb and the voltage sensor to record the signal of alternative voltage. They investigate the relationships between the frequency of flashing light and the frequency of ac voltage and between the intensity of flashing light and the frequency of ac voltage.This activity can be used as an extension of the activity ‘Light bulb operated with ac voltage’.
Electromagnetic induction	Measuring induced emf	Data-logging	How does a graph of induced EMF in a coil look like when a magnet falls through the coil?	In this activity students measure the voltage induced in the coil when a magnet falls through a coil and determine the change of magnetic flux during the magnet's fall.
Radioactivity	Monitoring radiation	Data-logging	Are we exposed to radiation in our daily life?	In this activity students investigate the background radiation and radiation from natural sources. In both studies, the students observe the random nature of radiation.
Radioactivity	Alpha, Beta, Gamma	Data-logging	How can radiation be stopped?	In this activity students investigate penetrating properties of different radiation. They measure the effect of absorbers placed between the radioactive sources and the radiation sensor.
Radioactivity	Half-life of Barium-137m	Data-logging	What is the half-life of Barium-137m isotope?	In this activity students measure the radioactive half-life of a meta-stable isotope of Barium, Ba-137m. The Ba-137m is “milked” from a “radionuclide cow”. During the experiment the activity of the Ba-137m is measured with the radiation sensor.
Radioactivity	Radioactive decay	Modeling	How to model radioactive decay?	In this activity students explore radioactive decay via a given decay model. Based on the model they determine the function, which describes the radioactive decay. Further they modify the model to describe a decay of a real radioactive isotope e.g. Barium 137m and compare how well the model fits the experimental results.

CMA Activity database - Summary Chemistry

Topic	Title	Type	Driving question	Description
Biochemistry	Michaelis-Menten kinetics	Modeling	How do reactions involving enzymes progress?	In this activity students study the functionality and reactivity of an enzyme using a model. Using the model, they answer questions about the reaction rate and concentrations of the various substances at certain times. Once the model works correctly, the constants from the Michaelis-Menten equation for the reaction rate are calculated/determined. In order to check these calculations, students also create a double reciprocal plot (the Lineweaver-Burk diagram) in which the x and y intercepts also describe these constants. This topic deals with certain aspects of biochemistry, since it deals with enzymes and their functionality. This activity also deals with concepts as reaction rate and creating models of (chemical) systems. Some existing knowledge of graphical modeling using Coach is recommended. Students start with a basic model that describes the first half of the reaction (the reversible binding between E and S). They study this model and eventually expand it by adding the second half of the reaction in which ES is converted to E+P.
Chemical analysis	Lambert-Beer's law	Data-logging	What is the relationship between absorption of light and concentration?	In this activity students will investigate the relationship between the absorption of light and the concentration of a chemical in a solution and use this relationship to determine the concentration of an unknown solution. They will perform a standard quantitative analysis of an unknown sample using absorption spectroscopy.
Chemical analysis	Chloride concentration of sports drinks	Data-logging	What is the concentration of chloride-ions in a sports drink?	In this activity students will investigate the chloride concentration in a sports drink. This is done by precipitating the chloride-ions with silver ions and measuring the resulting turbidity. By comparing the measurement value to a calibration curve the concentration of chloride can be determined.
Chemical analysis	Methanol in wine	Data-logging	What is the concentration of methanol in white wine?	In this activity, students study the amount of methanol in white wine using gaschromatography. Performing this experiment gives them hands-on knowledge about operating a gaschromatograph and its practical applications and limitations.
Chemical analysis	Compostion of deodorant spray	Data-logging	What is the composition of deodorant spray?	In this activity, students study the composition of deodorant spray using gas chromatography. Performing this experiment gives them hands-on knowledge about operating a gas chromatograph and its practical applications and limitations.
Chemical analysis	Water quality	Data-logging	What is the relationship between turbidity and water quality?	In this simple experiment students determine the turbidity of water from various sources using a turbidity sensor. First they study the water using the naked eye, after which they use the sensor to adequately perform a quantitative analysis. This experiment is highly suitable for an investigation at middle school level.
Chemical analysis	Iodine and acetone	Data-logging	What is the reaction rate constant k in the reaction between iodine and acetone	In this activity students will investigate the relationship between the absorption of light and the concentration of a chemical in a solution. First they will create a calibration curve using samples of known concentration. Then, they will use this curve to determine the concentration of an unknown sample. Using this relation, they will perform three experiments to investigate the reaction kinetics of a specific reaction and transform a decrease in adsorption over time into a decrease of concentration over time. Using the resulting diagrams they will determine the reaction rate and reaction order for each component of the reaction and lastly calculate the value for the reaction rate constant k.

Topic	Title	Type	Driving question	Description
Chemical analysis	Determination of sulfate content (titration)	Data-logging	How can you determine the concentration of sulfate ions in waste water by measuring conductivity?	In this activity the students perform a conductivity titration to determine the sulfate content of a water sample. The equivalence point can be determined from the resulting curve. Unlike an acid-base titration (where the equivalence point is at the point where the largest change occurs) the equivalence point can be found where the conductivity is at a minimum. At this point, the least amount of charged particles (in this case ions) are present, resulting in a low conductivity. The minimum occurs due to the precipitation reaction between Ba2+ and SO42-. As the amount of SO42- in the solution decreases (and the volume increases), conductivity will decrease. Once all the sulfate has precipitated, the addition of extra Ba2+ will increase the conductivity.
Chemical analysis	Compostion of lighter fluid	Data-logging	What is the composition of lighter fluid?	In this activity, students study the composition of lighter fluid using gas chromatography. Performing this experiment gives them hands-on knowledge about operating a gas chromatograph and its practical applications and limitations.
Chemical analysis	Iron content of tea	Data-logging	Can a daily cup of tea contribute to the recommended iron intake?	In this activity students investigate the relationship between the extinction of light and the concentration of a dissolved substance. This relationship is then used to determine the unknown concentration of iron in a tea solution. Students carry out a standard quantitative analysis using spectrometry. Students can extract the iron from tea themselves. This makes the experiment more realistic: it resembles a real analysis in which an unknown extract is compared to a calibration curve.
Thermochemistry	Endo- and exothermic reactions	Data-logging	How does the temperature change during chemical reactions?	In this activity students measure the temperature change in four chemical reactions and classify the reactions as exothermic or endothermic.
Thermochemistry	Energy content of food	Data-logging	How much energy is there in food?	This is an activity in which different student groups can investigate different items of food. A sample of a food of known mass is burned, heating a calorimeter. Students record the temperature of water heated in the colorimeter, calculate the energy transferred to the water, and hence estimate the energy present per unit mass of food.
Thermochemistry	Heat of combustion	Data-logging	What is the heat of combustion of magnesium?	In this activity students will measure the temperature change of two different reactions. Using Hess's law, they will use the collected data and a literature value to determine the enthalpy of combustion for magnesium.
Thermochemistry	Hess's law	Data-logging	How can enthalpy change be measured?	In this activity students measure temperature during three different but related reactions. Based on the measurement results they determine the enthalpy change for each of three reactions. They used the results to test the validity of Hess' Law.
Thermochemistry	Flame temperature	Data-logging	In what way can the temperature of a flame be influenced?	This experiment is a quantitative adaptation of a well-known experiment about flame temperature. In that experiment, students place a wire gauze vertically in the flame. As the wire glows in certain areas, but stays relatively cold in others, students see that the flame is not homogeneously hot. In this experiment, they use a thermocouple sensor capable of measuring temperatures up to 1350 degrees Celsius to actually measure the temperature of the burner flame.
Thermochemistry	Investigating heat patches	Data-logging	How do heat patches work?	In this activity, students study heat patches. These patches contain a mixture of pyrophoric iron, carbon and water. After opening, the mixture comes into contact with oxygen resulting in the oxidation of the iron. This is an exothermic reaction. The patch becomes warm/hot. An important part of this activity is that students should come up with their own experimental setup. Ideally, they think to measure both temperature and oxygen concentration in a closed container.

Topic	Title	Type	Driving question	Description
Chemical equilibrium	Introduction to equilibrium	Data-logging	What is a chemical equilibrium?	In soda water a chemical equilibrium establishes between limestone (calcium carbonate), carbon dioxide and dissolved calcium hydrogen carbonate. In this activity students use a conductivity sensor to study the dynamical equilibrium of this reaction.
Chemical equilibrium	Distribution equilibrium	Modeling	Which factors influence the equilibrium time and composition of a distribution equilibrium?	In this activity students will investigate a distribution equilibrium of iodine in water and hexane. They will build a dynamic model to study how the various variables influence the (reaching of the) equilibrium
Chemical equilibrium	Compartment model	Modeling	Which factors influence the distribution of a (harmful) substance over a human body?	In this activity student will investigate and use a compartment model. The model assumes that the different tissues etc. in the body are closed off units (compartments) between which exchanges of substances can occur. In this activity, we will work with a three-compartment system: tissue, blood and bones. Students will build a dynamic model to study which variables influence the (formation of) an equilibrium. They will also study accumulation.
Chemical equilibrium	Drug uptake	Modeling	How does drug uptake work?	In this activity students will use the compartment model to study the uptake of drugs in the human body. The compartment model from an earlier activity is adapted and extended to incorporate the periodical use of drugs. This differs from the earlier activity in the fact that the exposure is no longer a continuous flow.
Chemical equilibrium	Gasses in equilibrium	Modeling	How can you model the equilibrium between N2O4 and NO2?	In this activity students study an existing model of an irreversible reaction of N2O4 to NO2 and expand it in order to create a chemical equilibrium. In order to teach students to critically assess a model, the concentration quotient has to be calculated at some point in the activity. This activity focusses on the essence of modelling and less on the workings of an equilibrium
Chemical equilibrium	Le Chatelier's principle	Modeling	How can a chemical equilibrium be disturbed and what are the effects of such a disturbance?	In this activity students continue studying the NO2/N2O4 equilibrium. By influencing the equilibrium using Events a disruption of the equilibrium can be simulated. A new equilibrium is established. The concentrations of the substances involved have changed and the equilibrium has shifted in order to counteract the disruption of the equilibrium. This way, students see Le Chatelier's principle at work and deepen their knowledge of chemical equilibria. Existing knowledge of chemical equilibria is required for this activity
Chemical kinetics	Factors affecting rates of reations	Data-logging	Which factors affect the rate of reaction of a chemical reaction?	In this activity students investigate several factors (temperature, the particle size and the concentration of one of the reactants) that affect the rate of the reaction of magnesium metal with hydrochloric acid. In this reaction, hydrogen gas is produced as a product thus pressure will increase if the reaction container is a closed system. A pressure sensor is used to measure the change in pressure during the reaction.
Chemical kinetics	Rate and order of reactions	Data-logging	What is the rate and order of the reaction of a solution of thiosulphate with hydrochloric acid?	In this activity students investigate the rate of reaction between thiosulphate-ions and hydrochloric acid. By using an turbidity sensor to measure the amount of light that passes through the mixture, the reaction rate can be determined. The reaction order can also be calculated from the results.
Chemical kinetics	Models of irreversible reactions	Modelling	How does de reaction speed change for irreversible reactions?	In this activity students will use models to study the workings of several types of irreversible reactions. Using these models, they will answer some questions about reaction speed, changes in concentration and how these effect each other. They will also make changes to these models to make the model match a "real" reaction. This activity consists of three subactivities (a, b and c) in which different types of reactions are studied.

Topic	Title	Type	Driving question	Description
Chemical kinetics	Crystal violet: model and measurement	Modelling	What is the relationship between the reactants and reaction speed?	In this activity students will compare a given model to an actual measurement. A solution of crystal violet (CV) has a purple colour. When this solution is mixed with a solution of sodium hydroxide, a reaction occurs. During this reaction, CV disappears and the mixture slowly becomes colourless. Students will develop a better understanding of what the variables and constants in a reaction rate equation represent. Especially the effect of the value of k is important, since that is the value that influences the slope of the graph and is the only way to generate a good fit of the model to the data.
Chemical kinetics	Effect of a catalyst	Data-logging	What is the effect of a catalyst on the decomposition of hydrogen peroxide?	In this activity students will investigate the decomposition of hydrogen peroxide. They will also determine the reaction equation. Students will first perform a “blank” measurement: a predetermined amount of hydrogen peroxide solution will react due to a predetermined amount of catalyst. After that, they will set up their own investigation to determine the effect of (the amount of) the catalyst on the reaction rate.
Chemical kinetics	Effect of surface area	Data-logging	What is the effect of surface area on the rate of a reaction?	In this activity students will investigate the influence of surface area on the reaction rate using effervescent tablets. Students will first perform a 'blank' measurement: one solid tablet will be mixed with water. After that, they will set up their own investigation to determine the effect of surface area on the reaction rate.
Chemical kinetics	Magnesium and hydrochloric acid (model)	Modelling	What is the reaction rate equation for the reaction between magnesium and a hydrochloric acid solution?	In this activity students investigate the reaction between magnesium and a solution of hydrochloric acid. They do this by comparing the results from a video measurement to the results of the model
States of matter	Cooling curve of stearic acid	Data-logging	How does the temperature change during the cooling of stearic acid?	In this activity, the cooling of stearic acid, changing from liquid to solid is studied. Students record the temperature of stearic acid as it cools.
States of matter	Evaporation of alcohols	Data-logging	How does the molecular mass of an evaporating alcohol affect the rate of evaporation?	In this activity students investigate process evaporation. They use a temperature sensor to record temperature changes during evaporation of alcohols. They investigate how the molecular mass of evaporating alcohol affects the rate of evaporation.
States of matter	Evaporation of water	Data-logging	How does the temperature change during the evaporation of liquids?	In this activity students investigate the process of evaporation and use a temperature sensor to record temperature changes during evaporation of water and alcohol.
States of matter	Distillation of red wine	Data-logging	How does the temperature change during the distillation of red wine?	In this activity the distillation of red wine is studied. It is a fairly basic experiment in which one temperature sensor is used and the results appear on the screen in real time. The method makes it possible to observe the whole process, to explore the rate of temperature changes and compare the measured values with theoretical predictions.
States of matter	Heating curve of water	Data-logging	How does the temperature change during the heating of water?	In this activity a simple change of state (the boiling of water) is studied. Students record the temperature of water as it is heated to boiling. This method makes it possible the observe the whole process, to explore the rate of temperature changes and compare measured values with theoretical predictions. Students then study how adding salt influences the boiling point.
States of matter	Critical micelle concentration	Data-logging	What is the critical micelle concentration of sodium dodecylsulfate?	In this activity students carry out a relatively simple experiment: a soap solution is added to distilled water at a constant rate. The (increasing) conductivity of the solution is continually monitored using a sensor. A graph of conductivity vs. added volume of soap solution is produced. This activity deals with the formation of micelles. Students relate the movement of ions through the solution to the increase in conductivity, but at some point the size of the particle (the micelle) becomes relevant.

Topic	Title	Type	Driving question	Description
States of matter	Cooling curve of water	Data-logging	How does the temperature change during the cooling and freezing of water?	In this activity a simple change of state (the freezing of water) is studied. It is a basic experiment in which one temperature sensor is used and the temperature measurements appear on the screen in real time. Using this method it is possible to follow the temperature during the entire process of cooling and freezing in order to study the changes in temperature that occur and compare these to theoretical frameworks. Students then study how adding salt influences the freezing point.
Acids and bases	Acidic of basic?	Data-logging	Is a tested household substance acidic or basic?	In this simple experiments students predict whether various household solutions are acidic, basic or neutral and test their hypotheses by measuring with a pH sensor.
Acids and bases	Acid-base titration	Data-logging	How can you determine a concentration of an unknown acidic solution?	In these activity students use the titration method to determine unknown concentrations of acid solutions.
Acids and bases	Limewater	Data-logging	What is limewater and how does it work?	In this experiment students will investigate how limewater works. Students will investigate the ability to capture carbon dioxide using the CO2-sensor. By introducing limewater into an environment containing a high amount of CO2, the amount of CO2 will decrease. Next, students will investigate how the conductivity of the solution changes as carbon dioxide is added to the solution.
Acids and bases	Soda geyser and pH	Data-logging	How does the pH change during the "soda geyser" experiment and which variables are relevant to this process	In this experiment students investigate the pH-change as a result of the fast release of CO2. By removing the CO2, the amount of carbonic acid will decrease and the soda should become less acidic (higher pH). If the measurement is carried out accurately enough, this effect can be measured. The experiment is student driven. After an initial demonstration of the geyser and/or an instruction about the pH-sensor the students are required to come up with their own experimental setup for measuring the pH during the experiment. Students should also think about the complications their idea will cause.
Acids and bases	Titration with step motor burette	Data-logging	How can you determine a concentration of an unknown acidic solution?	In this activity students will carry out a titration to determine the concentration of an acidic solution. The equivalence point can be determined from the titration curve. Compared to a “regular” titration, the use an automated step motor burette adds an extra dimension to the experiment, allowing for addition of the base using constant speed. In that regard, this experiment focusses on setting up the experiment and analyzing the results. The actual execution of the experiment is done automatically once the student presses Start.
Acids and bases	Conductivity titration with step motor burette	Data-logging	How can you determine a concentration of an unknown acidic solution by measuring conductivity?	In this activity students will carry out a titration to determine the concentration of an acidic solution. The equivalence point can be determined from the curve. Unlike a pH curve (in which the equivalence point is the point where the largest change in pH occurs) the equivalence point in a conductivity curve is where the conductivity is at a minimum. This is the point where the least amount of charged particles (ions) are present to facilitate conductivity, so that conductivity is at its lowest. Compared to a “regular” titration, the use an automated step motor burette adds an extra dimension to the experiment, allowing for addition of the base using constant speed. In that regard, this experiment focusses on setting up the experiment and analyzing the results. The actual execution of the experiment is done automatically once the student presses Start.

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Topic	Title	Type	Driving question	Description
Acids and bases	Titration curve of amino acids	Data-logging	How is the reactivity and appearance of an amino acid influenced by the environment?	In this activity, students perform a titration of a random amino acid. The goal is to get hands on knowledge and experience with: amphoteric compounds, amino acids as zwitterions, the iso electric point and buffers. The amino acid is first completely protonated, after which a titration with sodium hydroxide solution is performed.
Redox reactions	Iron content of steel wool	Data-logging	What is the iron content in steel wool?	In this activity students will carry out a titration to determine the iron content in steel wool. The equivalence point can be determined from the titration curve. Compared to a "regular" titration, the use an automated step motor burette adds an extra dimension to the experiment, allowing for addition of the base using constant speed. In that regard, this experiment focusses on setting up the experiment and analyzing the results. The actual execution of the experiment is done automatically once the student presses Start.
Redox reactions	The blue bottle	Data-logging	How does the blue bottle work?	In this activity students are given a stoppered erlenmeyer flask containing a colorless (maybe slightly yellow) liquid. To introduce the phenomenon, the teacher shakes the bottle. The students take it from there and use amongst other possibilities an ORP-sensor to investigate the phenomenon.