Grade 9

A case study

A student from the US

He has been studying with us for almost three years now.

The beginning

- He already had good grades in his studies.
- He was already very busy with extra classes and extracurricular activities, which was a red flag for us.
- We reluctantly agreed to induct him into our program.

All the screenshots of the activities are taken from work done by the student in the last two years.

No other work from his batch has been included in this document.

We started with basic concepts and are dealing now with advanced topics taught in senior classes.

The snapshots may seem a bit advanced for his grade. We started with his grade and built his conceptual competence to bring him to this level. We do this with all our students. The other students in his batch have shown similar performance.

The start

- He joined a batch of six students.
- Three have dropped out since then.
- We run three one-hour sessions per week.

The story of three years

A summary of the activities the student has done in the last three years since he joined us.

Having taught him and his batch calculus, vectors, geometry, probability, abstract algebra, and statistics, we are now teaching them AI/ML in Python this summer. He is going into grade 10 this year!

They are already very good Python programmers, like all our other students.

Partial snapshot of his online folder

All students have their individual online folder of activities that includes programming as well as non-programming activities.

The recordings and notes of sessions are stored separately and made accessible to the students.

0 / Sritej

- ..
- Programming
- English
- Mathematics
- History
- Plotting
- HTML Programming
- Biology
- Chemistry
- Geography
- Physics

0 / Sritej / Programming

- ..
- Geometrical Plotting Part 3.ipynb
- Geometrical Plotting Part 2.ipynb
- Geometrical Plotting.ipynb
- Linspace.ipynb
- Python Introduction.ipynb
- CreateWordCloud.ipynb
- Python
- JavaScript
- String Formatting.ipynb
- Functions.ipynb
- Solar_System.ipynb
- Search_Text_In_txt_File.ipynb
- students.csv

0 / Sritej / English

- ..
- BookManager Engineer Song.ipynb
- VocabularyManager for Lyrics.ipynb
- Learning Spanish.ipynb
- LearnLanguageManager.ipynb
- BookManager Cinderella.ipynb
- BookManager Anna-Karenina.ipynb
- WordManager.ipynb
- Spelling Manager.ipynb
- Untitled.ipynb
- EnglishComprehensionManager.ipynb
- UsageManager.ipynb
- Word Scrambler.ipynb
- VocabularyManager.ipynb

0 / Sritej / Chemistry

- ..
- PeriodicTableManager.ipynb
- Periodic Table.ipynb
- ChemCalcManager.ipynb
- ChemicalReactionManager.ipynb
- Grade9ChemistryManager.ipynb
- AtomManager.ipynb
- ChemistryCourseOneManager.ipynb
- ChemistryManager.ipynb
- Chemistry Compounds.ipynb
- PtableUtil.ipynb

0 / Sritej / Plotting

..
GraphManager.ipynb
Graph Practice.ipynb
Evolution of species.ipynb
Evolution of species diagraph.ipynb
Interesting Patterns.ipynb
Plotting Equations.ipynb
DecodingXyGraphManager.ipynb
Plotting2DManager.ipynb
out
Drawing a Carrom Board.ipynb
Drawing a Badminton Court and its Calculations

0 / Sritej / Mathematics

..
Trigonometry.ipynb
Sin and Cos.ipynb
Mio First Program.ipynb
Math's and Plotting.ipynb
InequalityGridManager.ipynb
LogarithmManager.ipynb
BasicPlottingManagerPractice.ipynb
LawOfProportionManager.ipynb
SingleVariableManager.ipynb
PolynomialManager.ipynb
Building A Dream House.ipynb
PowerManager.ipynb
AdvancedPowerManager.ipynb

0 / Sritej / English

..
BookManager Engineer Song.ipynb
VocabularyManager for Lyrics.ipynb
Learning Spanish.ipynb
LearnLanguageManager.ipynb
BookManager Cinderella.ipynb
BookManager Anna-Karenina.ipynb
WordManager.ipynb
Spelling Manager.ipynb
Untitled.ipynb
EnglishComprehensionManager.ipynb
UsageManager.ipynb
Word Scrambler.ipynb
VocabularyManager.ipynb

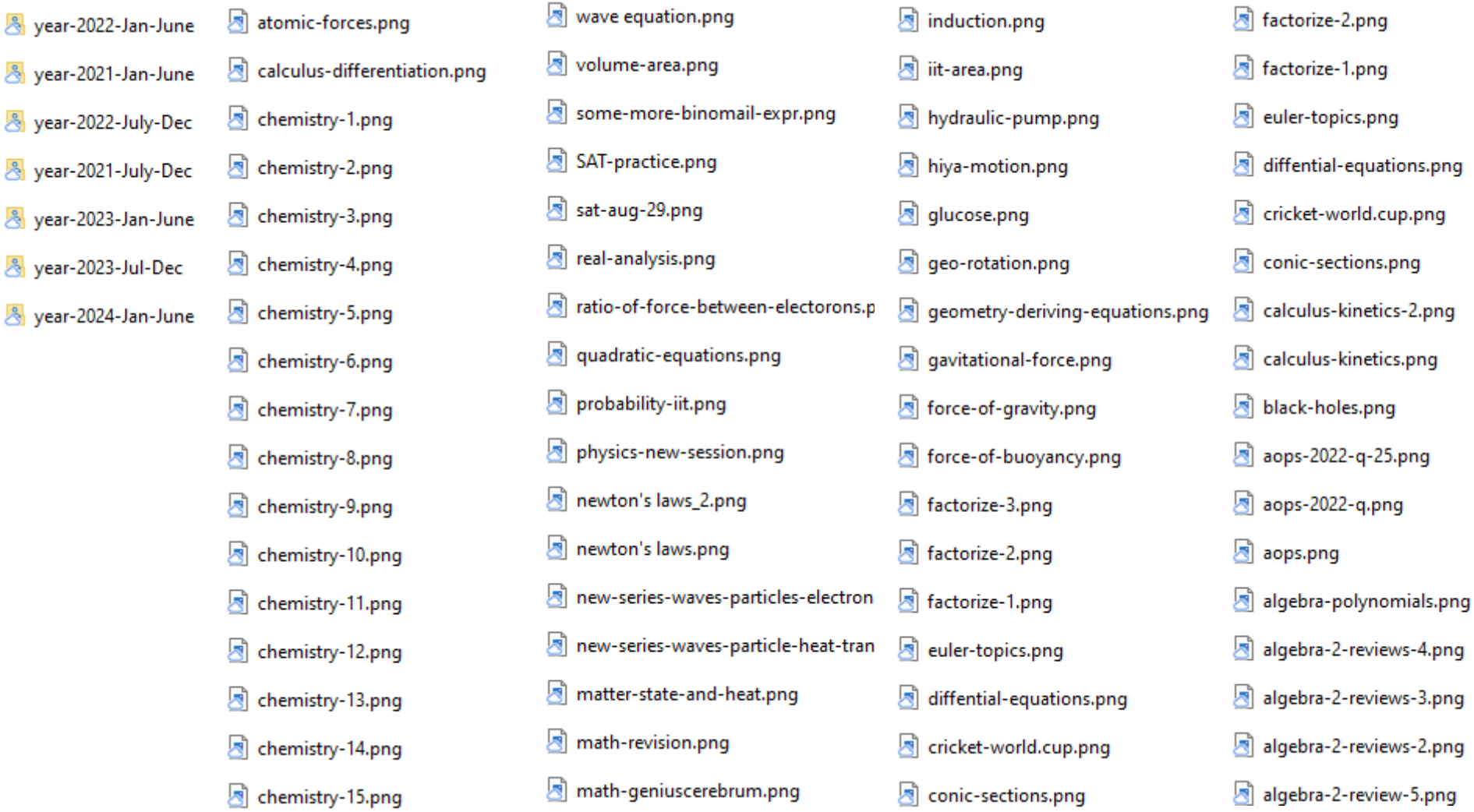
0 / Sritej / Programming

..
Input
Output
Python Basics.ipynb
Python Basics as Class.ipynb
How to Find Folders.ipynb
Reading a URL.ipynb
Reading an HTML Table.ipynb
Read and Write Files.ipynb
Read_and_Write_csv._Files.ipynb
Search_Text_In_txt_File.ipynb
students.csv
Solar_System.ipynb
Functions.ipynb

0 / Sritej / History

..
Ancient_Egypt.HTML.ipynb
Ancient_Egypt.html
History about Ashoka.ipynb
Cold War.ipynb
Ukraine and Russia.ipynb
Vikings History (Got Trolled Actual
History of French Revolution.ipynb

Partial snapshot of the notes folder of his batch



- waves.png
- volume-sphere.png
- volume-cone-2.png
- volume-cone.png
- volume-area.png
- vector-speed-distance.png
- trig-root.png
- trigonometry.png
- time-travel.png
- stats-average-vs-median.png
- stats.png
- potential-calculus.png
- polygon.png
- physic-vector.png
- periodic-table-trend.png
- optics-similar-triangle.png
- optics3.png
- maths-polygon.png
- latent-heat-2.png
- latent-heat.png
- iit-q.png
- history-of-usa-topics.png
- geometry-sritej.png
- geometry-revision.png
- geometry-figures_3.png
- geometry-figures_2.png
- geometry-figures.png
- geometry-3d.png
- geometr-overview-2.png
- geometr-overview.png
- gas-laws.png
- field-and-potential-multiple-charges.
- field-and-potential.png
- factorization.png
- electricit-and-magnets.png
- electricit.png
- dynamics-calculus.png
- coordinates-median.png
- coord-geom-euler-number.png
- coord-geom.png
- circuits.png
- chemstry-bonds.png
- chemistry-review-and-colors.png
- chemistry-mole-acide-base.png
- chemistry-bonds.png
- chemistry-acid-base-salt.png
- chemistry.png
- calculus-velocity-acceleration.png
- calculus-velocity.png
- calculus-area-volume-length-of-revolu
- calculus-area-circle.png
- work-torque.png
- work-energy-friction.png
- waves.png
- venus.png
- velocity-time-acceleration.png
- vector-distance.png
- trig-overview.png
- trigonometry-graph.png
- trig-fromulae.png
- trig-calc.png
- triangle-sides.png
- radio-decay.png
- puzzles.png
- projectile.png
- pos-value-coord.png
- mechanics.png
- lines and ratios.png

mechanics.png
lines and ratios.png
history.png
gravitation-wormholes.png
field-and-forces.png
euler-number.png
energy-waves.png
curved-vs-plain-surfaces.png
congruency.png
chemistry-valence.png
calculus-physics-philosophy.png
binomial-calculus.png
atomic-model.png
area.png
architecture-racism.png
aops-q-25-2021.png
aops-q-24-23-22-2021.png
xn-permutation-probability.png
xn-permutation.png
xnmanager.png
work-vector-3.png
work-vector_2.png
work-vector.png
work-calculation.png
vector-triangle.png
vectors-defs.png
vector-area.png
speed-time.png
spectrum-and-colors.png
slicing-shapes.png
similar-triangles.png
russia-ukraine.png
russian-revolution.png
quadratic_equation_and_roots_derivati
quadratic_equation_and_roots.png
quadratic_equation.png
prob-mar-10.png
physics-math-force-vector-gravitation.p
number-systems.png
mechanics-work-force.png
matrix-atoms.png
matrix.png
linear-angular-motions.png
kinetic_energy.png
ke-pe.png
jan04-2022-questions-waves-hiltler.png
integrated-learning-xn.png
infinity-large-numbers-2.png
how-volume-works.png
heat-specific-latent.png
god-religion.png
atoms-mole-structure.png
calculus-derive-xn.png
circle-and-angles.png
circle-and-angles-2.png
circle-and-its-parts.png
combination.png
desktop.ini
electronic-config.png
electronic-structure.png
force-displacement-work.png
geometry-walking.png
infinity-large-numbers.png
linear-equations-rohan.png

He, like all our students, is also a good programmer because it helps them learn Math, Physics, Chemistry, Geography, and other subjects better and faster.

He knows Python (including pandas, numpy, and sympy), JavaScript, HTML, CSS, and SVG.

He is familiar with Java and OOP. It was never our objective to turn him into a professional programmer. Yet, he is only one month away from being good enough to work as a professional software programmer.

```python
import pandas as pd
```

```python
webpage = "https://nssdc.gsfc.nasa.gov/planetary/factsheet/planet_table_ratio.html"
webpage
```

```
'https://nssdc.gsfc.nasa.gov/planetary/factsheet/planet_table_ratio.html'
```

```python
tables = pd.read_html(webpage, header = 0)
tables
```

```
[              Unnamed: 0  MERCURY   VENUS  EARTH      MOON   MARS   JUPITER  \
 0                   Mass   0.0553   0.815      1    0.0123  0.107     317.8
 1               Diameter    0.383   0.949      1    0.2724  0.532     11.21
 2                Density    0.985   0.951      1     0.606  0.714     0.241
```

```python
t.index
```

```
RangeIndex(start=0, stop=19, step=1)
```

```python
t.columns
```

```
Index(['Unnamed: 0', 'MERCURY', 'VENUS', 'EARTH', 'MOON', 'MARS', 'JUPITER',
       'SATURN', 'URANUS', 'NEPTUNE', 'PLUTO'],
      dtype='object')
```

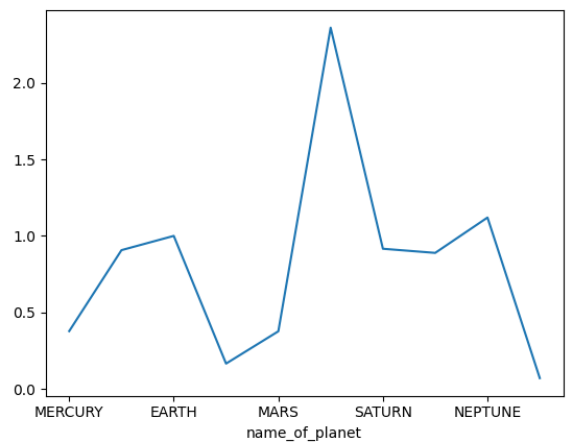
```python
t.rename(columns = {'Unnamed: 0':'PROPERTIES'}, inplace = True)
```

```python
t = t.set_index('PROPERTIES')
t
```

PROPERTIES	MERCURY	VENUS	EARTH	MOON	MARS	JUPITER	SATURN	URANUS	NEPTUNE	PLUTO
Mass	0.0553	0.815	1	0.0123	0.107	317.8	95.2	14.5	17.1	0.0022
Diameter	0.383	0.949	1	0.2724	0.532	11.21	9.45	4.01	3.88	0.187

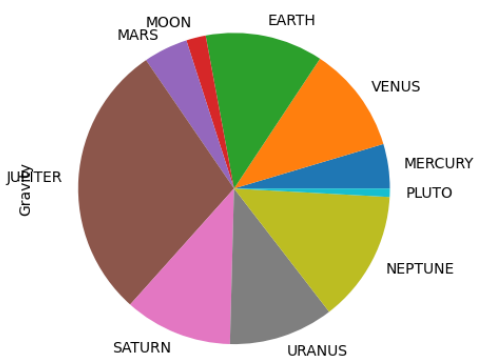
```python
t.Gravity.astype(float).plot()
```

```
<Axes: xlabel='name_of_planet'>
```



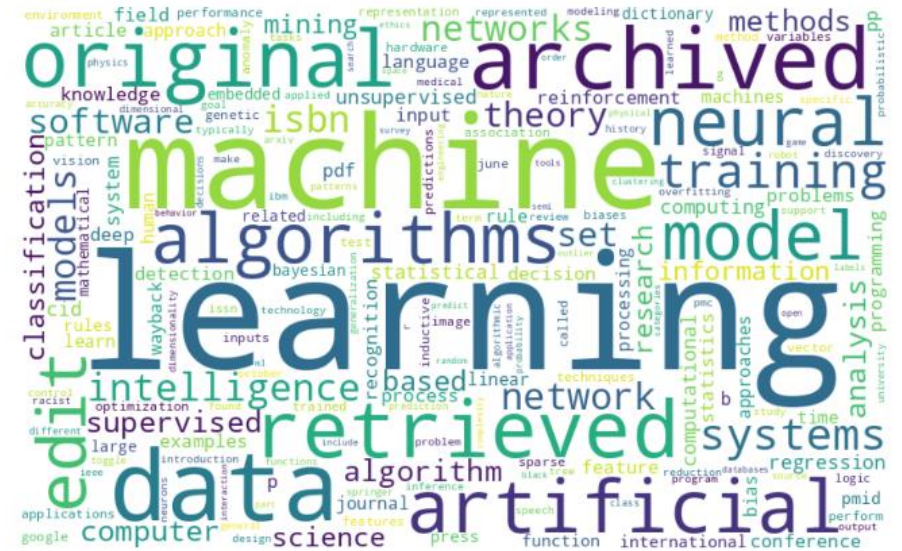

```python
t.Gravity.astype(float).plot.pie()
```

```
<Axes: ylabel='Gravity'>
```

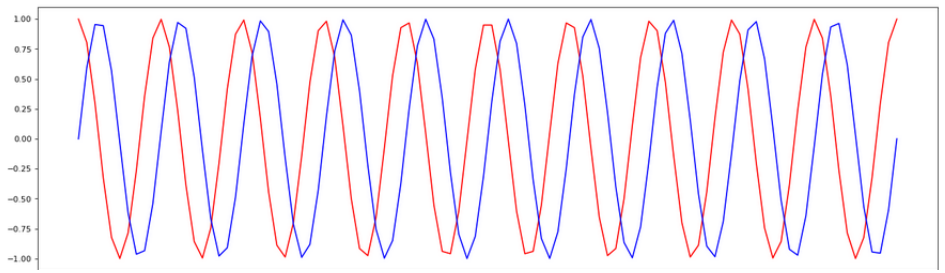



```html
<html>
    <head>
        <script language = "javascript" type = "text/javascript">
            <!--
            let friends = ["Sritej", "Ganesh", "Hector", "Santiago"];
            for (friend of friends){
                console.log(friend)
            }

            for (let i = 0; i < friends.length; i++){
                console.log(friends[i])
            }
            //--!>
            </script>
    </head>
    <body>
    </body>
</html>
```

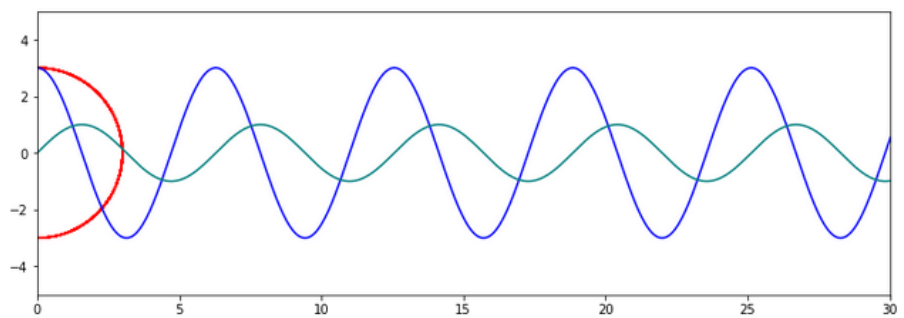
```python
plt.figure(figsize = [20,10])
word_cloud = WordCloud(
    width = 800,
    height = 500,
    background_color = 'white').generate_from_frequencies(frequencies)

plt.imshow(word_cloud, interpolation = 'bilinear')
plt.axis("off")
plt.show()
```



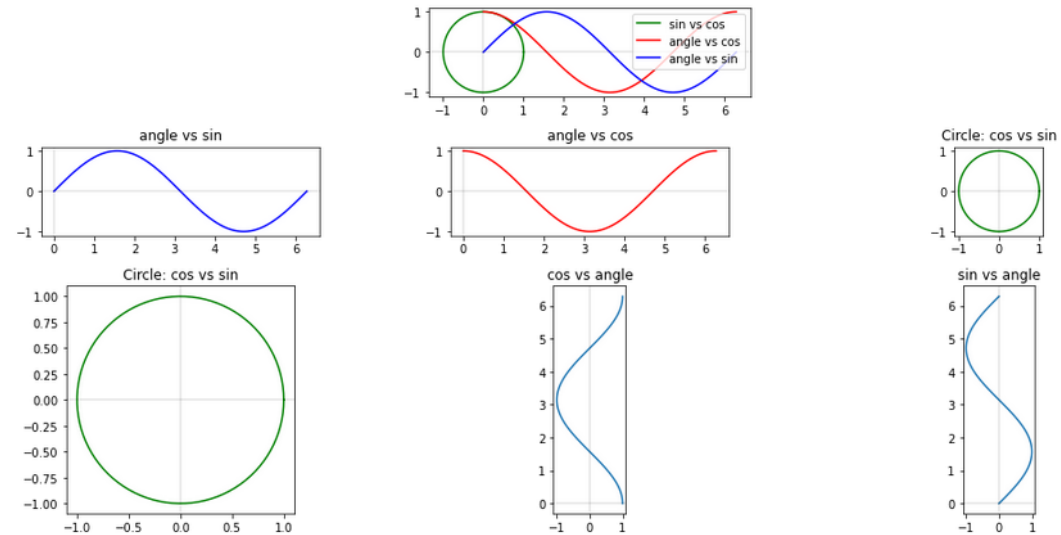
```
figure(figsize=(20, 6), dpi=80)

#theta = np.linspace(0 * np.pi, 10 * np.pi, 100)

t = np.linspace(0, 1, 100)
f = 10
w = 2 * np.pi * f
theta = w * t

y1 = np.cos(theta)
y2 = np.sin(theta)

plt.plot(theta, y1, color = 'red')
plt.plot(theta, y2, color = 'blue')

plt.show()
```



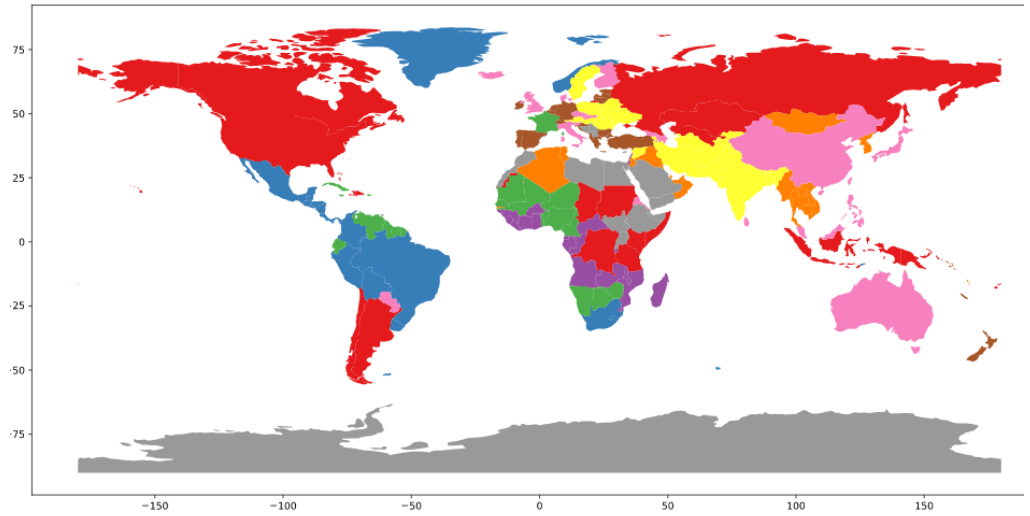
```
plt.figure(figsize = (12, 6))

t = linspace(0, 5, 1000)
f = 2
w = 2 * pi * f
angles = w * t
r = 3 #It is called amplitude of the wave

plt.plot(r * cos(angles), r * sin(angles), color = 'red')

plt.plot(angles, r * cos(angles), color = 'blue')
plt.plot(angles, sin(angles), color = 'teal')

plt.xlim(0, 30)
plt.ylim(-5, 5)
plt.gca().set_aspect('equal', adjustable='box')
plt.show()
```

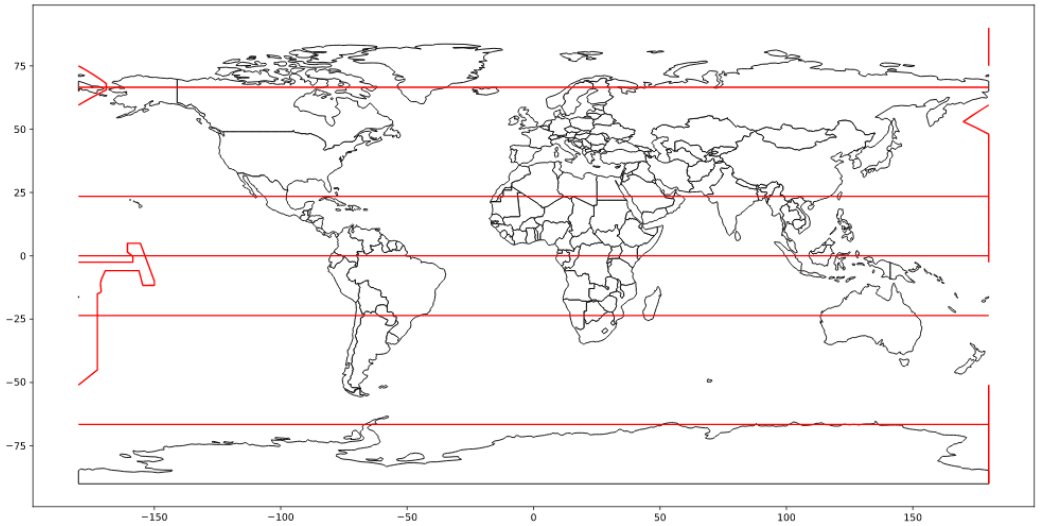


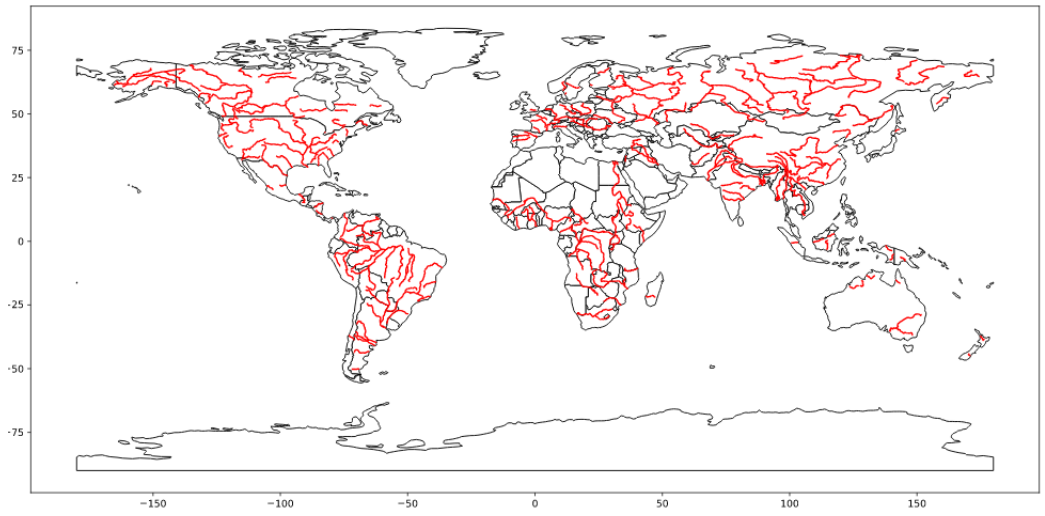
```
ax.axvline(x = 0, color = (0, 0, 0, .1))
ax.axhline(y = 0, color = (0, 0, 0, .1))
ax.legend()

fig.tight_layout()
plt.show()
```

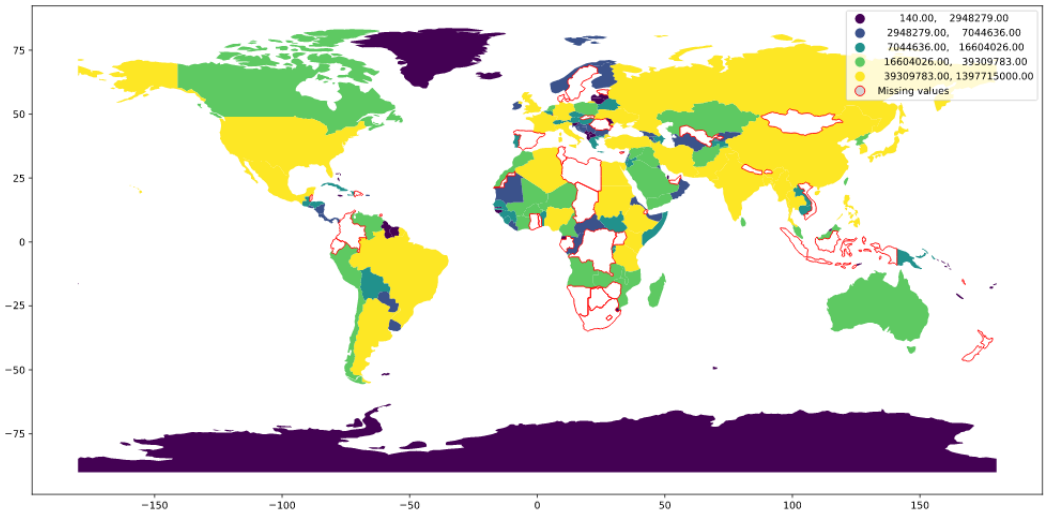


Geoplotting to study geography





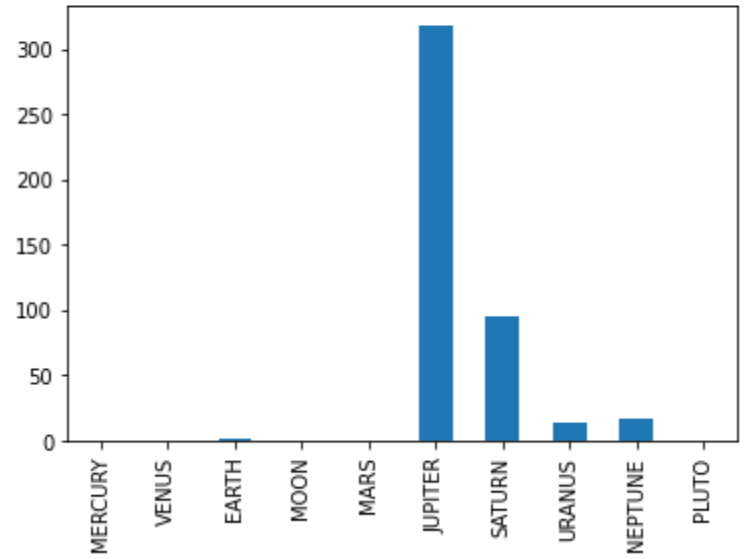




He is good at data refining, visualization, and analysis

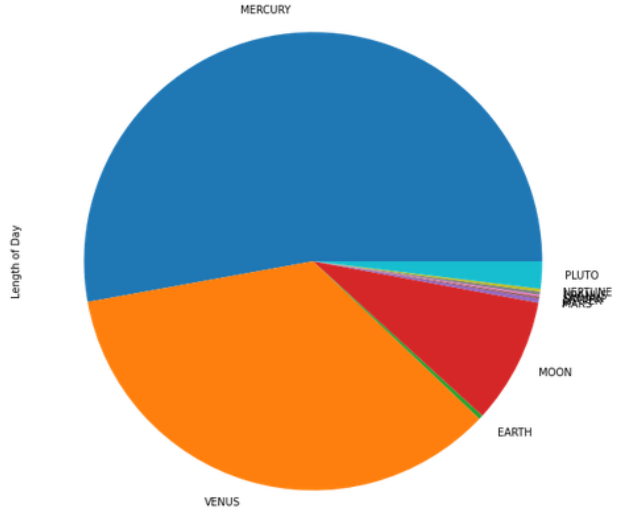
```
1  ss.Mass.astype(float).plot.bar()
2
```

<AxesSubplot:>



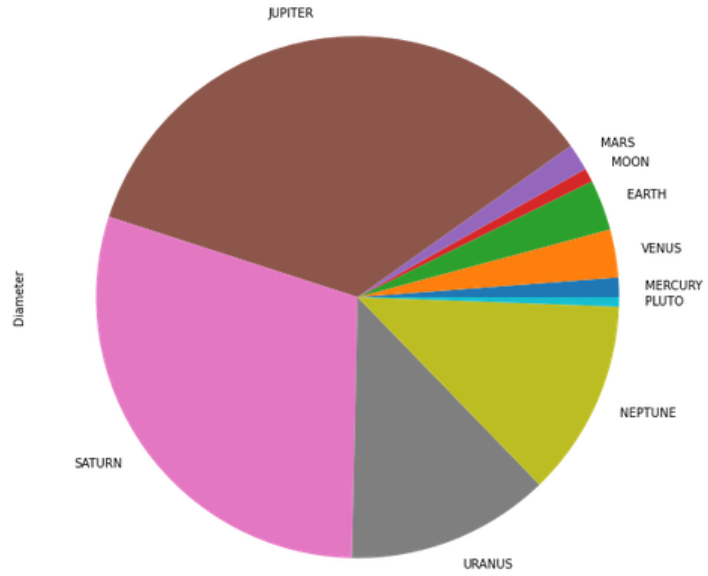

```
In [13]:
1  plt.figure(figsize=(10,10))
2  ss["Length of Day"].astype(float).plot.pie()
3
4
```

Out[13]: <AxesSubplot:ylabel='Length of Day'>



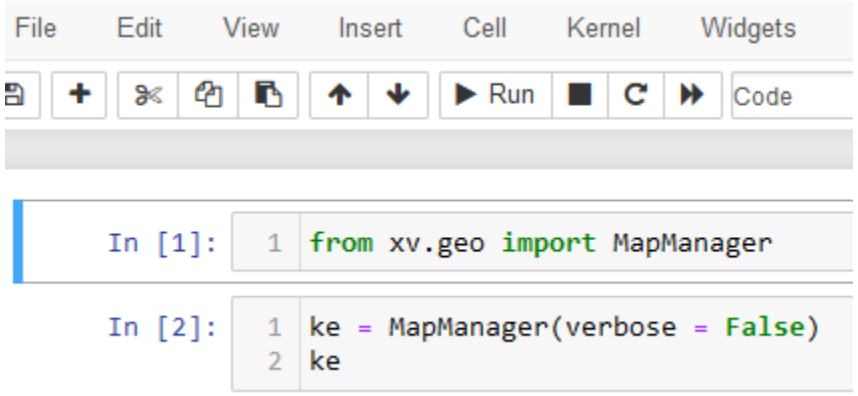

```
In [11]:
1  plt.figure(figsize=(10,10))
2  ss.Diameter.astype(float).plot.pie()
3
```

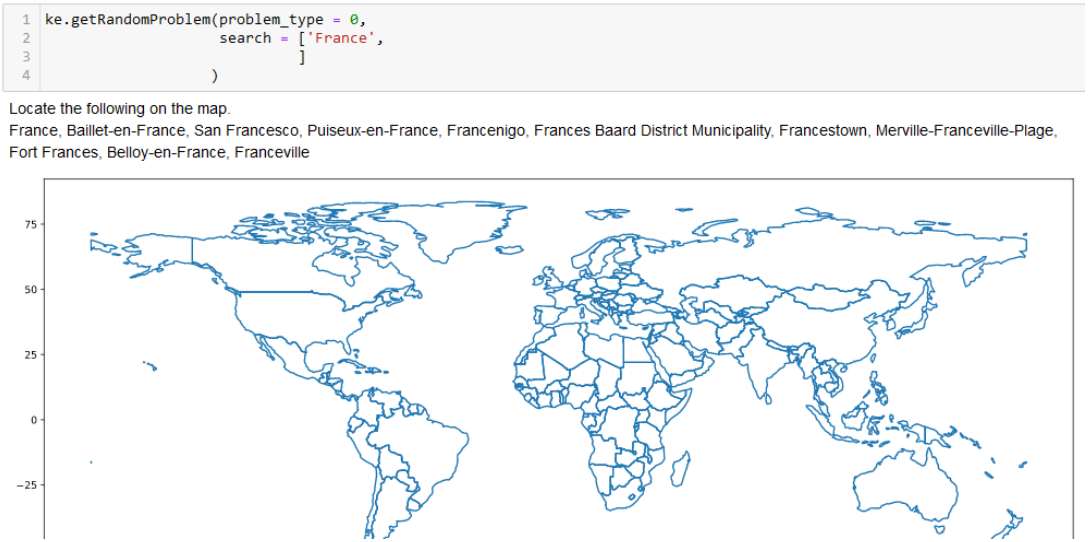
Out[11]: <AxesSubplot:ylabel='Diameter'>



Geoplotting

- Plotting countries, continents, rivers, and other landscapes
- Locating and identifying things on maps
- Analyzing and predicting about places and verifying whether their analytical conclusions are right or not.





‘Managers’ are our modern form of books and question banks

All managers can generate an unlimited number of non-repetitive questions based on a set of concepts.

The managers shown in this document are only those which were done by this student. He used a large number of managers, but only a few are presented in this document.

Each manager contains a large number of problem types. This document shows it for a few managers. In other cases, random sample problems have been shown.

Managers from math.

```
In [1]:  1  from xv.math.algebra import AlgebricExpressionManager

In [2]:  1  ke = AlgebricExpressionManager()

In [3]:  1  ke.printProblemTypes()
         2
```

```
0. _problem_add
1. _problem_add_advanced
2. _problem_subtract
3. _problem_subtract_advanced
4. _problem_multiple_subtracts
5. _problem_multiply
6. _problem_multiply_advanced
7. _problem_divide
8. _problem_divide_advanced_1
9. _problem_divide_advanced_2
10. _problem_divide_advanced_3
11. _problem_division_with_zero
12. _problem_power_with_zero
13. _problem_abs_values
```

Find the absolute value of

if $x < 0,\ y >= 0$

Answer:

$y - x$

Solution:

$\text{abs}\,(x - y)$

$= |x - y|$

Let $x = -8$, and $y = 5$

$= |(-8) - (5)|$

$= |-13|$

$= 13$

Hence,

$|x - y| = y - x$ See r

Note:

x + y = -3

x - y = -13

y - x = 13

-(x + y) = 3

$-5v + 8x + 2z$

$-9v - w + x - 2y + 6z$

Answer:

$4v + w + 7x + 2y - 4z$

Solution:

We have to subtract second expression from f

$-5v + 8x + 2z$

$-9v - w + x - 2y + 6z$

The coefficients of variables v, w, x, y, z are:

$$\begin{bmatrix} v & w & x & y & z \\ -5 & 0 & 8 & 0 & 2 \\ -9 & -1 & 1 & -2 & 6 \end{bmatrix}$$

As We have to subtract second expression fro
we will change sign of each coefficient in the

$$\begin{bmatrix} v & w & x & y & z \\ -5 & 0 & 8 & 0 & 2 \\ 9 & 1 & -1 & 2 & -6 \end{bmatrix}$$

Add the columns:

$$\begin{bmatrix} v & w & x & y & z \\ 4 & 1 & 7 & 2 & -4 \end{bmatrix}$$

⇒ The sum of expressions:

$= 4v + w + 7x + 2y - 4z$

We can rewrite

$\sqrt[3]{261} = \sqrt[3]{(216 + 45)}$ where $x = 216$ an

$f(\Delta x + x) = (\text{Value of function}) + (\text{Rate of ch}$

$$= f(x) + \left(\frac{d}{dx} f(x)\right) \cdot \Delta x$$

$$= f(x) + \left(\frac{d}{dx} \sqrt[3]{x}\right) \cdot \Delta x$$

$$= f(x) + \left(\frac{1}{3x^{\frac{2}{3}}}\right) \cdot \Delta x$$

$$= \sqrt[3]{216} + \left(\frac{216^{-\frac{2}{3}}}{3}\right) \cdot (45)$$

$$= 6 + \frac{5}{12}$$

$$= \frac{77}{12}$$ actual value is $\sqrt[3]{261}$

Solve $\dfrac{(4 - -5)}{6 \times 8 + \frac{(9-5)}{\left(\frac{5}{-8}\right)+(5x-4)}} \times (6 - 2)$

Answer:

$\dfrac{1485}{31552}$

Solution:

$$\frac{(4 - -5)}{6 \times 8 + \frac{(9-5)}{\left(\frac{5}{-8}\right)+(5x-4)}} \times (6 - 2)$$

$$= \frac{9}{6 \times 8 + \frac{(9-5)}{\left(\frac{5}{-8}\right)+(5x-4)}} \times (6 - 2)$$ as $(4 - -5) =$

$$= \frac{9}{4 \times 6 \times 8 + \frac{(9-5)}{\left(\frac{5}{-8}\right)+(5x-4)}}$$ as $(6 - 2) = 4$

Find relation between a, $v(s)$ and s

where:

a = acceleration

$v(s)$ = velocity

s = displacement

t = time

Answer:

$v^2(s) = 2as + v^2(0)$

Solution:

First Part:

$$a = \frac{d}{dt} v(s)$$

$$\implies a = \frac{d}{ds} v(s) \frac{d}{dt} s$$

$$\implies a = v(s) \frac{d}{ds} v(s)$$

$$\implies \int_0^s a\, ds = \int_0^s v(s) \frac{d}{ds} v(s)\, ds$$

$$\implies as = -\frac{v^2(0)}{2} + \frac{v^2(s)}{2}$$

$$\implies 2as = -v^2(0) + v^2(s)$$

Second Part:

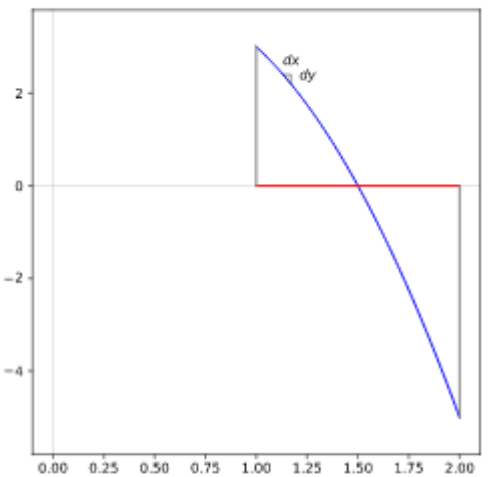
$$a = v(s) \frac{d}{\square} v(s)$$

Find length of the curve $f(x) = -4x^2 + 4x + 3$ between $x = 1$ and $x = 2$.

Answer:

$-\frac{\sqrt{17}}{4} - \frac{\text{asinh}(4)}{16} + \frac{\text{asinh}(12)}{16} + \frac{3\sqrt{145}}{4}$

Solution:



The length of curve

$dL = \sqrt{dx^2 + dy^2}$

$= \sqrt{df(x)^2 + dx^2}$

$= \sqrt{\left(\frac{d}{dx} f(x)\right)^2 + 1}\, dx$

$\rightarrow L = \left| \int_1^2 \sqrt{\left(\frac{d}{dx} f(x)\right)^2 + 1}\, dx \right|$

$= \left| \int_1^2 \sqrt{\left(\frac{d}{dx}(-4x^2 + 4x + 3)\right)^2 + 1}\, dx \right|$

Find surface area of the the cone whose base has radius 1 and height 3.

Answer:

$\pi\left(1 + \sqrt{10}\right)$

Solution:

A cone has one circular base and slant surface area

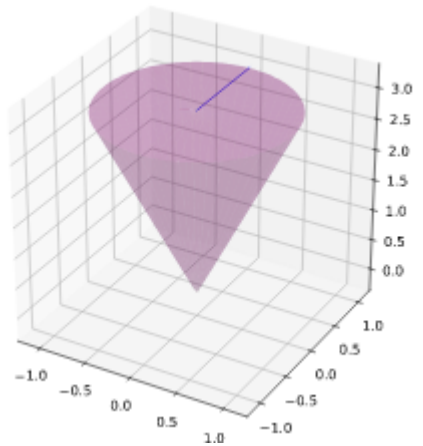
= area of circular base + slant surface area

- $\pi r^2 + \pi r l$

  where l is slant length and is equal to $\sqrt{h^2 + r^2} = \sqrt{(1^2 + 3^2)} = \sqrt{10}$

- $\pi r(r + l)$
- $\pi * 1\left(1 + \sqrt{10}\right)$
- $\pi * 1\left(1 + \sqrt{10}\right)$
- $\pi\left(1 + \sqrt{10}\right)$

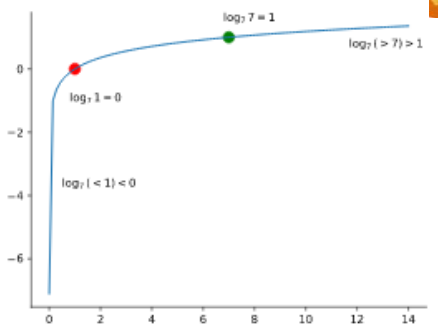
Cone (radius: 1, length: 3, center: (0, 0, 0), theta: 2π)



The value of $\log_7 343.1$ is: -0.2625, 0.04898, 1.007, 2, 3

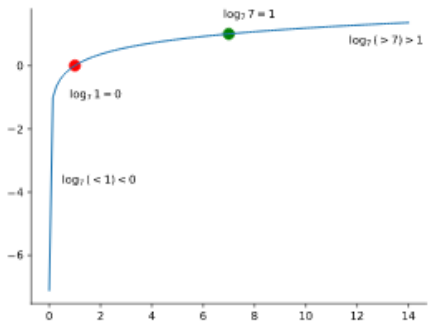
Answer:

3



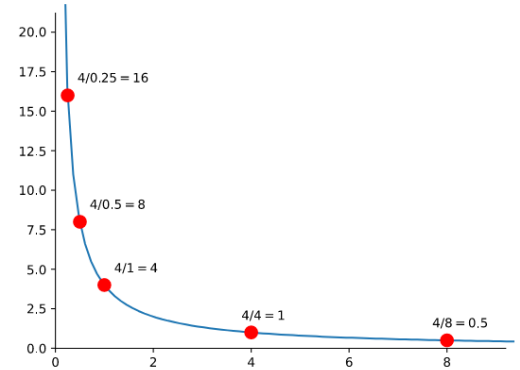
Solution:

$\log_7 343.1 = 3$




```
import matplotlib.pyplot as plt
from matplotlib import pyplot as plt
```

The value of $\frac{4}{3.1}$ is: 11.43, 6.667, 4.706, 3.636, 2.5, 1.905, 1.29



Answer:

1.29

```
ke.getRandomProblem(problem_type= 18)
```

Simplify the followings:

$$\frac{8.0+0.4}{40.0} * \frac{1}{6.0}$$

```
ke.printAnswer()
```

$\frac{7}{200}$ or

0.035

```
ke.printSolution()
```

$$\frac{8.0+0.4}{40.0} * \frac{1}{6.0}$$

$$= \frac{8.4}{40.0} * \frac{1}{6}$$

$$= \frac{\frac{42}{5}}{40} * \frac{1}{6}$$

$$= \frac{42 * 1}{40 * 5} * \frac{1}{6}$$

$$= \frac{42 * 1 * 1}{40 * 5 * 6}$$

$$= \frac{42}{1200}$$

$$= \frac{7}{200}$$

```
ke.getRandomProblem(problem_type = 19)
```

Prove that
$\frac{2}{5} < \log_{10} 3 < \frac{1}{2}$

```
ke.printAnswer()
```

$\frac{2}{5} < \log_{10} 3 < \frac{1}{2}$

```
ke.printSolution()
```

$\log_{10} 3 \quad ? \quad \frac{2}{5}$

$\Rightarrow 3 \quad ? \quad 10^{\frac{2}{5}}$

$\Rightarrow 3^5 > 10^2,$

Now $\log_{10} 3 \quad ? \quad \frac{1}{2}$

$\Rightarrow \quad 3 \quad ? \quad 10^{\frac{1}{2}}$

$\Rightarrow \quad 3^2 < 10,$ which is true

Hence $\frac{2}{5} < \log_{10} 3 < \frac{1}{2}$

Write arithmetic series of z^6 terms, with first term (t_0) as $\sqrt[9]{x}$ and the common difference as $-y$

Answer:

$$((\sqrt[9]{x}) + (-y) \cdot 0) + ((\sqrt[9]{x}) + (-y) \cdot 1) + ((\sqrt[9]{x}) + (-y) \cdot 2) + \cdots + ((\sqrt[9]{x}) + (-y) \cdot (z^6 - 2)) + ((\sqrt[9]{x}) + (-y) \cdot (z^6 - 1))$$

It can also be written as $\sum_{k=0}^{z^6-1} ((\sqrt[9]{x}) + (-y) \cdot k)$

Solution:

next term = (previous term) + (common difference)

$t_n = t_0 + n *$ **common difference**

Please note that we start count of terms from 0.

$$t_0 = \sqrt[9]{x} = ((\sqrt[9]{x}) + (-y) \cdot 0)$$

$$t_1 = t_0 + (-y) = ((\sqrt[9]{x}) + (-y) \cdot 0) + (-y) = ((\sqrt[9]{x}) + (-y) \cdot 1)$$

$$t_2 = t_1 + (-y) = ((\sqrt[9]{x}) + (-y) \cdot 1) + (-y) = ((\sqrt[9]{x}) + (-y) \cdot 2)$$

...

$$t_{z^6-1} = t_{z^6-2} + (-y) = ((\sqrt[9]{x}) + (-y) \cdot (z^6 - 2)) + (-y) = ((\sqrt[9]{x}) + (-y) \cdot (z^6 - 1))$$

$$t_{z^6} = t_{z^6-1} + (-y) = ((\sqrt[9]{x}) + (-y) \cdot (z^6 - 1)) + (-y) = ((\sqrt[9]{x}) + (-y) \cdot (z^6))$$

Therefore, the series is

$$((\sqrt[9]{x}) + (-y) \cdot 0) + ((\sqrt[9]{x}) + (-y) \cdot 1) + ((\sqrt[9]{x}) + (-y) \cdot 2) + \cdots + ((\sqrt[9]{x}) + (-y) \cdot (z^6 - 2)) + ((\sqrt[9]{x}) + (-y) \cdot (z^6 - 1))$$

$$= x * *(1/9) + x * *(1/9) - y + x * *(1/9) - 2 * y + \cdots + x * *(1/9) - y * (z * *6 - 2) + x * *(1/9) - y * (z * *6 - 1)$$

It can also be written as $\sum_{k=0}^{z^6-1} ((\sqrt[9]{x}) + (-y) \cdot k)$

Solve the followings:

Q1. $---9$

Q2. $--9$

Q3. $9 * 9$

Q4. $-9 * 9$

Q5. $9 * -9$

Q6. $-9 * -9$

Q7. $--9 * 9$

Q8. $9 * --9$

Q9. $--9 * ---9$

Q10. $-9 * --9$

Q11. $--9 * -9$

Solution 28.
$(-2)/(-10) = \frac{1}{5}$

Solution 29.
$10^2 = 100$

Solution 30.
$2^{10} = 1024$

Solution 31.
$10^{-2} = \frac{1}{100}$

Solution 32.
$2^{-10} = \frac{1}{1024}$

Solution 33.
$(-10)^2 = -100$

Solution 34.
$(-2)^{10} = -1024$

Solution 35.
$(-10)^{-2} = -\frac{1}{100}$

Solution 36.
$(-2)^{-10} = -\frac{1}{1024}$

Solution 37.
$log_2 10 = \frac{10}{3}$

Solution 38.
$log_{10} 2 = \frac{3}{10}$

```
from xv.math.basicmaths import NumberUnitManager
```

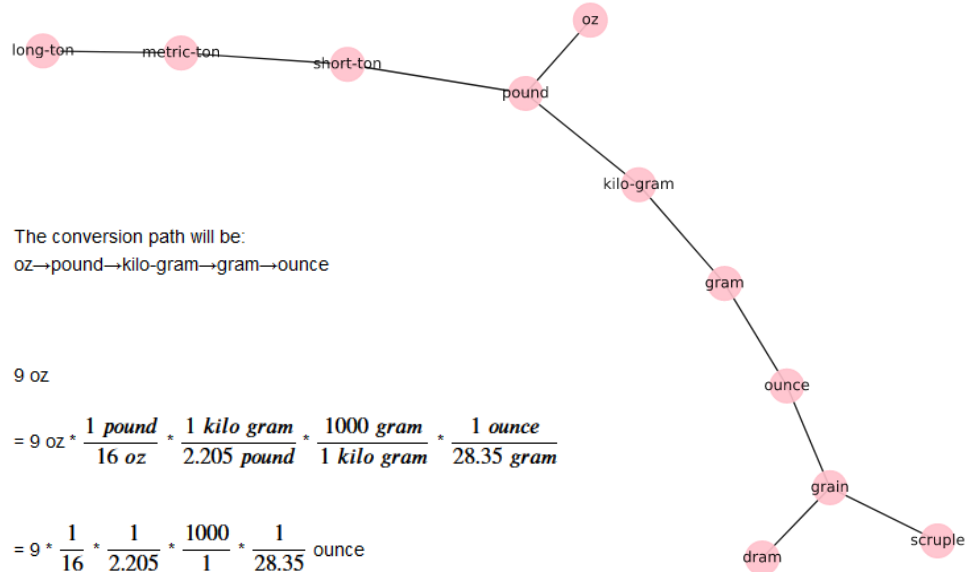
```
ke = NumberUnitManager()
```

```
ke.getRandomProblem(problem_type = 4)
```

Convert 9 oz to ounce.

Note: You may use the following table:

1 ounce = 28.35 gram
1 pound = 16 oz
1 kilo-gram = 2.205 pound
1 pound = 0.0005 short-ton
1 metric-ton = 1.12 short-ton
1 long-ton = 1.016 metric-ton
1 grain = 0.05 scruple
1 grain = 0.01667 dram
1 grain = 0.00208 ounce
1 kilo-gram = 1000 gram



The conversion path will be:
oz→pound→kilo-gram→gram→ounce

9 oz

$$= 9 \text{ oz} * \frac{1 \ pound}{16 \ oz} * \frac{1 \ kilo \ gram}{2.205 \ pound} * \frac{1000 \ gram}{1 \ kilo \ gram} * \frac{1 \ ounce}{28.35 \ gram}$$

$$= 9 * \frac{1}{16} * \frac{1}{2.205} * \frac{1000}{1} * \frac{1}{28.35} \text{ ounce}$$

= 9 * 0.9998120353373564 ounce

= 8.998308318036207 ounce

```
ke.getRandomProblem(problem_type = 11)
```

Form 2-letter words from letters r, k, v, g, f, u, x. The words need not be meaningful

```
ke.printAnswer()
```

84

```
ke.printSolution()
```

ways of selecting 3 from 9 items

$$= \binom{9}{3}$$

$$= \frac{9!}{(9-3)!\ 3!}$$

$$= \frac{9!}{6!\ 3!}$$

$$= \frac{362880}{720 * 6}$$

$$= 84$$

```
ke.getRandomProblem(problem_type= 2)
```

Find the ratio of numbers 0.014, 0.031 and 0.58

```
ke.printAnswer()
```

14 : 31 : 580

```
ke.printSolution()
```

The greatest common divisor (GCD) of the numbers 27, 12 and 3 =

To get ratio, we have to divide the numbers by the GCD.

Ratio of numbers 27, 12 and 3

$$= \frac{27}{3} : \frac{12}{3} : \frac{3}{3}$$

$$= 9 : 4 : 1$$

```
ke.printSolution()
```

Numbers:

$$\frac{1}{2}, -\frac{2}{7}, \frac{6}{1}, \frac{1}{1}, \frac{1}{2}, -\frac{2}{1}$$

Common Denominators:

Let us make all denominators equal to their LCM = 14

$$= \frac{1*7}{2*7}, -\frac{2*2}{7*2}, \frac{6*14}{1*14}, \frac{1*14}{1*14}, \frac{1*7}{2*7}, -\frac{2*14}{1*14}$$

$$= \frac{7}{14}, -\frac{4}{14}, \frac{84}{14}, \frac{14}{14}, \frac{7}{14}, -\frac{28}{14}$$

Sum:

As we have common denom

$$= \frac{80}{14}$$

$$= \frac{80\ /\ 2}{14\ /\ 2}$$

$$= \frac{40}{7}$$

$$= \frac{40}{7}$$

Average:

Average of numbers

$$= \frac{\frac{40}{7}}{6}$$

$$= \frac{1}{6} * \frac{40}{7}$$

$$= \frac{20}{21}$$

Sorted Numbers:

$$-\frac{28}{14}, -\frac{4}{14}, \frac{7}{14}, \frac{7}{14}, \frac{14}{14}, \frac{84}{14}$$

$$= -\frac{2}{1}, -\frac{2}{7}, \frac{1}{2}, \frac{1}{2}, \frac{1}{1}, \frac{6}{1}$$

Median:

The number of fractions is 6, an even number.

The middle term is, $\frac{6+1}{2} = \frac{7}{2}$ th term.

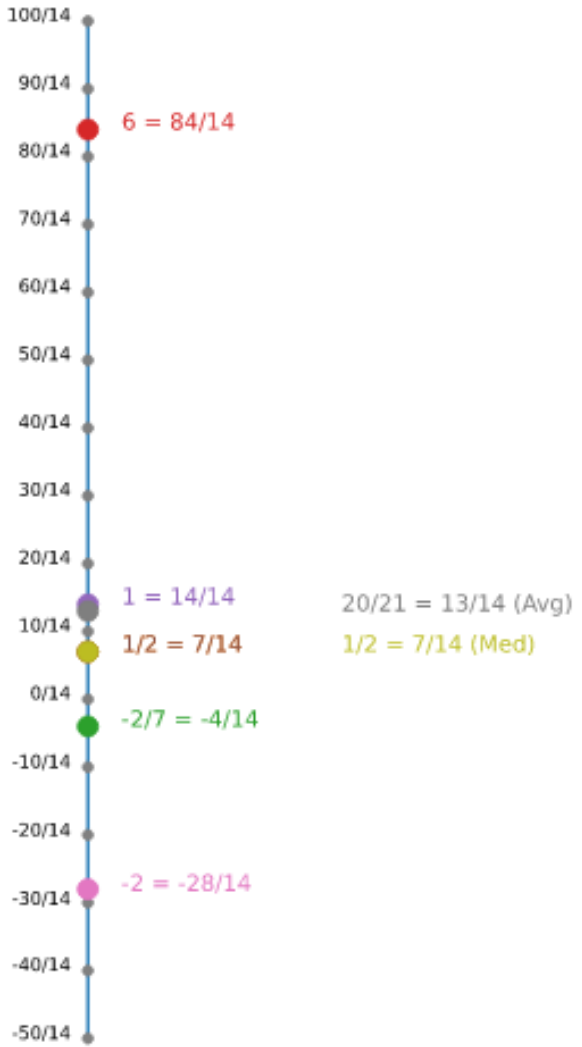
Hence, the median will be average of 3rd and 4th terms.

Median

$$= \frac{\frac{1}{2} + \frac{1}{2}}{2}$$

$$= \frac{1}{2}$$

$$= \frac{1}{2}$$



```
ke.getRandomProblem(problem_type = 7)
```

Marium has 7 *farm*. Each *farm* has 2 *garden*. Each *garden* has 60 *tree*. Each *tree* has 10 *fruit* cost of maintaining each tree is $0.5. Answer the following questions:

1. What is the total number of farm?
2. What is the total number of garden?
3. What is the total number of tree?
4. What is the total number of fruit?
5. What is the total number of box?
6. What is the total sales value?
7. What is the total cost?
8. What is the net profit?

```
ke.printSolution()
```

The equation of the question are as follows:

1 *Mary* = 8 *garden*

1 *garden* = 20 *tree*

1 *tree* = 20 *fruit*

1 *fruit* = $\frac{1}{12}$ *box*

1 *box* = $800/3 [sell price]

1 *garden* = $200 [cost price]

Let us do calculations:

Total sales revenue

$= 8\ garden$

$= 8\ garden * \frac{20\ tree}{garden}$ So, 160 *tree*

$= 8\ garden * \frac{20\ tree}{garden} * \frac{20\ fruit}{tree}$ So, 3200 *fruit*

$= 8\ garden * \frac{20\ tree}{garden} * \frac{20\ fruit}{tree} * \frac{box}{12\ fruit}$ So, 800/3 *box*

$= 8\ garden * \frac{20\ tree}{garden} * \frac{20\ fruit}{tree} * \frac{box}{12\ fruit} * \frac{\$8}{box}$

$= 8 * 20 * 20 * \frac{1}{12} * \$8$

$= \$6400/3$

Cost

$= \frac{\$200}{garden}$

$= \frac{\$200}{garden} * 8\ garden$

$= \$1600$

Net Profit
= Total Cost - Total Revenue

$= \$6400/3 - \$1600$

$= \$1600/3$

Expand:

$$\left(\frac{x}{3y} + xy\right)^4$$

Answer:

$$= x^4y^4 + \frac{4x^4y^2}{3} + \frac{2x^4}{3} + \frac{4x^4}{27y^2} + \frac{x^4}{81y^4} + \cdots$$

Solution:

$$\left(\frac{x}{3y} + xy\right)^4$$

$$= \sum_{k=0}^{4} \binom{4}{k} \left(\frac{x}{3y}\right)^{4-k} (xy)^k$$

$$= \binom{4}{0} \cdot \left(\frac{x}{3y}\right)^4 \cdot (xy)^0 + \binom{4}{1} \cdot \left(\frac{x}{3y}\right)^3 \cdot (xy)^1 + \binom{4}{2} \cdot \left(\frac{x}{3y}\right)^2 \cdot$$

$$= 1 \cdot \frac{x^4}{81y^4} \cdot 1 + 4 \cdot \frac{x^3}{27y^3} \cdot xy + 6 \cdot \frac{x^2}{9y^2} \cdot x^2y^2 + 4 \cdot \frac{x}{3y} \cdot x^3y^3 + 1 \cdot$$

$$= \frac{x^4}{81y^4} + \frac{4x^4}{27y^2} + \frac{2x^4}{3} + \frac{4x^4y^2}{3} + x^4y^4 + \cdots$$

$$= x^4y^4 + \frac{4x^4y^2}{3} + \frac{2x^4}{3} + \frac{4x^4}{27y^2} + \frac{x^4}{81y^4} + \cdots$$

5. $z = 3 - 3i$

modulus of $z = r = |z| = \sqrt{(3)^2 + (-3)^2} = 4.24$

argument or phase of $z = \phi(z) = tan^{-1}\left(\frac{-3}{3}\right) = tan^{-1}\left(\frac{-3}{3}\right) = -0.785 = -45^o$

Now,

$(3 - 3i)^4$

$= \left(re^{i(2n\pi+\phi)}\right)^4$

$= r^4 e^{4(2n\pi+\phi)i}$

$4\ (2n\pi + \phi)$ can be solved for $n = 0, 1, 2, 3, \ldots$

The distinct values are:
$\theta_0 = (2 * 0 * \pi + -45^o) * 4 = 180^o$

Write expression for arranging k items from a collection of n items

P_k^n

Note: P_k^n is read as n permutation k.

Answer:

$$\frac{n!}{(-k+n)!}$$

Solution:

Arranging k out of n things.

As we start with n things and r places:
1. For first place, we can choose any item from n things, so we have n choices.
2. For second place, we can choose any item from remainder $n - 1$ things, so we have n
3. For third place, we can choose any item from remainder $n - 2$ things, so we have $n -$ –

Thus, for kth place, the choice will be $n - (k - 1) = n - k + 1$

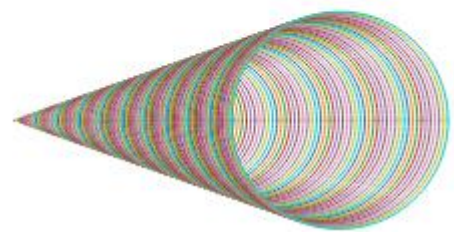
Now, all choices are dependent on each other, so will get a product to get the result.

$$\implies P_k^n = n(n-1)(n-2)\cdots(n-k+2)(n-k+1)$$

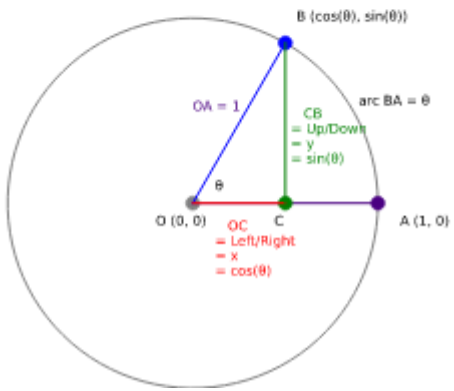
$$\implies P_k^n = \frac{n(n-1)(n-2)\cdots(n-k+2)(n-k+1)(n-k)(n-k-1)\cdots * 3}{(n-k)(n-k-1)\cdots * 3 * 2 * 1}$$

$$\implies P_k^n = \frac{n!}{(-k+n)!}$$

```
for i in np.linspace(0, length_of_curve, number_of_rangs):
    r = i
    x = r * cos(theta) + r * move_left_right
    y = r * sin (theta) + r * move_up_down
    plt.plot(x,y)

#optional code
plt.gca().set_aspect('equal')
plt.axis('off')
plt.show()
```



```
#plot point B
plt.plot(cos(theta), sin(theta), marker = 'o', color = 'blue', marker
plt.gca().annotate(f'B (cos(θ), sin(θ))', xy=(cos(theta) * 1.12, sin(

#plot radius OB
plt.plot((0, cos(theta)), (0, sin(theta)), color = 'blue')

#plot point C
plt.plot(cos(theta), 0, marker = 'o', color = 'green', markersize = 1
plt.gca().annotate(f'C', xy=(cos(theta) * .88,  -0.12), xycoords="dat

#plot line OC
label = f'''   OC
= Left/Right
= x
= cos(θ)'''

plt.plot((0, cos(theta)), (0, 0), color = 'red')
plt.gca().annotate(label, xy=(+0.12,  -0.39), xycoords="data", color

#plot line CB
label = f'''   CB
= Up/Down
= y
= sin(θ)'''

plt.plot((cos(theta), cos(theta)), (0, sin(theta)), color = 'green')
plt.gca().annotate(label, xy=(cos(theta)+0.03,  sin(theta)/4), xycoor

#optional code
plt.xlim(-1.2, 1.2)
plt.ylim(-1.2, 1.2)
plt.gca().set_aspect('equal')
plt.axis('off')
plt.show()
```



Find formula of $\cos(A-B)$ and $\sin(A-B)$

Answer:

$$\cos(A-B) = \sin(A)\sin(B) + \cos(A)\cos(B)$$

$$\sin(A-B) = \sin(A)\cos(B) - \sin(B)\cos(A)$$

Solution:

$$e^{i(A-B)} = e^{iA}e^{-iB}$$

$$\implies i\sin(A-B) + \cos(A-B) = (i\sin(A) + \cos(A))(-i\sin(B$$

$$\implies i\sin(A-B) + \cos(A-B) = \sin(A)\sin(B) + i\sin(A)\cos($$

Taking real terms of both sides:

$$\implies \cos(A-B) = \sin(A)\sin(B) + \cos(A)\cos(B)$$

Taking imaginary terms of both sides:

$$\implies \sin(A-B) = \sin(A)\cos(B) - \sin(B)\cos(A)$$

Prove

$$e^{i\theta} = \cos(\theta) + i\sin(\theta)$$

Answer:

$$e^{i\theta} = 1 + i\theta - \frac{\theta^2}{2} - \frac{i\theta^3}{6} + \frac{\theta^4}{24} + \frac{i\theta^5}{120} + O\left(\theta^6\right)$$

$$\cos(\theta) = 1 - \frac{\theta^2}{2} + \frac{\theta^4}{24} + O\left(\theta^6\right)$$

$$\sin(\theta) = \theta - \frac{\theta^3}{6} + \frac{\theta^5}{120} + O\left(\theta^6\right)$$

$$\implies e^{i\theta} = \cos(\theta) + i\sin(\theta)$$

Solution:

$$e^{i\theta} = 1 + i\theta - \frac{\theta^2}{2} - \frac{i\theta^3}{6} + \frac{\theta^4}{24} + \frac{i\theta^5}{120} + O\left(\theta^6\right)$$

$$\cos(\theta) = 1 - \frac{\theta^2}{2} + \frac{\theta^4}{24} + O\left(\theta^6\right)$$

$$\sin(\theta) = \theta - \frac{\theta^3}{6} + \frac{\theta^5}{120} + O\left(\theta^6\right)$$

$$\implies e^{i\theta} = \cos(\theta) + i\sin(\theta)$$

Find approximate value of the square root of 1030.

```
ke.printAnswer()
```

10.10

```
ke.printSolution()
```

$$(a+b)^{\frac{1}{3}} = a^{\frac{1}{3}} + \frac{1}{3}a^{\frac{1}{3}-1}\cdot b^1 + \cdots$$

$$= a^{\frac{1}{3}} + \frac{1}{3}a^{-\frac{2}{3}}\cdot b + \cdots$$

Let $x = a^{\frac{1}{3}}$

$$\Rightarrow x^2 = a^{\frac{2}{3}}$$

$$\Rightarrow \frac{1}{x^2} = a^{-\frac{2}{3}}$$

$$\Rightarrow (a+b)^{\frac{1}{3}} \approx x + \frac{1}{3}\frac{1}{x^2}\cdot b$$

The closest perfect 3 power of a number is $1000 = 10^3$.
Therefore,

$$1030 = 1000 + 30$$

$$\Rightarrow a = 1000$$

$$b = 30$$

$$x = 1000^{\frac{1}{3}} = 10$$

$$(1030)^{\frac{1}{3}} = (1000+30)^{\frac{1}{3}}$$

$$= x + \frac{1}{3}\frac{1}{x^2}\cdot b$$

$$= 10 + \frac{1}{3}\cdot\frac{1}{10^2}\cdot 30$$

$$= 10 + \frac{30}{300}$$

$$= 10 + 0.1$$

$$= 10.1$$

Please note that the actual root is 10.10.

```
0. _problem_traditional_division
1. _problem_divisible_by_multiples_of_10
2. _problem_divisible_by_4_8
3. _problem_divisible_by_2_5
4. _problem_divisible_by_3_9
5. _problem_divisible_by_6
6. _problem_divisible_by_7_13_17_19_29
7.  problem divisible by 11
```

Is 733100 divisible by 7?

Answer:

False

Solution:

We will apply last digit reduction meth
The reduction factor for 7 is -2.

Step 1: Number = 733100

-2 times of the last digit of 733100
= -2 * 0 = 0

Remove the last digit from 733100
= 73310

Add 0 from 73310
= 73310 + 0 = 73310

Step 2: Number = 73310

-2 times of the last digit of 73310
= -2 * 0 = 0

Remove the last digit from 73310
= 7331

Add 0 from 7331
= 7331 + 0 = 7331

Step 3: Number = 7331

-2 times of the last digit of 7331
= -2 * 1 = -2

Remove the last digit from 7331

Physics is easy for him

File Edit View Insert Cell Kernel Widgets Help

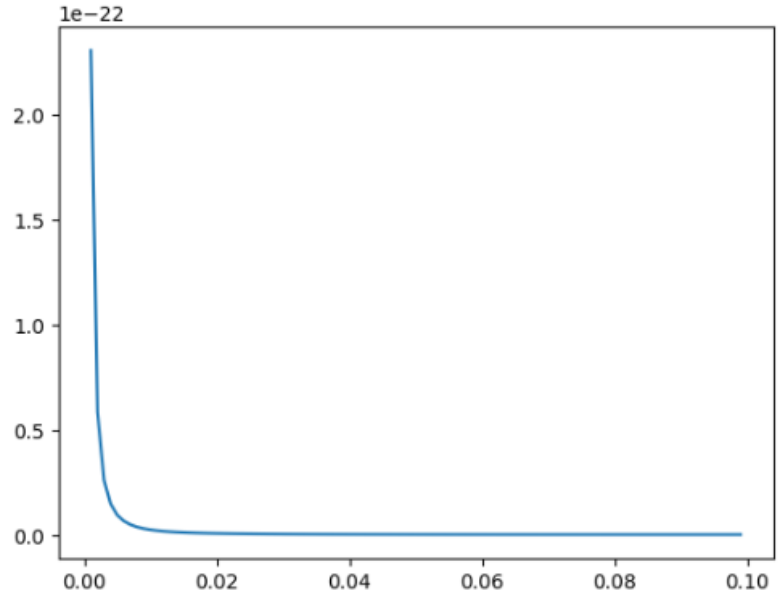
Run Code

```
In [5]:
1 import matplotlib.pyplot as plt
2 import numpy as np

In [3]:
1 q1 = 1.60217663e-19
2 q1

Out[3]: 1.60217663e-19

In [4]:
1 q2 = 1.60217663e-19
2 q2

Out[4]: 1.60217663e-19

In [12]:
1 e0 = 8.854e-12
2 e0

Out[12]: 8.854e-12

In [13]:
1 r = 0.037
2 r

Out[13]: 0.037

In [18]:
1 r = np.linspace(0.037, 1, 100)

In [26]:
1 r = np.linspace(0.001, 0.099, 100)

In [27]:
1 F = 1/(4 * np.pi * e0) * (q1 * q2)/ r ** 2

In [28]:
1 F = (q1 * q2) / (4 * np.pi * e0 * r ** 2)
```

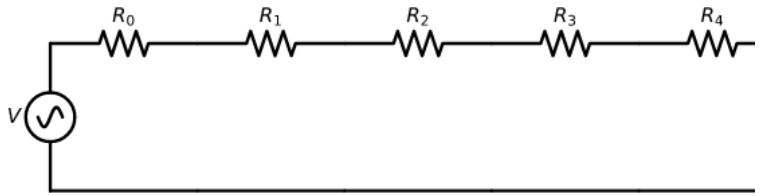
View Insert Cell Kernel Widgets Help

Run Code

```
:
1 F = 1/(4 * np.pi * e0) * (q1 * q2)/ r ** 2

:
1 F = (q1 * q2) / (4 * np.pi * e0 * r ** 2)

:
1 plt.plot(r, F)

: [<matplotlib.lines.Line2D at 0x7fd4f201b8e0>]
```



A circuit has resistances R_0, R_1, R_2, R_3 and R_4 in a series connected to a voltage source V. What



Answer:

$R_0 + R_1 + R_2 + R_3 + R_4$

Solution:

The total voltage is sum of voltages across each resistances in a series.

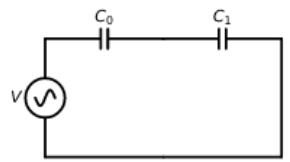
$$V = V_0 + V_1 + V_2 + V_3 + V_4$$

As the current through each of the resistance in a series must be same:

$$\implies IR = IR_0 + IR_1 + IR_2 + IR_3 + IR_4$$

$$\implies R = R_0 + R_1 + R_2 + R_3 + R_4$$

The capacitors with capacitances C_0 and C_1 are connected in a



Answer:

$\left(\frac{1}{\frac{1}{C_1}+\frac{1}{C_0}}\right)V$

Solution:

The total voltage on all capacitors connected in a series is the su

$$V = V_0 + V_1$$

As the charge on each capacitor in a series is same:

$$\implies \frac{q}{C} = \frac{q}{C_1} + \frac{q}{C_0}$$

$$\implies \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_0}$$

$$\implies C = \frac{1}{\frac{1}{C_1}+\frac{1}{C_0}}$$

$$\implies q = CV = \left(\frac{1}{\frac{1}{C_1}+\frac{1}{C_0}}\right)V$$

ors is given by

$$\cdot y(t)\cdot\hat{j} + z(t)\cdot\hat{k}$$

and acceleration $\vec{a}(t)$.

Answer:

$$\vec{v}(t) = \hat{i}\cdot\frac{d}{dt}x(t) + \hat{j}\cdot\frac{d}{dt}y(t) + \hat{k}\cdot\frac{d}{dt}z(t)$$

$$\vec{a}(t) = \hat{i}\cdot\frac{d^2}{dt^2}x(t) + \hat{j}\cdot\frac{d^2}{dt^2}y(t) + \hat{k}\cdot\frac{d^2}{dt^2}z(t)$$

Solution:

$$\vec{r}(t) = x(t)\cdot\hat{i} + y(t)\cdot\hat{j} + z(t)\cdot\hat{k}$$

$$\implies \vec{v}(t) = \frac{d}{dt}\vec{r}(t)$$

$$= \frac{\partial}{dt}\left(x(t)\cdot\hat{i} + y(t)\cdot\hat{j} + z(t)\cdot\hat{k}\right)$$

$$= \hat{i}\cdot\frac{d}{dt}x(t) + \hat{j}\cdot\frac{d}{dt}y(t) + \hat{k}\cdot\frac{d}{dt}z(t)$$

$$\implies \vec{a}(t) = \frac{d}{dt}\vec{v}(t)$$

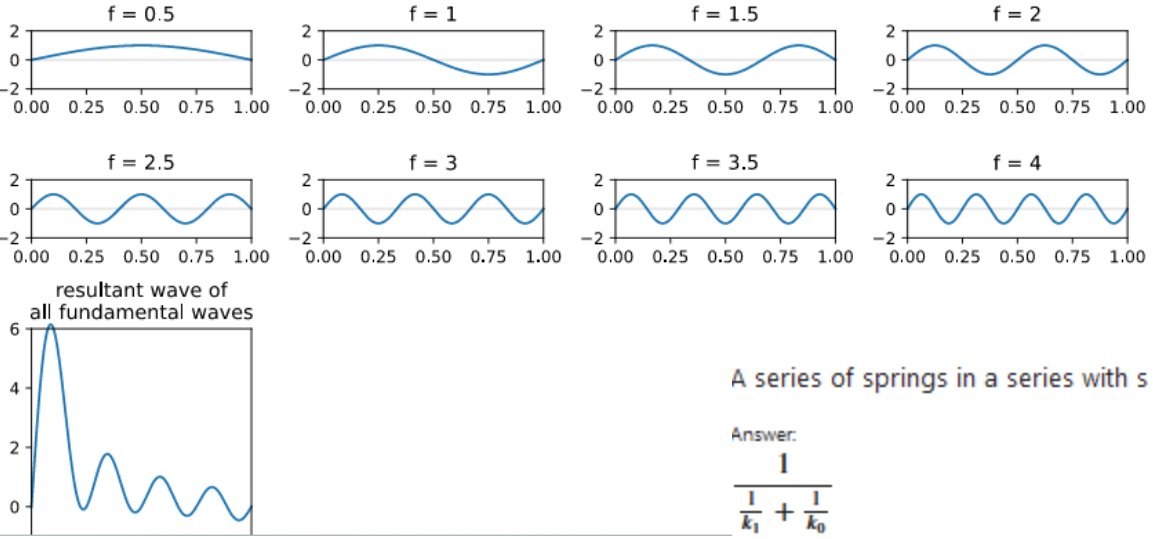
$$= \frac{\partial}{dt}\left(\hat{i}\cdot\frac{d}{dt}x(t) + \hat{j}\cdot\frac{d}{dt}y(t) + \hat{k}\cdot\frac{d}{dt}z(t)\right)$$

$$= \hat{i}\cdot\frac{d^2}{dt^2}x(t) + \hat{j}\cdot\frac{d^2}{dt^2}y(t) + \hat{k}\cdot\frac{d^2}{dt^2}z(t)$$

```
Setting plt.close()
Before deleting defs: len(str(soup)) = 90495
After deleting defs: len(str(soup)) = 89401
Setting plt.ion()
Problem Template: _problem_plot_fundamental_frequencies
```

Plot waves with fundamental frequencies.

Answer:



The potential energy due to two

$$\left[\vec{U}_{ij}\right] = \frac{1}{4\pi\epsilon_0}\frac{q_i q_j}{|\vec{r}_i - \vec{r}_j|}$$

The net potential energy of the s
1. the sum of potential energy, (
2. the sum of potential energy of

$$\vec{U} = \vec{U}_{ext0} + \vec{U}_{ext1} + \vec{U}_{01}$$

$$= q_0 V(\vec{r}_0) + q_1 V(\vec{r}_1) + \frac{1}{4\pi\epsilon_0}\frac{q_0 q_1}{|\vec{r}_0 - \vec{r}_1|}$$

$$= q_0 V(\vec{r}_0) + q_1 V(\vec{r}_1) + \frac{1}{4\pi\epsilon_0}\left(\frac{q_0 q_1}{|\vec{r}_0 - \vec{r}_1|}\right)$$

A series of springs in a series with s

Answer:

$$\frac{1}{\frac{1}{k_1}+\frac{1}{k_0}}$$

Solution:

The total displacement is sum of dis

$$x = x_0 + x_1$$

As the force through each of the spr

$$\implies \frac{F}{k} = \frac{F}{k_1} + \frac{F}{k_0}$$

$$\implies \frac{1}{k} = \frac{1}{k_1} + \frac{1}{k_0}$$

$$\implies k = \frac{1}{\frac{1}{k_1}+\frac{1}{k_0}}$$

Problem Template: _problem_length

If sticks of lengths l_0, l_1, l_2, l_3 and l_4 are joined together, what is the resultant length?

```
ke.printAnswer()
```

$$\vec{l} = \vec{l}_0 + \vec{l}_1 + \vec{l}_2 + \vec{l}_3 + \vec{l}_4$$

```
ke.printSolution()
```

Assuming that the sticks are joined in a straight line, the resultant length when sticks of lengths l_0, l_1, l_2, l_3 a

$$l = l_0 + l_1 + l_2 + l_3 + l_4$$

If they are not joined in a straight line, the resultant length will be a vector value:

$$\vec{l} = \vec{l}_0 + \vec{l}_1 + \vec{l}_2 + \vec{l}_3 + \vec{l}_4$$

In absence of any information, the second result is more appropriate.

M4. The motors of a rocket launched from the Earth are used only near the Earth in order to give the rocket just velocity of the rocket is a minimum and calculate the speed with which it hits the Moon's surface (the motion of

	Mass /kg	Radius /km
Earth	6.0×10^{24}	6.4×10^{3}
Moon	7.3×10^{22}	1.7×10^{3}

Earth-Moon distance = 3.8×10^{5} km.

Answer:
M4. 3.4×10^{5} km from centre of Earth; 2.4 km s^{-1}.

Find the heat required to convert 100 °C steam to 150 °C steam
q = mcΔT
q = (25 g)x(2.09 J/g·°C)[(150 °C - 100 °C)]
q = (25 g)x(2.09 J/g·°C)x(50 °C)
q = 2612.5 J
The heat required to convert 100 °C steam to 150 °C steam = 2612.5

Step 6:

Find total heat energy. In this final step, put together all of the answers from the previous calculations

HeatTotal = HeatStep 1 + HeatStep 2 + HeatStep 3 + HeatStep 4 + HeatStep 5
HeatTotal = 522.5 J + 8350 J + 10450 J + 56425 J + 2612.5 J
HeatTotal = 78360 J

Answer:

The heat required to convert 25 grams of -10 °C ice into 150 °C steam is 78360 J or 78.36 kJ.

Express f as a function of v, u

f = Focal length of mirror
u = Distance of object from mirror
v = Distance of image from mirror

Use constant = 1

```
ke.printAnswer()
```

$$\frac{1}{f} \propto \frac{u+v}{uv}$$

$$\implies \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$

```
ke.printSolution()
```

Let:

f = Focal length of mirror
u = Distance of object from mirror
v = Distance of image from mirror

The relation between variables:

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$$

$$\implies \oint_C \vec{E}\,\vec{dS} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}\,4\pi r^2$$

$$\implies \oint_C \vec{E}\,\vec{dS} = \frac{q}{\epsilon_0}$$

advanced_form

$$v = \frac{d}{dt}s \implies \int_{s_0}^{s} 1\,ds = \int_{t_0}^{t} v\,dt \implies s - s_0 = \int_{t_0}^{t} v\,dt$$

$$a = \frac{d}{dt}v \implies \int_{v_0}^{v} 1\,dv = \int_{t_0}^{t} a\,dt \implies v - v_0 = \int_{t_0}^{t} a\,dt$$

$$\implies \frac{d}{dt}s = v_0 + \int_{t_0}^{t} a\,dt \implies \int_{s_0}^{s} 1\,ds = \int_{t_0}^{t}\left(v_0 + \int_{t_0}^{t} a\,dt\right)dt$$

$$a = \frac{d}{dt}v \implies a = \frac{d}{dt}s\frac{d}{ds}v \implies a = v\frac{d}{ds}v \implies \int_{s_0}^{s} a\,ds = \int_{v_0}^{v} v\,dv$$

$$p = mv = m\frac{d}{dt}s$$

$$\implies \frac{d}{dt}s = v_0 + \int_{t_0}^{t} a\,dt \implies \int_{s_0}^{s} 1\,ds = \int_{t_0}^{t}\left(v_0 + \int_{t_0}^{t} a\,dt\right)dt$$

$$a = \frac{d}{dt}v \implies a = \frac{d}{dt}s\frac{d}{ds}v \implies a = v\frac{d}{ds}v \implies \int_{s_0}^{s} a\,ds = \int_{v_0}^{v} v\,dv$$

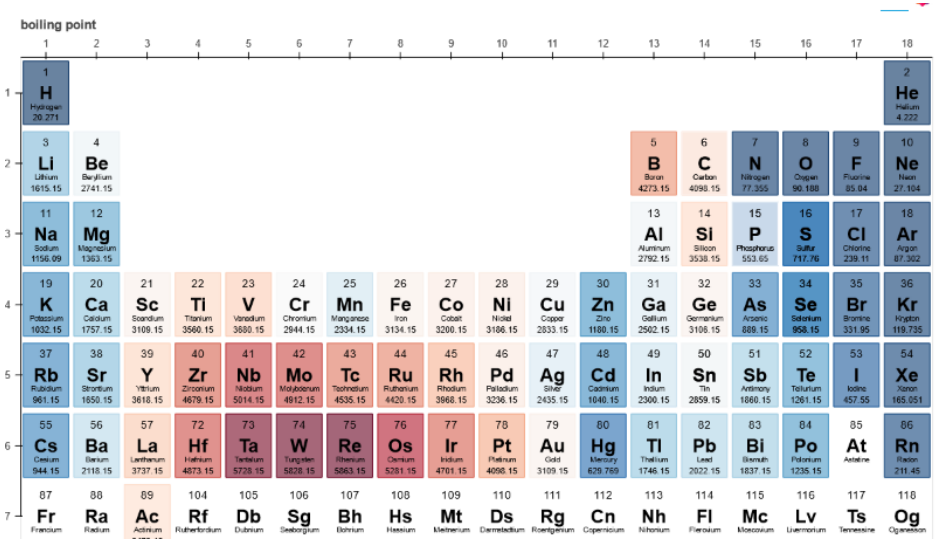
$$p = mv = m\frac{d}{dt}s$$

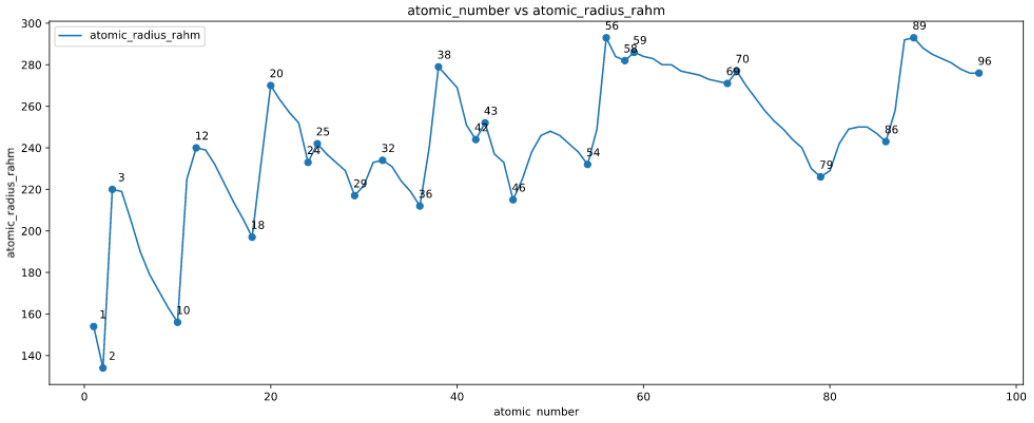
$$F = ma = m\frac{d}{dt}v = m\frac{d^2}{dt^2}s$$

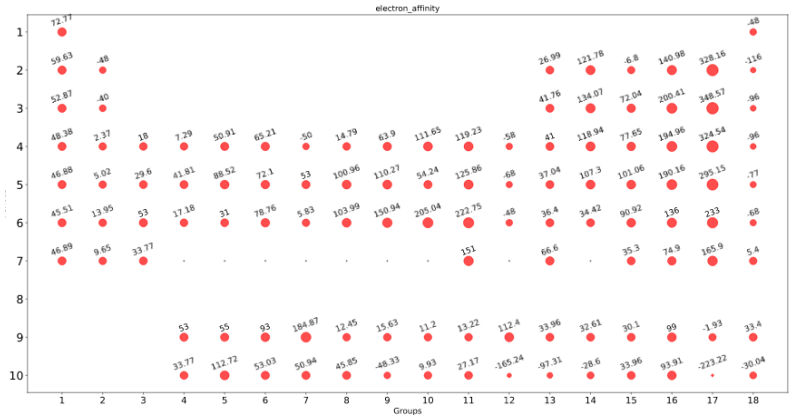
$$W = Fs$$

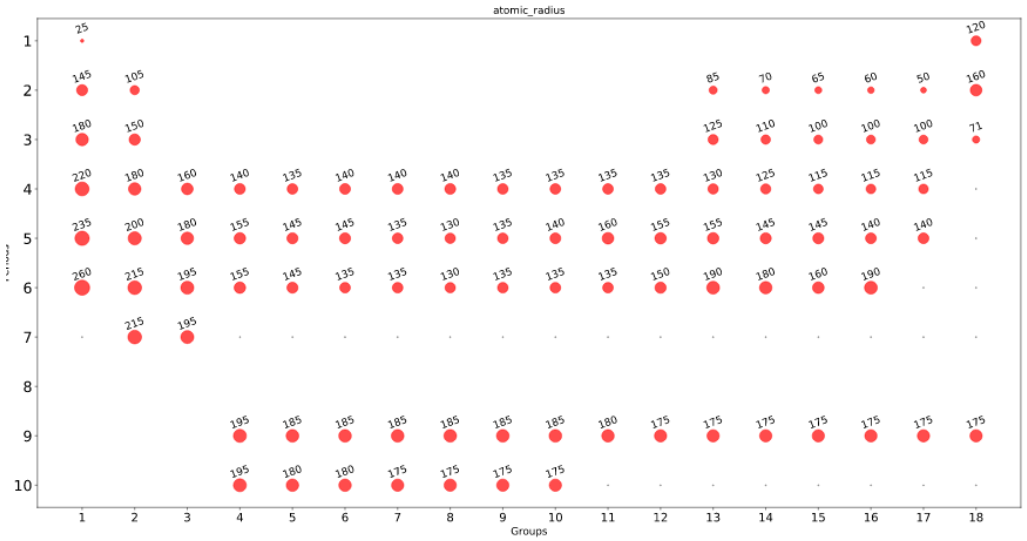
Chemistry has been in-depth and fun

He uses periodic table plotting to enhance his understanding of elements and their properties



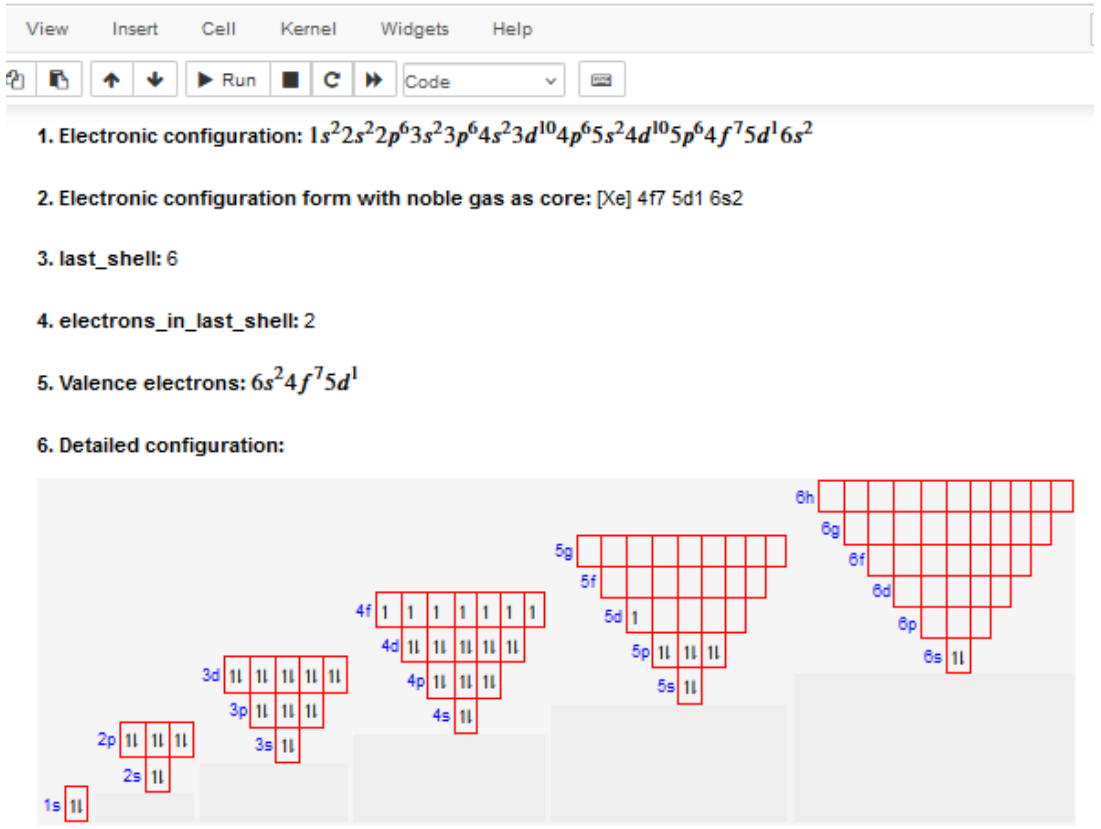






He knows atoms, their structures, electronic configurations, possible bonds and much more

- He can not only write the electronic configuration as shown but also interpret them to predict possible bonds.
- He is also well versed in all topics of high school chemistry and has already covered almost everything of AP Chemistry.



0 / xv-jupyter-notebooks / managers

..

- AtomManager.ipynb
- ChemicalReactionManager.ipynb
- PeriodicTrendsManager.ipynb
- AcidBaseManager.ipynb
- ComplexCompoundManager.ipynb
- ChemCalcManager.ipynb
- AcidBaseManager-Copy1.ipynb
- TopicsManager.ipynb
- AtomManager-NUTAN.ipynb
- PhysicalChemistryManager.ipynb
- HighSchoolChemistryManager.ipynb
- MolarManager.ipynb
- MoleculesManager.ipynb
- GroupPropertiesManager.ipynb
- ElementGroupManager.ipynb
- ElementsManager.ipynb
- FunctionalGroupManager.ipynb
- EnvironmentManager.ipynb
- FunctionalGroupManager.ipynb
- EnvironmentManager.ipynb
- Grade10HonorsManager.ipynb
- ChemistryFormulaManager.ipynb
- AmideGroupManager.ipynb
- PhysicalChemistryManager-Copy1.ipynb
- PeriodicTableManager.ipynb
- ReactivityManager.ipynb
- AtomManager-RISHI.ipynb
- NumericalChemistryManager.ipynb
- SmilesManager.ipynb
- VisualizationManager.ipynb
- out
- misc.ipynb
- MoleculesManager-Copy1.ipynb
- ReactionMechanismManager.ipynb
- NamedReactionsManager.ipynb
- py3Dmol-examples.ipynb
- SolutionManager.ipynb

```
1 from xv.chemistry.physical import AtomManager
```

```
1 ke = AtomManager(verbose = False)
2 ke.printProblemTypes()
```

```
0. _problem_atomic_fundamental_particles
1. _problem_calculate_particles
2. _problem_identify_element
3. _problem_predict_new_element
4. _problem_element_mass
5. _problem_based_on_chemical_formula
6. _problem_spd_orbital_shapes
7. _problem_possible_quantum_numbers
8. _problem_electronic_config
9. _problem_electronic_config_noble_gases
10. _problem_forming_a_compound
11. _problem_valence_electronic_config
12. _problem_ionization_energy_of_atom
13. _problem_positive_ionization_energies_of_elemen
14. _problem_electronic_config_based_props
15. _problem_element_isotopes
16. _problem_bond_energy_inorganic_covalent_bonds
17. _problem_bond_energy_organic_covalent_bonds
18. _problem_oxides_of_an_element
19. _problem_compare_reactivity_of_elements
```

```
1 ke.getRandomProblem(problem_type = 10, verbose = Tru
```

```
Problem Template: _problem_forming_a_compound
```

How can elements with atomic numbers 3 and 83 form compounds?

```
1 ke.printAnswer()
```

Li_3Bi

Lithium (Li, 3):

Electronic configuration : $1s^2 2s^1$

Valence electrons (1) : $2s^1$

Electrons in the last shell: 1

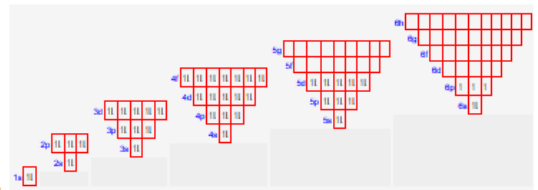
As the valence electrons in the last shell of Li are 1, the best possible choice for this atom is to lose 1 electrons.

Bismuth (Bi, 83):

Electronic configuration : $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 4f^{14} 5d^{10} 6s^2 6p^3$

Valence electrons (5) : $6s^2 4f^{14} 5d^{10} 6p^3$

Electrons in the last shell: 5



For Bi, with 3 unpaired electrons in the last shell, the best possible choice is to share or gain 3 electrons. It can do share or gain in parts too.

Likely Compounds:

For Bi, with 3 unpaired electrons in the last shell, the best possible choice is to share or gain 3 electrons. It can do share or gain in parts too.

As the valence electrons in the last shell of Li are 1, the best possible choice for this atom is to lose 1 electrons.

Likely Compounds:

For Bi, with 3 unpaired electrons in the last shell, the best possible choice is to share or gain 3 electrons. It can do share or gain in parts too.

As the valence electrons in the last shell of Li are 1, the best possible choice for this atom is to lose 1 electrons.

Chemical formula: Li_3Bi

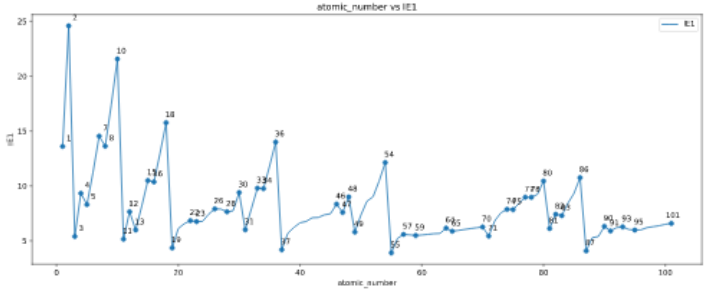
$$3\ Li + Bi \xrightarrow{\text{By electron transfer}} Li_3Bi$$

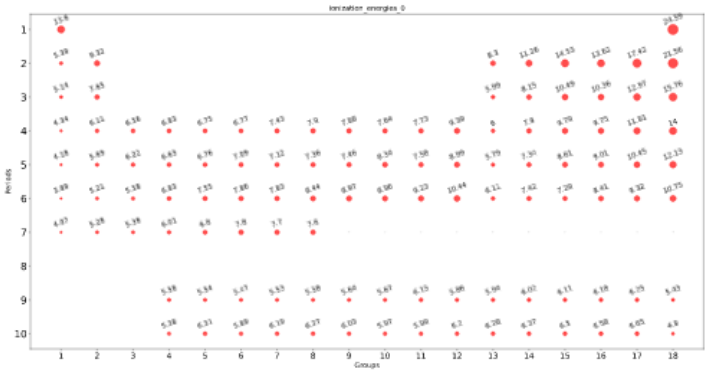
$$3 \cdot 1 = 3\ Li \xrightarrow{\text{electrons transferred to}} 1 \cdot 3 = 3\ Bi$$

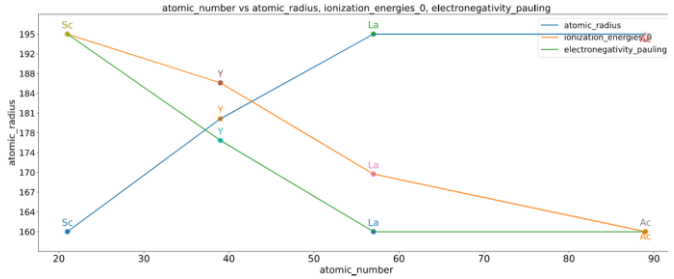
See the links for more information.

1. Li_3Bi

First Ionization Energies:



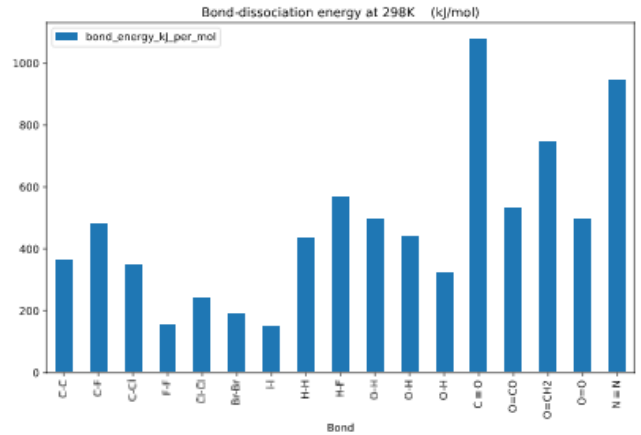




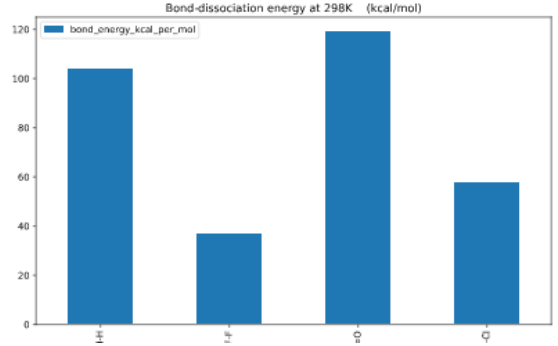
8	H–H	hydrogen	104.0	436	4.52	H	Strong, nonpolarizable bond
9	H–F	hydrogen fluoride	136.0	569	5.90	H,F	Very strong
10	O–H	in water	119.0	497	5.15	O,H	Very strong, hydroxyl radical reactive with almost all organics exothermically by H atom abstraction
11	O–H	in methanol	105.0	440	4.56	O,H	Slightly stronger than C–H bonds
12	O–H	in α-tocopherol (an antioxidant)	77.0	323	3.35	O,H	O–H bond strength depends strongly on substituent on O
13	C≡O	carbon monoxide	257.0	1077	11.16	C,O	Strongest bond in neutral molecule
14	O=CO	carbon dioxide	127.0	532	5.51	C,O	Slightly stronger than C–H bonds, surprisingly low due to stability of C≡O
15	O=CH2	formaldehyde	179.0	745	7.75	C,O,H	Much stronger than C–H bonds
16	O=O	oxygen	119.0	495	5.15	O	Stronger than single bonds, weaker than many other double bonds
17	N≡N	nitrogen	226.0	945	9.79	N	One of the strongest bonds, large activation energy in production of ammonia

Note:

Bond energy kcal per mol: Bond-dissociation energy at 298K (kcal/mol)
Bond energy kJ per mol: Bond-dissociation energy at 298K (kJ/mol)
Bond energy ev per bond: Bond-dissociation energy at 298K (eV/bond)



Molecules	hydrogen	fluorine	oxygen	chlorine
bond energy kcal per mol	104.0	37.0	119.0	58.0
bond energy kJ per mol	436	157	498	242
bond energy eV per bond	4.52	1.62	5.15	2.51
elements	H	F	O	Cl
Comment	Strong, nonpolarizable bond	Very weak, in conjunction with strong C-F and H-F bonds, leads to an explosive reaction with hydrocarbons	Stronger than single bonds, weaker than many other double bonds	Indicated by facility of photochemical chlorinations



What is the name of this complex ion $[CrCl_2(H_2O)$

Answer:

tetraaquadichlorochromium(III) ion

Solution:

ligands:

Cl chloro

H_2O aqua

In alphabetical order: aqua chloro

There are 4 aqua and 2 chloro ligands and both are r

tetra aqua di chloro

metal:

metal: Cr

Oxidation number of $H_2O = 0$. Hence,

$x + 2(-1) + 0 = 1 \Rightarrow x = +3$

Therefore, oxidation Number of Cr = +3. It will be cal

chromium(III)

name of molecule:

tetra aqua di chloro chromium(III) ion.

tetraaquadichlorochromium(III) ion.

Solution:

complex compound:

ammine tetra aqua chromium (II) sulfate

anion:

sulfate = SO_4^{2-}

complex ion:

ammine tetra aqua chromium (II)

ligands:

ammine: NH_3

tetra aqua: $(H_2O)_4$

metal:

chromium(II): Cr(II)

Oxidation number of $NH_3 = 0$.

Oxidation number of $H_2O = 0$.

Oxidation number of $Cr(II) = +2$.

Hence, charge on ion: $0 + 0 + 2 = +2$

chemical formula of complex ion:

$[Cr(H_2O)_4(NH_3)]^{2+}$

$[Cr(NH_3)(H_2O)_4]^{2+}$

chemical formula of molecule:

$[Cr(H_2O)_4(NH_3)]SO_4$

$[Cr(NH_3)(H_2O)_4]SO_4$

According to the Lewis definition, an acid is any species which can accept a lone pair of electrons, and a base is any species which can donate a lone pair of

In the first reaction ZnO accepts a pair of electrons from $NaOH$.

$$\underset{\text{Lewis acid}}{ZnO} + 2\,\underset{\text{Lewis base}}{NaOH} + H_2O = Na_2Zn(OH)_4$$

In the second reaction H_2SO_4 accepts a pair of electrons from ZnO.

$$\underset{\text{Lewis acid}}{ZnO} + \underset{\text{Lewis base}}{H_2SO_4} = ZnSO_4 + H_2O$$

If a molecule/ion behaves both like a Lewis acid and a Lewis base, it it called amphoteric molecule/ion.

ZnO acts both like a Lewis acid and a Lewis base.

An amphiprotic molecule is slightly different. It is a molecule that can both accept or donate a proton, making it an acid as well as a base according to Bron and base.

All amphiprotic molecules are amphoteric molecules. But some of the amphoteric molecules may not be amphiprotic molecules as they may accept a pair protons.

Answer:

Reactant

$\mathbf{Ti = 47.867}$ gram

Reactant

$\mathbf{N_2 = 14.007}$ gram

Product

$\mathbf{TiN = 61.874}$ gram

Solution:

We have,

$$\mathbf{2Ti + N_2 \rightarrow 2TiN}$$

All calculations are based on standard mass of elements and particles.

$$Ti = 47.867$$

$$\longrightarrow 2 \cdot Ti = 2 \cdot (47.867) = 2 \cdot 47.867 = 95.734$$

$$N_2 = 2 \cdot 14.007 = 28.014$$

$$Ti = 47.867$$

$$N = 14.007$$

$$\longrightarrow 2 \cdot TiN = 2 \cdot (47.867 + 14.007) = 2 \cdot 61.874 = 123.748$$

Now, let us create a table with data calculated above.

$$\mathbf{2Ti + N_2 \rightarrow 2TiN}$$

Particulars	Reactant Ti	Reactant N_2	Product TiN
moles (a)	2	1	2
standard mass in gram (b)	95.734	28.014	123.748
given mass in gram (c)			61.874
ratio of given mass and standard mass ($d = c/b$)			$\frac{61.874}{123.748} = 0.5$
calculated mass in gram ($e = d \cdot b$)	$0.5 \cdot 95.734 = 47.867$	$0.5 \cdot 28.014 = 14.007$	$0.5 \cdot 123.748 = 61.874$

Problem Template: _problem_nth_order_rate_of_reaction

Find the equation of concentration and expression of half-life of a reaction o

Answer:

$$C = \frac{4C_0}{\left(C_0^{\frac{1}{2}} kt + 2\right)^2}$$

$$T_{\frac{1}{3}} = \frac{2\left(-1 + 2^{\frac{1}{2}}\right)}{C_0^{\frac{1}{2}} k}$$

Solution:

Let concentration of reactant is C.

For $\frac{3}{2}$th order reaction:

$$Rate = k \cdot C^{\frac{3}{2}} \quad \cdots \text{(i)}$$

$$\longrightarrow -\frac{d}{dt}C = k \cdot C^{\frac{3}{2}}$$

$$\longrightarrow -\frac{1}{C^{\frac{3}{2}}} dC = kdt$$

$$\longrightarrow \frac{1}{C^{\frac{3}{2}}} dC = -kdt$$

If the concentration changes from C_0 to C in time 0 to t.

$$\longrightarrow \int_{C_0}^{C} \frac{1}{C^{\frac{3}{2}}} dC = -k \cdot \int_0^t 1 \, dt \quad \cdots \text{(ii)}$$

$$\longrightarrow \left[-\frac{2}{C^{\frac{1}{2}}}\right]_{C_0}^{C} = -k \cdot |t|_0^t$$

$$\longrightarrow \frac{2}{C_0^{\frac{1}{2}}} - \frac{2}{C^{\frac{1}{2}}} = -kt$$

$$\longrightarrow C = \frac{4C_0}{\left(C_0^{\frac{1}{2}} kt + 2\right)^2} \quad \cdots \text{(iii)}$$

If the concentration changes from C_0 to its half, $\frac{C_0}{2}$, in time 0 to $T_{\frac{1}{2}}$, called

$$\longrightarrow \int_{C_0}^{\frac{C_0}{2}} \frac{1}{C^{\frac{3}{2}}} dC = -k \cdot \int_0^{T_{\frac{1}{2}}} 1 \, dt \quad \cdots \text{(iv)}$$

Problem Template: _problem_props_of_rate_of_reaction

Find the order and dimension of the rate constant for the reaction given below:

$$\mathbf{3Mg + N_2 \rightarrow Mg_3N_2}$$

$$\text{Rate of reaction} = k\left[\text{Mg}\right]^{\frac{3}{2}} [\text{N}_2]^2$$

Answer:

$$\text{Order of reaction} = \frac{3}{2} + 2 = \frac{7}{2}$$

$$\text{Dimension } (k) = \text{Dimension}\left(\frac{(\text{length}^3)^{\frac{3}{2}}}{\text{amount of substance}^{\frac{3}{2}} \cdot \text{time}}\right)$$

Solution:

Order of reaction is sum of exponents of concentrations in the rate equation.

$$\text{Rate of reaction} = k\left[\text{Mg}\right]^{\frac{3}{2}} [\text{N}_2]^2 \quad \cdots \text{(i)}$$

$$\text{Order of reaction} = \frac{3}{2} + 2 = \frac{7}{2} \quad \cdots \text{(ii)}$$

$$\text{The unit of concentration} = \frac{\text{mol}}{\text{liter}}$$

$$\text{The unit of rate of change in concentration} = \frac{\text{unit of concentration}}{\text{s}} = \frac{\frac{\text{mol}}{\text{liter}}}{\text{s}} = \frac{\text{mo}}{\text{liter}}$$

Therefore from (i),

$$\text{Rate of reaction} = k\left[\text{Mg}\right]^{\frac{3}{2}} [\text{N}_2]^2$$

$$\text{Unit (Rate of reaction)} = k\left(\frac{\text{mol}}{\text{liter}}\right)^{\frac{3}{2}} \left(\frac{\text{mol}}{\text{liter}}\right)^2$$

$$= \frac{k \cdot \text{mol}^{\frac{7}{2}}}{\text{liter}^{\frac{7}{2}}}$$

$$\longrightarrow \frac{\text{mol}}{\text{liter} \cdot \text{s}} = \frac{k \cdot \text{mol}^{\frac{7}{2}}}{\text{liter}^{\frac{7}{2}}}$$

$$\longrightarrow k = \frac{\text{liter}^{\frac{3}{2}}}{\text{mol}^{\frac{3}{2}} \cdot \text{s}}$$

Converting it into dimension:

$$\text{Dimension } (k) = \text{Dimension}\left(\frac{(\text{length}^3)^{\frac{3}{2}}}{\quad}\right) \quad \cdots \text{(iii)}$$

$$PV = nRT$$

$$\longrightarrow P = \frac{n}{V} RT = CRT \quad \text{where C is concentrati}$$

$$\longrightarrow P = CRT \quad \cdots \text{(i)}$$

Now, let us create a table of data required for equilibri

$$\mathbf{F + e^- \rightarrow F^-}$$

Particulars	Reactant F
Initial moles	1
Equilibrium moles (α is conversion factor.)	$1 - \alpha$
Initial partial pressures (assumed)	P
Equilibrium partial pressures	$P(1 - \alpha)$
Concentration symbols	$[F]$
Concentration as function of moles and volume	$\frac{1 - \alpha}{V}$
Pressure as function of concentration, R and T using (i)	$[F]\,RT$

Therefore,

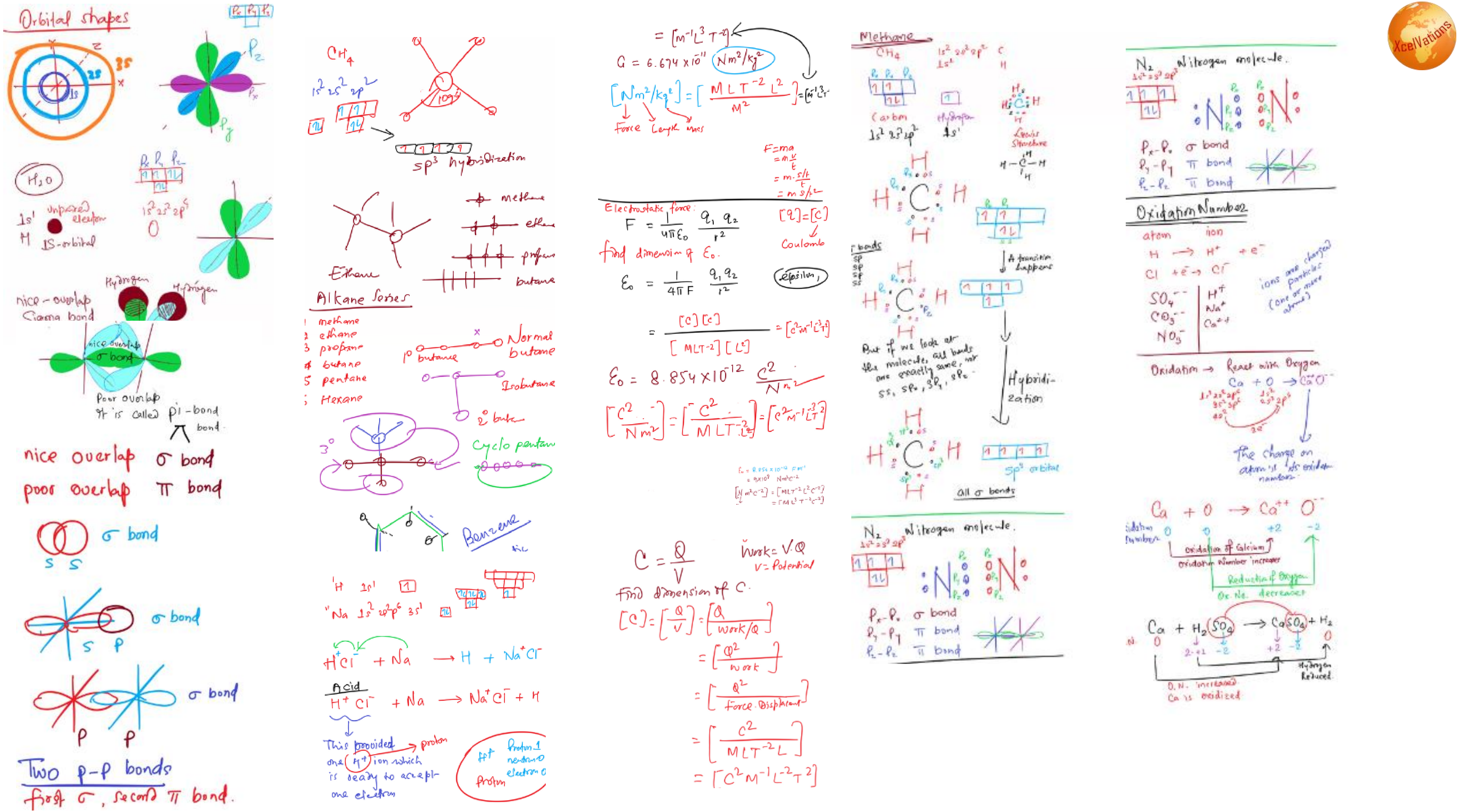
$$K_c = \frac{[F^-]}{[F]\ [e^-]}$$

$$= \frac{\frac{\alpha}{V}}{\frac{1-\alpha}{V} \cdot \frac{1-\alpha}{V}}$$

$$K_p = \frac{P_{F^-}}{P_F \ P_{e^-}}$$

$$= \frac{P\alpha}{P(1-\alpha) \cdot P(1-\alpha)}$$

$$= \frac{RT\,[F^-]}{RT\,[F] \cdot RT\,[e^-]}$$

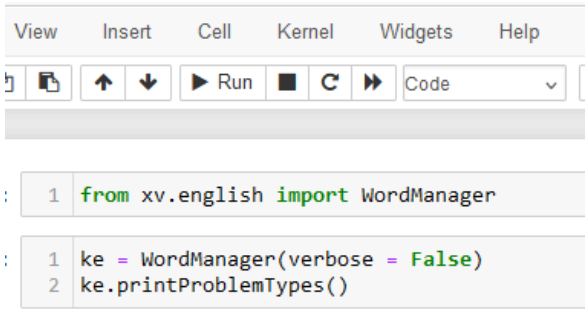

Orbital shapes
1s
2s
3s
P_z
P_x
P_y
H_2O
$1s^1$
unpaired electron
H
1S-orbital
$1s^2 2s^2 2p^4$
O
nice-overlap
Sigma bond
Hydrogen
Hydrogen
nice overlap
σ bond
Poor overlap
It is called pi-bond
π bond
nice overlap σ bond
poor overlap π bond
σ bond
s s
σ bond
s p
σ bond
p p
Two p-p bonds
first σ, second π bond
CH_4
$1s^2 2s^2 2p^2$
109°
sp^3 hybridization
methane
ethane
propane
butane
Ethane
Alkane Series
1 methane
2 ethane
3 propane
4 butane
5 pentane
6 Hexane
Normal butane
1° butane
Isobutane
2° butane
3°
Cyclo pentane
Benzene
H $1s^1$
Na $1s^2 2s^2 2p^6 3s^1$
$H^+Cl^- + Na \rightarrow H + Na^+Cl^-$
Acid
$H^+Cl^- + Na \rightarrow Na^+Cl^- + H$
This provided one H^+ ion which is ready to accept one electron
proton
H^+ proton
proton 1
neutron 0
electron 0
$= [M^{-1}L^3T^{-2}]$
$G = 6.674 \times 10^{-11}$ Nm^2/kg^2
$[Nm^2/kg^2] = [\frac{MLT^{-2}L^2}{M^2}] = [M^{-1}L^3T^{-2}]$
Force Length mass
F=ma
$= m\frac{v}{t}$
$= m\cdot\frac{s/t}{t}$
$= m\, s/t^2$
Electrostatic force:
$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$
[q]=[C]
Coulomb
find dimension of ε_0.
$\varepsilon_0 = \frac{1}{4\pi F}\frac{q_1 q_2}{r^2}$
epsilon
$= \frac{[C][C]}{[MLT^{-2}][L^2]} = [C^2M^{-1}L^{-3}T^2]$
$\varepsilon_0 = 8.854 \times 10^{-12}$ $\frac{C^2}{Nm^2}$
$[\frac{C^2}{Nm^2}] = [\frac{C^2}{MLT^{-2}L^2}] = [C^2M^{-1}L^{-3}T^2]$
$C = \frac{Q}{V}$
Work = V.Q
V = Potential
Find dimension of C.
$[C] = [\frac{Q}{V}] = [\frac{Q}{Work/Q}]$
$= [\frac{Q^2}{Work}]$
$= [\frac{Q^2}{Force \cdot Displacement}]$
$= [\frac{C^2}{MLT^{-2}L}]$
$= [C^2M^{-1}L^{-2}T^2]$
Methane
CH_4
$1s^2 2s^2 2p^2$ C
$1s^1$ H
Carbon
$1s^2 2s^2 2p^2$
Hydrogen
$1s^1$
Lewis Structure
A transition happens
But if we look at the molecule, all bonds are exactly same, not ss, sp_x, sp_y, sp_z.
Hybridization
sp^3 orbital
All σ bonds
N_2 Nitrogen molecule.
$1s^2 2s^2 2p^3$
$P_x - P_x$ σ bond
$P_y - P_y$ π bond
$P_z - P_z$ π bond
Oxidation Number
atom ion
$H \rightarrow H^+ + e^-$
$Cl + e^- \rightarrow Cl^-$
SO_4^{--}
CO_3^{--}
NO_3^-
H^+
Na^+
Ca^{++}
ions are charged particles (one or more atoms)
Oxidation → React with Oxygen
$Ca + O \rightarrow Ca^{++}O^{--}$
The charge on atom is its oxidation number.
$Ca + O \rightarrow Ca^{++}O^{--}$
Oxidation Number 0 0 +2 -2
oxidation of Calcium
oxidation Number increases
Reduction of Oxygen
Ox. No. decreases
$Ca + H_2SO_4 \rightarrow CaSO_4 + H_2$
0 +1 -2 +2 -2 0
Hydrogen Reduced
O.N. increased
Ca is oxidized
XcelVations

SAT English is tough but we made lot of progress.

We did sample papers, read prose, poetry and articles.

Learning English has been comprehensive

- We focused on vocabulary, pronunciation, reading poetry, and articles, and doing SAT test papers.
- The focus is on analytical learning, which is required for modern English tests.




```
0. _problem_uncountable_nouns_ending_in_s
1. _problem_common_plural_nouns
2. _problem_word_usage
3. _problem_word_usage_fill_blanks
4. _problem_irregular_plural_forms
5. _problem_irregular_singular_forms
6. _problem_noun_plural_fill_blanks
7. _problem_noun_fill_blanks
8. _problem_pronoun_fill_blanks
9. _problem_adjective_fill_blanks
10. _problem_verb_fill_blanks
11. _problem_adverb_fill_blanks
12. _problem_preposition_fill_blanks
13. _problem_conjunction_fill_blanks
14. _problem_interjection_fill_blanks
15. _problem_determiner_fill_blanks
16. _problem_predeterminer_fill_blanks
17. _problem_fill_confusing_words
18. _problem_match_confusing_words_meanings
19. _problem_fill_misspelled_words
20. _problem_find_misspelled_out
21. _problem_fill_gender_words
```

```
21. _problem_fill_gender_words
22. _problem_gender_match_columns
23. _problem_option_genders
24. _problem_find_odd_gender
25. _problem_word_with_opposite_gender
26. _problem_thesaurus_match_synonyms
27. _problem_thesaurus_match_antonyms
28. _problem_find_odd_synonyms_antonyms
29. _problem_idioms_match_columns
30. _problem_find_synonym_thesaurus
31. _problem_find_antonym_thesaurus
32. _problem_find_by_synonyms_antonyms
33. _problem_regular_synonyms
34. _problem_regular_antonyms
35. _problem_collective_nouns
36. _problem_regular_nouns_singular_plural
37. _problem_regular_adjective_forms
38. _problem_regular_similes
39. _problem_regular_homonyms
40. _problem_regular_homophones
41. _problem_compound_prepositions
42. _problem_animal_sounds
43. _problem_animal_youngs
44. _problem_single_word_for_phrases
45. _problem_american_british_words
```

```
:  1 from xv.english import VocabularyManager
```

```
:  1 ke = VocabularyManager()
   2 ke.printProblemTypes()
```

```
0. _problem_english_for_junior_competitions
1. _problem_english_toefl_words
2. _problem_predict_similar_opposite_words
3. _problem_single_word_for_phrase
4. _problem_answer_yes_no
5. _problem_fill_confusing_words_with_meanings_and_usages
6. _problem_fill_misused_word_sets_with_usages
7. _problem_fill_confusing_words
8. _problem_fill_misspelled_words
9. _problem_fill_homophone_words
10. _problem_identify_homophone_words_in_sentences
11. _problem_fill_similar_opposite_words
12. _problem_fill_weird_words
13. _problem_predict_prefixes
14. _problem_predict_suffixes
15. _problem_predict_word_roots
16. _problem_words_related_to_phobia
17. _problem_words_related_to_mania
18. _problem_fill_in_with_appropriate_words
19. _problem_test_yourself
```

```
In [1]:  1 from xv.english import SpellingManager
```

```
In [2]:  1 ke = SpellingManager()
         2 ke.printProblemTypes()
```

```
0. _problem_random_spellings
1. _problem_leading_word_spellings
2. _problem_trailing_word_spellings
3. _problem_closest_syllables_pairs
4. _problem_homophone_words
5. _problem_prefixes_word_pairs
6. _problem_suffixes_word_pairs
7. _problem_misspelling_prone_pairs
8. _problem_confusing_word_pairs
9. _problem_gender_word_pairs
10. _problem_phrases
11. _problem_idioms
12.  problem game guess word
```

```
In [1]:  1 from xv.english import BookManager
```

```
In [2]:  1 ke = BookManager(file_path = "The Race f
         2 ke.printProblemTypes()
```

```
0. _problem_book_translate
1. _problem_hear_and_write
2. _problem_read_a_text
3. _problem_put_sentence_in_order
4. _problem_put_paragraph_in_order
5. _problem_insert_a_sentence
6. _problem_word_usage
7. _problem_fill_words_of_a_pos
8. _problem_word_usage_fill_blanks
9. _problem_noun_fill_blanks
10. _problem_pronoun_fill_blanks
11. _problem_adjective_fill_blanks
12. _problem_verb_fill_blanks
13. _problem_adverb_fill_blanks
14. _problem_preposition_fill_blanks
15. _problem_conjunction_fill_blanks
16. _problem_interjection_fill_blanks
17. _problem_determiner_fill_blanks
18. _problem_predeterminer_fill_blanks
19. _problem_fill_confusing_words
20. _problem_match_confusing_words_meanings
22. _problem_find_misspelled_out
23. _problem_fill_gender_words
24. _problem_gender_match_columns
25. _problem_option_genders
26. _problem_find_odd_gender
27. _problem_word_with_opposite_gender
28. _problem_thesaurus_match_synonyms
29. _problem_thesaurus_match_antonyms
30. _problem_find_odd_synonyms_antonyms
31. _problem_idioms_match_columns
32. _problem_find_synonym_thesaurus
33. _problem_find_antonym_thesaurus
34. _problem_find_by_synonyms_antonyms
```

American spellings are given below. Use British spellings to fill in the blanks.

license, equaled, woolen, centimeter

"You have to get a _____ for an organ, and you haven't got one, and in that way you collect a crowd. Where do you lodge?" **- Crime And Punishment By Fyodor Dostoyevsky**

... Thus do they juggle and trifle in all their discourses at our expense; and they could not give me one proposition against which I should not know how to raise a contrary of _____ force **- Essays Of Michel De Montaigne — Complete By Michel De Montaigne**

... At first, they were a mere storm of coarse red caps and coarse _____ rags; but, as they filled the place, and stopped to dance about Lucie, some ghastly apparition of a dance-figure gone raving mad arose among them. ... **- A Tale Of Two Cities**

... erre-à-poisson through the sewer de la sonnerie, the rue popincourt, through the sewer of the chemin-vert, the rue de la roquette, through the sewer of the rue de lappe; it covered the drain of the rue des champs-élysées to the height of thirty-five _____ ; and, to the south, through the vent of the seine, performing its functions in inverse sense, it penetrated the rue mazarine, the rue de l'échaudé, and the rue des marais, where it stopped at a distance of one hundred and nine metres, a f ... [trimmed chars by brute force] **- Les Misérables By Victor Hugo**

license, equaled, woolen, centimeter

Answer:
licence, centimetres, equal, woollen

Solution:
license: licence
equaled: equalled
woolen: woollen
centimeter: centimetre

"You have to get a licence for an organ, and you haven't got one, and in that way you collect a crowd. Where do you lodge?" **- Crime And Punishment By Fyodor Dostoyevsky**

... Thus do they juggle and trifle in all their discourses at our expense; and they could not give me one proposition against which I should not know how to raise a contrary of equal force. **- Essays Of Michel De Montaigne — Complete By Michel De Montaigne**

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... erre-à-poisson through the sewer de la sonnerie, the rue popincourt, through the sewer of the chemin-vert, the rue de la roquette, through the sewer of the rue de lappe; it covered the drain of the rue des champs-élysées to the height of thirty-five centimetres ; and, to the south, through the vent of the seine, performing its functions in inverse sense, it penetrated the rue mazarine, the rue de l'échaudé, and the rue des marais, where it stopped at a distance of one hundred and nine metres, a f ... [trimmed chars by brute force] **- Les Misérables By Victor**

Fill in the blanks with words similar to the sounds **asses and roosters** make.

... hamsher one noue lit babstis babler sobed a way just fineshing his sermon he says o good lord i hop you will consider what foue hints i have given and i will cleare it up sum time hence i am much wore down now the wether being very worme to day less _____ & so went on fire fire & brimstone & grunting & fithing and tried to cry & snufel & blow the sconks horne & sum the old souls & yong fouls sot to crying i tuck my hat and went out houe mankind & women kind is imposed upon all over the world more ... [trimmed chars by brute force] **- A Pickle For The Knowing Ones By Timothy Dexter**

... n whare he was bone he sade now whare what is all that now whare was your mother over shaderd i says my mother was if i was to gess no i tell in now town borne o on the water i says you beat me and so wee lafed and it shuk of the spleane shoue him a crows neast he can carve one a fine fellow--i shold had all marbel if any bodey could to me the prise so i have sent for 8 busts for kings and grat men and 1 lion & 2 gray hounds i hope to hear in foue days to all onnest men **- A Pickle For The Knowing Ones By Timothy Dexter**

Solution:
roosters: crow
asses: bray

... hamsher one noue lit babstis babler sobed a way just fineshing his sermon he says o good lord i hop you will consider what foue hints i have given and i will cleare it up sum time hence i am much wore down now the wether being very worme to day less bray & so went on fire fire & brimstone & grunting & fithing and tried to cry & snufel & blow the sconks horne & sum the old souls & yong fouls sot to crying i tuck my hat and went out houe mankind & women kind is imposed upon all over the world more ... [trimmed chars by brute force] **- A Pickle For The Knowing Ones By Timothy Dexter**

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rigor, riggers, rigors

... endeavours to help forward the happiness of all other persons; for there never was any man such a morose and severe pursuer of virtue, such an enemy to pleasure, that though he set hard rules for men to undergo, much pain, many watchings, and other rigors , yet did not at the same time advise them to do all they could in order to relieve and ease the miserable, and who did not represent gentleness and good-nature as amiable dispositions. and from thence they infer that if a man ought to advance ... [trimmed chars by brute force] **- Utopia**

It was not till late next day that I spoke to Mrs. Grose; the rigor with which I kept my pupils in sight making it often difficult to meet her privately, and the more as we each felt the importance of not provoking-on the part of the servants quite as much as on that of the children-any suspicion of a secret flurry or that of a discussion of mysteries. I drew a great security in this particular from her mere smooth aspect. ... **- The Turn Of The Screw By Henry James**

Ham carrying me on his back and a small box of ours under his arm, and Peggotty carrying another small box of ours, we turned down lanes bestrewn with bits of chips and little hillocks of sand, and went past gas-works, rope-walks, boat-builders' yards, shipwrights' yards, ship-breakers' yards, caulkers' yards, riggers ' lofts, smiths' forges, and a great litter of such places, until we came out upon the dull waste I had already seen at a distance; when Ham said, **- David Copperfield By Charles Dickens**

Solution:
Homonym word: **shower**

The boys shower in the morning.
Tomorrow will be cloudy with showers.

... The ladies voluntarily permitted the gentlemen to review their legs. If I were in command, I would not permit the ladies to raise an umbrella under the "para para" of a shower . Their hastening figures are so fascinating. **- The American Diary Of A Japanese Girl By Yoné Noguchi**

The shower stopped. The pavements were glossed like a looking-glass. ... **- The American Diary Of A Japanese Girl By Yoné Noguchi**

... Condescend to enter!" I showered my wooden-clogged greeting over Ada. **- The American Diary Of A Japanese Girl By Yoné Noguchi**

Fill in the blanks with similes made of words, **sweet, stiff, honey and poker**.

"So you won't be my friend?" she said, smiling as _____ , and creeping close up. **- Wuthering Heights By Emily Brontë**

... "We ought to rehearse tonight. Come here, Amy, and do the fainting scene, for you are as _____ in that." **- Little Women By Louisa May Alcott**

Answer:
sweet as honey, stiff as a poker

Solution:
as stiff as a poker (a post, a board)
as sweet as honey (sugar)

"So you won't be my friend?" she said, smiling as sweet as honey , and creeping close up. **- Wuthering Heights By Emily Brontë**

... "We ought to rehearse tonight. Come here, Amy, and do the fainting scene, for you are as stiff as a poker in that." **- Little Women By Louisa May Alcott**

Solution:
herd of elephants
flock of goats

'Maria didn't need to be told. She grabbed the BIDON and went clattering down the stairs like a herd of elephants and in three minutes she was back with two pounds of bread under one arm and a half-litre bottle of wine under the other. I didn't stop to thank her; I just seized the bread and sank my teeth in it. ... **- Down And Out In Paris And London**

... t is true, as it is, they may all say what they like; though, to tell the truth, if the coral beads and the suit had not come i would not have believed it either; for in this village everybody thinks my husband a numskull, and except for governing a flock of goats , they cannot fancy what sort of government he can be fit for. god grant it, and direct him according as he sees his children stand in need of it. i am resolved with your worship's leave, lady of my soul, to make the most of this fair d ... [trimmed chars by brute force] **- Don Quixote By Miguel De Cervantes Saavedra**

Fill in the blanks with antonyms of the word 'junior'.

Solution:
The antonyms of junior: **lead, senior, experiences, old**

... It was, in a new form, the old , old trouble that eats the heart out of every civilization: snobbery, the desire for possessions, creditable appendages; and it is to escape this rather than the lusts of the flesh that saints retreat into the Himalayas. ... **- A Passage To India By E M Forster**

... He wanted to avenge Miss Quested and punish Fielding, while remaining scrupulously fair. He wanted to flog every native that he saw, but to do nothing that would lead to a riot or to the necessity for military intervention. The dread of having to call in the troops was vivid to him; soldiers put one thing straight, but leave a dozen others crooked, and they love to humiliate the civilian administration. ... **- A Passage To India By E M Forster**

"No more do I. My experiences here have cured me. But I want others to want it." **- A Passage To India By E M Forster**

... And trying not to sound patronizing, he stretched his hand over the table, and said: "We shall all have to hang together, old man, I'm afraid. I'm your junior in years, I know, but very much your senior in service; you don't happen to know this poisonous country as well as I do, and you must take it from me that the general situation is going to be nasty at Chandrapore during the next few weeks, very nasty indeed." **- A Passage To India By E M Forster**

Fill in the blanks with synonyms of the word 'faith'.

'I _____ ,' said Mr. Lorry, after another pause of feeble sympathy and humility, 'that you accompany Miss Manette to France?' - **A Tale Of Two Cities**

ne of the first considerations which arose in the business mind of Mr. Lorry when business hours came round, was this:-that he had no right to imperil Tellson's by sheltering the wife of an emigrant prisoner under the Bank roof, His own possessions, safety, life, he would have hazarded for Lucie and her child, without a moment's demur; but the great _____ he held was not his own, and as to that business charge he was a strict man of business. - **A Tale Of Two Cities**

... They were even boastful of its eminence in those particulars, and were fired by an express conviction that, if it were less objectionable, it would be less respectable. This was no passive _____ , but an active weapon which they flashed at more convenient places of business. Tellson's (they said) wanted no elbow-room, Tellson's wanted no light, Tellson's wanted no embellishment. ... - **A Tale Of Two Cities**

Mr. Cruncher, in an access of _____ , growlingly repeated the words after Miss Pross, like somebody at church. - **A Tale Of Two Cities**

Answer:
belief, hope, loyalty, trust

Solution:
The synonyms of faith: **belief, hope, loyalty, trust**

'I hope ,' said Mr. Lorry, after another pause of feeble sympathy and humility, 'that you accompany Miss Manette to France?' - **A Tale Of Two Cities**

ne of the first considerations which arose in the business mind of Mr. Lorry when business hours came round, was this:-that he had no right to imperil Tellson's by sheltering the wife of an emigrant prisoner under the Bank roof, His own possessions, safety, life, he would have hazarded for Lucie and her child, without a moment's demur; but the great trust he held was not his own, and as to that business charge he was a strict man of business. - **A Tale Of Two Cities**

... They were even boastful of its eminence in those particulars, and were fired by an express conviction that, if it were less objectionable, it would be less respectable. This was no passive belief , but an active weapon which they flashed at more convenient places of business. Tellson's (they said) wanted no elbow-room, Tellson's wanted no light, Tellson's wanted no embellishment. ... - **A Tale Of Two Cities**

Mr. Cruncher, in an access of loyalty , growlingly repeated the words after Miss Pross, like somebody at church. - **A Tale Of Two Cities**

Find all antonyms of **think**.

1. inconscient
2. muse
3. metaphysics
4. ruminate
5. educe
6. disregard

Usage:

... Never yet had I felt so unhappy, except during three days of sea- sickness at the beginning of my voyage from England. I sat musing and in great melancholy, until Yram made her appearance with light and supper. She too, poor girl, was miserable; for she had heard that I was to leave them. ... - **Erewhon**
... These they do not openly disregard , for conformity until absolutely intolerable is a law of Ydgrun, yet they have no real belief in the objective existence of beings which so readily explain themselves as abstractions, and whose personality demands a quasi-materialism which it baffles the imagination to realise. - **Erewhon**
LYNCH: Pornosophical philotheology. Metaphysics in Mecklenburgh street! - **Ulysses By James Joyce**
(Staggering Bob, a whitepolled calf, thrusts a ruminating head with humid nostrils through the foliage.) - **Ulysses By James Joyce**
The parties concerned, uniting, had increased and multiplied, which being done, offspring produced and educed to maturity, the parties, if not disunited were obliged tc reunite for increase and multiplication, which was absurd, to form by reunion the original couple of uniting parties, which was impossible. - **Ulysses By James Joyce**

Answer:

1. inconscient
2. muse
3. metaphysics
4. ruminate
5. educe
6. disregard

Match idioms with their meanings

1. all the same	**a.** It's too late
2. That ship has sailed	**b.** i am very happy to hear this.
3. get a word in edgewise	**c.** anyway; nevertheless; nonetheless.
4. that's music to my ears	**d.** be able to say something while someone else is talking a lot

Usage:

'Doctor Strong, of course,' returned the other; 'I call him the old Doctor; it's all the same , you know.' - **David Copperfield By Charles Dickens**
'You'd better get dressed and come down-stairs and never mind your imaginings,' said Marilla as soon as she could get a word in edgewise . 'Breakfast is waiting **Anne Of Green Gables**

Answer:
all the same: anyway; nevertheless; nonetheless.
That ship has sailed: It's too late
get a word in edgewise: be able to say something while someone else is talking a lot

Hear and write.

0:00 / 0:04

Answer:
If those cows had jumped on me he'd have never got over it."

Solution:
If those cows had jumped on me he'd have never got over it."

yter UsageManager Last Checkpoint: yesterday

View Run Kernel Settings Help

Code

```
ke.printProblemTypes()
```

```
0. _problem_correct_common_error
1. _problem_select_correct_sentence
2. _problem_badly_formed_sentences
3. _problem_select_incorrect_sentence
4. _problem_adjective_preposition_pairs
5. _problem_verb_preposition_pairs
6. _problem_verb_phrasal_verb_pairs
7. _problem_yet_or_already
8. _problem_always_or_forever
9. _problem_past_or_participle_verb
10. _problem_improper_article_before_a_noun
11. _problem_quantify_a_noun
12. _problem_let_may_might_can_could_would_should
13. _problem_quantifier_and_relative_words
14. _problem_place_the_adjective
15. _problem_comparative_or_superlative_adjective
16. _problem_form_of_pronoun
17. _problem_something_or_anything
18. _problem_confusing_words
19. _problem_normal_or_wishful
20. _problem_verb_object_to_infinitive
21. _problem_progressive_form
22. _problem_progressive_or_continuos_form
23. _problem_uncountable_nouns_ending_in_s
24. _problem_common_plural_nouns
25. _problem_irregular_plural_noun_forms
26. _problem_extreme_adjectives
27. _problem_it_or_there
28. _problem_all_or_with
29. _problem_which_word_is_more_appropriate
30. _problem_homophone_words
31. _problem_number_sinular_or_plural
32. _problem_number_representations_in_sentences
```

yter VocabularyManager Last Checkpoint: 8 days

View Run Kernel Settings Help

Code

```
ke.printProblemTypes()
```

```
0. _problem_english_for_junior_competitions
1. _problem_english_toefl_words
2. _problem_predict_similar_opposite_words
3. _problem_single_word_for_phrase
4. _problem_answer_yes_no
5. _problem_fill_confusing_words_with_meanings_and_usage
6. _problem_fill_misused_word_sets_with_usages
7. _problem_fill_confusing_words
8. _problem_fill_misspelled_words
9. _problem_fill_homophone_words
10. _problem_identify_homophone_words_in_sentences
11. _problem_fill_similar_opposite_words
12. _problem_fill_weird_words
13. _problem_predict_prefixes
14. _problem_predict_suffixes
15. _problem_predict_word_roots
16. _problem_words_related_to_phobia
17. _problem_words_related_to_mania
18. _problem_fill_in_with_appropriate_words
19. _problem_test_yourself
```

yter SpellingManager Last Check

View Run Kernel Settings Help

Code

```
0. _problem_random_spellings
1. _problem_leading_word_spellings
2. _problem_trailing_word_spellings
3. _problem_closest_syllables_pairs
4. _problem_homophone_words
5. _problem_prefixes_word_pairs
6. _problem_suffixes_word_pairs
7. _problem_misspelling_prone_pairs
8. _problem_confusing_word_pairs
9. _problem_gender_word_pairs
10. _problem_phrases
11. _problem_idioms
12. _problem_game_guess_word
```

yter EnglishComprehensionManager Last Checkpoint: 3 months ago

View Run Kernel Settings Help

Code

Comprehension Text:

Read the following article and answer the questions.
The Real Story of the Pied Piper

Question:

- How people remember lost children even today in Bungelosenstrasse?
- Hamelin was situated in which modern country?
- What really happened to the children?
- Is this story a complete fable?
- Was the pied piper a vengeful person?
- Which part of the story was an afterthought, rats or children?
- What is meaning of 'Bungelosenstrasse'?
- What was the real name of the Pied Piper of Hamelin?
- Which children survived the piper's revenge?

```
ke.printAnswer()
```

- According to the story, the children were last seen on one particular street in Hamelin. That street is now kn
  To this day, no one is allowed to dance or play music on this street.
- Hamelin was a German town.
- Historians don't know what happened to the children. The stained glass window that was once in the Ham
  with the town's children, but it does not provide details. There are several possibilities: 1. In the year of 1284
  piper, clothed in many kinds of colors, 130 children born in Hamelin were seduced and lost at the place of e
  rats prior to the disappearance of the children. 3. Some experts link the loss of the Hamelin children to anot

Comprehension to improve English and analytical ability in other subjects

Two roads diverged in a yellow wood,
And sorry I could not travel both
And be one traveler, long I stood
And looked down one as far as I could
To where it bent in the undergrowth;

Then took the other, as just as fair,
And having perhaps the better claim,
Because it was grassy and wanted wear;
Though as for that the passing there
Had worn them really about the same,

And both that morning equally lay
In leaves no step had trodden black.
Oh, I kept the first for another day!
Yet knowing how way leads on to way,
I doubted if I should ever come back.

I shall be telling this with a sigh
Somewhere ages and ages hence:
Two roads diverged in a wood, and I—
I took the one less traveled by,
And that has made all the difference.

3

Following the principles of community-based participatory research, tribal nations and research institutions are equal partners in health studies conducted on reservations. A collaboration between the Crow Tribe and Montana State University _____ this model: tribal citizens worked alongside scientists to design the methodology and continue to assist in data collection.

Which choice completes the text with the most logical and precise word or phrase?

A) circumvents
B) eclipses
C) fabricates
D) exemplifies

4

The parasitic dodder plant increases its reproductive success by flowering at the same time as the host plant it has latched onto. In 2020, Jianqiang Wu and his colleagues determined that the tiny dodder achieves this _____ with its host by absorbing and utilizing a protein the host produces when it is about to flower.

Which choice completes the text with the most logical and precise word or phrase?

A) synchronization
B) hibernation
C) prediction
D) moderation

5

Given that the conditions in binary star systems should make planetary formation nearly impossible, it's not surprising that the existence of planets in such systems has lacked _____ explanation. Roman Rafikov and Kedron Silsbee shed light on the subject when they used modeling to determine a complex set of factors that could support planets' development.

Which choice completes the text with the most logical and precise word or phrase?

A) a discernible
B) a straightforward
C) an inconclusive
D) an unbiased

6

Seminole/Muscogee director Sterlin Harjo _____ television's tendency to situate Native characters in the distant past: this rejection is evident in his series *Reservation Dogs*, which revolves around teenagers who dress in contemporary styles and whose dialogue is laced with current slang.

Which choice completes the text with the most logical and precise word or phrase?

A) repudiates
B) proclaims
C) foretells
D) recants

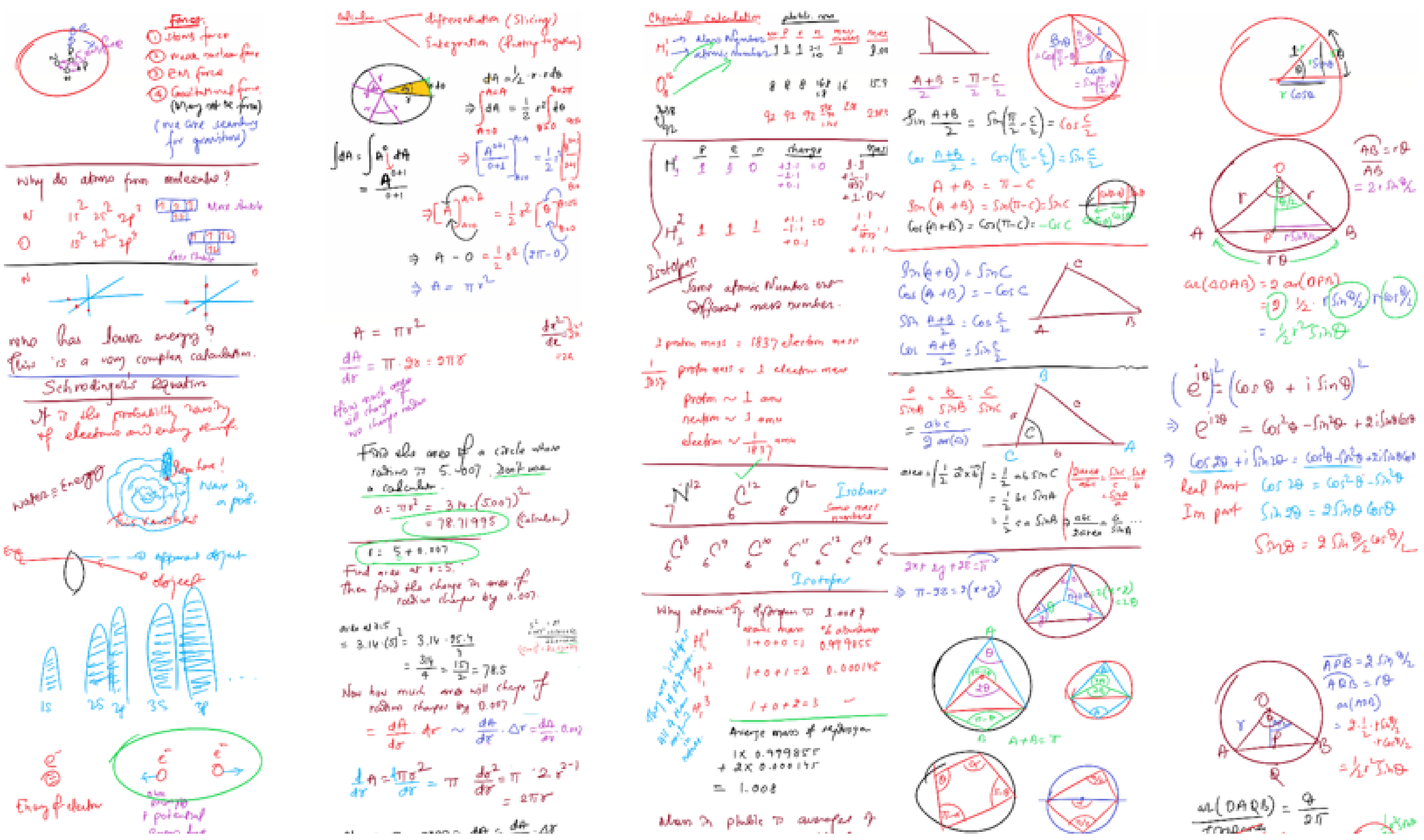
16

In the mountains of Brazil, *Barbacenia tomentosa* and *Barbacenia macrantha*—two plants in the Velloziaceae family—establish themselves on soilless, nutrient-poor patches of quartzite rock. Plant ecologists Anna Abrahão and Patricia de Britto Costa used microscopic analysis to determine that the roots of *B. tomentosa* and *B. macrantha*, which grow directly into the quartzite, have clusters of fine hairs near the root tip; further analysis indicated that these hairs secrete both malic and citric acids. The researchers hypothesize that the plants depend on dissolving underlying rock with these acids, as the process not only creates channels for continued growth but also releases phosphates that provide the vital nutrient phosphorus.

Which finding, if true, would most directly support the researchers' hypothesis?

A) Other species in the Velloziaceae family are found in terrains with more soil but have root structures similar to those of *B. tomentosa* and *B. macrantha*.
B) Though *B. tomentosa* and *B. macrantha* both secrete citric and malic acids, each species produces the acids in different proportions.
C) The roots of *B. tomentosa* and *B. macrantha* carve new entry points into rocks even when cracks in the surface are readily available.
D) *B. tomentosa* and *B. macrantha* thrive even when transferred to the surfaces of rocks that do not contain phosphates.

We create notes while teaching. In next few slides, we present a sample of some notes used by him.


Forces
Why do atoms form molecules?
Who has lower energy?
This is a very complex calculation.
Schrodinger's Equation
differentiation (Slicing)
Integration
$A = \pi r^2$
Find the area of a circle whose radius is 5.007. Don't use a calculator.
Chemical calculation
Isotopes
Same atomic Number but different mass number.
Isobars
Why atomic H is different
Average mass of Hydrogen
$\frac{A+B}{2} = \frac{\pi}{2} - \frac{C}{2}$
$A + B = \pi - C$
$\sin(A+B) = \sin C$
$\cos(A+B) = -\cos C$
$(\cos\theta + i\sin\theta)^2$
Real part $\cos 2\theta = \cos^2\theta - \sin^2\theta$
Im part $\sin 2\theta = 2\sin\theta\cos\theta$

$\log_{2^5} 2 = \frac{1}{5}$

$\log_{10} 10^6 = 6$

$\log_{\pi} \pi^6 = 6$

$\log_e e^5 = 5$

$e = \lim_{n\to\infty} \left(1+\frac{1}{n}\right)^n$

$\log x + \log y$

$\log x = \log_{10} x$

$\ln x = \log_e x = \log_{2.71} x$

$\log(2\pi)$

$4 \log x = \log x + \log x + \log x + \log x$

$4 \ln x = \ln x + \ln x + \ln x + \ln x = \ln x^4$

$\log 64 = \log_2 2^6$

$\log_a a^5 = 5 \log_a a$

$2 \log p - 3 \log(p+1)$

$= \log p^2 - \log(p+1)^3$

$= \log \frac{p^2}{(p+1)^3}$

ln = natural log

log natural

$pA + qB \rightarrow rC + sD$

$-\frac{1}{p}\frac{d[A]}{dt} = -\frac{1}{q}\frac{d[B]}{dt} = \dots$

$R \propto [A]^x [B]^y$

$= K[A]^x[B]^y$

order = 6 $\quad C \rightarrow \dots$

$C^{-6}\frac{dC}{dt} = kC^6 \cdot dt \cdot C^{-6}$

$\Rightarrow -C^{-6}dC = K\,dt$

$\Rightarrow -\int_{C_0}^{C} C^{-6}dC = K\int_0^t t^0 dt$

$\frac{C^{-6+1}}{-6+1} \qquad \frac{t^{0+1}}{0+1}$

$\frac{d x^n}{dx} = n x^{n-1}$

$\frac{d x^{n+1}}{dx} = (n+1)x^n$

$\int A\,dx = Q$

$\int (n+1)x^n dx = x^{n+1}$

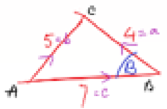
Are sides real?

5+4 > 7

7+4 > 5

5+7 > 4

Yes, they are real.



Find the angles.

$\vec{AB} + \vec{BC} = \vec{AC}$

$\Rightarrow \vec{c} + \vec{a} = \vec{b}$

$\Rightarrow (\vec{c}+\vec{a})^2 = (\vec{b})^2$

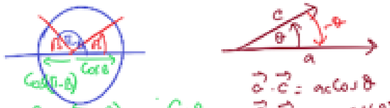
$\Rightarrow (\vec{c}+\vec{a})\cdot(\vec{c}+\vec{a}) = \vec{b}\cdot\vec{b}$

$\Rightarrow \vec{c}\cdot\vec{c} + \vec{a}\cdot\vec{c} + \vec{c}\cdot\vec{a} + \vec{a}\cdot\vec{a} = \vec{b}\cdot\vec{b}$

$\Rightarrow c^2 + 2\vec{c}\cdot\vec{a} + a^2 = b^2$

$\Rightarrow c^2 + 2ca\cos(\pi - B) + a^2 = b^2$

$\vec{c}\cdot\vec{c} = c \cdot c \cos 0 = c^2$

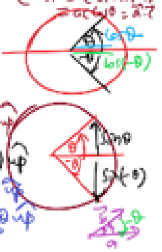


$\cos(\pi - B) = -\cos B$

$\vec{a}\cdot\vec{c} = ac\cos\theta$

$\vec{c}\cdot\vec{a} = ca\cos(-\theta)$

$\Rightarrow c^2 - 2ca\cos B + a^2 = b^2$



$\vec{a}\times\vec{b} = ab\sin\theta\,\hat{n}$

$\vec{b}\times\vec{a} = ba\sin(-\theta)\hat{n}$

$= -ba\sin\theta\,\hat{n}$

$= -ab\sin\theta\,\hat{n}$

$= -\vec{a}\times\vec{b}$

$\Rightarrow c^2 - 2ca\cos B + a^2 = b^2$

$\Rightarrow c^2 + a^2 - b^2 = 2ca\cos B$

$c^2 + a^2 - 2ca\cos B = b^2$

$a^2 + b^2 - 2ab\cos C = c^2$

$b^2 + c^2 - 2bc\cos A = a^2$

$c^2 + a^2 - 2ca\cos B = b^2$

$\cos C = \frac{a^2+b^2-c^2}{2ab}$

$a^2 = b^2 + c^2 - 2bc\cos A$

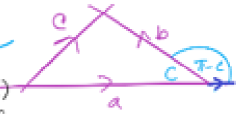
$\vec{a} + \vec{b} = \vec{c}$

$a^2 + b^2 + 2\vec{a}\cdot\vec{b} = c^2$

$\vec{a}\cdot\vec{b} = ab\cos(\pi - C)$

$= -ab\cos C$

$a^2 + b^2 - 2ab\cos C = c^2$



A manager gets \$102000 pa plus bonus of 1% of profit after his bonus. The bonus is \$15000. What's profit?

1% profit after bonus = 15000

1% (Profit − 15000) = 15000

$\text{Profit} = \frac{15000}{1\%} + 15000$

$= 15000\left(\frac{1}{1\%} + 1\right)$

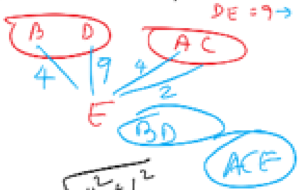
$= 15000(100+1)$

$= 15000 \cdot 101$

100% = 1

	u	v	w	x	y	z
A	5	7	2	3	4	5
B	2	9	8	3	4	2
C	7	3	1	5	4	1
D	6	2	8	1	4	2
E	7	1	6	3	2	1

AB = 5
AC = 2
AD = 9
AE = 4
BC = 6
BD = 1
BE = 4
CD = 7
CE = 2
DE = 9

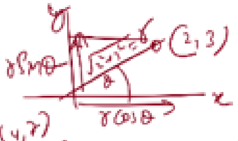


$(-1, 1) = \sqrt{(-1)^2 + 1^2}$

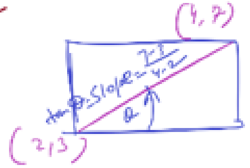
(2, 4) (1, 5)

(2, 3, 1) (5, 6, 7)

Slope =

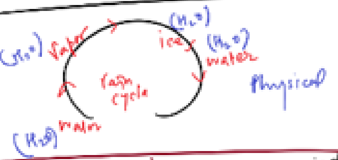


(2, 3) (4, 7)



Start 10°C 30° 10°C 28°C

takes longer time to heat up or cool down



Rain pollution / Acid Rain: chemical change

$SO_2 + H_2O \rightarrow H_2SO_3$

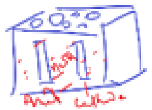
Sulphuric oxide. $\quad + H_2SO_4$

(Industrial waste) Sulphurous Acid, Sulphuric Acid

Lead Acid battery — discharging

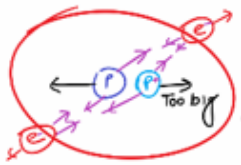
$PbO_2 + H_2SO_4 \leftrightarrow PbSO_4 + H_2O$

charging



Chemical Chge

Lithium Batteries



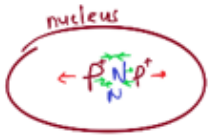
leads to unstable nucleus

→ strong force
→ electrostatic force
→ gravitational force (too weak)

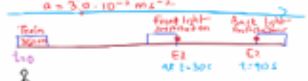
Strong force is very very strong but only for short distances.

Strong force
negligible
very powerful attraction
go away

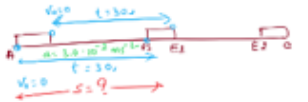
Strong force is like springs.

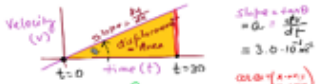


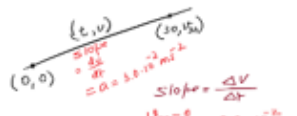
26 is last possible

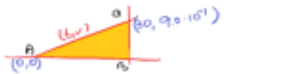


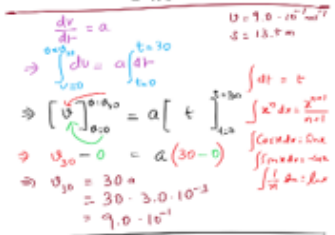
Observer: When will he see the two events and what will be the time delayed?

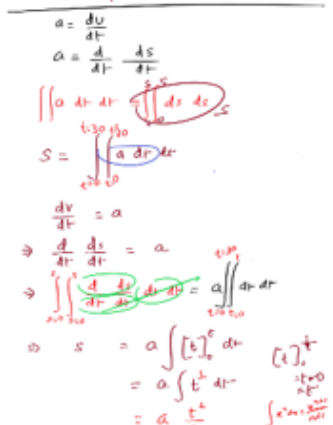




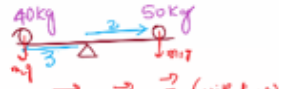








Physics



We calculate torque (τ). It has a direction.

$\vec{\tau} = \vec{r} \times \vec{F}$ (with direction)

$W = \vec{F} \cdot \vec{s}$ (no direction)

$\vec{\tau} = \vec{\tau}_1 + \vec{\tau}_2$

$= 2m\vec{i} \times 50kg \cdot 9.8 ms^{-2}(-\vec{j}) + 3m(-\vec{i}) \times 40kg \cdot 9.8 ms^{-2}(-\vec{j})$

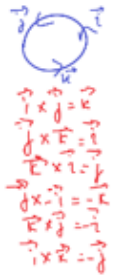
$= 9.8 \, kg m^2 s^{-2}(-100\vec{k} + 120\vec{k})$

$= 196 \, kg m^2 s^{-2} \vec{k}$

$= 196 \, Nm \, \vec{k}$

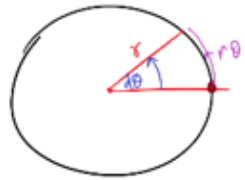
Torque = Nm

Work = Joule



Work done by a Torque

	translatory motion	Rotatory Motion
displacement	$\vec{s}$	$\vec{\theta}$
time	t	t
Velocity	$\vec{v} = \frac{d\vec{s}}{dt}$	$\vec{\omega} = \frac{d\vec{\theta}}{dt}$
acceleration	$\vec{a} = \frac{d\vec{v}}{dt}$	$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$
Force, Torque	$\vec{F} = m \cdot \vec{a}$	$\vec{\tau} = \vec{I} \cdot \vec{\alpha}$
Work	$W = \vec{F} \cdot \vec{s}$	$\omega = \vec{\tau} \cdot \vec{\theta}$



$v = \frac{ds}{dt} = \frac{r d\theta}{dt} = r\frac{d\theta}{dt} = r\omega$

$a = \frac{dv}{dt}$

$\vec{F} \propto \frac{d\vec{p}}{dt}$ (II law of motion) $\vec{p} = m\vec{v}$ momentum

$\Rightarrow \vec{F} = \frac{d\vec{p}}{dt}$ no constant = 1

$\Rightarrow \vec{F} = m\frac{d\vec{v}}{dt}$ if m is constant

$\Rightarrow \vec{F} = m\vec{a}$

$\frac{d(uvw)}{dr} = \frac{du}{dr}vw + u\frac{dv}{dr}w + uv\frac{dw}{dr}$

$\frac{d(x^5 \sin x \tan x)}{dx}$

$= \frac{dx^5}{dx}\sin x \tan x + x^5 \frac{d\sin x}{dx}\tan x + x^5 \sin x \frac{d\tan x}{dx}$

$= 5x^4 \sin x \tan x + x^5 \cos x \tan x + x^5 \sin x \sec^2 x$

$\frac{dx^n}{dx} = nx^{n-1}$

$\frac{d\sin x}{dx} = \cos x$

$\frac{d\cos x}{dx} = -\sin x$

$\frac{d\tan x}{dx} = \sec^2 x$

$\frac{d\ln x}{dx} = \frac{1}{x}$

$\frac{dr^2}{dr} = 2r^{2-1} = 2r$

$\frac{dr^n}{dr} = nr^{n-1}$

$\frac{dr^{-3}}{dr} = -3r^{-3-1} = -3r^{-4} = -\frac{3}{r^4}$

$\frac{d}{dt}\left(\frac{1}{t^1}\right) = -1t^{-1-1} = -1t^{-2} = -\frac{1}{t^2}$

function, subject

$\frac{dx^n}{dx} = nx^{n-1} \Rightarrow \int nx^{n-1}dx = x^n$

$\Rightarrow \int x^n dx = \frac{x^{n+1}}{n+1}$

$\frac{d\sin x}{dx} = \cos x \Rightarrow \int \cos x \, dx = \sin x$

$\frac{d\ln x}{dx} = \frac{1}{x} \Rightarrow \int \frac{1}{x}dx = \ln x$

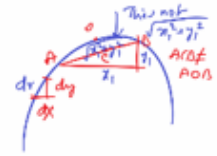
$\frac{d\tan x}{dx} = \sec^2 x \Rightarrow \int \sec^2 x dx = \tan x$

Work = $\vec{F} \cdot \vec{s}$

$= Fs\cos\theta$

θ is angle

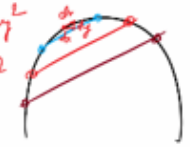
Calculus $\frac{dy}{dx}$



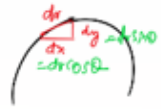
$dr^2 = dx^2 + dy^2$

$r^2 \neq x^2 + y^2$

$r = \int dr = \int \sqrt{dx^2 + dy^2}$



$\tan\theta = \frac{dy}{dx}$



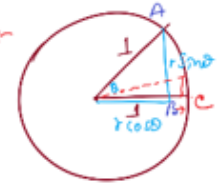
$AB \neq AC$ but

as $\theta \to 0$, $B \to C$

$\Rightarrow \theta \to 0$, $AB \to AC$

$\Rightarrow \lim_{\theta \to 0} AB = AC$

$\Rightarrow \lim_{\theta \to 0} \sin\theta = \theta$ As $r = 1$



$\Rightarrow \lim_{\theta \to 0} \frac{\sin\theta}{\theta} = 1$

$\Rightarrow \lim_{\theta \to 0} \frac{\sin\theta}{\theta}\frac{\cos\theta}{\cos\theta} = 1$

$\Rightarrow \lim_{\theta \to 0} \frac{\tan\theta}{\theta}\frac{1}{\cos\theta} = 1$

$\Rightarrow \lim_{\theta \to 0} \frac{\tan\theta}{\theta}\frac{1}{1} = 1$

$\Rightarrow \lim_{\theta \to 0} \frac{\tan\theta}{\theta} = 1$

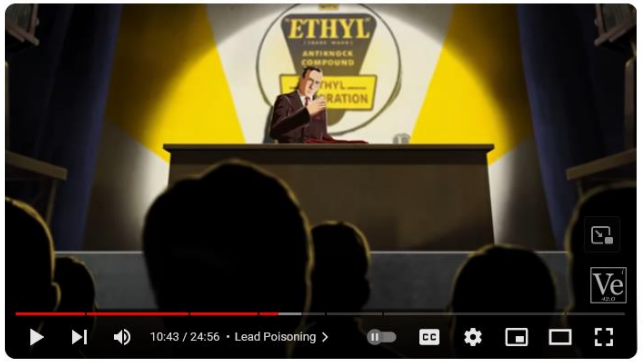
If $\theta \to 0$,

$\frac{\sin\theta}{\theta} = 1$ $\frac{\tan\theta}{\theta} = 1$

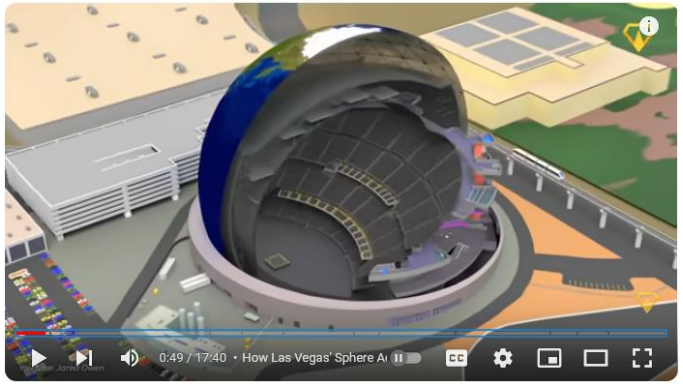
$\Rightarrow \boxed{\sin\theta = \tan\theta = \theta}$

We watch lot of documentaries and videos

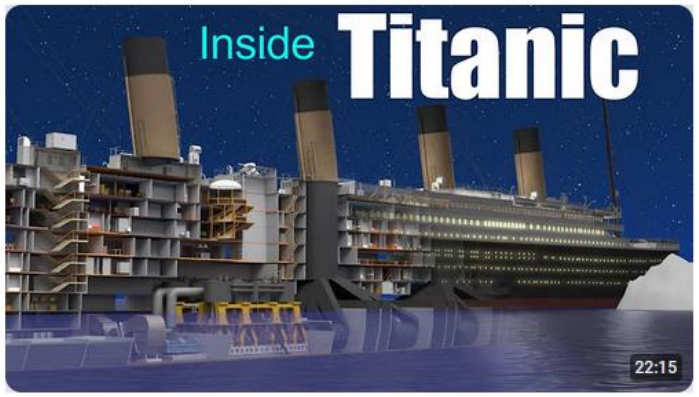
The man who tried to fake an element



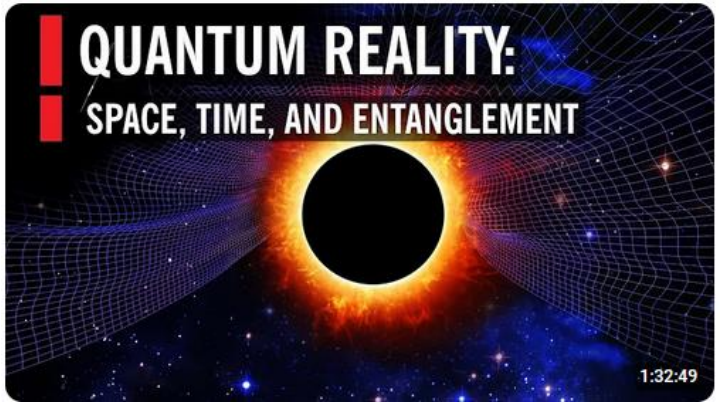
The Man Who Accidentally Killed The Most People In History

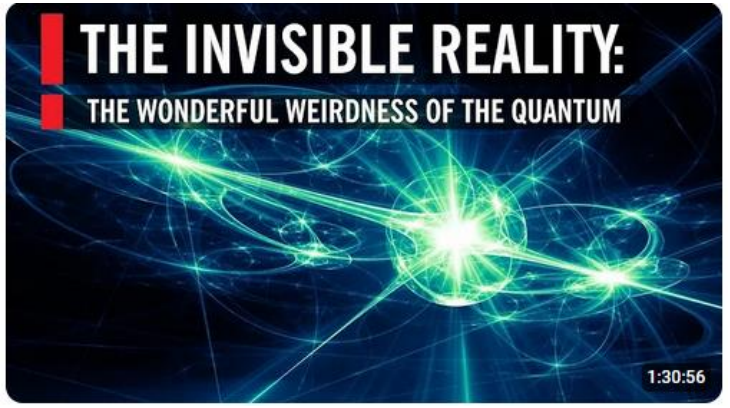


How Las Vegas' Sphere Actually Works

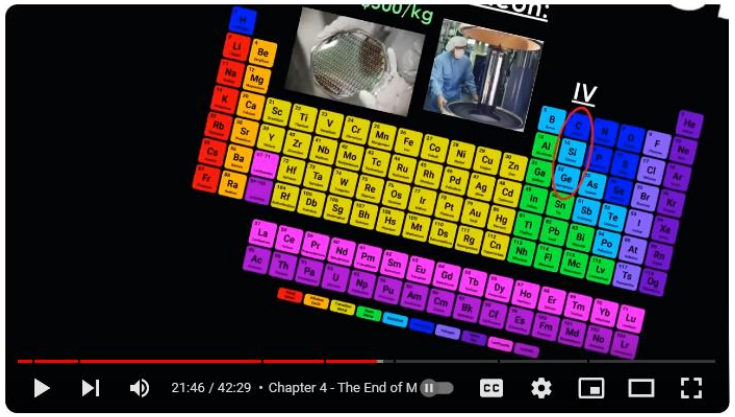


Seeing Further: Searching for the Echoes of Creation

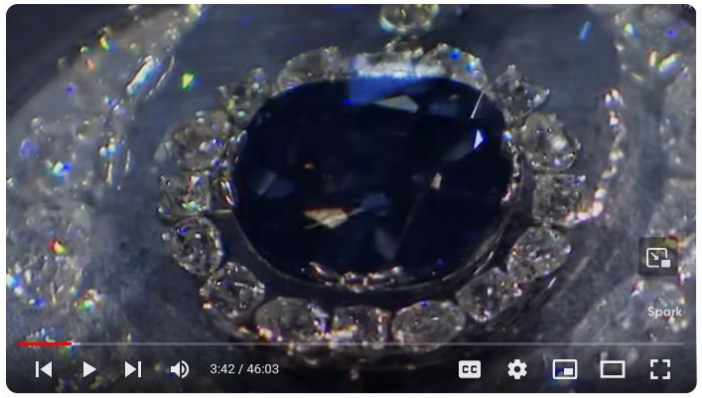




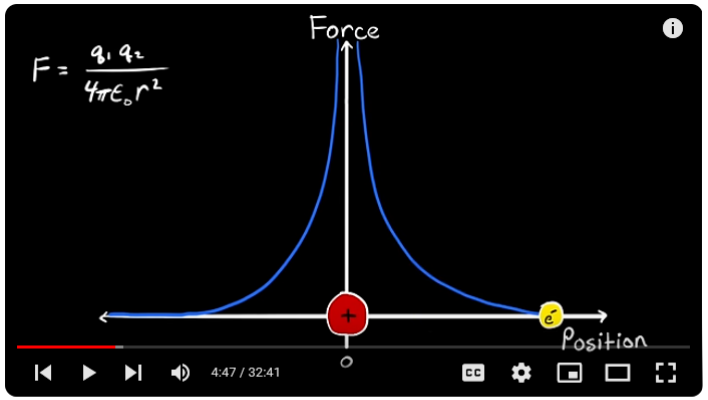
The Bogdanoffs: The Trolls who shook Physics



The man who almost faked his way to a Nobel Prize



How Science Harnesses The Incredible Power Of Diamonds | Naked Science |



The Actual Reason Semiconductors Are Different From Conductors and Insulators.

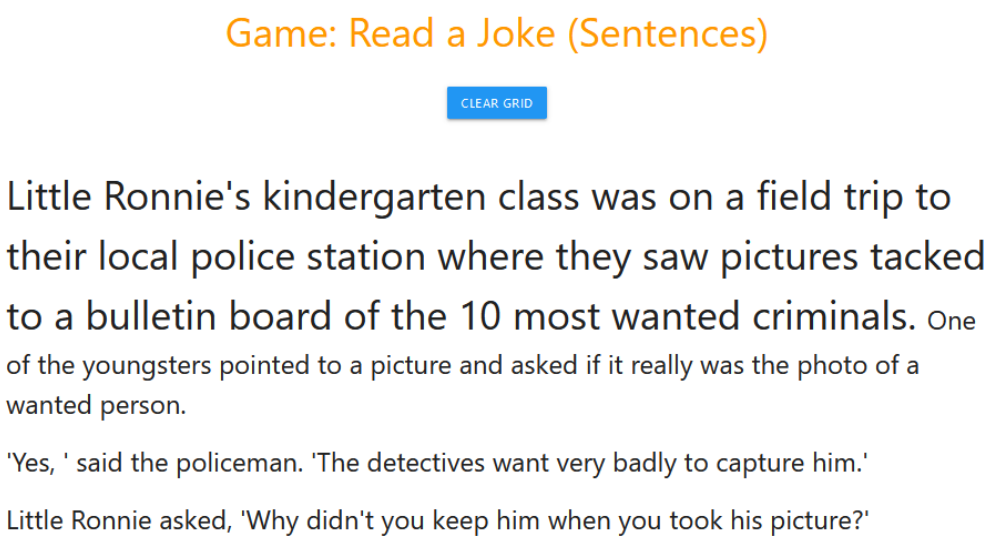
One Hour Of Mind-Blowing Mysteries Of The Atom | Full Documentary

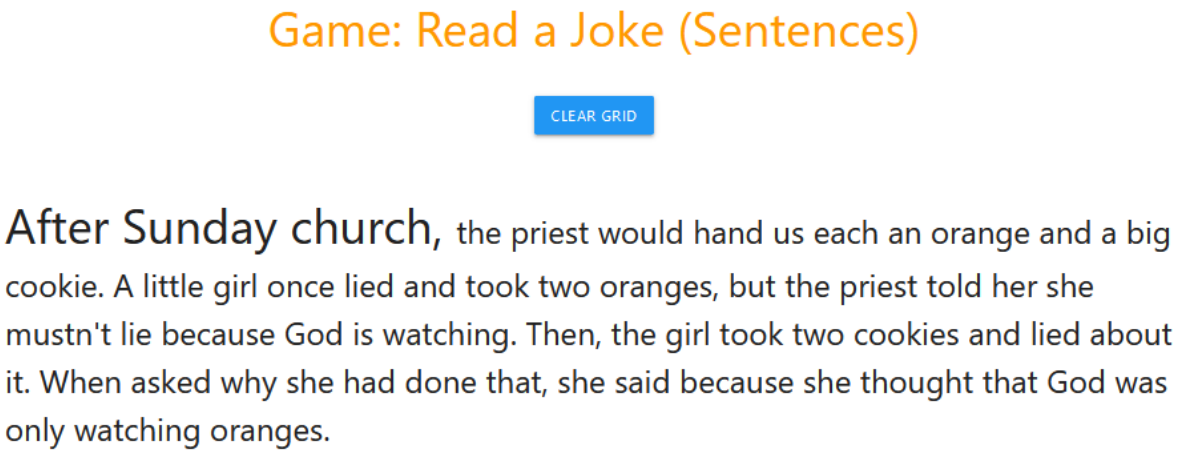
Exploring our Mind-Blowing Universe | BBC Earth Science

We had lot of fun too!

A collection of 2500 jokes!
We read and enjoyed together.

This improved his English like never before. He developed skill to read and speak with confidence. Now, he is one in the batch who makes others laugh with his witty comments and jokes.





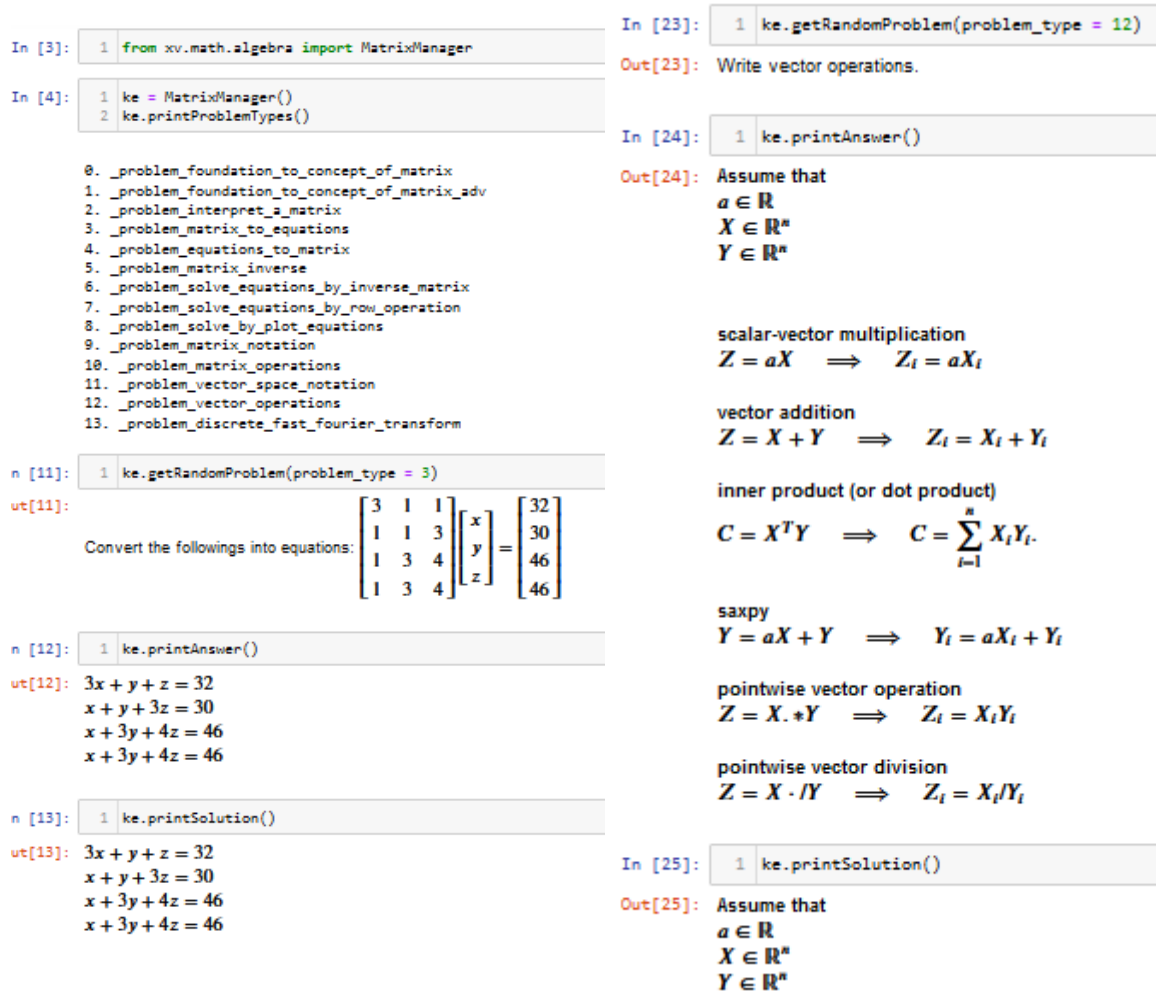
We have fun classes once in a while

- We watch funny videos, tell/create funny stories and draw funny cartoons
- They provide them new/alternate perspectives and improves their analytical ability and sense of humor.

Don’t forget that everything in this document is two year work of a student.

We have developed our own software to expedite the learning process.

- The user interface is web-based or Jupyter Notebook.
- Jupyter Notebook enhances creativity and facilitates tackling complex topics.
- The content has been designed to facilitate accelerated learning, focusing on interconnected concepts to eliminate the need for
  - rote memorization,
  - homework, and
  - additional practice.



The progress card

- He has already covered advanced topics, instilling in us the confidence to teach him AI/ML programming, which demands a deep understanding of complex mathematics and statistics to comprehend what is happening under the hood.

How many students studying elsewhere can achieve so much in two years?

Please note that we ensured with him too

- No memorization*
- No homework**
- No extra assignments**
- Programming is essential part of learning.

- When someone forgets something, we simply repeat it and this time it takes on tenth of the taken previous time for the same topic.

** Homework kills creativity and analytical ability of students and they are forced to spend their time in doing repetitive and boring assignments.

There is more:

- He is a state-level chess player, aspiring to become a professional chess player.
- SAT goal: 1590+
- This summer, they are learning AI/ML with Python. It will include:
  - scikit-learn
  - TensorFlow
  - PyTorch
  - Classification models
  - Regression models
  - Deep learning models

It's not just him; he's merely an illustrative case.

This isn't an isolated case; it's a typical story for all the students learning with us.

If you feel he is doing great, your kid could be in his place. We don't just cater to grade 9; we teach all school grades and college students. Moreover, we provide training to professionals in advanced science, math, and AI/ML.

Feel free to reach out to us by calling or messaging on WhatsApp at 756993343, or email us at admin@xcelvations.com.

You can also visit our website at http://www.xcelvations.com/ for more information.