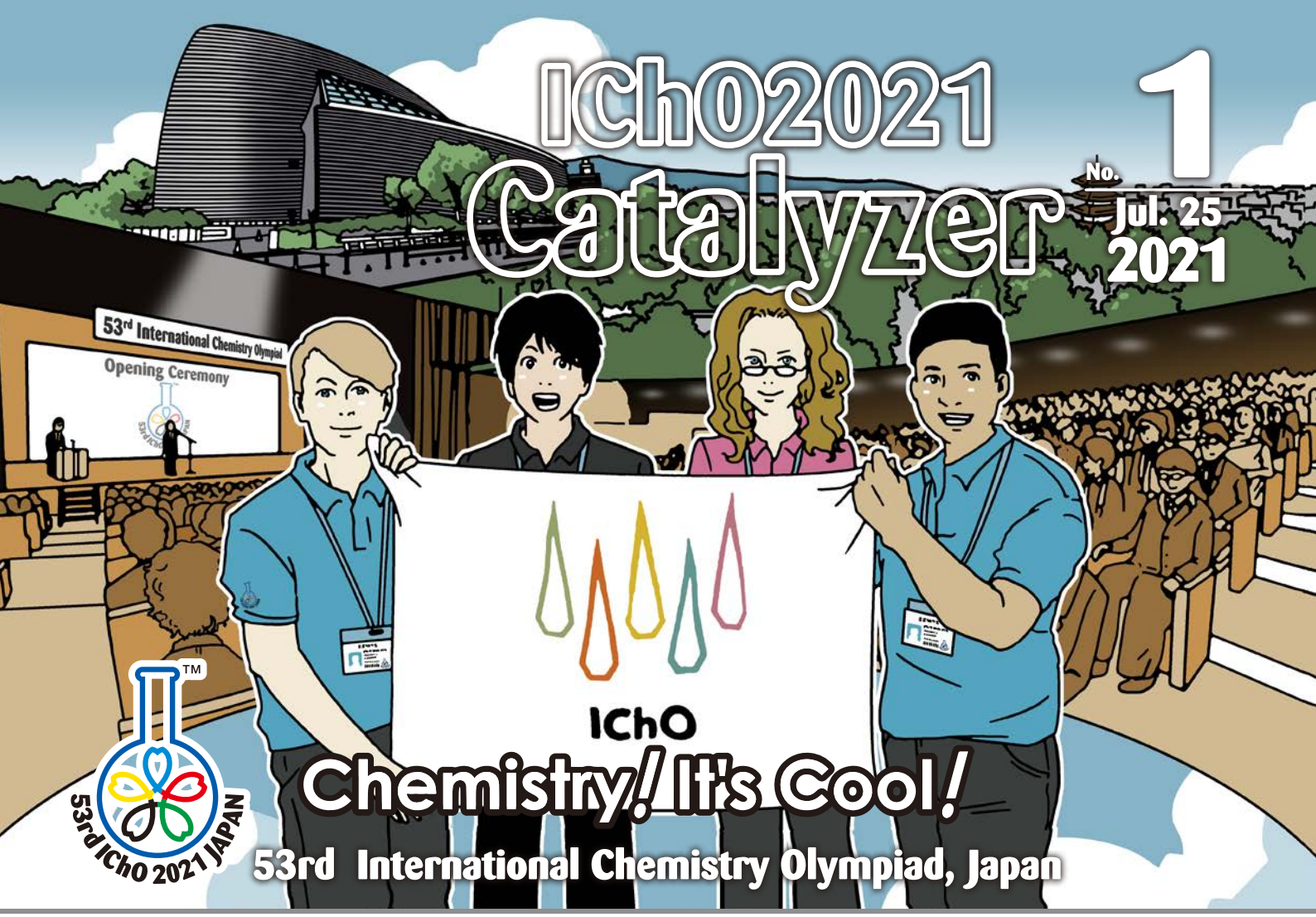
IChO2021 Catalyzer
No. 1
Jul. 25 2021



Cover illustration : Opening Celemony

Message

It is our great pleasure to host the 53rd International Chemistry Olympiad (IChO2021), a competition so rich in history since the first one in 1968, and to welcome very talented young students from 79 countries and regions around the world.

As important as it is as an academic subject, chemistry is also the basis for creating materials and substances with a vast range of functions that constantly supports our daily lives.

The COVID-19 pandemic is still plaguing the world. Chemistry is playing a vital role in the fight against COVID-19 by being applied for PCR and antigen testing to detect infection and its history and for the manufacture of COVID-19 treatment drugs.

Moreover, we expect chemistry to greatly contribute to achieving the Sustainable Development Goals, including the stable supply of food, the recycling of waste, and so on.

All the students participating in IChO2021 have the potential to address these various shared problems of the world and to open up a new path for humankind. It is a crucial issue for governments around the world to discover their talents and create an environment to develop fully these capabilities.

The International Science Olympiads, including IChO, have provided various opportunities for talented students to challenge, and contributed to discovering such students and fostering their capabilities. As the host country, Japan will make its utmost efforts to support this mission.

Because of COVID-19, like the previous Olympiad, IChO2021 will be held online. The organizers are planning to make full use of VR technology and avatar technology to provide remote tours to both state-of-the-art and traditional science and technology facilities, which large groups of people cannot usually visit. Unfortunately you will not be able to have direct interaction, however, with the creative use of these technologies, you will be able to overcome the barriers of distance and space to connect with your peers.

We hope that all of you representing your countries at this Olympiad will fully demonstrate your real abilities and the results of your efforts, improve yourselves through competitions, and make lasting friendships with peers.

It is our sincere wish that you all continue your self-improvement and make the most of your experiences to play active roles in leading your countries and the world.

HAGIUDA Koichi

the Minister of Education, Culture, Sports, Science and Technology

IChO2021 Japan Welcome Address at the Opening Ceremony on July 25

I am Kohei Tamao. Thank you for your kind introduction. It is a great pleasure and honor for me to say a few words at the opening ceremony of the 53rd International Chemistry Olympiad, IChO2021 Japan.

Dear talented high school students, mentors, scientific observers, guests, distinguished scholars, invigilators, Steering Committee members, and colleagues from all over the world, welcome to the Opening Ceremony of IChO2021 Japan.

Originally, we had been preparing to hold IChO2021 Japan at Kindai University, one of the biggest private universities in Japan, located in the lively and modern commercial city of Osaka in mid-west Japan, also known as the birthplace of chemical research in this country.

However, in light of the ongoing COVID-19 pandemic, we had no choice but to hold IChO2021 remotely, following the lead of IChO2020 Turkey last year.

This is the result of giving top priority to the safety of our young talented students and all participants, even at the expense of practical examinations and opportunities for in-person international exchange. I would like to thank all the International Steering Committee members led by Dr. Gábor Magyarfalvi for their enthusiastic discussion and acceptance of our decision.

Even under the difficult conditions presented by the COVID-19 pandemic, the good news is that we have accepted registrations from 85 countries and regions of the 89 to which we sent invitations. More than 320 students have been registered. I would like to express my sincere gratitude and respect for the wonderful efforts of mentors, teachers, and all concerned in each country to select talented students and set up the examination sites.

The theoretical examinations will be held on July 28th in each country, and the examination results, including gold, silver and bronze medalists, will be announced in the closing ceremony on August 2nd.

I am confident that the remote examinations on July 28th will be carried out in an atmosphere of justice, fairness, and trust, maintaining the spirit of IChO across space and time. It is my sincere hope that all the participating students will do their very best, showcasing the talents and skills they demonstrate every day.

As we are unable to hold the practical examinations, we have prepared a demonstration video of the practical tasks.

To compensate for the fact that the participants cannot meet in person, we will offer various initiatives for students to create international friendships and become familiar with Japanese culture and the state of art, science, and technology in this country.

For that purpose, VR avatars for all students have been prepared to facilitate remote networking and to give greater realism to virtual visits to sensitive areas such as the restoration site of an ancient Buddha statue and the world's largest synchrotron radiation facility, SPring-8, to which access is normally prohibited.

Dear students, now I would like to ask you to keep the following three things in mind, as you are about to enjoy a once-in-a-lifetime valuable experience.

First, you have been given hope and courage to overcome difficulties through your participation in this remote IChO2021 Japan.

Second, the unprecedented difficulties we have been facing can only be overcome by international friendships and trust. Thus, you should show gratitude and respect to your mentors, teachers, invigilators, and all others who have contributed to make this major international event a reality, despite the obstacles faced.

Third, I want you to remember that chemistry, the central science, is all around us. Chemistry must therefore play a key role in finding solutions for many global challenges, including energy, environmental, and resource-related issues that humanity is now facing.

I hope that IChO2021 Japan helps to foster many talented young people who will go on to play roles as future world leaders. While you do not have the opportunity to meet each other in person this time, I am convinced that one day you may meet each other somewhere in the world when you go to university or graduate school. I sincerely hope that you take the opportunities given to you as participants in this remote IChO2021 to create strong networks of international friendship, with the slogan "Chemistry*!* It's Cool*!*" as your watchword.

Finally, I would like to thank the Ministry of Education, Sports, Science and Technology (MEXT Japan) and the Japan Science and Technology Agency (JST) for their meaningful support, and the more than 180 chemical companies and trading companies in Japan as our sponsors for their substantial financial assistance, as well as numerous personal donations.

My special thanks are also due to all the members of the Japan Committee and Organizing Committee for IChO2021 Japan, as well as our secretariat and KNT Corporate Business Company, Ltd., as represented by the Vice President of the Japan Committee and Chair of the Fundraising Committee Dr. Kyohei Takahashi, Chairs of the Finance Committee the late Dr. Tadao Kondo and Dr. Teiji Koge, Chair of the Executive Committee Professor Yoshiki Chujo, Chair of the Scientific Committee Professor Hiroshi Nishihara, and member of the International Steering Committee Professor Nobuhiro Kihara.

Without their remarkable support and endeavors, this remote IChO2021 Japan would not be possible.

Now, it is my great pleasure to officially declare remote IChO2021 Japan open.

Thank you very much for your kind attention.

Dr. Kohei Tamao

President, IChO2021 Japan Committee
Chairman, Organizing Committee
for the 53rd IChO2021, Japan

Schedule of Remote IChO2021

Date	Student	Mentor
Jul 25, Sun	Opening Ceremony (Virtual Reality Venue)	J 15:00 C 08:00 E 02:00
	VR Closed	Receive the problem — J 21:00 C 14:00 E 08:00
Jul 26, Mon	VR Closed	Deadline of feedback — J 09:00 C 02:00 E 20:00
		Jury meeting — J 21:00 C 14:00 E 08:00
Jul 27, Tue	VR Closed	Receive the authorized problem Translation ▸▸▸ submission — J 09:00 C 02:00 E 20:00
Jul 28, Wed	Examination (5 hours) Start between J 14:00 ▼ 05:00 (Jul 29), C 07:00 ▼ 22:00, E 01:00 ▼ 16:00	Deadline of translation — J 09:00 C 02:00 E 20:00
		[Invigilator] Receive and print out the problem — J 11:00 C 04:00 E 22:00
		[Invigilator] Submit the solutions (Within 2 hours after the end of the examination)
Jul 29, Thu		Receive the solution and the grading scheme — J 09:00 C 02:00 E 20:00
	Activity (SPring-8 Virtual tour)	
Jul 30, Fri	Video: Practical Examination explanation	Receive grading (from Organizer, Request arbitration) — J 09:00 C 02:00 E 20:00
		Deadline of request, Jury meeting — J 21:00 C 14:00 E 08:00
Jul 31, Sat	Activity Video:History and Culture of Nara	Arbitration America (west) ▸▸▸ Asia ▸▸▸ Europe ▸▸▸ America (east) — J 09:00 C 02:00 E 20:00
Aug 1, Sun	Activity Video:Himeji Castle, Osaka, and Kyoto	Receive final results — J 09:00 C 02:00 E 20:00
		Activity Video:Himeji Castle, Osaka, and Kyoto
Aug 2, Mon	Closing Ceremony (Virtual Reality Venue)	J 21:00 C 14:00 E 08:00

J : JST = UTC + 9　C : CET = UTC + 2 (summer time)　E : EST = UTC - 4 (summer time)　00:00 (Brown color letters) : The night before

The VR video programs will be opened at 00:00 JST on each day.

Nobel Prize Research from Japan 01

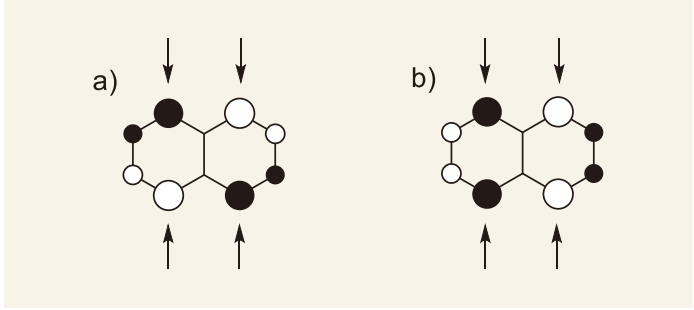
Frontier Orbital Theory

Kenichi Fukui

Photo by Kagaku-Dojin

Dr. Kenichi Fukui
(1918–1998)

How do chemical reactions occur? For chemistry students, the frontier orbitals called HOMO (Highest Occupied Molecular Orbital) and LUMO (Lowest Unoccupied Molecular Orbital) are extremely important. This concept of frontier orbitals was conceived by Kenichi Fukui, who in 1952 proposed that electrophilic substitution reactions in aromatic hydrocarbons occur at the position with the highest coefficient of HOMO, while nucleophilic reactions are determined by the coefficient of LUMO. This was an epoch-making concept, completely different from the conventional theory of organic electronics, which was based mainly on electron density.

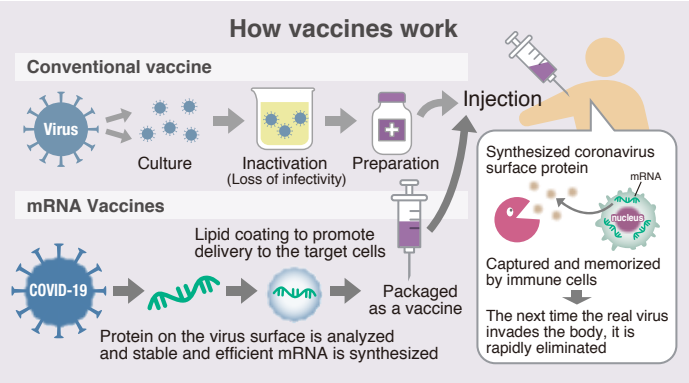


Frontier orbitals of naphthalene. a) HOMO. b) LUMO.
The arrows show locations where reactivity is higher.

In 1964, he further developed this theory by pointing out that the symmetry and phases of the HOMO and LUMO of the reacting molecule play important roles in cycloaddition reactions such as the Diels–Alder reaction. In 1981, he was awarded the Nobel Prize in Chemistry for "the theories concerning the course of chemical reactions," together with Roald Hoffmann, who separately published the Woodward–Hoffmann rules in 1965. Fukui was the first Japanese chemist and Asian person to be awarded the prize, which had until then been won by researchers from Europe and the United States. Today, the concept of HOMO–LUMO is widely used not only in chemical reactions and physical properties of molecules themselves, but also in molecular electronics, organic electroluminescence, enzymatic reactions, and electron transfer in interactions in biomolecules such as proteins.

COVID-19 and mRNA Vaccines

For certain infectious diseases, it is empirically known that once a person is infected they will not contract the disease again. This is due to the function of the immune system, which remembers the disease they have been infected with and can quickly eliminate the pathogen on the second infection. Vaccines make use of this biological function. Less virulent viruses or bacteria, as well as a portion of the pathogen (protein or polysaccharide), can be administered as a vaccine. This allows the immune system to remember the pathogen and prevent infection. Vaccines against COVID-19, a new type of coronavirus, which has had a major impact on our lives since 2020, are being vigorously developed around the world, resulting in the development of mRNA vaccines. Unlike conventional vaccines, mRNA vaccines deliver mRNA, the gene for the pathogen protein, into the human body. Although mRNA vaccines have been studied since the 1990s, they have not been put to practical use due to a number of drawbacks, including the following: 1) mRNA is not stable in vivo, 2) mRNA is not very efficient in the production of proteins, and 3) it is not easy to deliver mRNA into cells. Development of effective mRNA vaccines proceeded by solving these issues one by one. This was done through introducing artificial structures into the mRNA to prevent degradation by metabolism, and optimizing the RNA sequence to increase the efficiency of conversion into protein. Furthermore, by encapsulating the mRNA in lipid nanoparticles, researchers succeeded in efficiently delivering it into the cell. As a result, an extremely effective vaccine against coronaviruses has been developed.



Doshomachi

Kansai Scenes 1

"Medicine Town" and Sukunahikona Shrine

In the era of Toyotomi Hideyoshi (1537 to 1598), drug wholesalers were concentrated in the Doshomachi area of Osaka in accordance with the government's commercial policy. During the isolationist period of the Tokugawa shogunate (1603 to 1867), exchange with foreign nations was restricted to China and Holland. Drug wholesalers who imported drugs from those two countries established their businesses in Doshomachi, forming an officially approved guild, or *Kabunakama*, called the *Yakushunakagainakama.* In 1721, the Tokugawa government established an agency in Doshomachi for checking the quality of medicinal products made in Japan (*Wayakushu aratame kaisho*). Hence, all medicines commercially traded throughout Japan passed through Doshomachi first. All these historical connections led to Doshomachi being home to many pharmaceutical companies, making it Japan's first "medicine town," followed later by Nihonbashi Honcho in Tokyo.

The Doshomachi Pharmaceutical and Historical Museum (*Kusurinomachi Doshomachi Shiryokan*) is a great place to see exhibits of prescription medicines, instruments, equipments, and other related items used by medical wholesalers. The Sukunahikona Shrine, a Shinto shrine that is dedicated to medical deities, can also be found in Doshomachi.

Participating Teams

1 Armenia
2 Australia
3 Austria
4 Azerbaijan
5 Bangladesh
6 Belarus
7 Belgium
8 Brazil
9 Bulgaria
10 Canada
11 China
12 Chinese Taipei
13 Costa Rica
14 Croatia
15 Cyprus
16 Czech Republic
17 Denmark
18 El Salvador
19 Estonia
20 Finland
21 France
22 Georgia
23 Germany
24 Greece
25 Hungary
26 Iceland
27 India
28 Indonesia
29 Iran
30 Ireland
31 Israel
32 Japan
33 Kazakhstan
34 Korea
35 Kyrgyzstan
36 Latvia
37 Lithuania
38 Luxembourg
39 Malaysia
40 Mexico
41 Moldova
42 Mongolia
43 Montenegro
44 Netherlands
45 New Zealand
46 Nigeria
47 North Macedonia
48 Norway
49 Oman
50 Pakistan
51 Philippines
52 Poland
53 Portugal
54 Qatar
55 Romania
56 Russian Federation
57 Saudi Arabia
58 Serbia
59 Singapore
60 Slovakia
61 Slovenia
62 South Africa
63 Sri Lanka
64 Sweden
65 Switzerland
66 Syria
67 Tajikistan
68 Thailand
69 Trinidad and Tobago
70 Turkey
71 Turkmenistan
72 Ukraine
73 United Arab Emirates
74 United Kingdom
75 United States of America
76 Uruguay
77 Uzbekistan
78 Venezuela
79 Vietnam

Observer Teams

- Afghanistan
- Ecuador
- Egypt
- Kuwait
- Nepal
- Paraguay

Early Bird Communication

To Catalyzer

United Arab Emirates

Georgia

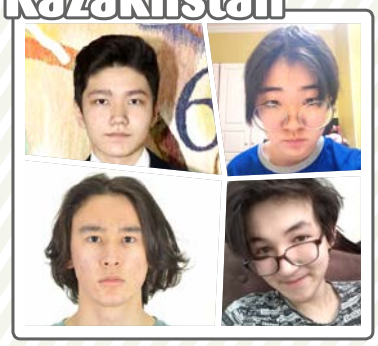
The Swedish team with the elements. Good luck with the Catalyser!

Vietnam

Students doing experiments in the lab and standing in front of the chemistry department gate.

Sweden (Sverige)

Kazakhstan



Croatia

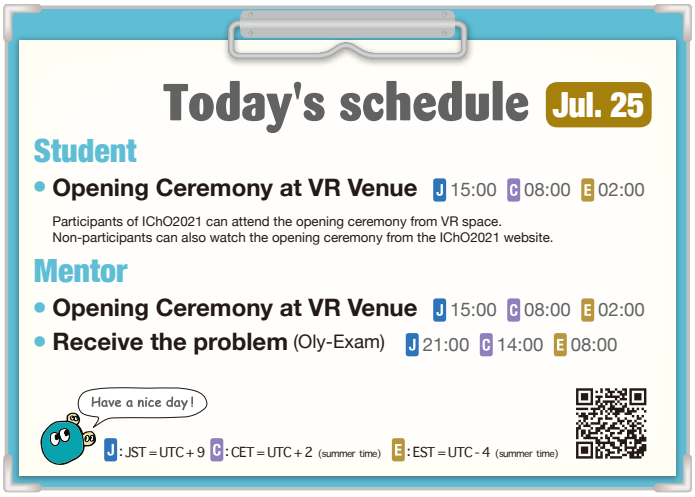
Bulgaria

Indonesia

This picture was taken during the IChO training session on July 5 2021.

Nigeria

We are glad to participate in 2021 Remote IChO competition. Regards from Nigeria.



Short short from Kansai | A Papier-mâché Tiger

In ancient Asia, tigers were considered to be messengers from the Gods, and their bones were used as a medicine and in lucky charms. In 1822, when Osaka was hit by the cholera epidemic that was sweeping the world at the time, an apothecary in Doshomachi, Osaka, created a Japanese herbal medicine containing tiger skulls and distributed it with a tiger-shaped charm made of paper called *Hariko-no-tora*, meaning a papier-mâché tiger. Although the medicine itself became obsolete, *Hariko-no-tora* are still handmade as traditional crafts. They are popular in the Kansai region as lucky charms that protect people from disease and express the wish for healthy growth of children.

Useful Japanese Phrases +α the Kansai dialect

Following on from the useful Japanese phrases introduced in Catalyzer No. 0, this edition features *Kansai-ben*, a dialect spoken in the Kansai region, where we had originally planned to hold the in-person IChO2021. Let's all try speaking *Kansai-ben!*

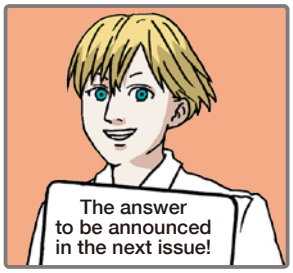
English	Standard Japanese	Kansai Dialect	
Good bye	Sayounara	Sainara	さいなら
I'm sorry.	Gomennasai	Sunmahen	すんまへん
My bad.	Gomen	Suman	すまん
Thank you!	Arigatou	Ohkini	おおきに
Yes	Hai	Soya	そや
No	Iie	Chau	ちゃう
foolish	bakamitai	ahokusa	あほくさ
nonsense	kudaranai	shoumona	しょうもな
strange	okashina	kettaina	けったいな
because	～ nanode	～ yasakai	～やさかい
tired	tsukareru	shindoi	しんどい
How about?	Dou?	Donai?	どない？
McDonald's	Mac	Makudo	まくど
Father	Tousan	Oton	おとん
Mother	Kasan	Okan	おかん

* These words are just some examples.

ELEMENT QUIZ Q1

A neodymium magnet, known as the world's strongest permanent magnet, is made of three elements. Which of the following is the correct combination?

1 (Nd, Pb, B)
2 (Nd, Pd, Fe)
3 (Nd, Fe, Co)
4 (Nd, Fe, B)



Chemistry! It's Cool!

53rd IChO 2021 JAPAN™
IChO2021 Catalyzer No. 1
Official Website
https://www.icho2021.org/
icho2021

Jul. 25
1908
Patented!
Production method of Umami flavor (AJINOMOTO)

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