

2026/27 Open Chemistry Olympiad Competition Problems
Junior group (Up to Year 10)
2nd october 2026

1. Clear as Limewater

(10 p)

The elements **A–E** react with one another to form a variety of compounds. The reaction between **A** and **B** produces the common compound **F**, whose volume increases upon freezing. The molar mass of gas **B** is 80% of the molar mass of element **C**. When **C** reacts with **F**, substances **G** and **A** are formed. **G** is sparingly soluble in water. Its clear aqueous solution, from which any undissolved **G** has been removed, is called limewater. Limewater is used in the laboratory to identify gas **I**, because the reaction between **G** and **I** produces **F** and the insoluble compound **M**, which turns the clear limewater milky. Compound **M** occurs naturally in several types of rock, including marble and limestone.

Gas **I** can be prepared by reacting the binary compound **H** with element **B**. When compound **I** reacts with element **D**, compound **H** is formed. The most abundant isotope of element **D** was adopted in 1961 as the basis for defining the atomic mass unit.

The reaction between substances **J** and **D** produces gas **H** and the binary compound **K**, which is used in pest control to repel moles. For this purpose, **K** is placed in the soil, where it reacts with substance **F** present in the soil. This reaction produces substance **G** and gaseous substance **L** ($M_L = 26 \text{ g/mol}$).

The reaction between elements **B** and **E** produces the binary compound **N**, which can react further with element **B** to form compound **O** ($w_E = 40.05\%$). Element **E** is a yellow, brittle substance used in greenhouses to eliminate pathogens. For this purpose, substance **E** is burned in an empty greenhouse in spring, after which the greenhouse is kept closed for several days. The greenhouse must not be entered after **E** has been burned because its combustion produces substance **N**, which is toxic and irritating to the respiratory tract. In addition, substance **N** can react further with substance **F** present in the greenhouse to form the corrosive compound **P**.

a) Identify substances **A–P** and write their chemical formulas. (8)

b) Give the chemical names of substances **K**, **L**, **M** and **P**. (2)

2. Versatile Inorganic Chemistry

(10 p)

The red liquid **X**, composed of atoms of three different elements in a molar ratio of 1 : 1 : 1, can be prepared by passing the colorless gas **A** into liquefied gas **B** at low temperature (**reaction 1**). Gas **A** is 1.035 times denser than air ($M_{\text{air}} = 29 \text{ g/mol}$). Compound **X** disproportionates upon reaction with water to form acids **C** and **D** and gas **A** (**reaction 2**).

The strong oxidizing properties of **X** can be demonstrated by several redox reactions. When compound **X** is pipetted into an aqueous solution of potassium iodide, the reaction mixture turns dark brown (**reaction 3**). When compound **X** is added to a solution of hydrogen sulfide in diethyl ether (an organic solvent), a pale yellow precipitate forms (**reaction 4**). **Reactions 3** and **4** produce water-soluble salts whose anions can be identified using a suitable silver(I) salt.

Compound **X** is also formed when concentrated acids **C** and **D** are mixed in a volume ratio of 1 : 3 (**reaction 5**). This acid mixture is capable of dissolving several noble metals. When an alloy of gold and platinum is dissolved in this acid mixture, gold forms the complex acid **E** ($w_{\text{gold}} = 57.97\%$, oxidation state of Au = III), while platinum forms the complex acid **F** ($w_{\text{platinum}} = 47.61\%$, oxidation state of Pt = IV) (**reaction 6**). In **reaction 6**, a reddish-brown gas **G** is evolved.

a) Write the molecular formulas of **A**, **C**, **D**, **E**, **F**, and **G**. (3)

b) Write and balance the equations for **reactions 1–6**.

(7)

1. $\text{A} + \text{B} \rightleftharpoons \text{X}$

2. $X + \text{water} \rightarrow C + D + A\uparrow$
3. potassium iodide + $X \rightarrow \dots + \dots$ (salt) + $A\uparrow$
4. hydrogen sulfide + $X \rightarrow \dots\downarrow + \dots$ (salt) + water
5. $C + D \rightarrow X + B\uparrow + \text{water}$
6. $\text{Au} + \text{Pt} + C + D \rightarrow E + F + G\uparrow + \text{water}$

3. Environmental Chemistry

(11 p)

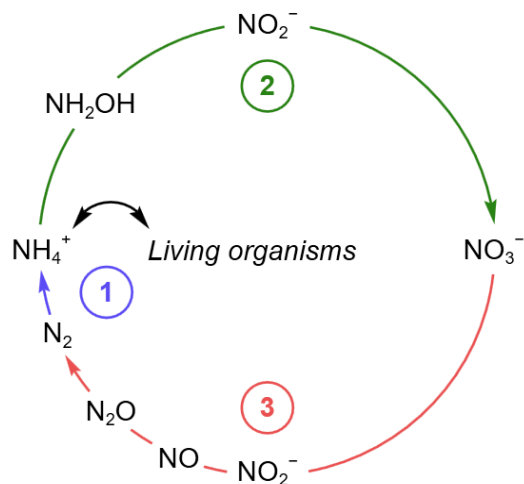
Nitrogen present in nitrate ions in water and soil is referred to as nitrate nitrogen (NO_3^- -N). Similarly, phosphorus present in phosphate ions is referred to as phosphate phosphorus (PO_4^{3-} -P). Excess nitrate nitrogen and phosphate phosphorus promote algal growth and eutrophication in bodies of water, resulting in a decrease in the oxygen content of the water.

- a) The maximum permitted concentration of nitrate nitrogen in drinking water is 50 mg/dm^3 . Calculate the number of nitrate ions in one cubic decimeter of such drinking water. (1)
- b) The phosphorus content of fertilizers is usually expressed as diphosphorus pentoxide. Calculate the mass percentage of phosphorus in 10.0 kg of fertilizer containing 10.0% by mass of diphosphorus pentoxide. (1)

Using the ratio between the molar mass of an ion and the atomic mass of the corresponding element, the mass concentration of an ion can be converted to the mass concentration of the element contained in that ion, and vice versa. The flow rate of treated wastewater discharged from a wastewater treatment plant into a river is $120 \text{ m}^3/\text{h}$, and its nitrate nitrogen concentration is $c = 3.10 \text{ mg/dm}^3$. The flow rate of the river is $2200 \text{ m}^3/\text{h}$, and the nitrate ion concentration in the river water is $c = 210 \text{ }\mu\text{g/dm}^3$.

- c) Calculate the:
 - i) mass concentration ($\mu\text{g/dm}^3$) of nitrate nitrogen in the river water; (1)
 - ii) total mass (μg) of nitrate nitrogen discharged from the wastewater treatment plant in one hour; (0.5)
 - iii) total mass (μg) of nitrate nitrogen carried by the river water in one hour; (0.5)
 - iv) mass concentration ($\mu\text{g/dm}^3$) of nitrate nitrogen after the treated wastewater and river water have mixed. (1)

The nitrogen cycle is the cycling of nitrogen and its chemical compounds within an ecosystem, as illustrated in simplified form in the accompanying diagram. First, atmospheric nitrogen is converted into ammonia, a form that is bioavailable to living organisms (1). Through nitrification, ammonia is converted into nitrate (2), which is then converted back into nitrogen through denitrification (3).



- d) Choose the correct term in each sentence. (1)
 - i) During nitrification, nitrogen is *oxidized* / *reduced*.
 - ii) During denitrification, nitrogen is *oxidized* / *reduced*.
- e) Balance equations i)–iv). (2)
 - i) $\dots \text{N}_2 + \dots \text{H}^+ + \dots \text{e}^- \rightarrow \dots \text{NH}_3 + \dots \text{H}_2$
 - ii) $\dots \text{NH}_3 + \dots \text{H}_2\text{O} \rightarrow \dots \text{NH}_2\text{OH} + \dots \text{H}^+ + \dots \text{e}^-$
 - iii) $\dots \text{NH}_4^+ + \dots \text{O}_2 \rightarrow \dots \text{NO}_2^- + \dots \text{H}^+ + \dots \text{H}_2\text{O}$
 - iv) $\dots \text{NO}_3^- + \dots \text{H}^+ + \dots \text{e}^- \rightarrow \dots \text{N}_2 + \dots \text{H}_2\text{O}$

- f) Hydroxylamine (NH_2OH) is a weakly basic intermediate in the nitrogen cycle. Draw the Lewis structure of protonated NH_2OH in an acidic aqueous solution. (1)

In some cases, bacteria carrying out denitrification use acetate of organic origin to reduce nitrate.

- g) Balance the following reaction equation. (1)
- $$\dots \text{CH}_3\text{COOH} + \dots \text{NO}_3^- \rightarrow \dots \text{N}_2 + \dots \text{CO}_2 + \dots \text{H}_2\text{O} + \dots \text{OH}^-$$
- h) Based on the reaction equation in part g), calculate the volume, in cubic decimeters, of CO_2 produced under standard conditions when 10.0 mmol of nitrate ions are reduced. (1)

4. Soft Drink

(7 p)

Mikk wanted to make a sweet drink. He knew that 100 mL of cola contains 10.6 g of sugar, so he thought that his drink should have the same sugar content.

- a) i) How many teaspoons of sugar should Mikk use to prepare 500 cm³ of a drink with this sugar content? Assume that one teaspoon of sugar has a mass of exactly 4.2 g. (0.5)
- ii) How many grams of water should Mikk add to the sugar to obtain 500 cm³ of a drink with this sugar content? The density of the resulting drink is 1.04 g/cm³. (1)

Mikk tasted the resulting drink, but unfortunately found it unbearably sweet. In fact, cola also contains phosphoric acid, whose acidity makes the high sugar content of the drink more tolerable. In the school chemistry laboratory, Mikk determined the phosphoric acid concentration in cola by titration and found it to be 7.0 mmol/dm³. Coincidentally, the chemistry laboratory also had an 85% phosphoric acid solution.

- b) To determine the amount of phosphoric acid, Mikk used its reaction with sodium hydroxide. Write and balance the equations for the reactions between sodium hydroxide and phosphoric acid in which...
- i) only the most acidic hydrogen atom in the phosphoric acid molecule reacts with sodium hydroxide; (1)
- ii) all hydrogen atoms in the phosphoric acid molecule react with sodium hydroxide. (1)
- c) How many mg of 85% phosphoric acid solution should be added to 500 cm³ of Mikk's drink to obtain the same phosphoric acid concentration as in cola? Assume that the volume of the added solution is sufficiently small that it does not affect the volume of the drink. (1)

Although the addition of phosphoric acid improved the drink, unlike commercially available soft drinks, it was not carbonated. Mikk decided to determine how much CO_2 is present in 500 cm³ of cola. To do this, he heated the drink and passed the evolved gas through a saturated solution of barium hydroxide. Mikk separated and dried the salt that formed; after drying, its mass was 14.1 g.

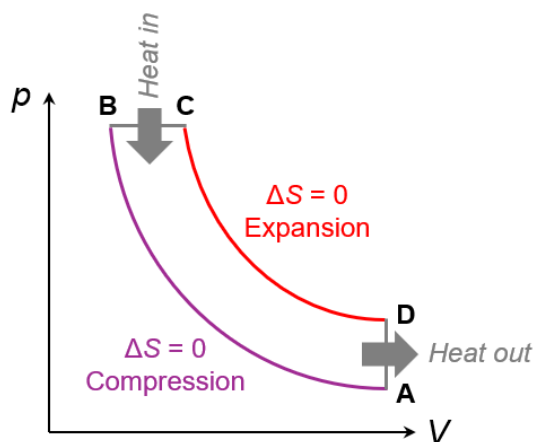
- d) Write the balanced equation for the reaction between barium hydroxide and carbon dioxide. (0.5)
- e) i) Calculate the mass of CO_2 in the cola, assuming that the reaction proceeded to completion and that the salt formed was completely insoluble. (1)
- ii) Calculate the mass percentage of CO_2 in the cola. (0.5)
- iii) What volume would the CO_2 contained in 500 cm³ of cola occupy under standard conditions? (0.5)

5. Sparkless Ignition

(10 p)

In a diesel engine, the chemical energy stored in the fuel is converted during combustion into heat and, in part, into mechanical work. Unlike in a gasoline engine, the fuel in a diesel engine is not ignited by an electric spark. Instead, the air drawn into the cylinder is strongly compressed before the fuel is added, and the fuel is injected into the hot compressed air.

The operation of a diesel engine can be described in a simplified manner using the **Diesel cycle**. Between points A and B, the air in the cylinder is compressed adiabatically. In an adiabatic process, the gas does not



exchange heat with its surroundings. At point **B**, the expansion, or power stroke, begins, during which the gases perform useful work and thereby provide mechanical energy to the engine. During **B** $\rightarrow$ **C**, fuel is injected into the cylinder and combustion takes place. In the ideal Diesel cycle, this is treated as an isobaric, or constant-pressure, process during which the volume of the gas increases. During **C** $\rightarrow$ **D**, the gases continue to expand adiabatically without any additional heat input until point **D**, where the power stroke ends. The cycle is completed by **D** $\rightarrow$ **A**, which is treated as heat rejection at constant volume, i.e. an isochoric process.

Many passenger cars have four-cylinder engines, but in this problem we consider the operation of only one cylinder. The displacement volume of the cylinder, i.e. the volume swept by the piston, is $V_{\text{work}} = 0.500 \text{ dm}^3$. When the piston is at its uppermost position, a gas volume of $V_B = 31.25 \text{ cm}^3$ remains in the cylinder. At the beginning of compression, the air temperature is $T_A = 300 \text{ K}$ and the pressure is $p_A = 1.00 \text{ bar}$. The compression ratio of the engine is given by $r = V_A/V_B$, where V_A is the gas volume at the beginning of compression.

a) i) Calculate the volume V_A and **ii)** calculate the compression ratio r of the engine. (1)

For the reversible adiabatic compression of an ideal gas, the following relations apply: $TV^{\gamma-1} = \text{const}$ and $pV^{\gamma} = \text{const}$.

b) i) Determine the air temperature T_B at the end of compression and **ii)** the air pressure p_B at the end of compression. Use $\gamma = 1.40$ for air. (2)

Diesel fuel ignites at a sufficiently high temperature even without an electric spark. In this simplified model, assume that the fuel used undergoes autoignition at temperatures of at least $T_{\text{ign}} = 530 \text{ K}$. The autoignition temperature is the lowest temperature at which a substance spontaneously ignites in air without an external spark or flame.

c) i) Determine whether the temperature of the compressed air is high enough for the fuel to autoignite. Justify your answer using the calculated temperature. (0.5)

ii) In the ideal model, the **A** $\rightarrow$ **B** process is treated as a reversible adiabatic process. Determine whether the entropy of the air in the cylinder changes during this process. (0.5)

Diesel fuel is a mixture of many hydrocarbons. In addition to hydrocarbons, it also contains very small amounts of various lubricants and other additives that improve its properties. For simplicity, however, we may assume that the fuel consists entirely of cetane ($\text{C}_{16}\text{H}_{34}$).

d) Assume that at a certain point, 34.0 mg of cetane is injected into the cylinder. (1.5)

i) Balance the equation for the complete combustion of cetane. Use integer coefficients.

ii) Calculate the amount of substance of the injected cetane.

iii) Calculate the amount of substance of oxygen required for the complete combustion of the cetane.

We will now check whether there is actually enough oxygen in the cylinder. By amount of substance, air consists of approximately 21.0% oxygen and 79.0% nitrogen. The total pressure of a mixture of ideal gases is equal to the sum of the partial pressures of the gases in the mixture: $p = p_1 + p_2 + \dots + p_n$. The partial pressure p_i of a component is related to its mole fraction x_i by $p_i = x_i p$. For an ideal gas, the equation of state is $pV = nRT$, where $R = 8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$. $1 \text{ bar} = 1.00 \cdot 10^5 \text{ Pa}$.

e) i) Using the total pressure p_B obtained in part **b) ii)**, calculate the partial pressure of oxygen, p_{O_2} , at point **B**. (1)

ii) Using the partial pressure of oxygen, T_B , and V_B , calculate the amount of substance of oxygen in the cylinder using the ideal gas equation. (1.5)

iii) Compare your result with the amount of oxygen required, as calculated in part **d) iii)**. Determine whether there is enough oxygen for the complete combustion of all the injected cetane. (0.5)

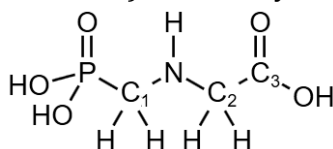
The molar enthalpy of combustion of cetane is $\Delta_c H = -10.7 \text{ MJ}\cdot\text{mol}^{-1}$. In a real engine, not all of

the energy released during combustion is converted into mechanical work. Assume that 40% of the energy released by the combustion of the fuel is converted into useful mechanical work.

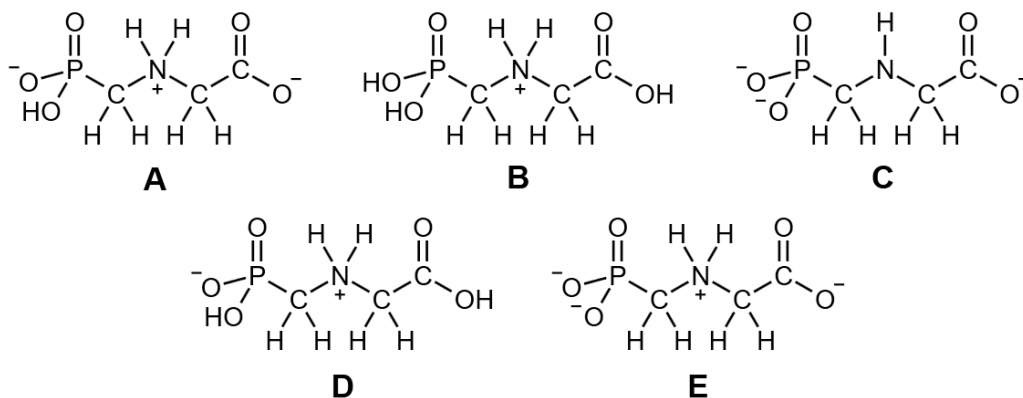
- f) **i)** Calculate the energy released by the complete combustion of the cetane injected during one engine cycle, in kilojoules (kJ). (1)
- ii)** Calculate the useful mechanical work obtained during one engine cycle if the efficiency of the engine (η) is 40%. Give your answer in kilojoules. (0.5)

6. The Chemistry of Glyphosate (10 p)

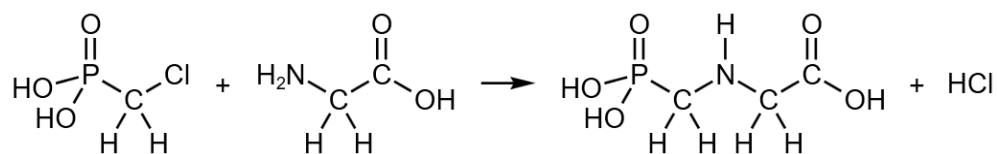
Glyphosate (see the structural formula below) is a widely used herbicide in agriculture.



- a) Determine the oxidation states of the carbon atoms labeled **1–3** in the glyphosate molecule. (1.5)
- b) Calculate the mass percentage (%) of phosphorus in the glyphosate molecule. (0.5)
- c) Calculate the number of carbon atoms in 1.00 mg of glyphosate. (1)
- The glyphosate molecule can be represented in two ways: in its neutral or ionized form. In aqueous solution, glyphosate exists in different charged forms depending on the pH of the solution.
- d) Determine whether the **i)** carboxyl group ($-\text{COOH}$), **ii)** amino group ($-\text{NHR}$, where R is a substituent), and **iii)** phosphonic group ($-\text{PO}(\text{OH})_2$) have acidic or basic properties. (1.5)
- e) Arrange the ionic forms **A–E** of glyphosate in order of **increasing** pH of the aqueous solution. (2.5)



Historically, glyphosate has been synthesized from chloromethylphosphonic acid and the amino acid glycine.



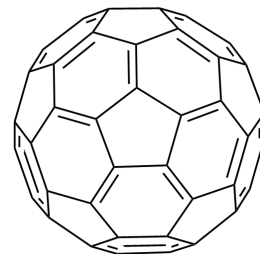
- f) Calculate the volume, in cubic centimeters, of $0.1500 \text{ mol} \cdot \text{dm}^{-3}$ (M) aqueous NaOH solution required to neutralize the gaseous HCl produced by the complete reaction of 0.50 kg of chloromethylphosphonic acid under standard conditions. (2)

7. Geometric Molecules

(10 p)

Fullerenes are allotropes of carbon whose molecules form closed polyhedra. In the following, we consider only fullerenes whose surfaces consist of pentagons and hexagons. Each vertex of the polyhedron corresponds to one carbon atom, and each edge corresponds to one chemical bond between carbon atoms. Exactly three edges meet at each vertex. For a convex polyhedron, Euler's formula applies, where V , E , and F denote the numbers of vertices, edges, and faces, respectively:

$$V - E + F = 2$$



Let the molecular formula of a fullerene be C_n , the number of pentagons be p , and the number of hexagons be h .

- Express the number of edges E of the fullerene in terms of the number of carbon atoms n . Calculate the sum of the coefficients in the relation. Write the relation in the form $E = xn + y$ and give $x + y$ as your answer. (1)
- Express the number of edges E of the polyhedron in terms of p and h by **i)** counting the edges of the faces of the polyhedron and **ii)** using Euler's formula. Calculate the sum of the coefficients in each relation. Write the relations in the form $E = xp + yh + z$ and give $x + y + z$ as your answer. (2)
- Using your answers to the previous questions, express in terms of the number of carbon atoms n : **i)** the number of pentagons p and **ii)** the number of hexagons h . Calculate the sum of the coefficients in each relation. Write the relations in the forms $p = xn + y$ and $h = xn + y$, and give $x + y$ as your answer. (2)
- Calculate the numbers of pentagons p , hexagons h , and edges E in the fullerenes **i)** C_{60} and **ii)** C_{70} . (1)

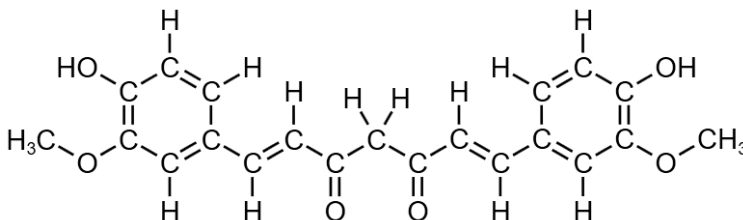
In C_{60} fullerene, no two pentagons share an edge. We refer to a bond between a pentagon and a hexagon as a 5-6 bond, and a bond between two hexagons as a 6-6 bond.

- Determine the number of **i)** 5-6 bonds, N_{5-6} , and **ii)** 6-6 bonds, N_{6-6} , in C_{60} . (2)
- In a simplified chemical model, all 6-6 bonds are treated as double bonds and all 5-6 bonds as single bonds. During bromination of a fullerene (reaction with molecular bromine), one Br_2 molecule adds across each double bond.
- i)** Write the molecular formula of the product formed upon complete bromination of C_{60} , and **ii)** calculate the maximum mass, in grams, of bromine that can add to 360 mg of C_{60} fullerene. (2)

8. Reddishwhite Photography

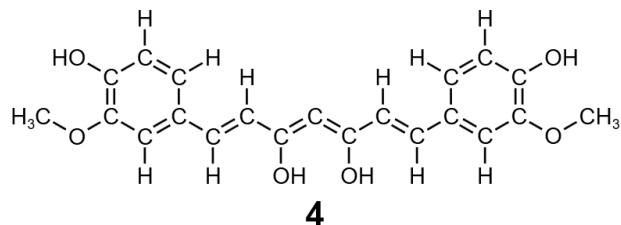
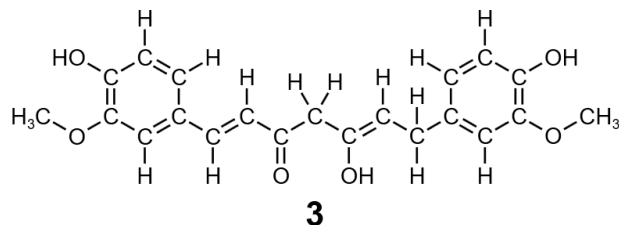
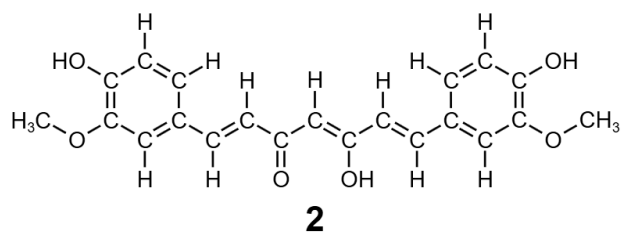
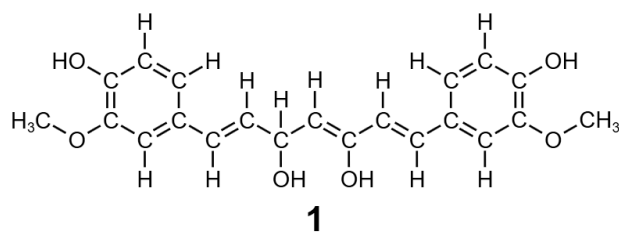
(10 p)

One of the most common types of anthotype (from the Greek άνθος, "flower," and τύπος, "print") is turmeric anthotype, in which the photosensitive plant pigment is curcumin, the yellowish-orange pigment found in turmeric powder (see the structural formula below).



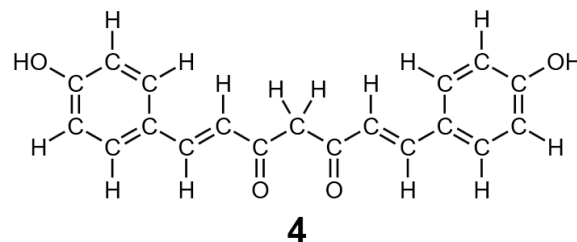
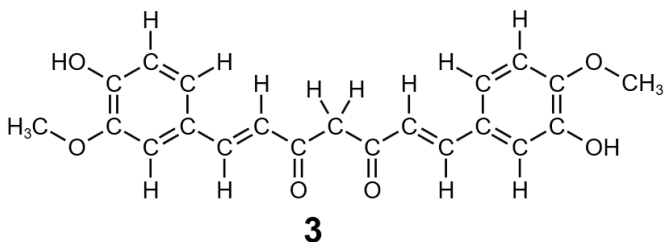
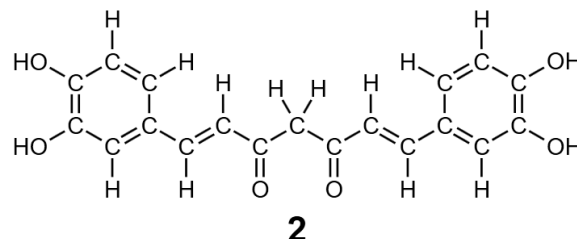
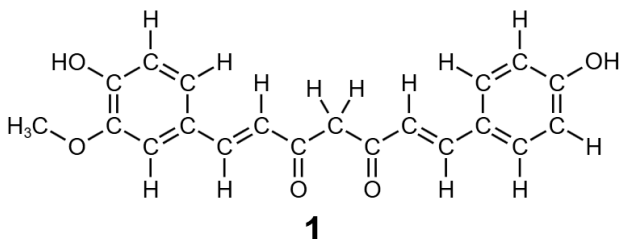
Like many 1,3-diketones, curcumin occurs naturally as a keto-enol tautomer.

- Choose which of the structures **1-4** below represents the enol form of curcumin. *Hint: its IUPAC name is (1E,4Z,6E)-5-hydroxy-1,7-bis(4-hydroxy-3-methoxyphenyl)hepta-1,4,6-trien-3-one.* (1)

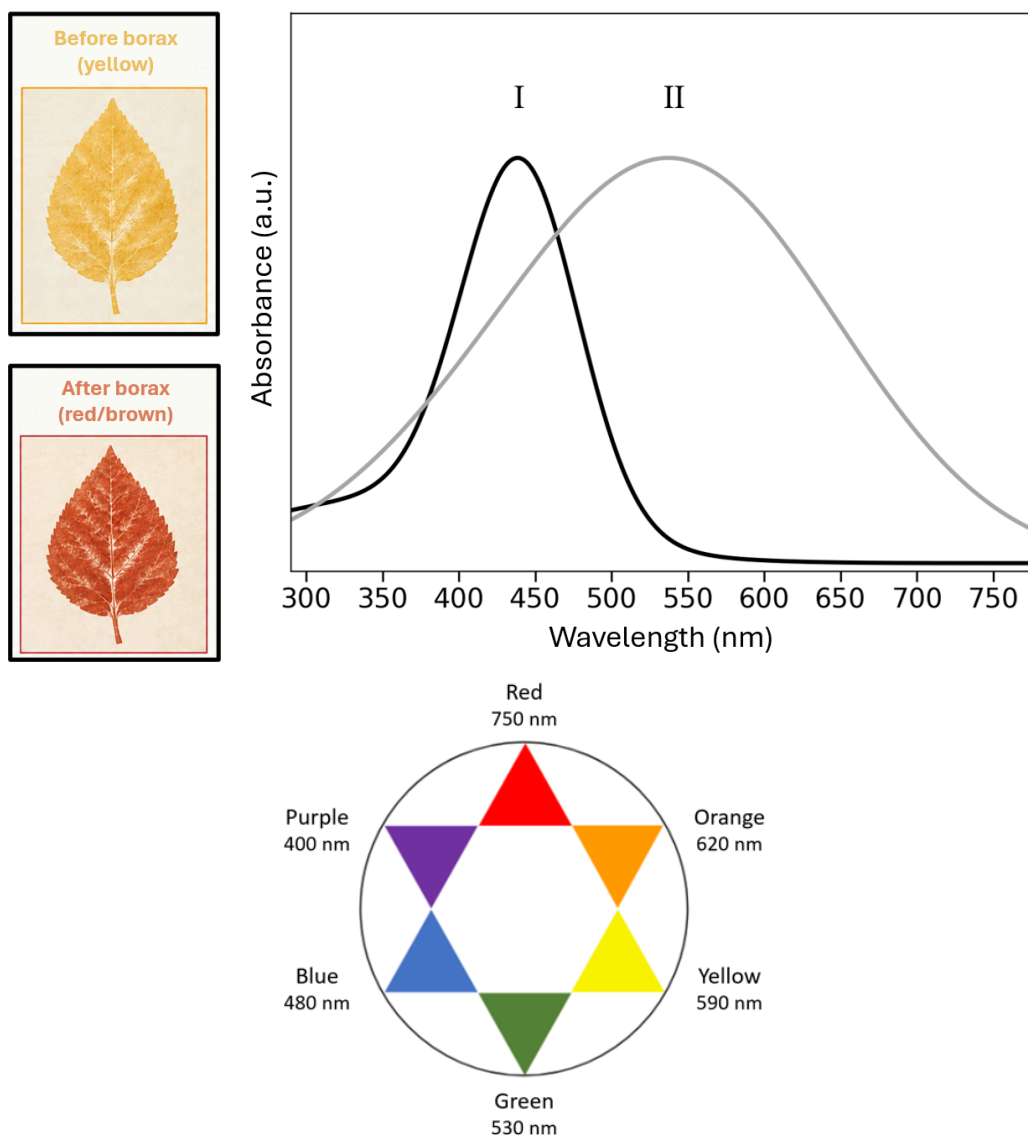


In addition to curcumin, natural turmeric powder also contains smaller amounts of demethoxycurcumin (molecular formula $C_{20}H_{18}O_5$) and bisdemethoxycurcumin ($C_{19}H_{16}O_4$).

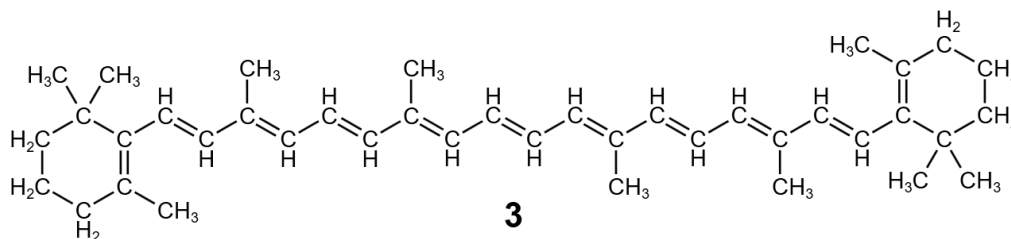
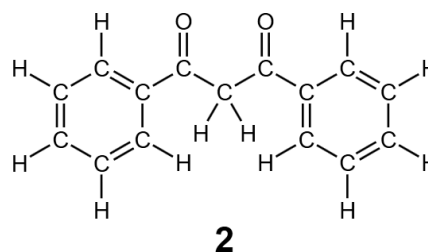
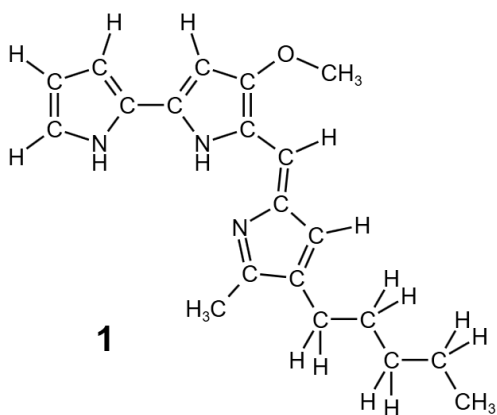
b) From structures **1–4** below, choose the structural formulas of **i)** demethoxycurcumin and **ii)** bisdemethoxycurcumin. (2)



During the anatype process, a selected object (e.g. a leaf) is placed on paper impregnated with a plant pigment, and the paper is exposed to light until the photosensitive pigment not covered by the object decomposes under UV light. The object is then removed, leaving its image on the paper. Turmeric anatype differs from other types of anatype in that a developing solution is used. After exposure to light, the photographic paper is treated with a solution of borax ($Na_2B_4O_7$, sodium tetraborate). The undecomposed curcumin reacts with $B(OH)_4^-$ ions present in the solution to form the reddish-brown complex **A** ($C_{21}H_{21}BO_8$), which does not decompose upon exposure to light, thereby producing the final image.



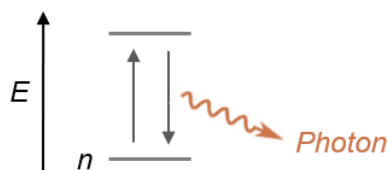
- c) Choose which of the absorption spectra shown above (I or II) corresponds to **i)** curcumin and **ii)** complex **A**. Use the complementary color wheel for visible light to interpret the spectra. (0.5)
- d) Choose the geometry (electron-domain geometry) of the $\text{B}(\text{OH})_4^-$ ion. (0.5)
- ☐ Linear
 - ☐ Tetrahedral
 - ☐ Octahedral
 - ☐ Trigonal planar
- e) Draw the structural formula of complex **A** ($\text{C}_{21}\text{H}_{21}\text{BO}_8$). (3)
- The natural yellowish-orange color of curcumin arises from the light absorption associated with its conjugated carbon chain and aromatic phenyl groups.
- f) **i)** Determine which of the molecules (**1–3**) below could have a color similar to that of natural curcumin. (1)
- ii)** Determine which of the molecules below could react with borax in a manner similar to curcumin. (1)
- iii)** Determine which of the molecules below also has a naturally occurring demethoxy analogue. (1)



9. Illuminati (Latin: enlightened)

(10 p)

Light-emitting diodes (LEDs) convert electrical energy into light using semiconductors. In a semiconductor, an electron is excited from a lower energy level n to a higher energy level, after which it “falls” back to the lower energy level and releases a photon.



Semiconductor materials are commonly produced by chemical vapor deposition, in which volatile compounds are used as precursors and react to form a solid product. The volatile compounds are often trimethyl compounds (compounds containing three methyl groups ($-\text{CH}_3$)).

a) Draw the planar structural formula of trimethylgallium ($\text{Ga}(\text{CH}_3)_3$). (1)

Two common semiconductor materials used in LEDs are the nitrides InN and GaN , which emit infrared and ultraviolet light, respectively. To obtain intermediate colors, the material $\text{In}_x\text{Ga}_{1-x}\text{N}$ is produced. The color of the emitted light falls somewhere within the visible region depending on the value of x .

b) Write and balance the reaction equation for the preparation of $\text{In}_x\text{Ga}_{1-x}\text{N}$ when $x = 0.2$ using trimethylindium, trimethylgallium, and ammonia as the starting materials. (1)

c) During the preparation of 1.00 grams of a semiconductor material with an unknown indium fraction, 0.0282 mol of methane was released. Calculate the indium fraction x in the semiconductor material. (2)

The energy, and therefore the color, of the emitted photon is determined by the band gap of the material, i.e. the energy difference between the levels involved in the electron transition. Producing a blue LED was particularly challenging because it requires a material with a wide band gap. Energy and wavelength are related by the following equation, where E is the energy of the electron in electronvolts (eV), Planck's constant $h = 4.136 \cdot 10^{-15} \text{ eV} \cdot \text{s}$, the speed of light $c = 3 \cdot 10^8 \text{ m} \cdot \text{s}^{-1}$, and λ is the wavelength:

$$E = hc/\lambda$$

- d)** Calculate the range of band-gap energies required for a semiconductor to be used in a blue LED, assuming that blue light has wavelengths of 450–500 nm. Give your answer in electronvolts. (2)

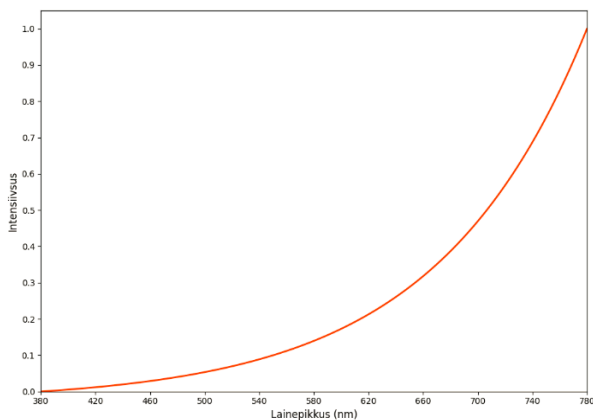
The band gap of a mixture of two semiconductor materials can be calculated from the band gaps of the pure materials using the following equation:

$$E(\text{In}_x\text{Ga}_{1-x}\text{N}) = x \cdot E(\text{InN}) + (1 - x) \cdot E(\text{GaN})$$

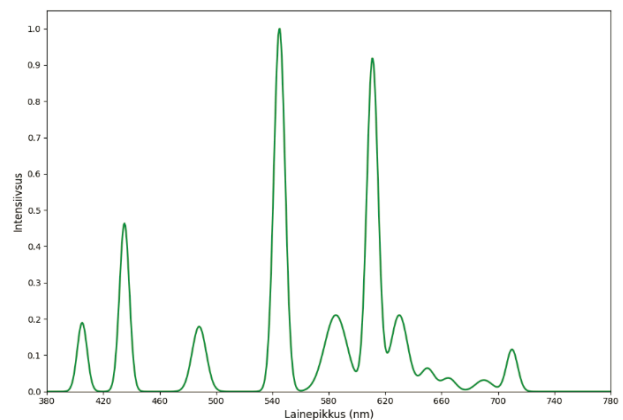
- e)** Calculate the band gap of $\text{In}_x\text{Ga}_{1-x}\text{N}$ when $x = 0.2$. $E(\text{InN}) = 0.69 \text{ eV}$ ja $E(\text{GaN}) = 3.4 \text{ eV}$. (1)
f) Determine whether the semiconductor material from part **e)** would be suitable for producing a blue LED. (1)

White LEDs consist of a blue LED coated with a light-sensitive material called a luminophore. The luminophore converts part of the blue light into light of a lower wavelength, and the light it emits has a continuous spectrum.

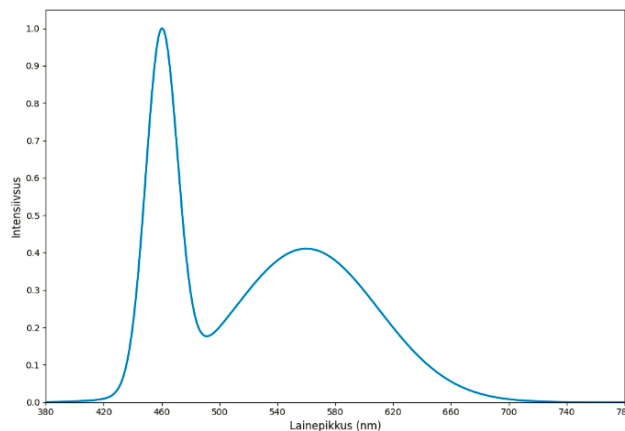
- g)** Choose the spectrum (A–C) corresponding to a white LED. (1)



A



B



C

One example of a luminophore is $\text{Y}_3\text{Al}_5\text{O}_{12}$ doped with Ce^{3+} . In a doped material, some of the atoms in the crystal lattice are replaced by dopant ions (Ce^{3+}).

- h)** The ionic radii of the ions in the crystal lattice and of the dopant ion are given below (Å). Choose which ion in the crystal lattice Ce^{3+} is most likely to replace. (1)

Ion	Y^{3+}	Al^{3+}	O^{2-}	Ce^{3+}
Radius	104 Å	67.5 Å	126 Å	115 Å