



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 ▾ / [REDACTED]	☐ 0 ▾ / [REDACTED] Programming	☐ 0 ▾ / [REDACTED] English	☐ 0 ▾ / [REDACTED] Chemistry
☐ ..	☐ ..	☐ ..	☐ ..
☐ Programming	☐ Geometrical Plotting Part 3.ipynb	☐ BookManager Engineer Song.ipynb	☐ PeriodicTableManager.ipynb
☐ English	☐ Geometrical Plotting Part 2.ipynb	☐ VocabularyManager for Lyrics.ipynb	☐ Periodic Table.ipynb
☐ Mathematics	☐ Geometrical Plotting.ipynb	☐ Learning Spanish.ipynb	☐ ChemCalcManager.ipynb
☐ History	☐ Linspace.ipynb	☐ LearnLanguageManager.ipynb	☐ ChemicalReactionManager.ipynb
☐ Plotting	☐ Python Introduction.ipynb	☐ BookManager Cinderella.ipynb	☐ Grade9ChemistryManager.ipynb
☐ HTML Programming	☐ CreateWordCloud.ipynb	☐ BookManager Anna-Karenina.ipynb	☐ AtomManager.ipynb
☐ Biology	☐ Python	☐ WordManager.ipynb	☐ ChemistryCourseOneManager.ipynb
☐ Chemistry	☐ JavaScript	☐ Spelling Manager.ipynb	☐ ChemistryManager.ipynb
☐ Geography	☐ String Formatting.ipynb	☐ Untitled.ipynb	☐ Chemistry Compounds.ipynb
☐ Physics	☐ Functions.ipynb	☐ EnglishComprehensionManager.ipynb	☐ PtableUtil.ipynb
	☐ Solar_System.ipynb	☐ UsageManager.ipynb	
	☐ Search_Text_In_txt_File.ipynb	☐ Word Scrambler.ipynb	
	☐ students.csv	☐ VocabularyManager.ipynb	

☐ 0

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

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

☐ 0

Mathematics

☐ Trigonometry.ipynb
☐ Sin and Cos.ipynb
☐

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

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

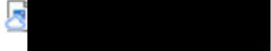
☐ 0

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

Partial snapshot of the notes folder of his batch

 year-2022-Jan-June	 atomic-forces.png	 wave equation.png	 induction.png	 factorize-2.png
 year-2021-Jan-June	 calculus-differentiation.png	 volume-area.png	 iit-area.png	 factorize-1.png
 year-2022-July-Dec	 chemistry-1.png	 some-more-binomial-expr.png	 hydraulic-pump.png	 euler-topics.png
 year-2021-July-Dec	 chemistry-2.png	 SAT-practice.png	 [REDACTED] motion.png	 differential-equations.png
 year-2023-Jan-June	 chemistry-3.png	 sat-aug-29.png	 glucose.png	 cricket-world.cup.png
 year-2023-Jul-Dec	 chemistry-4.png	 real-analysis.png	 geo-rotation.png	 conic-sections.png
 year-2024-Jan-June	 chemistry-5.png	 ratio-of-force-between-electrons.p	 geometry-deriving-equations.png	 calculus-kinetics-2.png
	 chemistry-6.png	 quadratic-equations.png	 gravitational-force.png	 calculus-kinetics.png
	 chemistry-7.png	 probability-iit.png	 force-of-gravity.png	 black-holes.png
	 chemistry-8.png	 physics-new-session.png	 force-of-buoyancy.png	 aops-2022-q-25.png
	 chemistry-9.png	 newton's laws_2.png	 factorize-3.png	 aops-2022-q.png
	 chemistry-10.png	 newton's laws.png	 factorize-2.png	 aops.png
	 chemistry-11.png	 new-series-waves-particles-electron	 factorize-1.png	 algebra-polynomials.png
	 chemistry-12.png	 new-series-waves-particle-heat-tran	 euler-topics.png	 algebra-2-reviews-4.png
	 chemistry-13.png	 matter-state-and-heat.png	 differential-equations.png	 algebra-2-reviews-3.png
	 chemistry-14.png	 math-revision.png	 cricket-world.cup.png	 algebra-2-reviews-2.png
	 chemistry-15.png	 math-genius-ceremon.png	 conic-sections.png	 algebra-2-review-5.png

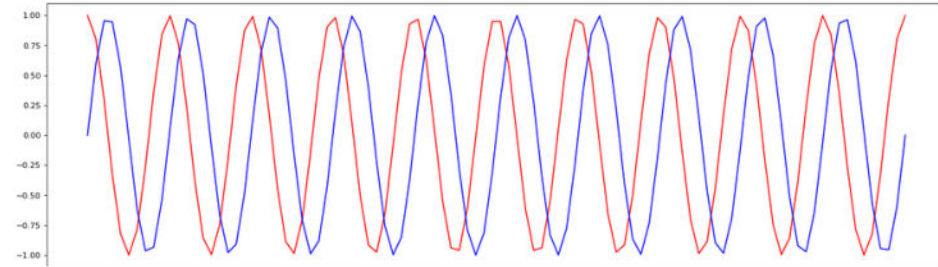
 waves.png	 maths-polygon.png	 electricit-and-magnets.png	 work-torque.png
 volume-sphere.png	 latent-heat-2.png	 electricit.png	 work-energy-friction.png
 volume-cone-2.png	 latent-heat.png	 dynamics-calculus.png	 waves.png
 volume-cone.png	 iit-q.png	 coordinates-median.png	 venus.png
 volume-area.png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

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

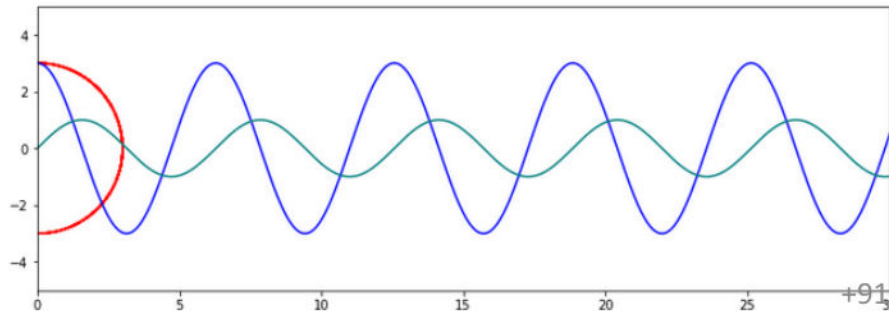
He, like all our students, is also a good programmer because it helps them learn Math, Physics, Chemistry, Geography, and other subjects better and faster.

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.

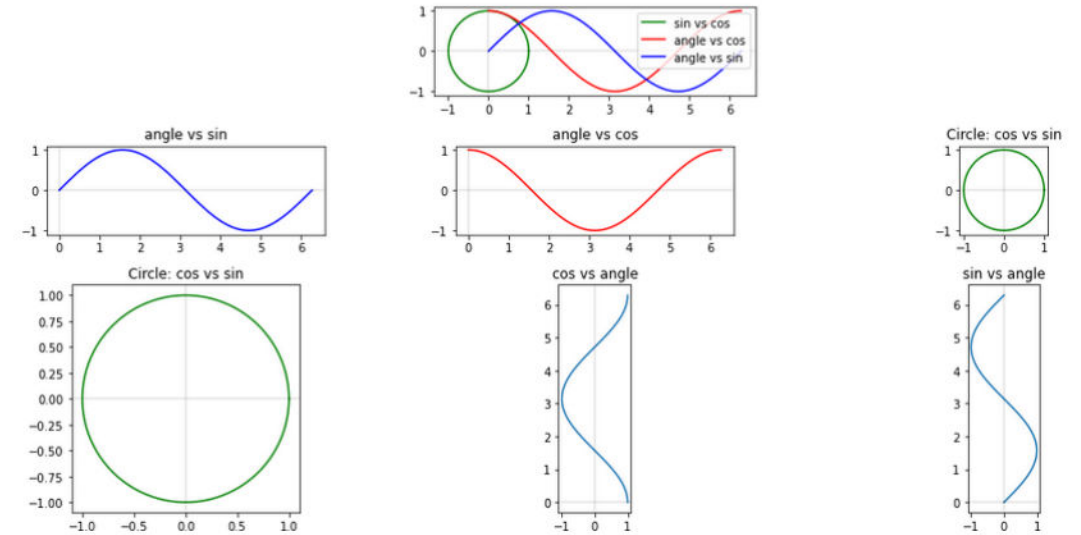

```
1 figure(figsize=(20, 6), dpi=80)
2
3 #theta = np.linspace(0 * np.pi, 10 * np.pi, 100)
4
5 t = np.linspace(0, 1, 100)
6 f = 10
7 w = 2 * np.pi * f
8 theta = w * t
9
10 y1 = np.cos(theta)
11 y2 = np.sin(theta)
12
13 plt.plot(theta, y1, color = 'red')
14 plt.plot(theta, y2, color = 'blue')
15
16 plt.show()
```



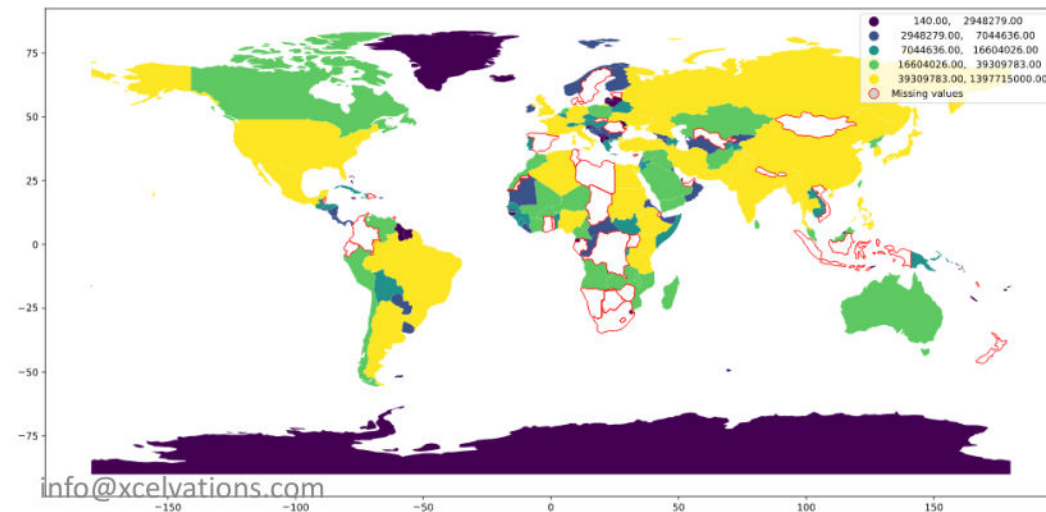
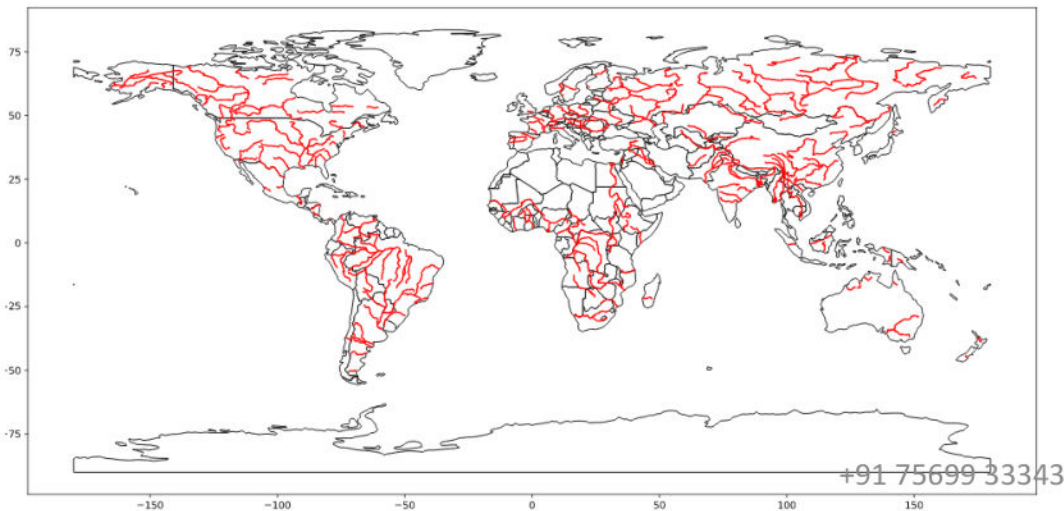
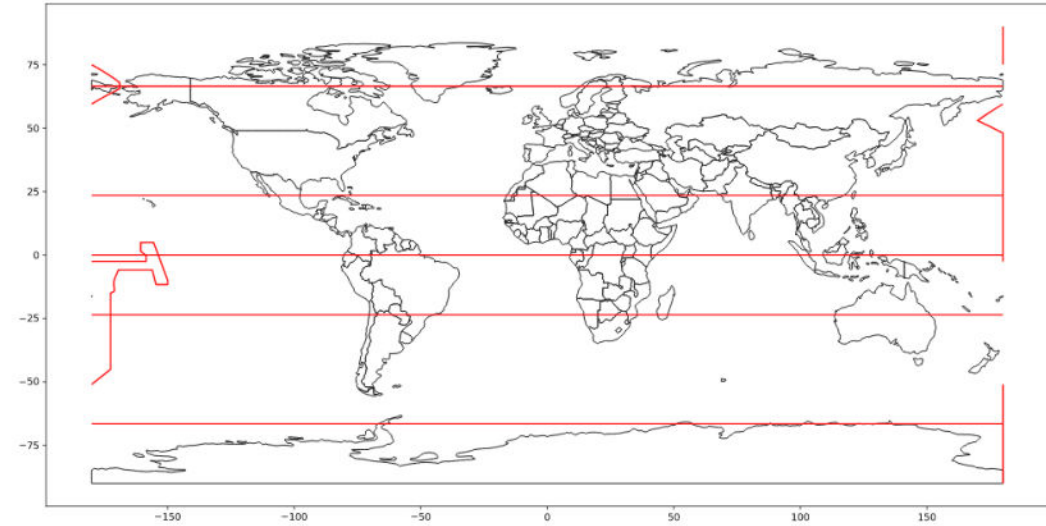
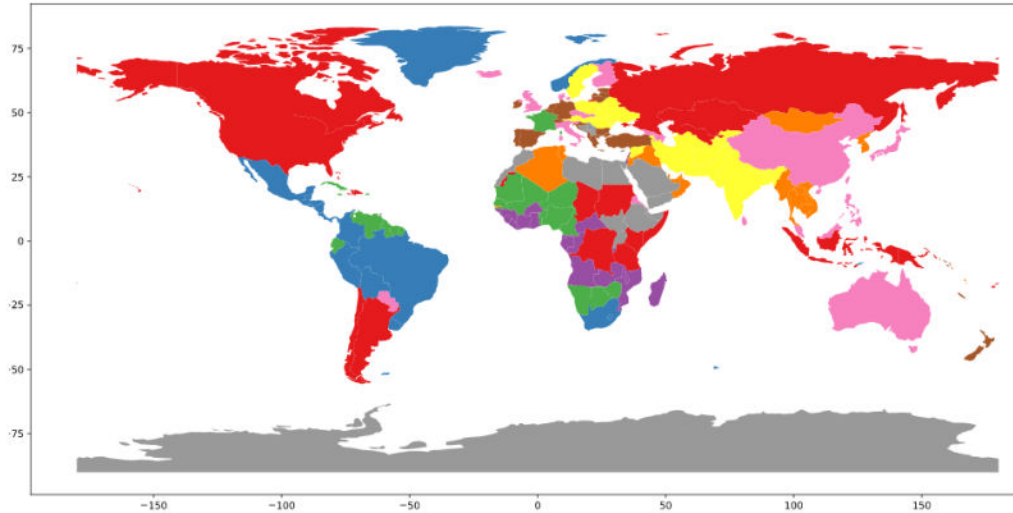
```
1 plt.figure(figsize = (12, 6))
2
3 t = linspace(0, 5, 1000)
4 f = 2
5 w = 2 * pi * f
6 angles = w * t
7 r = 3 #It is called amplitude of the wave
8
9 plt.plot(r * cos(angles), r * sin(angles), color = 'red')
10
11 plt.plot(angles, r * cos(angles), color = 'blue')
12 plt.plot(angles, sin(angles), color = 'teal')
13
14 plt.xlim(0, 30)
15 plt.ylim(-5, 5)
16 plt.gca().set_aspect('equal', adjustable='box')
17 plt.show()
```



```
64 ax.set_aspect('equal')
65 ax.axvline(x = 0, color = (0, 0, 0, .1))
66 ax.axhline(y = 0, color = (0, 0, 0, .1))
67 ax.legend()
68
69 fig.tight_layout()
70 plt.show()
```



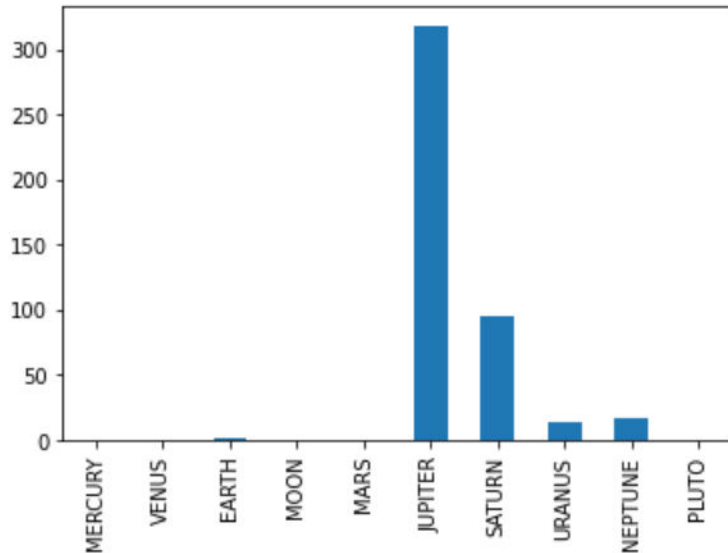
Geoplotting to study geography



He is good at data refining, visualization, and analysis

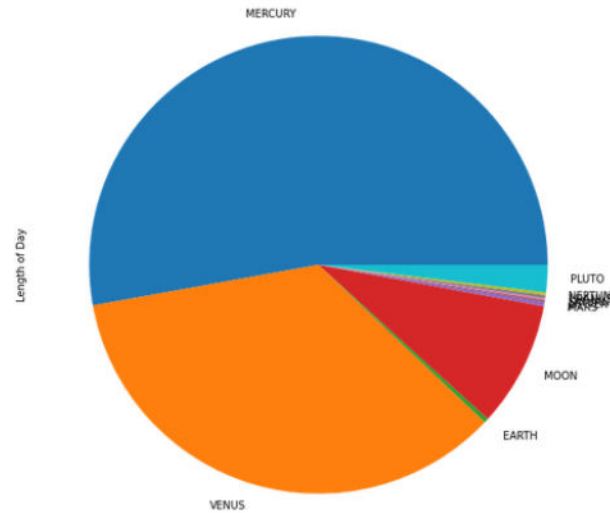
```
1 ss.Mass.astype(float).plot.bar()
2
```

<AxesSubplot:>



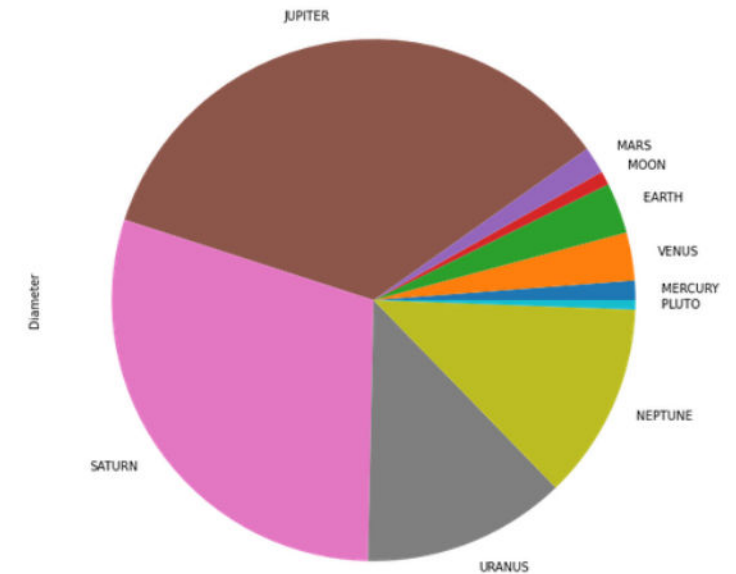
```
In [13]: 1 plt.figure(figsize=(10,10))
2 ss["Length of Day"].astype(float).plot.pie()
3
4
```

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



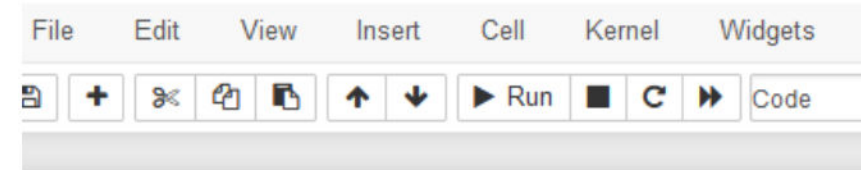
```
In [11]: 1 plt.figure(figsize=(10,10))
2 ss.Diameter.astype(float).plot.pie()
3
```

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.



```
In [1]: 1 from xv.geo import MapManager
```

```
In [2]: 1 ke = MapManager(verbose = False)
        2 ke
```

```
1 ke.getRandomProblem(problem_type = 0,
2                       search = ['France'],
3                               ]
4 )
```

Locate the following on the map.

France, Baillet-en-France, San Francisco, Puiseux-en-France, Francenigo, Frances Baard District Municipality, Francetown, Merville-Franceville-Plage, Fort Frances, Belloy-en-France, Franceville





‘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 AlgebraicExpressionManager
```

```
In [2]: 1 ke = AlgebraicExpressionManager()
```

```
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
```

```
Problem type: _problem_
Find the absolute value of
if  $x < 0$ ,  $y \geq 0$ 
```

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 1
 $-5v + 8x + 2z$
 $-9v - w + x - 2y + 6z$

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 from 1 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:

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

$\Rightarrow$ The sum of expressions:
 $= 4v + w + 7x + 2y - 4z$

We can rewrite

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

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

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

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

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

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

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

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

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

Answer:

1485

31552

Solution:

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

$$= \frac{9}{6 \times 8 + \frac{(9-5)}{(\frac{5}{-8}) + (5 \times -4)} \times (6 - 2)} \quad \text{as } (4 - -5) = 9$$

$$= \frac{9}{4 \times 6 \times 8 + \frac{(9-5)}{(\frac{5}{-8}) + (5 \times -4)} \times (6 - 2)} \quad \text{as } (6 - 2) = 4$$

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:

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

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

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

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

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

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

Second Part:

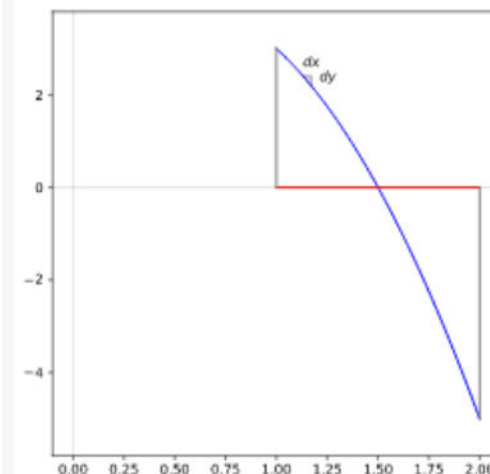
$$a = v(s) \frac{d}{ds} v(s)$$

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

Answer:

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

Solution:



The length of curve

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

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

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

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

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

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

Answer:

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

Solution:

A cone has one circular base and slant surface area

• area of circular base + slant surface area

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

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

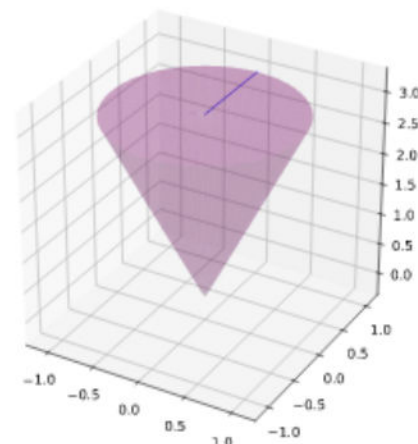
$$= \pi r(r + l)$$

$$= \pi \times 1(1 + \sqrt{10})$$

$$= \pi \times 1(1 + \sqrt{10})$$

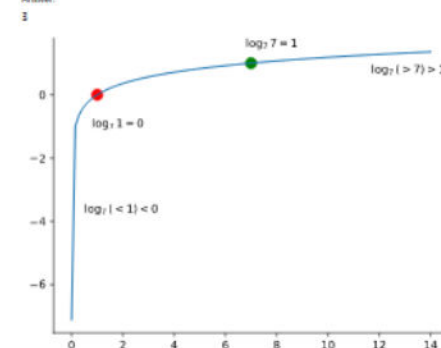
$$= \pi(1 + \sqrt{10})$$

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



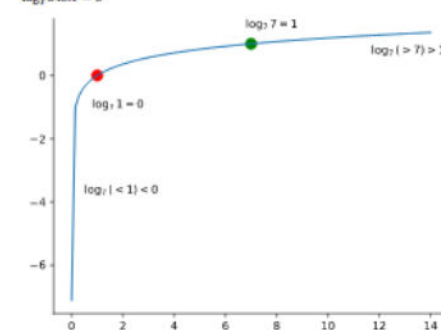
The value of $\log_7 343.1$ is: -0.2625, 0.04898, 1.007, 2, 3

Answer:



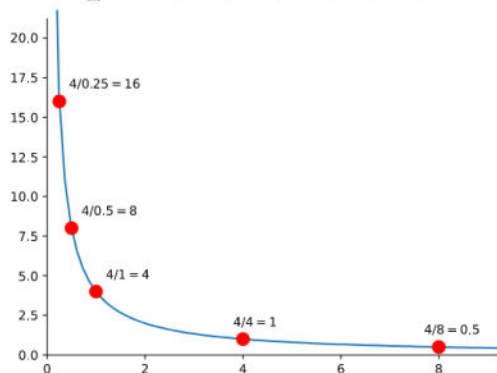
Solution:

$$\log_7 343.1 = 3$$



Import matplotlib.pyplot as plt
from matplotlib import pyplot as plt

The value of $\frac{4}{31}$ is: 11.43, 6.667, 4.706, 3.636, 2.5, 1.905, 1.29



Answer:

1.29

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

Simplify the followings:

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

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

$$\frac{7}{200} \quad \text{or}$$

0.035

```
1 ke.printSolution()
```

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

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

$$= \frac{\frac{42}{20}}{40} * \frac{1}{6}$$

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

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

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

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

Write arithmetic series of z^6 terms, with first term (t_0) as $\sqrt[3]{x}$ and the common difference as $-y$

Answer:
 $((\sqrt[3]{x}) + (-y) \cdot 0) + ((\sqrt[3]{x}) + (-y) \cdot 1) + ((\sqrt[3]{x}) + (-y) \cdot 2) + \dots + ((\sqrt[3]{x}) + (-y) \cdot (z^6 - 2)) + ((\sqrt[3]{x}) + (-y) \cdot (z^6 - 1))$

It can also be written as $\sum_{k=0}^{z^6-1} ((\sqrt[3]{x}) + (-y) \cdot k)$

Solution:
 next term = (previous term) + (common difference)
 $t_n = t_0 + n * \text{common difference}$

Please note that we start count of terms from 0.

$$t_0 = \sqrt[3]{x} = ((\sqrt[3]{x}) + (-y) \cdot 0)$$

$$t_1 = t_0 + (-y) = ((\sqrt[3]{x}) + (-y) \cdot 0) + (-y) = ((\sqrt[3]{x}) + (-y) \cdot 1)$$

$$t_2 = t_1 + (-y) = ((\sqrt[3]{x}) + (-y) \cdot 1) + (-y) = ((\sqrt[3]{x}) + (-y) \cdot 2)$$

...

$$t_{z^6-1} = t_{z^6-2} + (-y) = ((\sqrt[3]{x}) + (-y) \cdot (z^6 - 2)) + (-y) = ((\sqrt[3]{x}) + (-y) \cdot (z^6 - 1))$$

$$t_{z^6} = t_{z^6-1} + (-y) = ((\sqrt[3]{x}) + (-y) \cdot (z^6 - 1)) + (-y) = ((\sqrt[3]{x}) + (-y) \cdot (z^6))$$

Therefore, the series is
 $((\sqrt[3]{x}) + (-y) \cdot 0) + ((\sqrt[3]{x}) + (-y) \cdot 1) + ((\sqrt[3]{x}) + (-y) \cdot 2) + \dots + ((\sqrt[3]{x}) + (-y) \cdot (z^6 - 2)) + ((\sqrt[3]{x}) + (-y) \cdot (z^6 - 1))$

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

It can also be written as $\sum_{k=0}^{z^6-1} ((\sqrt[3]{x}) + (-y) \cdot k)$

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

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

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

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

```
1  
2  
3 ke.printSolution()  
4
```

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

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

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

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

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

$$\Rightarrow 3^2 < 10, \text{ which is true}$$

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

Solve the followings:

$$\text{Q1. } \quad \quad -9$$

$$\text{Q2. } \quad \quad -9$$

$$\text{Q3. } \quad 9 * 9$$

$$\text{Q4. } \quad -9 * 9$$

$$\text{Q5. } \quad 9 * -9$$

$$\text{Q6. } \quad -9 * -9$$

$$\text{Q7. } \quad \quad -9 * 9$$

$$\text{Q8. } \quad 9 * \quad \quad -9$$

$$\text{Q9. } \quad \quad -9 * \quad \quad -9$$

$$\text{Q10. } \quad -9 * \quad \quad -9$$

$$\text{Q11. } \quad \quad -9 * -9$$

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.

$$\log_{10} 2 = \frac{3}{11}$$

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

```
1 ke = NumberUnitManager()
```

```
1 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

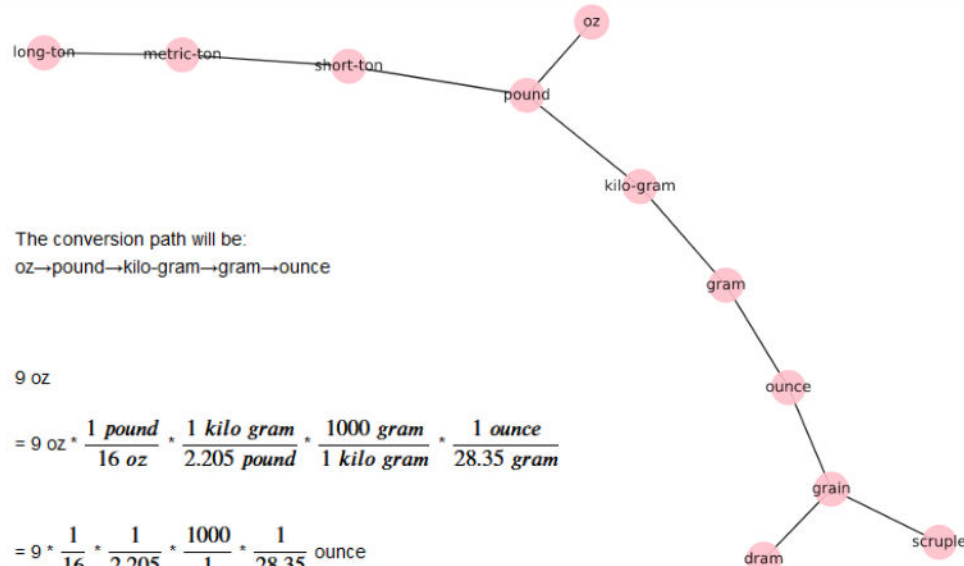
1 long-ton = 1.016 metric-ton

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

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

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

$$= 9 * 0.9998120353373564 \text{ ounce}$$

$$= 8.998308318036207 \text{ ounce}$$

```
1 ke.getRandomProblem(problem_type = 11)
2
```

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

```
1 ke.printAnswer()
2
```

84

```
1 ke.printSolution()
2
```

ways of selecting 3 from 9 items

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

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

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

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

= 84

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

Find the ratio of numbers 0.014, 0.031 and 0.58

```
1 ke.printAnswer()
2
```

14 : 31 : 580

```
1 ke.printSolution()
2
```

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

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

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

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

Sorted Numbers:

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

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

Median:

The number of fractions is 6, an even number.

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

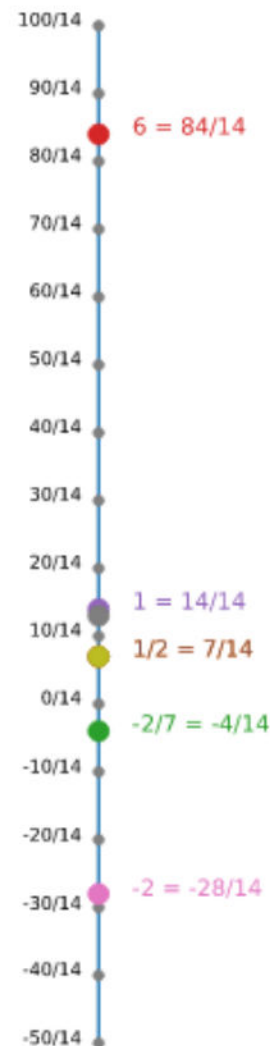
Hence, the median will be average of 3rd and 4th terms.

Median

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

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

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



20/21 = 13/14 (Avg)

1/2 = 7/14 (Med)

```
1 ke.getRandomProblem(problem_type = 7)
2
```

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?

```
1 ke.printSolution()
```

The equation of the question are as follows:

$$1 \text{ Mary} = 8 \text{ garden}$$

$$1 \text{ garden} = 20 \text{ tree}$$

$$1 \text{ tree} = 20 \text{ fruit}$$

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

$$1 \text{ box} = \$800/3 \quad [\text{sell price}]$$

$$1 \text{ garden} = \$200 \quad [\text{cost price}]$$

Let us do calculations:

Total sales revenue

$$= 8 \text{ garden}$$

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

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

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

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

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

$$= \$6400/3$$

Cost

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

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

$$= \$1600$$

$$\text{Net Profit} = \text{Total Cost} - \text{Total Revenue}$$

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

$$= \$1600/3$$

$$5. z = 3 - 3i$$

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

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

Now,

$$(3 - 3i)^4$$

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

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

$$4(2n\pi + \phi) \text{ can be solved for } n = 0, 1, 2, 3, \dots$$

The distinct values are:

$$\theta_0 = (2 * 0 * \pi + -45^\circ) * 4 = 180^\circ$$

Caputur.

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

Answer:

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

Solution:

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

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

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

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

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

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

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:

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

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 $n - 1$ choices.
3. For third place, we can choose any item from remainder $n - 2$ things, so we have $n - 2$ choices.

Thus, for k th 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.

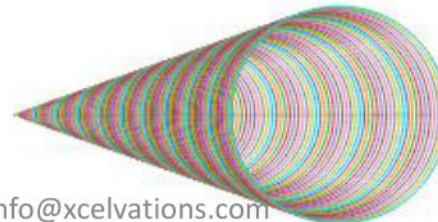
$$\Rightarrow P_k^n = n(n-1)(n-2) \dots (n-k+2)(n-k+1)$$

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

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

```
from math import pi, sin, cos, radians, atan2, hypot, degrees
def plot_circle(r, theta):
    x = r * cos(theta)
    y = r * sin(theta)
    plt.plot(x, y)
```

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



```
plt.plot(cos(theta), sin(theta), marker = 'o', color = 'blue', markersize = 10)
plt.gca().annotate('B', xy=(cos(theta), sin(theta)), xytext=(cos(theta) * 1.12, sin(theta) * 1.12), color = 'blue', fontweight = 'bold', size = 12)

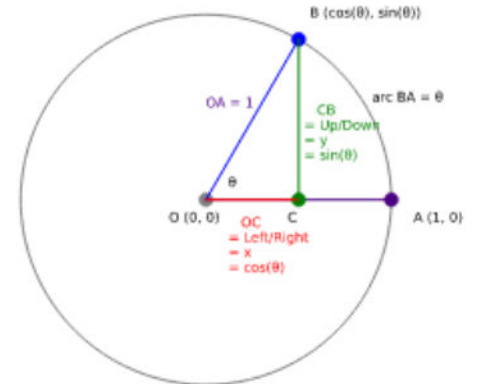
plt.plot((0, cos(theta)), (0, sin(theta)), color = 'blue')

plt.plot(cos(theta), 0, marker = 'o', color = 'green', markersize = 10)
plt.gca().annotate('C', xy=(cos(theta) * .88, -0.12), xytext=(cos(theta) * .88, -0.12), color = 'green', fontweight = 'bold', size = 12)

plt.plot((0, cos(theta)), (0, 0), color = 'red')
plt.gca().annotate('OC', xy=(0.12, -0.39), xytext=(0.12, -0.39), color = 'red', fontweight = 'bold', size = 12)

plt.plot(cos(theta), cos(theta), (0, sin(theta)), color = 'green')
plt.gca().annotate('CB', xy=(cos(theta)+0.83, sin(theta)/4), xytext=(cos(theta)+0.83, sin(theta)/4), color = 'green', fontweight = 'bold', size = 12)

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



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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:

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

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

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

Taking real terms of both sides:

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

Taking imaginary terms of both sides:

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

Prove

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

Answer:

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

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

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

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

Solution:

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

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

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

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

Find approximate value of the square root of 1030.

```
ke.printAnswer()
```

10.10

```
ke.printSolution()
```

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

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

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

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

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

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

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

$$1030 = 1000 + 30$$

$$\Rightarrow a = 1000$$

$$b = 30$$

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

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

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

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

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

$$= 10 + 0.1$$

$$= 10.1 \quad +91 \ 75699 \ 33343$$

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

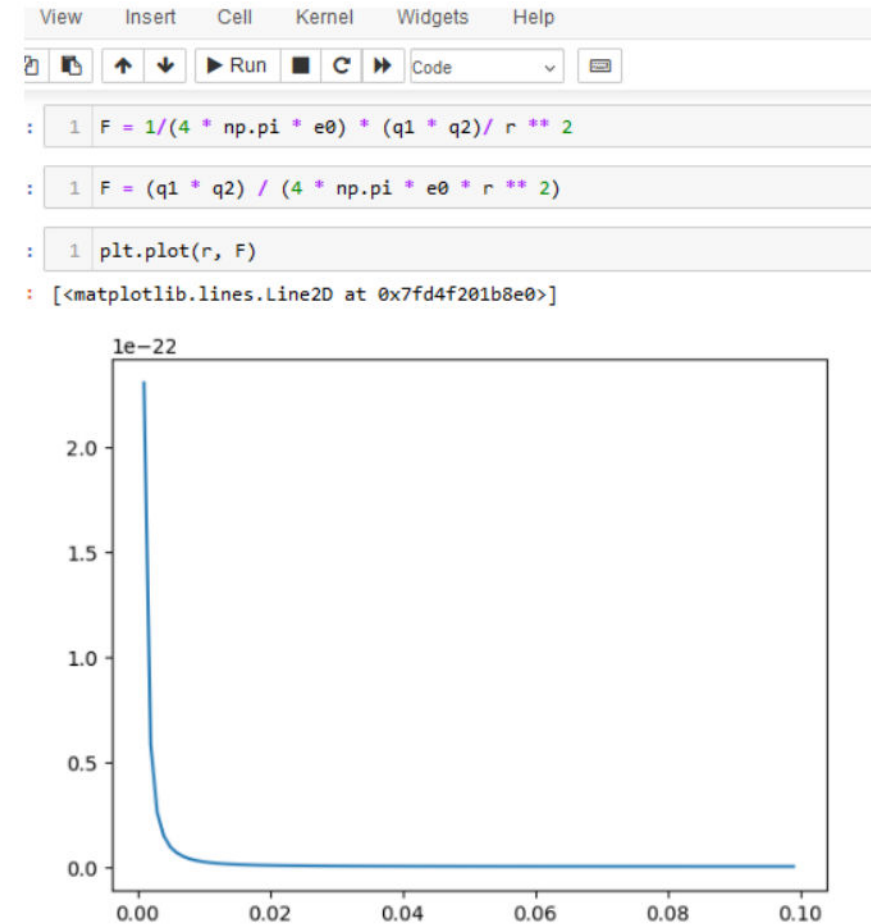
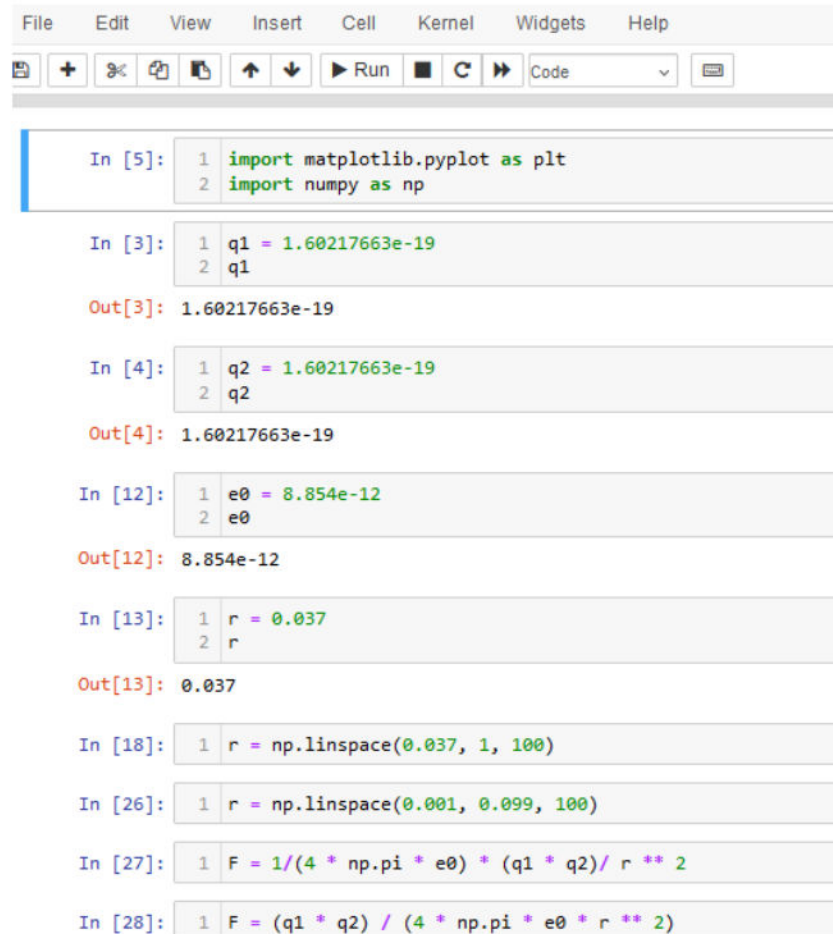
-2 times of the last digit of 7331

$$= -2 * 1 = -2$$

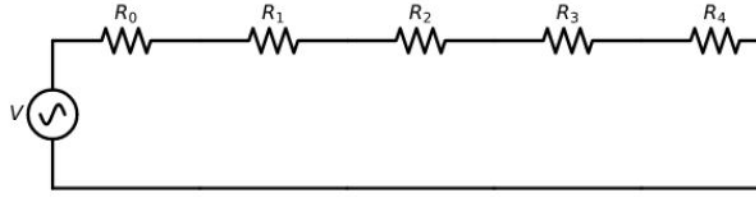
Remove the last digit from 7331

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Physics is easy for him



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.

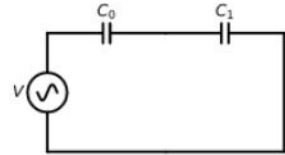
$$V = V_0 + V_1 + V_2 + V_3 + V_4$$

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

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

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

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 sum

$$V = V_0 + V_1$$

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

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

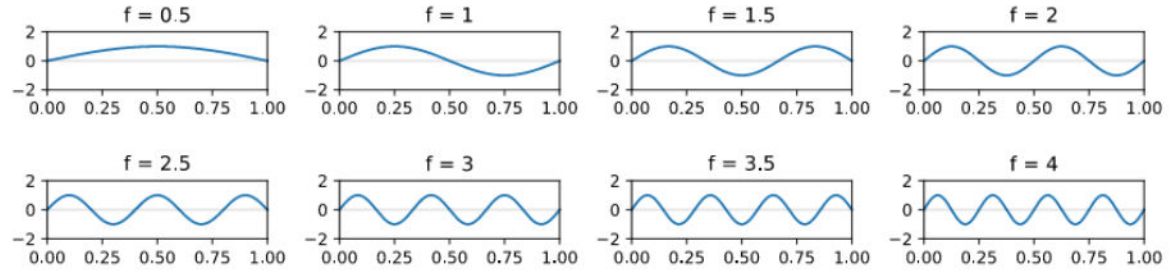
$$\Rightarrow \frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_0}$$

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

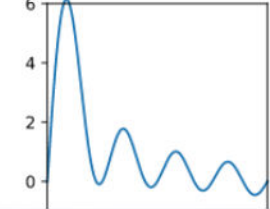
$$\Rightarrow q = CV = \left(\frac{1}{\frac{1}{C_1} + \frac{1}{C_0}} \right) V$$

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:



resultant wave of
all fundamental waves



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:

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

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

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

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

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

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

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

ors is given by

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

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

The potential energy due to two

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

The net potential energy of the s

1. the sum of potential energy, $\vec{U}$
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 spi

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

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

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



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 and l_4 are joined together is

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

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 the rocket is assumed to be in a straight line).

	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

$$q = mc\Delta T$$

$$q = (25 \text{ g}) \times (2.09 \text{ J/g} \cdot \text{°C}) \times [(150 \text{ °C} - 100 \text{ °C})]$$

$$q = (25 \text{ g}) \times (2.09 \text{ J/g} \cdot \text{°C}) \times (50 \text{ °C})$$

$$q = 2612.5 \text{ J}$$

The heat required to convert 100 °C steam to 150 °C steam = 2612.5 J

Step 6:

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

$$\text{HeatTotal} = \text{HeatStep 1} + \text{HeatStep 2} + \text{HeatStep 3} + \text{HeatStep 4} + \text{HeatStep 5}$$

$$\text{HeatTotal} = 522.5 \text{ J} + 8350 \text{ J} + 10450 \text{ J} + 56425 \text{ J} + 2612.5 \text{ J}$$

$$\text{HeatTotal} = 78360 \text{ J}$$

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()
```

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

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

```
ke.printSolution()
```

Let:

f = Focal length of mirror

u = Distance of object from mirror

v = Distance of image from mirror

The relation between variables:

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

$$\Rightarrow \oint_C \vec{E} \cdot d\vec{S} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r} \cdot 4\pi r^2$$

$$\Rightarrow \oint_C \vec{E} \cdot d\vec{S} = \frac{q}{\epsilon_0}$$

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advanced_form

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

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

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

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

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

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

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

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

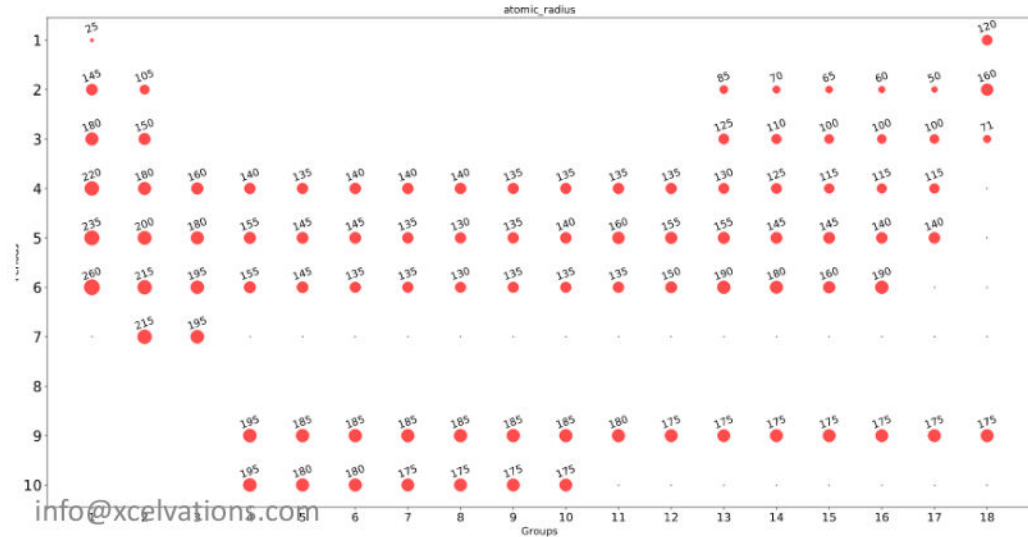
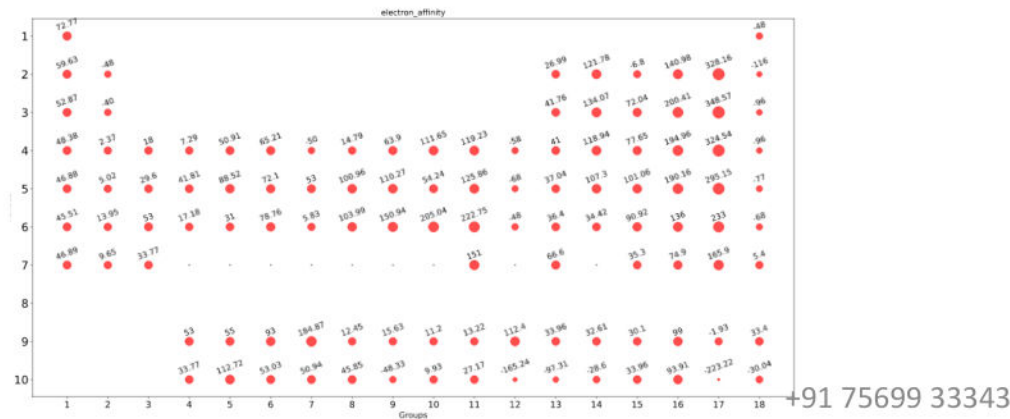
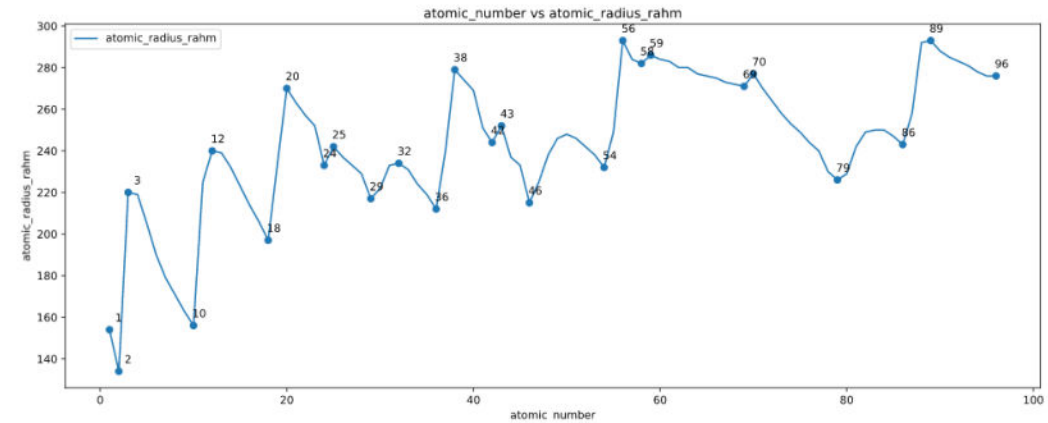
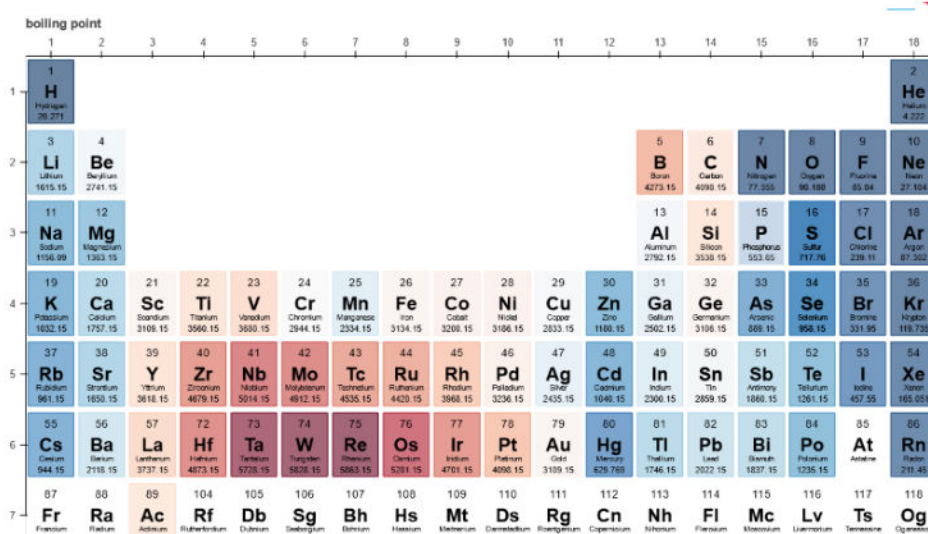
$$F = ma = m \frac{d}{dt}v = m \frac{d^2}{dt^2}s$$

$$W = Fs$$



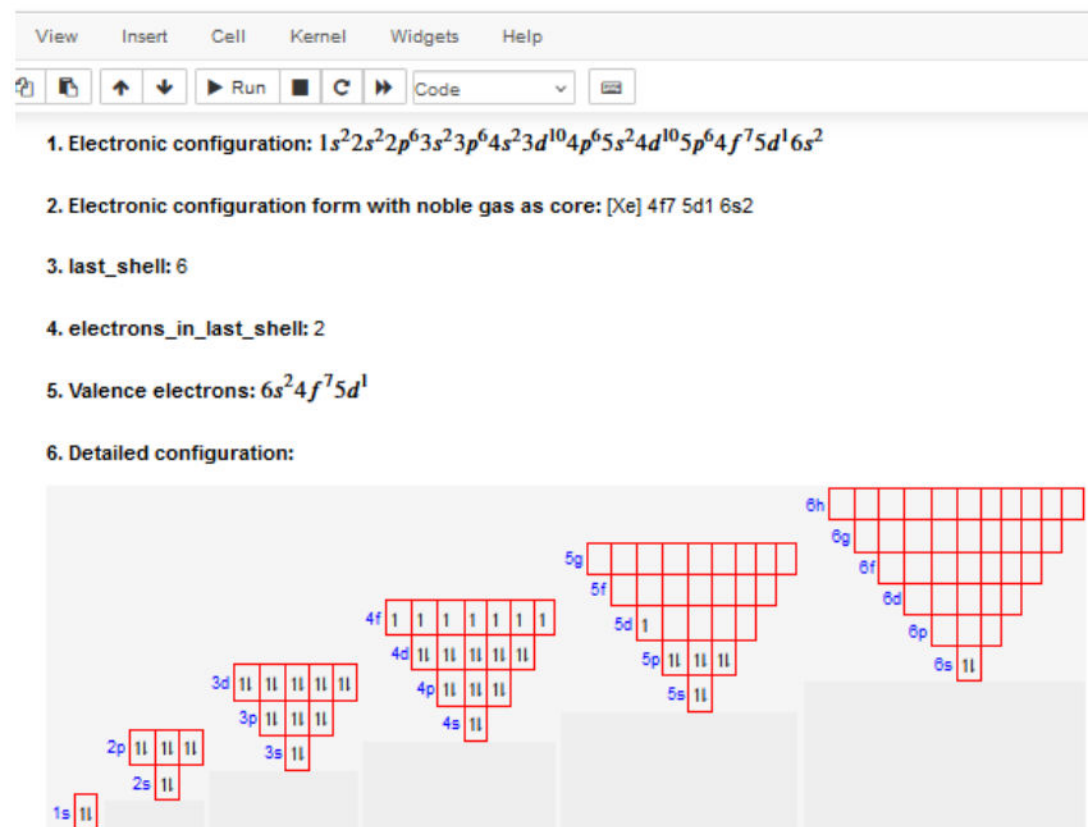
Chemistry has been in-depth and fun

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

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AtomManager.ipynb

ChemicalReactionManager.ipynb

PeriodicTrendsManager.ipynb

AcidBaseManager.ipynb

ComplexCompoundManager.ipynb

ChemCalcManager.ipynb

AcidBaseManager-Copy1.ipynb

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MolarManager.ipynb

MoleculesManager.ipynb

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ElementGroupManager.ipynb

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FunctionalGroupManager.ipynb

EnvironmentManager.ipynb

FunctionalGroupManager.ipynb

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ChemistryFormulaManager.ipynb

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PhysicalChemistryManager-Copy1.ipynb

PeriodicTableManager.ipynb

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NumericalChemistryManager.ipynb

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VisualizationManager.ipynb

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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_element
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 = True)

Problem Template: _problem_forming_a_compound
How can elements with atomic numbers 3 and 83 form compounds?

1 ke.printAnswer()
```

Li₃Bi

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 electron.

Bismuth (Bi, 83):
Electronic configuration : $1s^2 2s^2 2p^6 3s^2 3p^4 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 4f^{14} 5d^{10} 6s^2 6p^3$
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 pairs 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 pairs too.

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

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 pairs too.

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

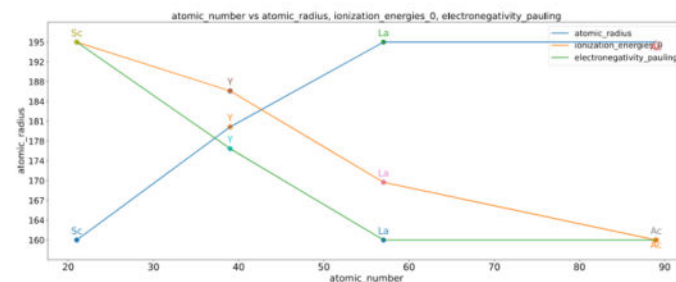
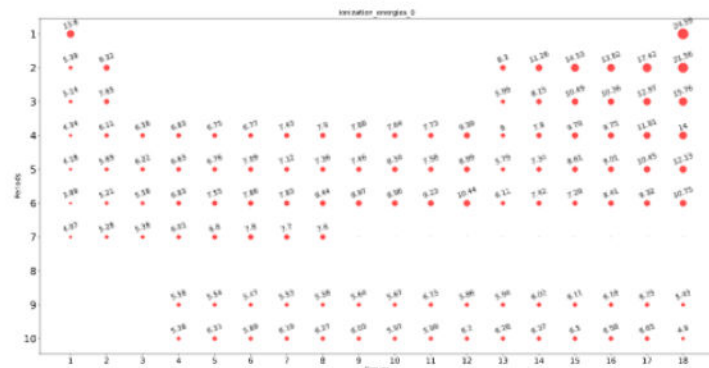
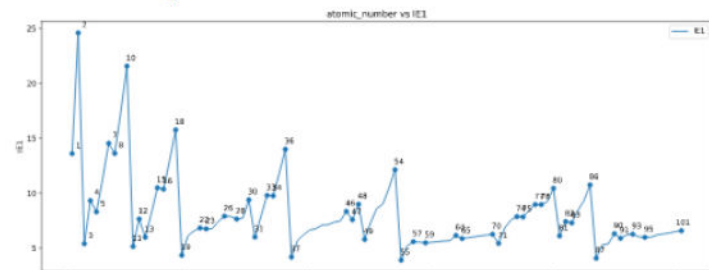
Chemical formula: **Li₃Bi**

$3 \text{ Li} + \text{Bi}$ By electron transfer $\rightarrow \text{Li}_3\text{Bi}$

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

See the links for more information.
1. [Li₃Bi](#)

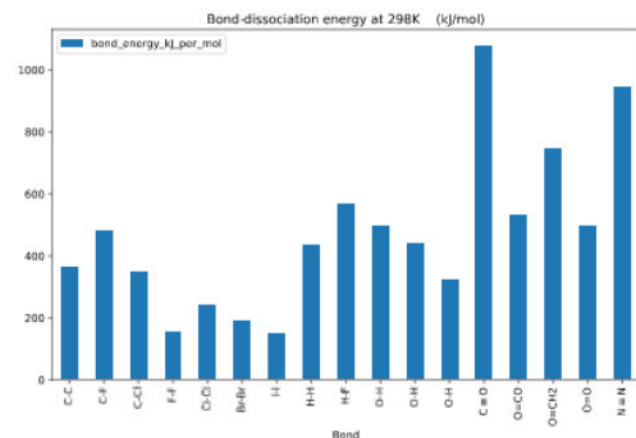
First Ionization Energies:



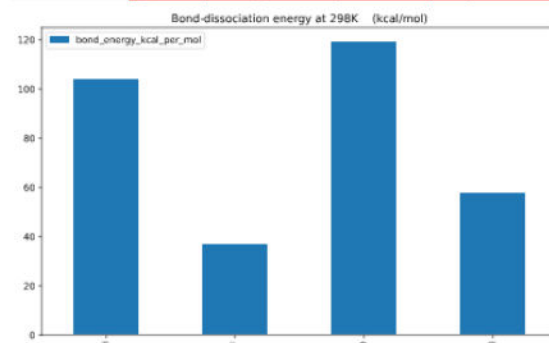
8	H-H	hydrogen	104.0	436	4.32	H	Strong, nonpolarizable bond
9	H-F	hydrogen fluoride	136.0	569	5.92	H-F	Very strong
10	C-H	in water	119.0	427	5.15	C-H	Very strong, hydroxyl radical reactive with almost all organic substances by H atom abstraction
11	C-H	in methane	105.0	440	4.48	C-H	Slightly stronger than C-H bonds
12	C-H	in alcohols (an environment)	111.0	423	5.28	C-H	C-H bond strength depends strongly on substituent on O
13	C=O	carbon monoxide	227.0	1077	11.16	C=O	Strongest bond in neutral molecule
14	C=O	carbon dioxide	127.0	532	5.51	C=O	Slightly stronger than C-H bonds, surprisingly low due to stability of CO
15	C=O	formaldehyde	119.0	745	7.75	C=O-H	Much stronger than C-H bonds
16	C=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	4.32	1.62	5.15	2.51
elements	H	F	O	Cl
Comment	Strong, nonpolarizable bond	Very weak, in conjunction with strong C-H 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 $[\text{CrCl}_2(\text{H}_2\text{O})_4]$

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 $\text{H}_2\text{O} = 0$. 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: $(\text{H}_2\text{O})_4$

metal:

chromium(II): Cr(II)

Oxidation number of $\text{NH}_3 = 0$.

Oxidation number of $\text{H}_2\text{O} = 0$.

Oxidation number of $\text{Cr(II)} = +2$.

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

chemical formula of complex ion:

$[\text{Cr}(\text{H}_2\text{O})_4(\text{NH}_3)]^{2+}$

$[\text{Cr}(\text{NH}_3)(\text{H}_2\text{O})_4]^{2+}$

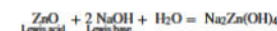
chemical formula of molecule:

$[\text{Cr}(\text{H}_2\text{O})_4(\text{NH}_3)]\text{SO}_4$

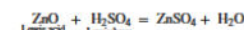
$[\text{Cr}(\text{NH}_3)(\text{H}_2\text{O})_4]\text{SO}_4$

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 .



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



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

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

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

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Answer:

Reactant

Ti = 47.867 gram

Reactant

N₂ = 14.007 gram

Product

TiN = 61.874 gram

Solution:

We have,



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

$$\text{Ti} = 47.867$$

$$\rightarrow 2 \cdot \text{Ti} = 2 \cdot (47.867) = 2 \cdot 47.867 = 95.734$$

$$\text{N}_2 = 2 \cdot 14.007 = 28.014$$

$$\text{Ti} = 47.867$$

$$\text{N} = 14.007$$

$$\rightarrow 2 \cdot \text{TiN} = 2 \cdot (47.867 + 14.007) = 2 \cdot 61.874 = 123.748$$

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



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 · 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

Answer:

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

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

Solution:

Let concentration of reactant is C.

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

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

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

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

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

If the concentration changes from C₀ to C in time 0 to t.

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

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

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

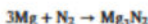
$$\rightarrow C = \frac{4C_0}{\left(C_0^{\frac{1}{2}}kt + 2\right)^2} \quad \dots (iii)$$

If the concentration changes from C₀ to its half, $\frac{C_0}{2}$, in time 0 to T_{1/2}, called

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

Problem Template: _problem_prop_of_rate_of_reaction

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



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

Answer:

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

$$\text{Dimension (k)} = \text{Dimension} \left(\frac{(\text{length})^{\frac{3}{2}}}{\text{amount of substance}^{\frac{7}{2}} \cdot \text{time}} \right)$$

Solution:

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

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

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

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

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

Therefore from (i),

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

$$\begin{aligned} \text{Unit (Rate of reaction)} &= k \left(\frac{\text{mol}}{\text{liter}} \right)^{\frac{3}{2}} \left(\frac{\text{mol}}{\text{liter}} \right)^2 \\ &= \frac{k \cdot \text{mol}^{\frac{7}{2}}}{\text{liter}^{\frac{7}{2}}} \end{aligned}$$

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

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

Converting it into dimension:

$$\text{Dimension (k)} = \text{Dimension} \left(\frac{(\text{length})^{\frac{3}{2}}}{\text{amount of substance}^{\frac{7}{2}} \cdot \text{time}} \right) \quad \dots (iii)$$

$$PV = nRT$$

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

$$\rightarrow P = CRT \quad \dots (i)$$

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



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

Therefore,

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

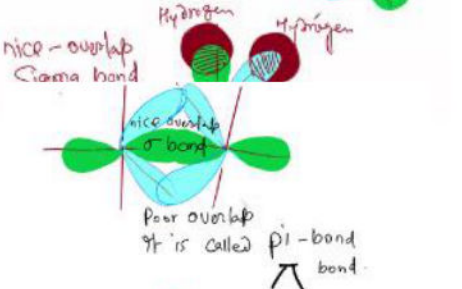
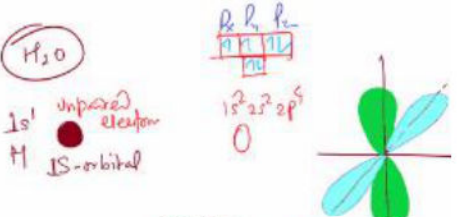
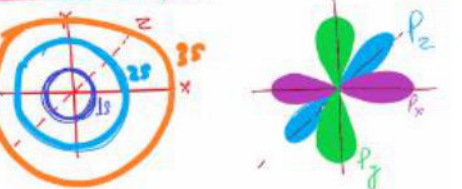
$$= \frac{\frac{x}{V}}{\frac{1-x}{V} \cdot \frac{1-x}{V}}$$

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

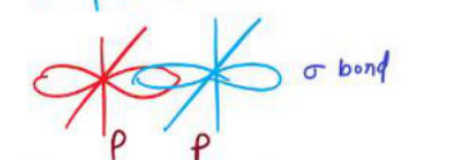
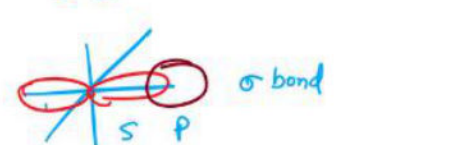
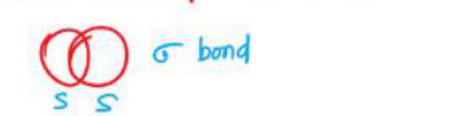
$$= \frac{P_x}{P(1-x) \cdot P(1-x)}$$

$$= \frac{RT [\text{F}^-]}{RT (1-x) \cdot RT (1-x)}$$

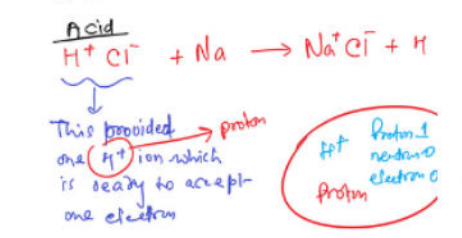
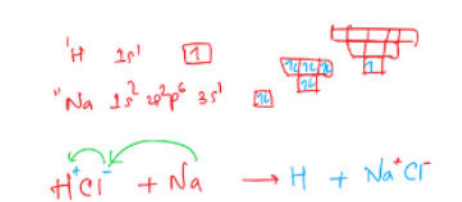
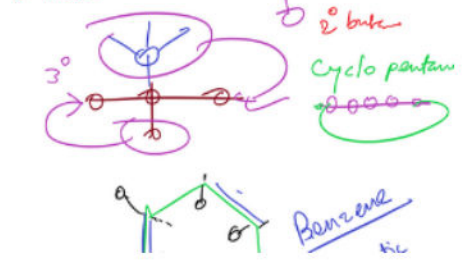
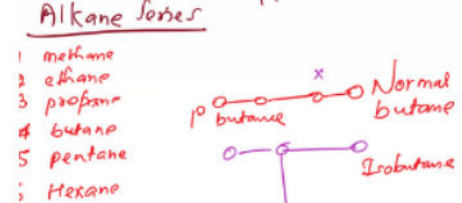
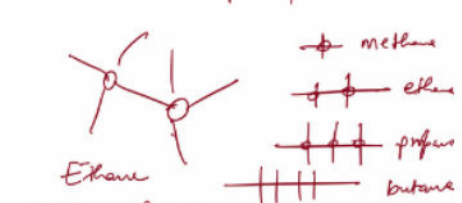
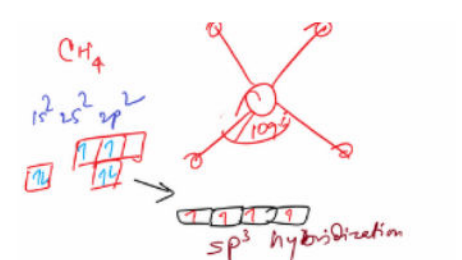
Orbital shapes



nice overlap sigma bond
poor overlap pi bond



Two p-p bonds
first sigma, second pi bond.



$G = 6.674 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$

$[Nm^2/kg^2] = [\frac{MLT^{-2}L^2}{M^2}] = [M^{-1}L^3T^{-2}]$

Force Long units

Electrostatic force:

$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$

find dimension of ϵ_0 .

$\epsilon_0 = \frac{1}{4\pi F} \frac{q_1 q_2}{r^2}$

$[C] = [C]$
Coulomb

$[Epsilon]$

$\epsilon_0 = 8.854 \times 10^{-12} \frac{C^2}{Nm^2}$

$[C^2/Nm^2] = [\frac{C^2}{MLT^{-2}L}] = [C^2M^{-1}L^{-1}T^2]$

$[C] = [C]$
Coulomb

$C = \frac{Q}{V}$

Find dimension of C.

$[C] = [\frac{Q}{V}] = [\frac{Q}{Work/Q}]$

$= [\frac{Q^2}{Work}]$

$= [\frac{Q^2}{Force \times Displacement}]$

$= [\frac{C^2}{MLT^{-2}L}]$

$= [C^2M^{-1}L^{-1}T^2]$

$C = \frac{Q}{V}$

Work = V.Q
V = Potential

Find dimension of C.

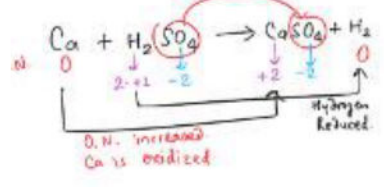
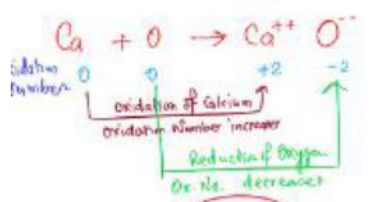
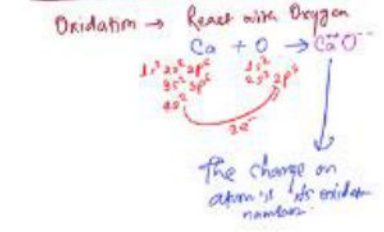
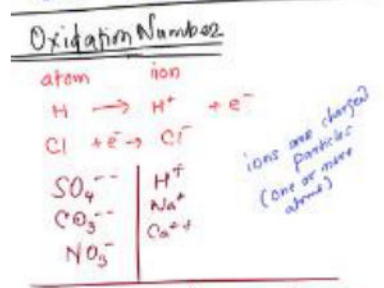
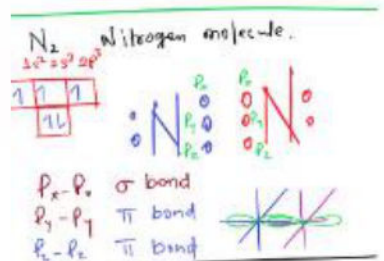
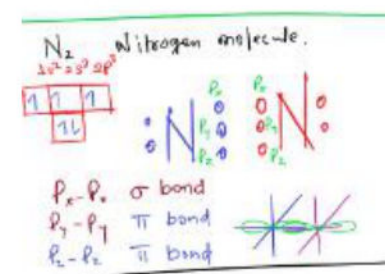
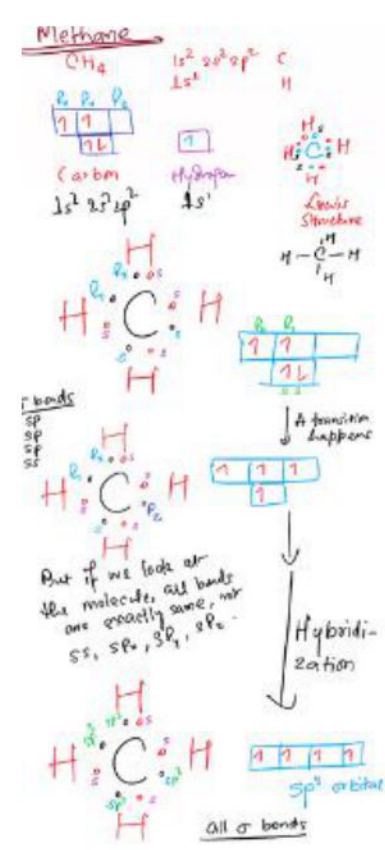
$[C] = [\frac{Q}{V}] = [\frac{Q}{Work/Q}]$

$= [\frac{Q^2}{Work}]$

$= [\frac{Q^2}{Force \times Displacement}]$

$= [\frac{C^2}{MLT^{-2}L}]$

$= [C^2M^{-1}L^{-1}T^2]$





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.

```
View  Insert  Cell  Kernel  Widgets  Help
[Icons] [Run] [Code]

1 from xv.english import WordManager

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

```
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
21. _problem_find_misspelled_out
22. _problem_fill_gender_words
23. _problem_gender_match_columns
24. _problem_option_genders
25. _problem_find_odd_gender
26. _problem_word_with_opposite_gender
27. _problem_thesaurus_match_synonyms
28. _problem_thesaurus_match_antonyms
29. _problem_find_odd_synonyms_antonyms
30. _problem_idioms_match_columns
31. _problem_find_synonym_thesaurus
32. _problem_find_antonym_thesaurus
33. _problem_find_by_synonyms_antonyms
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 l'appe; 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**

... At first, they were a mere storm of coarse red caps and coarse **woollen** 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 l'appe; 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 Hugo**

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 skonks horne & sum the old souls & yong fousl 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 bodye 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 skonks horne & sum the old souls & yong fousl 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-dogged 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**

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9517509933343

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. inconsiderate
2. muse
3. metaphysics
4. ruminate
5. educate
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 **in** 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 whitepoll 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 **educated** to maturity, the parties, if not disunited were obliged to 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. inconsiderate
2. muse
3. metaphysics
4. ruminate
5. educate
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.



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."

/ter UsageManager Last Checkpoint: yesterday

yter VocabularyManager Last Checkpoint: 8 days

/ter EnglishComprehensionManager Last Checkpoint: 3 months ago

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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_continuous_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_singular_or_plural
32. _problem_number_representations_in_sentences
```

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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

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Code

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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
```

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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 Bungenlosenstrasse?
- 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 'Bungenlosenstrasse'?
- 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 known. 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 Hamelin 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 rats prior to the disappearance of the children. 3. Some experts link the loss of the Hamelin children to another

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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.



- Energy of electron

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$$\frac{u(DAQb)}{f_{max}} = \frac{Q}{2\pi}$$

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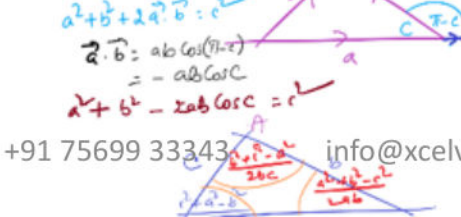
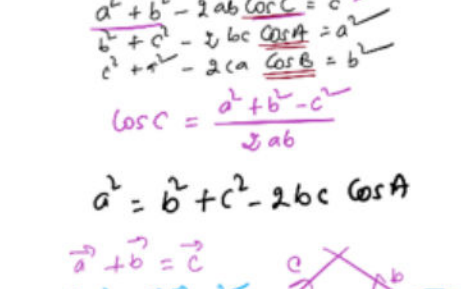
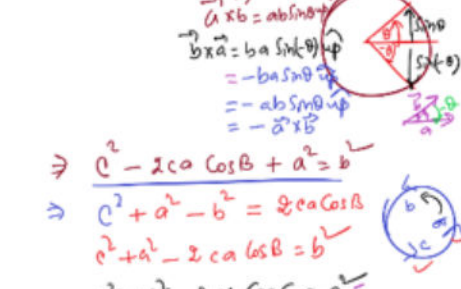
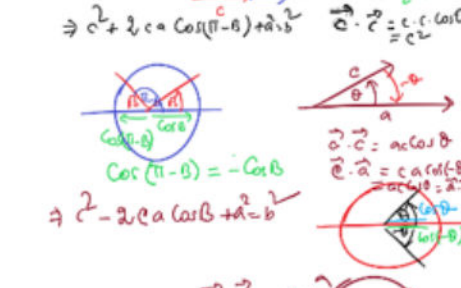
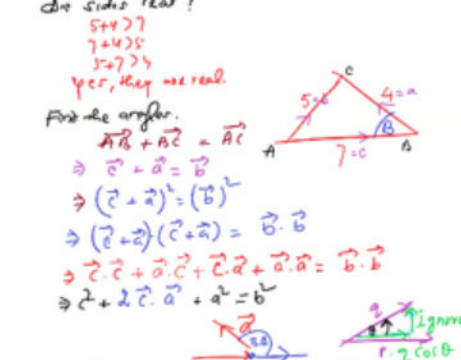
$P A + Q B \rightarrow R C + S D$
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$\frac{dC}{dt} = K C^6$
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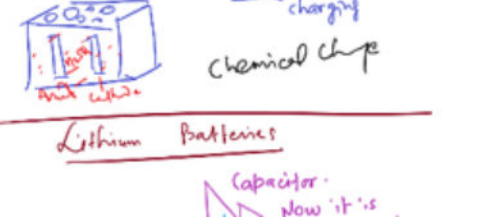
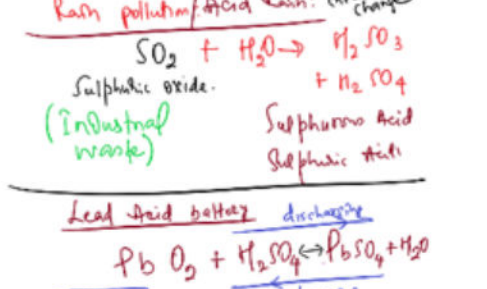
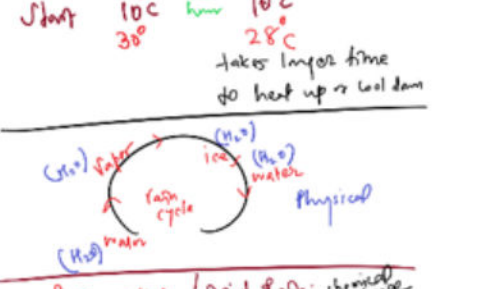
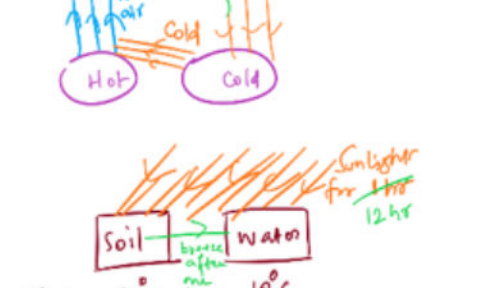
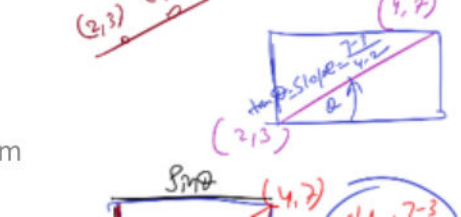
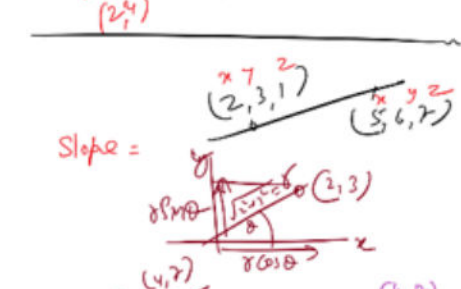
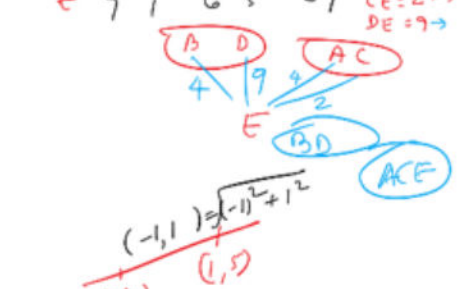
$\frac{dx^n}{dx} = nx^{n-1}$
 $\frac{dx^{n+1}}{dx} = (n+1)x^n$
 $\frac{dx^{n+1}}{dx} = (n+1)x^n$

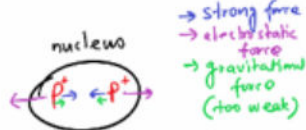
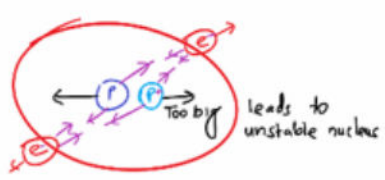
$\int A dx = Q$
 $\int (n+1)x^n dx = \frac{x^{n+1}}{n+1}$



Manager gets \$102000 p.a.
 plus bonus of 1% of profit
 after his bonus. the bonus is
 \$15000. what is profit?
 1% profit after bonus = 15000
 1% (Profit - 15000) = 15000
 Profit = $\frac{15000}{1\%} + 15000$
 Profit = 15000 (100 + 1)
 Profit = 15000 * 101
 Profit = 1515000

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

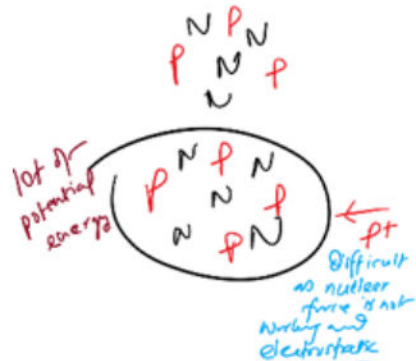
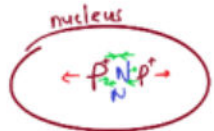




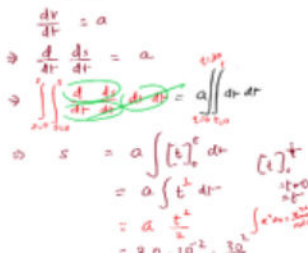
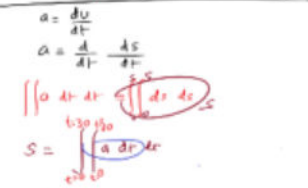
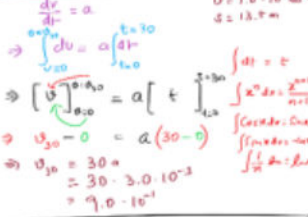
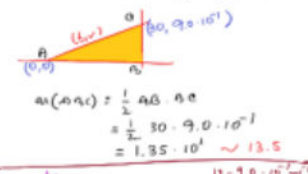
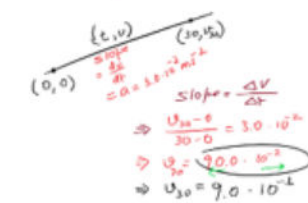
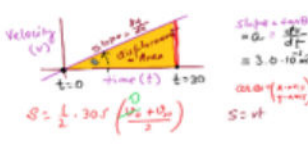
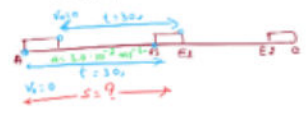
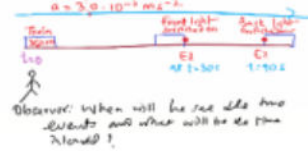
Strong force is very very strong but only for short distances.

Strong force is negligible

Very powerful attraction $\rightarrow$ strong



26 is last possible nucleus



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



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

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

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

$$= 2 \text{ m} \hat{i} \times 50 \text{ kg} \cdot 9.8 \text{ ms}^{-2} (-\hat{j})$$

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

$$= 98 \text{ kg m}^2 \text{ s}^{-2} (-100\hat{k} + 120\hat{k})$$

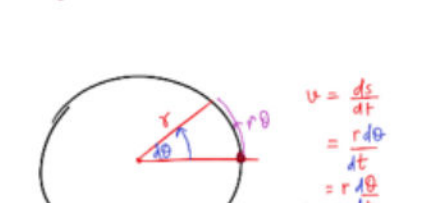
$$= 196 \text{ kg m}^2 \text{ s}^{-2} \hat{k}$$

$$= 196 \text{ Nm} \hat{k}$$

Torque = Nm
Work = Joule

Work done by a Torque

displacement	$\vec{s}$	Rotational Motion	$\vec{\theta}$
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	$\vec{F} = m \cdot \vec{a}$		$\vec{\tau} = I \cdot \vec{\alpha}$
Work	$W = \vec{F} \cdot \vec{s}$		$W = \vec{\tau} \cdot \vec{\theta}$



Work = $\vec{F} \cdot \vec{s}$
 $F \cos \theta$
 θ is angle

$\vec{F} \propto \frac{d\vec{p}}{dt}$ (II law of motion)
 $\vec{p} = m\vec{v}$
 $\Rightarrow \vec{F} = \frac{d\vec{p}}{dt}$ no constant
 $\Rightarrow \vec{F} = m \frac{d\vec{v}}{dt}$ if m is constant
 $\Rightarrow \vec{F} = m\vec{a}$

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

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

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

$$\frac{dx^2}{dx} = 2x^{2-1} = 2x$$

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

$$\frac{d}{dx} \left(\frac{1}{x^3} \right) = -3x^{-3-1} = -3x^{-4} = -\frac{3}{x^4}$$

$$\frac{d}{dt} \left(\frac{1}{t^2} \right) = -2t^{-2-1} = -2t^{-3} = -\frac{2}{t^3}$$

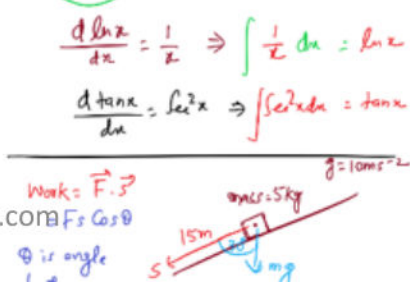
$$\frac{dx^n}{dx} = nx^{n-1} \Rightarrow \int nx^{n-1} dx = x^n$$

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

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

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

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

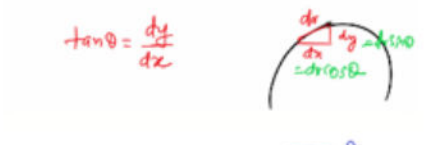


Calculus
 $\frac{dy}{dx}$
 $dx^2 = dx^2 + dy^2$

$$r^2 = x^2 + y^2$$

$$r = \sqrt{x^2 + y^2}$$

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



AB $\neq$ AC but
 $\theta \rightarrow 0$,
 $B \rightarrow C$
 $\Rightarrow \theta \rightarrow 0$,
 $AB \rightarrow AC$
 $\Rightarrow \theta \rightarrow 0$,
 $AB = AC$
 $\Rightarrow \theta \rightarrow 0$,
 $\sin \theta = \theta$ as $x \rightarrow 1$

$$\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} = 1$$

$$\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} \cdot \frac{\cos \theta}{\cos \theta} = 1$$

$$\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} \cdot \frac{1}{\cos \theta} = 1$$

$$\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} \cdot \frac{1}{1} = 1$$

$$\lim_{\theta \rightarrow 0} \frac{\sin \theta}{\theta} = 1$$

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

$$\Rightarrow \sin \theta = \tan \theta = \theta$$



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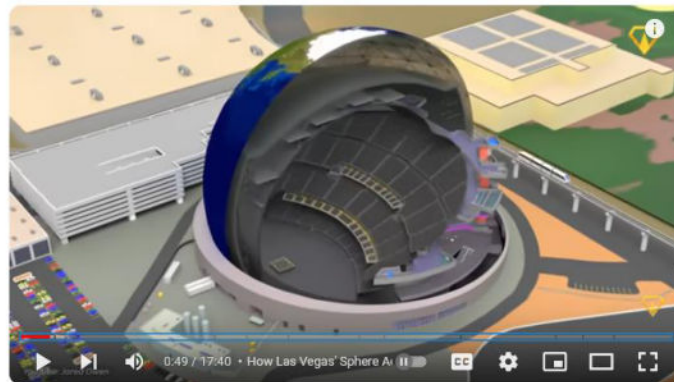
We watch lot of documentaries and videos



The man who tried to fake an element

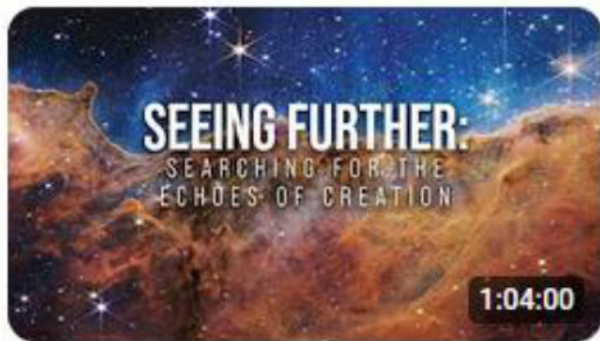


The Man Who Accidentally Killed The Most People In History

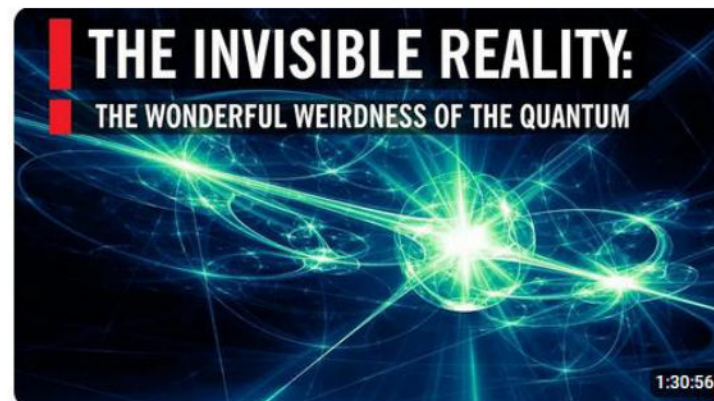
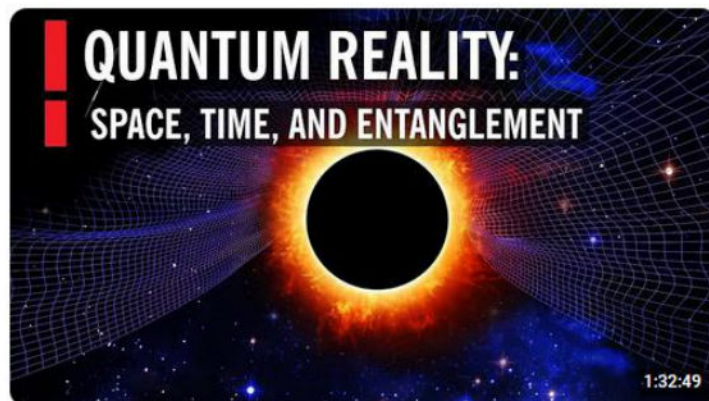
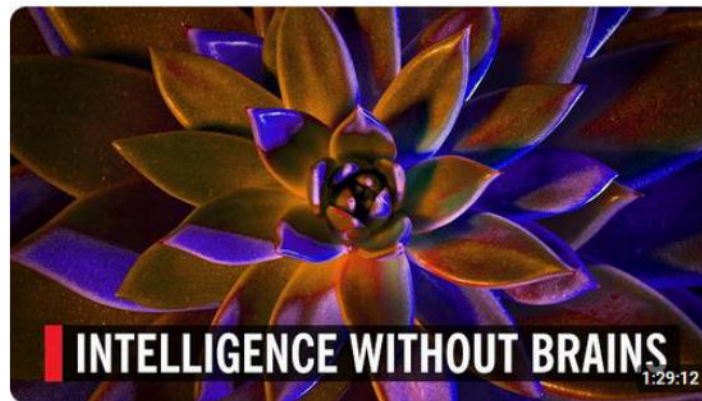


How Las Vegas' Sphere Actually Works



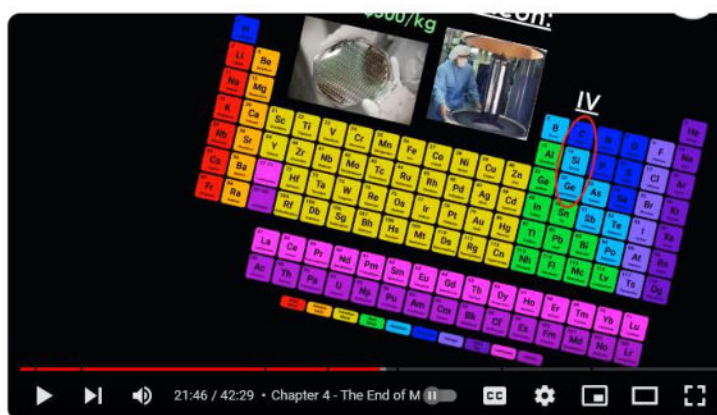


Seeing Further: Searching for the Echoes of Creation





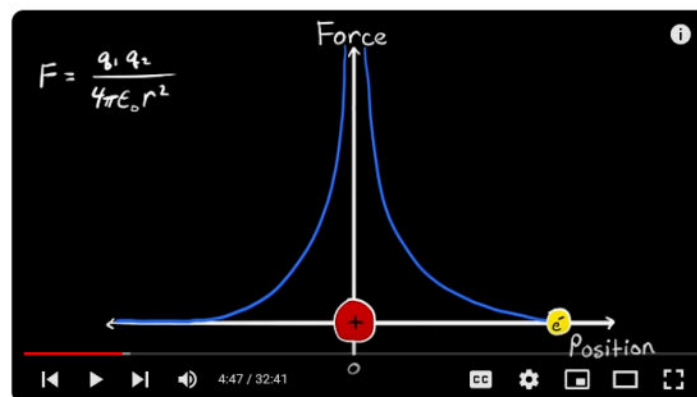
The Bogdanoffs: The Trolls who shook Physics



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.

Game: Read a Joke (Sentences)

CLEAR GRID

Little Ronnie's kindergarten class was on a field trip to their local police station where they saw pictures tacked to a bulletin board of the 10 most wanted criminals. One of the youngsters pointed to a picture and asked if it really was the photo of a wanted person.

'Yes, ' said the policeman. 'The detectives want very badly to capture him.'

Little Ronnie asked, 'Why didn't you keep him when you took his picture?'

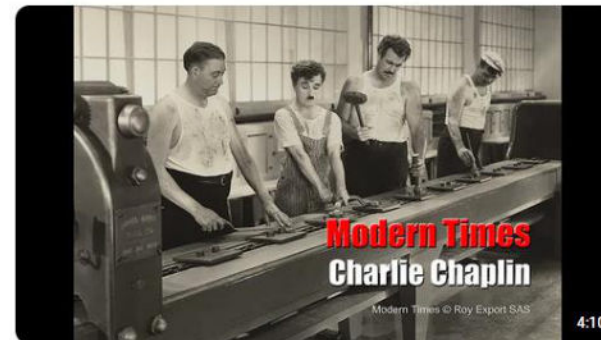
Game: Read a Joke (Sentences)

CLEAR GRID

After Sunday church, the priest would hand us each an orange and a big cookie. A little girl once lied and took two oranges, but the priest told her she mustn't lie because God is watching. Then, the girl took two cookies and lied about it. When asked why she had done that, she said because she thought that God was only watching oranges.

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.

```
In [3]: 1 from xv.math.algebra import MatrixManager
```

```
In [4]: 1 ke = MatrixManager()
        2 ke.printProblemTypes()
```

```
0. _problem_foundation_to_concept_of_matrix
1. _problem_foundation_to_concept_of_matrix_adv
2. _problem_interpret_a_matrix
3. _problem_matrix_to_equations
4. _problem_equations_to_matrix
5. _problem_matrix_inverse
6. _problem_solve_equations_by_inverse_matrix
7. _problem_solve_equations_by_row_operation
8. _problem_solve_by_plot_equations
9. _problem_matrix_notation
10. _problem_matrix_operations
11. _problem_vector_space_notation
12. _problem_vector_operations
13. _problem_discrete_fast_fourier_transform
```

```
n [11]: 1 ke.getRandomProblem(problem_type = 3)
```

```
ut[11]: Convert the followings into equations: 
$$\begin{bmatrix} 3 & 1 & 1 \\ 1 & 1 & 3 \\ 1 & 3 & 4 \\ 1 & 3 & 4 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 32 \\ 30 \\ 46 \\ 46 \end{bmatrix}$$

```

```
n [12]: 1 ke.printAnswer()
```

```
ut[12]: 3x + y + z = 32
        x + y + 3z = 30
        x + 3y + 4z = 46
        x + 3y + 4z = 46
```

```
n [13]: 1 ke.printSolution()
```

```
ut[13]: 3x + y + z = 32
        x + y + 3z = 30
        x + 3y + 4z = 46
        x + 3y + 4z = 46
```

```
In [23]: 1 ke.getRandomProblem(problem_type = 12)
```

```
Out[23]: Write vector operations.
```

```
In [24]: 1 ke.printAnswer()
```

```
Out[24]: Assume that
a ∈ ℝ
X ∈ ℝn
Y ∈ ℝn
```

scalar-vector multiplication

$$Z = aX \implies Z_i = aX_i$$

vector addition

$$Z = X + Y \implies Z_i = X_i + Y_i$$

inner product (or dot product)

$$C = X^T Y \implies C = \sum_{i=1}^n X_i Y_i$$

saxpy

$$Y = aX + Y \implies Y_i = aX_i + Y_i$$

pointwise vector operation

$$Z = X \cdot Y \implies Z_i = X_i Y_i$$

pointwise vector division

$$Z = X \cdot / Y \implies Z_i = X_i / Y_i$$

```
In [25]: 1 ke.printSolution()
```

```
Out[25]: Assume that
a ∈ ℝ
X ∈ ℝn
Y ∈ ℝn
```

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 +91 75699 33343, or email us at info@xcelvations.com.

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

