The periodic table of elements and IYPT2019

Suzanne Issa
David Cole-Hamilton

EuChemS Task Group
Saskia van der Vies, Christophe Coperet, Nicola Armaroli, Jelena Lazić, Alex Schiphorst, David Cole-Hamilton (Chair), assisted by Elena Lenci, Katarzyna Josefowska, Robert Parker
uChemS Projects

*Women in their element. The Historic Role of Female Scientists in the (Pre)History of the Periodic Table* edited by Annette Lykknes and Brigitte van Tiggelen.

*Setting their Table: Women and the Periodic Table of Elements.* Murcia, Spain, 11-12th Feb.

EYCN Video Competition (Yacintha Vermeer)  >250 entries

Video Game

Periodic Table for Schools

https://wilkinsonfoundation.org
Women in their Element


The 38 chapters include:
- understanding the concept of elements
- identifying properties
- developing analytical methods
- mapping the radioactive series
- finding applications of elements
- drawing attention to toxicity and

On a table ASC Fall meeting, San Diego
Setting their Table: Women and the Periodic Table of Elements
International Symposium, Murcia February 11-12, 2019

- Global Women’s Breakfast organized by IUPAC

Unveiling of 10 laureates of the IUPAC Periodic Table of Younger Chemists.

Working Party on the History of Chemistry
The leaky pipeline
Chemistry UK

Donna Strickland
Nobel Prize 2018
Physics

Frances Arnold
Nobel Prize 2018
Chemistry

Lisa Cifarelli
President SIF

Pilar Goya
President EuChemS

Sicaa Orlandi
President FNCF

Roberta Sessoli
Discovered first molecular magnetic
RSC Centenary Award, 2019

Alice Soldà
Past Chair EYCI
**Video Game**

**Elemental Escapades – A Periodic Table Adventure**

Launched European Parliament 22\(^{nd}\) January 2019
Available at IYPT launch, Paris 29\(^{th}\) January 2019
Updated April 2019
- 2489 downloads

International edition 30\(^{th}\) September 2019
- French, German, Spanish, Italian, Croatian,
- Serbian, Dutch, Polish, Romanian, Greek and English

EYCN arranged the translations.


Nick Cole-Hamilton
Sandy Russell
Scott Darcy

EuChemS General Assembly, Bucharest 3\(^{rd}\) October, 2019
Elemental Escapades. A Periodic Table Adventure

Mendelev Society Meeting

Celebrating D.I. Mendelev’s Periodic System. A Historical Perspective

September 10-13, 2019, St Petersburg,

Mendelev’s teaching wall chart, 1876

Working Party on the History of Chemistry
EICC-5
5th EUCHEMS INORGANIC CHEMISTRY CONFERENCE

Moscow, 24-28 June 2019
eicc5.ru

ORGANIZERS

EuChemS
European Chemical Society

Russian Academy of Sciences

МИНИСТЕРСТВО НАУКИ И ВЫСШЕГО ОБРАЗОВАНИЯ РОССИЙСКОЙ ФЕДЕРАЦИИ
Mendelev’s first Periodic Table

<table>
<thead>
<tr>
<th>Element</th>
<th>Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>1</td>
</tr>
<tr>
<td>Be</td>
<td>9.4</td>
</tr>
<tr>
<td>Mg</td>
<td>24</td>
</tr>
<tr>
<td>Zn</td>
<td>65.2</td>
</tr>
<tr>
<td>Cd</td>
<td>112</td>
</tr>
<tr>
<td>B</td>
<td>11</td>
</tr>
<tr>
<td>Al</td>
<td>27.4</td>
</tr>
<tr>
<td>?</td>
<td>68</td>
</tr>
<tr>
<td>Ur</td>
<td>116</td>
</tr>
<tr>
<td>Au</td>
<td>197</td>
</tr>
<tr>
<td>C</td>
<td>12</td>
</tr>
<tr>
<td>Si</td>
<td>28</td>
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<tr>
<td>?</td>
<td>70</td>
</tr>
<tr>
<td>Sn</td>
<td>118</td>
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<tr>
<td>N</td>
<td>14</td>
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<tr>
<td>P</td>
<td>31</td>
</tr>
<tr>
<td>As</td>
<td>75</td>
</tr>
<tr>
<td>Sb</td>
<td>122</td>
</tr>
<tr>
<td>Bi</td>
<td>210</td>
</tr>
<tr>
<td>O</td>
<td>16</td>
</tr>
<tr>
<td>S</td>
<td>32</td>
</tr>
<tr>
<td>Se</td>
<td>79.4</td>
</tr>
<tr>
<td>Te</td>
<td>128?</td>
</tr>
<tr>
<td>Li</td>
<td>7</td>
</tr>
<tr>
<td>Na</td>
<td>23</td>
</tr>
<tr>
<td>K</td>
<td>39</td>
</tr>
<tr>
<td>Rb</td>
<td>85.4</td>
</tr>
<tr>
<td>Cs</td>
<td>133</td>
</tr>
<tr>
<td>Tl</td>
<td>204?</td>
</tr>
<tr>
<td>Ca</td>
<td>40</td>
</tr>
<tr>
<td>Sr</td>
<td>87.6</td>
</tr>
<tr>
<td>Ba</td>
<td>137</td>
</tr>
<tr>
<td>Pb</td>
<td>207?</td>
</tr>
<tr>
<td>F</td>
<td>19</td>
</tr>
<tr>
<td>Cl</td>
<td>35.5</td>
</tr>
<tr>
<td>Br</td>
<td>80</td>
</tr>
<tr>
<td>?</td>
<td>45</td>
</tr>
<tr>
<td>Ce</td>
<td>92</td>
</tr>
<tr>
<td>?Er</td>
<td>56</td>
</tr>
<tr>
<td>La</td>
<td>94</td>
</tr>
<tr>
<td>?Yt</td>
<td>60</td>
</tr>
<tr>
<td>Di</td>
<td>95</td>
</tr>
<tr>
<td>?In</td>
<td>75.6</td>
</tr>
<tr>
<td>Th</td>
<td>118?</td>
</tr>
</tbody>
</table>

Presented to the Russian Academy 6th March 1869
All 63 known elements included
Gaps left and predictions made for unknown elements
### Periodische Gesetzmässigkeit der Elemente nach Mendelejef.

<table>
<thead>
<tr>
<th>Reihe</th>
<th>Gruppe I R² O</th>
<th>Gruppe II RO</th>
<th>Gruppe III R² O³</th>
<th>Gruppe IV RH₄ R² O²</th>
<th>Gruppe V RH₃ R₂ O⁵</th>
<th>Gruppe VI RH² R² O⁷</th>
<th>Gruppe VII RH R² O⁷</th>
<th>Gruppe VIII RO₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H = 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Li = 7</td>
<td>Be = 9,4</td>
<td>B = 12</td>
<td>N = 14</td>
<td>O = 16</td>
<td>F = 19</td>
<td>Fe = 56, Co = 59</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Na = 23</td>
<td>Mg = 24</td>
<td>Al = 27,3</td>
<td>P = 31</td>
<td>S = 32</td>
<td>Cl = 35,5</td>
<td>Ni = 59, Cu = 63</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>K = 39</td>
<td>Ca = 40</td>
<td>Sc = 44</td>
<td>V = 51</td>
<td>Cr = 52</td>
<td>Mn = 55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>(Cu = 63)</td>
<td>Zn = 65</td>
<td>Ga = 68</td>
<td>Ti = 48</td>
<td>Cr = 52</td>
<td>Mn = 55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Rb = 85</td>
<td>Sr = 87</td>
<td>Y = 88</td>
<td>Zr = 90</td>
<td>Nb = 94</td>
<td>Mo = 96</td>
<td>Ru = 104, Rh = 104</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>(Ag = 108)</td>
<td>Cd = 112</td>
<td>In = 113</td>
<td>Sn = 118</td>
<td>Sb = 122</td>
<td>Te = 125</td>
<td>Pd = 106, Ag = 108</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Cs = 133</td>
<td>Ba = 137</td>
<td>La = 139</td>
<td>Pa = 234</td>
<td>Bi = 210</td>
<td>W = 184</td>
<td>Pt = 194, Os = 195</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>(Au = 196)</td>
<td>Hg = 200</td>
<td>TI = 204</td>
<td>Pb = 206</td>
<td>Bi = 210</td>
<td>U = 240</td>
<td>Ir = 193, Au = 196</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>(-)</td>
<td>Er = 170</td>
<td>Ta = 182</td>
<td>W = 184</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>(-)</td>
<td>Th = 231</td>
<td>U = 240</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
- 2014 Found rolled up under a lecture Theatre (Dr Alan Aitken)
- 2018 Conserved 2108-9 Researched by Pilar Gil, University of Andrews Special Collections
- 1885 Printed in Vienna
- 1888 Purchased by Professor Purdie from a German supplier
- Ga and Sc added some other changes
- 65 elements
The 90 natural elements that make up everything

How much is there? Is that enough?


[Inspired by WF Sheehan’s ‘A Periodic Table with Emphasis’]
90 elementi chimici e la loro disponibilità relativa sulla Terra

Ci basteranno?

Scopri di più e divertiti con il videogiooco su http://bit.ly/euchems-pt

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Launch European Parliament 22\textsuperscript{nd} January 2019,atherine Stihler and Clare Moody MEPs Publicity in 6 continents

IYPT Launch, Paris, 29\textsuperscript{th} January

Travelling Exhibition Japan

Historical landmark
EA Crete
Nicola Armaroli

Italian Roadshow >3000 teachers and students
Imagining the Periodic Table

The Scores
St Andrews
3rd – 27th October
2019
Macedonian stamp

First day cover

9th October, 2019
The 90 natural elements that make up everything

How much is there? Is that enough?


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Avoid conflict minerals

**Traceability**

Smart phone companies trace source of metals from mining to phone

**Tantalum**

Used in microcapacitors

< 50 years left

2002-6 only 1 % from conflict zones

As it gets scarcer, temptation increases
The Circular Economy

Reduce

Repair

Replace (materials)

Reuse/recycle
Smart phones use and discard

EU 10 M phone upgrades / month

Many lie around at home (40% from survey) wasting valuable resources

Most reused in developing countries (Reuse) and then trashed or mined for some metals under appalling conditions often by children

Modular phones where parts can be replaced are available (Repair)

Can **YOU** justify changing your phone every 2-3 years (Reduce)
Indium is already very widely dispersed (by-product of zinc mining).

Annual demand
- 770 tonnes

World reserves (easily mined)
- 15,000 tonnes

Lifetime (current usage)
- 20 years

Much more difficult to extract; price rises

https://www.nrel.gov/docs/fy16osti/62409.html
Recycle, Replace, Reduce

Recycle
• Small amounts of ITO on every computer / phone screen
• We need companies that will do ethical recycling of elements in electrical goods (opportunity)
• We need incentives to hand in our electronic devices

Replace
• Must find equivalent materials using earth abundant metals (graphene, SbSnO₂, CaMoO₃)
• Requires huge research effort

Reduce
• Change your phone and computer less often
The 90 natural elements that make up everything

How much is there? Is that enough? What are we recycling?
Helium

MRI Imaging

Deep sea diving

Helium/oxygen reduces “the Bends”

Liquid helium cooled

Once released into the atmosphere it will be lost into outer space forever
Main suppliers
Qatar – Closed
USA – Closing 2021
Tanzania – Opening 2020

Enough for 8-12 years

Can we really justify using helium celebration balloons when this precious resource will be lost forever?
10% of helium is used in party balloons (47% in Russia)

“Dirty” helium recycled from MRI scanners, “cannot be used in science and academic applications”

“Re-liquefying is currently considered uneconomical from the locations of where the filling application take place”

Helium concentration is ~95%; Tanzanian field <10%)

In < 100 years **ALL** the Tanzanian helium will be lost

Can we really justify using helium celebration balloons when this precious resource will be lost forever?
Trains delayed by balloons

Network Rail: 619 balloon related incidents in last year - many dangerous.
Found on a beach in Andrews
Ibraltar National Day

Balloon release banned
Rare Earth Elements

- Dyprosium (Dy) used in magnets for windmills
- Potential problem in the longer term

Fears about long term supply

- Large find in sea off Japan in 2013
- Off the danger list
To keep your phone for longer
To hand in your phone at the end of its life
Never to use helium balloons
Why can you never trust elements?

Because the make up absolutely everything!
Scopri di più e divertiti con il videogioco su http://bit.ly/euchems-pt
Comparison of subjects - Leaky Pipeline

- Biology
- Chemistry
- Physics