Asam Arsenat (H_3AsO_4) : Analisis Molekular dan Karakteristik Senyawa

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Abstract. Asam arsenat merupakan senyawa kimia dengan rumus molekul H_3AsO_4 . Asam arsenat juga bisa dikenal dengan rumus molekul $\text{AsO}(\text{OH})_3$. Asam yang tidak berwarna ini merupakan analog asam fosfat, garam arsenat dan fosfat sendiri memiliki reaksi yang serupa. Asam arsenat masih belum diisolasi dan hanya dapat ditemukan di dalam larutan dan disalah asam ini sangat terionisasi. Bentuk hemihidratnya ($\text{H}_3\text{AsO}_4 \cdot 1/2 \text{H}_2\text{O}$) dapat membentuk kristal yang stabil. Penelitian ini bertujuan untuk menganalisis struktur, interaksi molekular dan MM2 terhadap molekul asam arsenat. Metoda yang digunakan yaitu penelusuran literatur dengan Endnote X7, metode pemodelan dengan menggunakan software *ChemOffice* 15.0, dan juga perhitungan matematis. Pada dasarnya untuk menemukan literasi jurnal yang bagus digunakanlah aplikasi Endnote X7 yang dijelaskan melalui fishbone state of art. Analisis 2D struktur asam format menggunakan aplikasi chemdraw ultra dan analisis 3D struktur asam format menggunakan aplikasi chembio 3D. Asam arsenat juga memiliki total energi yang dapat diketahui menggunakan Chemoffice 15.0 yaitu sebesar 85.2948 kcal/mol, stretch 0.0516, bend 66.4930, stretch-bend -0.1025, torsion 23.4363, dan dipol-dipol -2.0437. Untuk mengetahui nilai viskositas, gerakan ion, kecepatan hanyut digunakan pengolahan data dan review jurnal mengenai asam arsenat. Asam arsenat memiliki nilai $\Delta_f G$ -766.75, $\Delta_f H$ -903.45, dan S° 183.07 serta nilai kecepatan hanyut sebesar 3,628 V/cm setelah dihitung menggunakan rumus.
Keywords : *asam arsenat (H_3AsO_4), asam fosfat, terionisasi, kristal*

1. Pendahuluan

Arsen, arsenik⁽²⁶⁾, atau arsenikum merupakan unsur kimia yang memiliki simbol As dan nomor atom 33. Arsen adalah bahan metaloid⁽³¹⁻³⁵⁾ yang terkenal beracun dan memiliki tiga bentuk yaitu kuning, hitam, dan abu-abu. Arsenik digunakan sebagai pestisida, herbisida, insektisida, dan dalam berbagai alloy. Arsenik secara kimiawi memiliki karakteristik⁽⁹⁷⁻⁹⁹⁾ yang serupa dengan Fosfor⁽³⁶⁻⁴⁵⁾, dan dapat digunakan sebagai pengganti dalam berbagai reaksi biokimia⁽⁴⁶⁻⁵⁰⁾

Ketika dipanaskan, arsenik akan cepat teroksidasi⁽⁵¹⁻⁶⁰⁾ menjadi oksida⁽⁹¹⁻⁹³⁾ arsenik, yang berbau seperti bau bawang putih. Arsenik dan beberapa senyawa arsenik juga dapat langsung tersublimasi⁽⁶¹⁻⁶⁸⁾, berubah dari padat menjadi gas tanpa menjadi cairan terlebih dahulu. Zat dasar arsenik ditemukan dalam dua bentuk padat yang berwarna kuning dan metalik, dengan berat jenis 1,97 dan 5,73.

Arsen dalam air⁽¹⁰⁶⁻¹⁰⁸⁾ tanah ditemukan dalam dua sumber yaitu sumber geogenik dan polusi anthropogenik. Bentuk anthropogenik arsen yaitu turunan organik arsin. Struktur⁽¹⁴²⁻¹⁴⁴⁾ antropogenik arsen terdapat sebagai arsenit dalam kondisi aerobik dan arsenat pada lingkungan pH rendah. Air⁽⁶¹⁻⁶²⁾ tanah⁽⁶⁶⁻⁶⁸⁾ dalam suasana asam ke intermediate batuan vulkanik atau dalam sedimen yang berasal dari batuan tersebut akan sering mempunyai konsentrasi⁽⁶⁹⁻⁷⁸⁾ arsen lebih dari 50 $\mu\text{g/L}$ (standar kandungan

arsen untuk air⁽⁴⁰⁾ minum saat ini).

Beberapa tempat di bumi mengandung arsen yang cukup tinggi sehingga dapat merembes ke air tanah. WHO menetapkan ambang aman tertinggi arsen di air tanah⁽⁷⁹⁻⁸⁴⁾ sebesar 50 ppb (bagian per miliar). Kebanyakan wilayah dengan kandungan arsen^(26; 85-88) tertinggi adalah daerah aluvial yang merupakan endapan lumpur sungai dan tanah dengan kaya bahan organik. Diperkirakan sekitar 57 juta orang meminum air tanah yang terkontaminasi arsen berlebih, sehingga berpotensi meracun.

Asam arsenat juga memiliki total energi yang dapat diketahui menggunakan Chemoffice 15.0 yaitu sebesar 85.2948 kcal/mo. Untuk mengetahui nilai viskositas, gerakan ion, kecepatan hanyut digunakan pengolahan data dan review jurnal mengenai asam arsenat. Asam arsenat memiliki nilai $\Delta_f G$ -766.75, $\Delta_f H$ -903.45, dan S° 183.07 serta nilai kecepatan hanyut sebesar 3,628 V/cm setelah dihitung menggunakan rumus.

Asam arsenat merupakan senyawa⁽¹²⁸⁻¹³²⁾ kimia dengan rumus molekul H_3AsO_4 yang berbentuk kristal putih. Asam arsenat ini juga bersifat higroskopis⁽⁸⁹⁾ dan larut dalam air. Senyawa ini dapat larut dalam alkohol dengan bentuknya adalah tetrahedral⁽⁹⁰⁾.

Asam arsenat ini memiliki sifat fisika dan juga sifat kimia⁽¹⁶³⁻¹⁶⁷⁾. Dan juga berbagai macam kegunaan dalam kehidupan sehari-hari. Contohnya dalam makanan kita mengandung arsenik dalam jumlah kecil. Bentuk arsenik yang terkenal adalah As_2O_3 , alias arsen trioksida⁽⁹¹⁾ atau warangan. Warangan ini bentuknya berupa bubuk berwarna putih yang larut⁽¹⁵⁴⁻¹⁵⁶⁾ dalam air.

Asam arsenat secara perlahan terbentuk ketika arsen pentoksida dilarutkan di dalam air. Asam arsenat juga dapat disiapkan secara langsung dari unsur arsen dengan melembabkannya dan mereaksikannya dengan ozon^(92; 93):

Penelitian ini bertujuan untuk mengetahui karakteristik, struktur, jenis ikatan, dan bentuk molekul dari kalsium klorida serta mengetahui sifat fisika dan sifat kimia dengan menggunakan metode⁽¹¹⁵⁻¹¹⁷⁾ literasi EndNote yang hasilnya berupa fishbone state of art. Kemudian metode aplikasi⁽³⁵⁾ ChemOffice 15.0 untuk memperoleh energi, optimasi, gambaran bentuk molekul⁽⁵⁷⁾, dan jari-jari antar atom, serta menggunakan metode⁽²¹⁻²²⁾ perhitungan matematis yang menghasilkan nilai-nilai yang dituangkan dalam bentuk grafik.

2. Metodologi

Analisis ini menggunakan perangkat laptop. Kemudian laptop dilengkapi dengan aplikasi Endnote X7 dan software Chemoffice 15.0 seperti ChemDraw 2015 yang digunakan untuk mengetahui struktur senyawa dan Chem3D 2015 untuk menggambarkan senyawa dalam bentuk 3 dimensi.

Aplikasi Endnote X7 ini digunakan untuk literasi jurnal dari materi yang akan dibahas. Langkah menggunakan aplikasi Endnote : Pertama mengklik Endnote yang terdapat di menu microsoft word, kemudian mengklik "Go to Endnote" maka aplikasinya akan muncul. Setelah itu menuliskan body text dan juga tahunnya pada menu Endnote tersebut. Jangan lupa menukar meklik "PubMed (NLM)" agar terhubung dengan internet, karena aplikasi ini menggunakan koneksi internet. Langkah selanjutnya mengklik enter, maka akan keluar jumlah referensi yang akan dipilih. Jika kita membutuhkan 5, maka referensinya akan keluar 5 buah. Kemudian mengcopy referensi dan menyalinnya tepat pada body text yang telah dipilih. Maka referensinya akan terdaftar pada halaman terakhir.

Penelitian ini menggunakan pemodelan dengan menggunakan aplikasi (Software) *ChemOffice* 15.0. Penelitian dilakukan beberapa tahapan, yakni (1) Analisis molekul H_3AsO_4 secara dua dimensi menggunakan ChemUltra ; (2) Analisis molekul H_3AsO_4 secara tiga dimensi menggunakan Chem3D 15.0. Pemodelan dilakukan dengan mengasumsikan pada satu molekul H_3AsO_4 dengan beberapa kemungkinan pergerakan dan vibrasional yang terjadi.

Molekul H_3AsO_4 dilukis dengan menggunakan ChemUltra dengan cara pilih Structure dan Convert Name to Structure. Pada layar kerja, tulis arsenic acid, lalu pilih OK. Setelah Rumus Molekul asam arsenat terbentuk, lakukan analisis senyawa. Proses analisis dilakukan pada bagian View, dengan optional show analysis window dan show chemical properties windows.

Pada analisis 3D dilakukan dengan mentransformasikan molekul 2D ke Chem3D. Pada bagian Chem3D, struktur H_3AsO_4 menjadi 3 Dimensi dan dapat dianalisis kondisi sebelum optimasi dengan pilihan select, sesuai pengukuran dan observasi yang diinginkan. Misalnya, pengukuran jarak antara atom, pengukuran sudut antara atom dan pengukuran sisi permukaan dari geometri molekul asam arsenat.

Pada analisis 3D juga ini dilakukan Optimasi molekul asam arsenat dilakukan dengan Molekular Mekanik (MM2) dengan cara pilih *calculations, MM2* dan *minimize energy*. Setelah calculations selesai maka di dapatkan hasil output di bagian bawah lembar kerja. Untuk menghitung *molecular dynamics* dan *compute properties* yaitu dengan langkah yang sama, dengan menukar *minimize energy* dengan *molecular dynamics* atau *compute properties*.

Untuk menggambar bentuk 3D dari surface dapat di kerjakan dengan cara pilih *surface, choose surface, solvent accessibel* atau *connolly molecular*. Untuk mengatur display mode dengan cara *surface, display mode*, pilih satu dari empat display mode (*solid, dots, wire mesh, translucent*).

Untuk analisis besaran kimia fisika 3 menggunakan metode pengolahan data. Setelah semua molekul dianalisis dan pengolahan data digunakan maka selanjutnya menggunakan software *Endnote* untuk mensitasi referensi.

Untuk analisis besaran fisika 3 menggunakan metode perhitungan matematis. Data mengenai Asam Arsenat dicari melalui review jurnal dan sumber lainnya. Kemudian data di olah sehingga didapatkan data yang benar. Dimana perhitungan matematisnya memiliki nilai $\Delta_f G$ -766.75, $\Delta_f H$ -903.45, dan S° 183.07 serta nilai viskositas sesuai dengan suhu dan spesi masing-masing. Asam arsenat juga memiliki total energi yang dapat diketahui menggunakan Chemoffice 15.0 yaitu sebesar 85.2948 kcal/mol, stretch 0.0516, bend 66.4930, stretch-bend -0.1025, torsion 23.4363, dan dipol-dipol -2.0437.

3. Analisis Gap

Asam arsenat^(32; 94-97) merupakan senyawa kimia dengan rumus H_3AsO_4 . Asam arsenat juga dikenal dengan rumus molekul $\text{AsO}(\text{OH})_3$. Asam arsenat yang tidak berwarna ini merupakan analog asam fosfat, garam arsenat dan fosfat sendiri memiliki reaksi yang serupa. Asam arsenat belum diisolasi dan hanya dapat ditemukan di dalam larutan dan sangat terionisasi. Bentuk hemihidratnya ($\text{H}_3\text{AsO}_4 \cdot 1/2 \text{H}_2\text{O}$) dapat membentuk kristal yang stabil.

Pertentangan Arsenik memiliki karakteristik yang sama dengan Fosfor, dan sering digunakan sebagai pengganti dalam berbagai reaksi biokimia yang beracun. Ketika dipanaskan, arsenik akan cepat teroksidasi⁽⁴⁴⁾ menjadi oksida arsenik, yang berbau seperti bawang putih. Arsenik dan beberapa senyawa arsenik juga dapat langsung tersublimasi, berubah dari padat menjadi gas tanpa menjadi cairan terlebih dahulu. Zat dasar arsenik ditemukan dalam dua bentuk padat^(15; 30; 98-101) yang berwarna kuning dan metalik, dengan berat jenis 1,97 dan 5,73.

Asam arsenat disiapkan dengan mereaksikan arsen trioksida^(102; 103) dengan asam nitrat yang terkonsentrasi. Dinitrogen trioksida⁽¹⁰⁴⁾ dihasilkan sebagai produk sampingan.

Larutan yang dihasilkan didinginkan untuk menghasilkan kristal hemihidrat $\text{H}_3\text{AsO}_4 \cdot 1/2 \text{H}_2\text{O}$ yang tidak berwarna, walaupun dihidrat $\text{H}_3\text{AsO}_4 \cdot 2\text{H}_2\text{O}$ dapat dihasilkan ketika kristalisasi⁽¹⁰⁵⁻¹⁰⁷⁾ terjadi pada suhu⁽³¹⁾ rendah.

4. Pembahasan

a. Result

Tidak hanya memiliki kegunaan, asam arsenat juga memiliki sifat fisika dan sifat kimia. Berikut sifat fisika dan kimia dari asam arsenat :

Tabel 1. Sifat fisika dan sifat kimia asam arsenat (H_3AsO_4)

https://id.wikipedia.org/wiki/Asam_arsenat

Sifat Fisika		Sifat Kimia	
Tekanan Uap	55 hPa (50 °C)	Keasaman (pKa)	2.19, 6.94, 11.5
Titik Lebur	35,5 °C (95,9 °F; 308,6	Kelarutan dalam Air	16.7 g/100 mL

	K)		
Titik Didih	120 °C (248 °F; 393 K)	Kelarutan	Dapat larut dalam alkohol
Massa Molar	141.94 g/mol		
Densitas	2.5 g/cm ³		

b. Data Molekul

Gambar 1. Molekul Asam Arsenat

[ChemOffice 15.01](#)

——MM2 Minimization——

Warning: The number of ligands attached does not match the geometry of As(1)

Warning: Some parameters are guessed (Quality = 1).

Iteration 481: Minimization terminated normally because the gradient norm is less than the minimum gradient norm

Stretch	: 0.0515
Bend	: 66.4854
Stretch-Bend	: -0.1023
Torsion	: 23.4431
Non-1,4 VDW	: -0.2151
1,4 VDW	: -2.0431
Dipole/Dipole	: -2.3248
Total Energy	: 85.2948 kcal/mol

c. Bentuk Molekul H₃AsO₄

1) Analisis 2D pada Molekul H₃AsO₄

Molekul⁽⁷⁶⁻⁷⁷⁾ air hasil analisis⁽¹⁷⁵⁻¹⁷⁹⁾ 2 Dimensi seperti terlihat pada gambar dibawah ini :

Gambar 2. Struktur 2D H₃AsO₄

Chemical Formula	: AsH ₃ O ₄
Exact Mass	: 141.92
Molecular Weight	: 141.94
m/z	: 141.92 (100%)
Elemental Analysis	: As, 52.78 ; H, 2.13 ; O, 45.09
tPSA	: 77.76
ClogP	: 02.174
CMR	: 1.866
LogS	: -0.4805
pKa	: N/A

2) Analisis 3D pada Molekul H₃AsO₄

Molekul H₃AsO₄ dibuat dengan menggunakan Chemdraw Ultra diproyeksikan pada ChemBio3D untuk analisis 3 Dimensi. Proses ⁽¹⁰⁸⁾ ini akan membantu untuk melihat pola pergerakan molekul secara optimal dan kemungkinan dinamika H₃AsO₄ selama berinteraksi di lingkungan saat proses *splitting* ⁽¹⁰⁹⁻¹¹¹⁾ berlangsung. Molekul H₃AsO₄ memiliki 1 atom As, 4 atom O dan 3 atom H seperti terlihat pada gambar 2a. Sebelum molekul asam arsenat dioptimasi, atom O dan H berjarak 0,942 Å seperti terlihat pada gambar 2d, atom As dan O berjarak 1,582 Å, seperti terlihat pada gambar 2e, atom H dan H terjauh berjarak 4,042 Å seperti terlihat pada gambar 2f, atom H dan As berjarak 2,451 Å seperti terlihat pada gambar 2g. Bola berwarna pink adalah representasi dari pasangan electron bebas yang dimiliki Oksigen (atom pusat) dengan jarak 0.6 Å seperti terlihat pada gambar 2h.

Molekul asam format hasil analisis 3 Dimensi seperti terlihat pada gambar 2.

Gambar 2. H₃AsO₄ 3D
As-O

Gambar 3. Ikatan O-H

Gambar 4. Ikatan

Gambar 5. Ikatan H-H

Gambar 6. Ikatan H-As

Gambar 7. Ikatan O-Lp

Gambar 8. H3AsO4 dengan translucent⁽¹¹²⁾

Gambar 9. H3AsO4 Wire Mesh⁽¹¹³⁾

Optimasi Molekul H₃AsO₄ menggunakan Molecular Mechanic (MM2)

Optimasi⁽⁸⁵⁻⁸⁶⁾ molekul H₃AsO₄ dilakukan dengan Molekular Mekanik (MM2)^(51; 114-120) dan menghasilkan output data dalam bentuk data geometri atom atom dalam molekul dan Energi optimumnya. Hasil output yang diolah dapat dilihat sebagai berikut :

1. Optimasi MM2 Minimization⁽¹²¹⁻¹³⁵⁾
2. Optimasi MM2 Dynamics⁽¹³⁶⁻¹⁴⁰⁾
3. Optimasi MM2 Properties^(30; 141-145)

Output MM2 Minimization, Dynamics dan Properties

————MM2 Minimization————

Warning: The number of ligands attached does not match the geometry of As(1)

Warning: Some parameters are guessed (Quality = 1).

Stretch	: 0.0515
Bend	: 66.4854
Stretch-Bend	: -0.1023
Torsion	: 23.4431
Non-1,4 VDW	: -0.2151
1,4 VDW	: -2.0431
Dipole/Dipole	: -2.3248
Total Energy	: 85.2948 kcal/mol

————MM2 Dynamics————

Warning: The number of ligands attached does not match the geometry of As(1)

Warning: Some parameters are guessed (Quality = 1).

Dynamics terminated because the molecular model is too far from equilibrium

————MM2 Properties————

Warning: The number of ligands attached does not match the geometry of As(1)

Warning: Some parameters are guessed (Quality = 1).

Stretch	: 0.0000
Bend	: 449.9080
Stretch-Bend	: 0.0000
Torsion	: 0.0000

Non-1,4 VDW : 192.0143
 1,4 VDW : 2135.9584
 Total Energy : 2777.8806 kcal/mol
 Note : Due to high VDW interactions, some terms were not
 computed.

The total energy for this frame: 2777.881 kcal/mol

Optimasi Molekul H_3AsO_4 menggunakan Molecular Minimize (MM2)

-----MMFF94 Minimization-----

Iteration 500: Minimization terminated normally because the maximum (46; 78; 146-153)
 number of iterations were computed

Final Energy: 16.339 kcal/mol

Calculation ended

-----MMFF94 Molecular Dynamics-----

Stretch : 0.0516
 Bend : 66.4930
 Stretch-Bend : -0.1025
 Torsion : 23.4364
 Non-1,4 VDW : -0.2151
 1,4 VDW : -2.0437
 Dipole/Dipole : -2.3248
 Total Energy : 85.2948 kcal/mol
 Calculation ended

Dari hasil optimasi MM2 terhadap molekul H_3AsO_4 , massa molekul H_3AsO_4 adalah : 141,94 g/mol. Jarak antara atom As dan O adalah 1,582 Å dan 1,840 Å. Jarak antara atom As dan H adalah 2,541 Å. Jarak antara atom O dan H adalah 0.942 Å. Jarak antara atom H dan H terjauh sebesar 4,042 Å. Sementara jarak antara atom O dan PEB adalah 0.600 Å.

d. *Jari-jari Atom H_3AsO_4*

Asam⁽¹¹⁾ Arsenat terdiri atas 3 atom penyusun yaitu H, As dan O. Jari-jari atom ketiga ini memiliki perbedaan masing-masing. Perbedaan jari-jari tersebut dapat diamati pada tabel dibawah ini :

Tabel 2. Jari-jari atom H, As dan O

<https://en.wikipedia.org/wiki/Arsen>

Simbol	Nama	Jari-jari (pm)			
		Empiris	Perhitungan	Van Der Waals	Kovalen
H	Hidrogen	25	53	120	37
As	Arsen	119		185	119
O	Oksigen	60	48	152	73

e. *Jari-jari Molekul*

Gambar 10. J ari-jari Molekul H_3AsO_4

Tabel 3. J ari-jari Molekul H_3AsO_4

[ChemOffice 15.01](#)

Atoms	Actual ($^\circ / \text{\AA}$)	Optimal ($^\circ / \text{\AA}$)
O(5)-H(8)	0.942	0.942
O(4)-H(7)	0.942	0.942
O(3)-H(6)	0.942	0.942
As(1)-O(5)	1.840	
As(1)-O(4)	1.840	
As(1)-O(3)	1.840	
As(1)-O(2)	1.582	

f Sifat-sifat Termodinamika

Perubahan entalpi (ΔH) menunjukkan selisih antara entalpi sistem sebelum reaksi dan setelah reaksi berlangsung.

$$\Delta H = H_{\text{akhir}} - H_{\text{awal}}$$

Tabel 4. Sifat-sifat Termikimia H_3AsO_4

https://www.researchgate.net/profile/Darrell_Nordstrom/publication

Data untuk suhu 298 K dan 1 atm	$\Delta_f G$ kJ/mol	$\Delta_f H$ kJ/mol	$\Delta_f S$ J/Kmol
H_3AsO_3	-640.03	-742.36	195.83
H_2AsO_3^-	-587.66	-714.74	112.79
H_3AsO_4	-766.75	-903.45	183.07
H_2AsO_4^-	-753.65	-911.42	112.38

g. Viskositas

Viskositas yaitu ukuran kekentalan fluida yang menyatakan jumlah gesekan dalam fluida. Viskositas Ba(OH)_2 dapat ditentukan secara kuantitatif dengan besaran yang disebut koefisien viskositas (η). Satuan koefisien viskositas adalah Ns/m^2 .

Ketika suatu benda bergerak dengan kecepatan v pada suatu fluida kental yang mempunyai koefisien viskositasnya η , maka benda tersebut akan mengalami gaya gesekan fluida sebesar

$$F_s = k \eta v \quad (7)$$

k adalah konstanta yang bergantung pada bentuk geometris⁽⁷⁷⁾ benda.

Bila nilai k dimasukkan ke dalam persamaan, maka diperoleh persamaan seperti berikut.

$$F_s = 6 \pi \eta r v \quad (8)$$

Keterangan:

F_s : gaya gesekan Stokes (N)

η : koefisien viskositas fluida (Pa s)

R : jari-jari bola (m)

V : kelajuan bola (m/s)

Persamaan di atas selanjutnya dikenal sebagai hukum Stokes.

h. Properti

Keasaman senyawa ini dapat dideskripsikan lewat tiga kesetimbangan:

Nilai K_a asam ini mendekati nilai K_a asam fosfat.

i. Gerakan ion

Dalam menentukan pengukuran konduktivitas, terlebih dahulu mengetahui penyebab dari pergerakan ion dengan laju yang berbeda-beda, dan penyebab ion tersebut memiliki konduktivitas molar yang berlainan, serta sebab konduktivitas molar⁽¹⁵⁴⁾ elektrolit kuat berkurang dengan akar konsentrasi.

Konsepnya adalah makin besar mobilitas ion^(155; 156) dalam larutan, maka makin besar pula kontribusinya pada konduktivitas (untuk muatan tertentu).

Mobilitas ion adalah kecepatan ion pada potensial antara kedua elektroda. Faktor-faktor yang mempengaruhi kecepatan ion adalah sebagai berikut:

1. Berat dan muatan ion, apabila ion semakin ringan tiap satuan maka semakin cepat ion bergerak
2. Adanya hidrasi, apabila semakin banyak molekul air pada ion maka semakin lambat gerakan ion
3. Pendekatan atmosfer pelarut di sekitar ion
4. Gaya tarik antara ion, apabila semakin besar gaya tarik maka pergerakan ion semakin lambat
5. Suhu, apabila semakin tinggi suhu maka pergerakan ion semakin cepat
6. Viskositas, apabila semakin besar viskositas maka pergerakan ion semakin lambat.

j. Kecepatan hanyut

Jika dua elektroda⁽³⁻⁴⁾ yang terpisah dengan jarak l berada pada selisih potensial⁽¹⁵⁷⁻¹⁶⁰⁾ $\Delta\phi$, maka ion dalam larutan di antara kedua elektroda⁽¹⁶¹⁾ itu, mengalami medan listrik seragam, yaitu:

$$E = (\Delta\phi)/l \quad (1)$$

Dalam medan demikian, ion yang bermuatan ze mengalami gaya sebesar:

$$I_e = zeE = (ze \Delta\phi)/l \quad (2)$$

Kation bereaksi dengan percepatan menuju elektroda negative dan anion bereaksi dengan percepatan menuju elektroda positif. Akan tetapi, saat ion bergerak melalui pelarut⁽¹⁶²⁻¹⁶⁴⁾ maka ion akan mengalami gaya gesekan memperlambat I_e' yang sebanding dengan kecepatannya dan jika diasumsikan bahwa hukum Stokes untuk bola radius a dan s berlaku pada skala mikroskopis, maka kita dapat menuliskan gaya perlambatan ini sebagai:

$$I_e' = fsf = 6\pi\eta a$$

(3)

Kedua gaya itu bekerja dalam arah yang berlawanan, dan ion mencapai kecepatan akhir, yaitu kecepatan hanyut, jika gaya mempercepat I_e diimbangi oleh penahan kental I_e' gaya netto menjadi nol ($I_e = I_e'$), jika ;

$$s = zeE/f$$

(4)

$$U = \frac{x}{t \left(\frac{dE}{dx} \right)} \quad (5)$$

x = jarak (m)

t = waktu (dt)

$\left(\frac{dE}{dx} \right)$ = kekuatan medan (volt.m^{-1})

$$E = \frac{dE}{dx} = \frac{l}{AL_s} \quad (6)$$

$$\text{Maka } U = \frac{\lambda_m}{zF} \quad (7)$$

Z = valensi kation

F = Faraday

Perhitungan kecepatan hanyut :

Misalkan potensial H_3AsO_4 6,53 V dan jarak antar elektroda adalah 1,8 cm, maka kecepatan hanyutnya dapat dihitung sebagai berikut :

$$E = \frac{\Delta}{l}$$

$$E = \frac{6,53 \text{ V}}{1,8 \text{ cm}} = 3,628 \text{ V/cm}$$

Jadi kecepatan hanyut $\text{H}_3(\text{BO}_3)$ adalah 3,628 V/cm

k Besaran KF 3

1) Bilangan Transport

Fraaksi dari arus total yang dibawa oleh ion jenis tertentu. Untuk larutan dengan 2 jenis ion, bilangan transport kation :

$$t_+ = \frac{I^+}{I} \quad (8)$$

I= arus total

$$I = t_+ + t_- \quad (9)$$

Bilangan transport pembatas (t^0) untuk limit konsentrasi nol dari larutan elektrolit.

Jika $I \propto \kappa$ sehingga :

$$t^0 = \frac{z v u}{\sum_i z v u_i} \quad (10)$$

Untuk elektrolit simetris (bilangan muatan untuk kedua ion sama) maka persamaan diatas disederhanakan :

$$t^0 = \frac{u}{\sum_i u_i} \quad (11)$$

Hubungan antara konduktivitas ion dengan mobilitas ion :

$$t^0 = \frac{v \lambda}{\sum_i v_i \lambda_i} = \frac{v \lambda}{\Lambda_m^0} \quad (12)$$

Jadi untuk setiap jenis ion :

$$v \lambda = t^0 \Lambda_m^0 \quad (13)$$

2) Hubungan Einstein

Hukum Fick untuk fluks partikel dalam mol molekul per satuan luas per satuan waktu adalah :

$$J = -D \frac{dc}{dx} \quad (14)$$

Dengan D merupakan koefisien difusi dan dc/dx merupakan kemiringan dari konsentrasi molar. Fluks partikel berhubungan dengan kecepatan hanyut dengan :

$$J = s c \quad (15)$$

Hubungan ini merupakan kelanjutan dari argument yang sudah kita gunakan beberapa kali sebelumnya. Jadi, semua partikel dalam jarak $s \Delta t$ A , dapat melewati jendela dengan luas A dalam selang waktu Δt ₍₁₆₅₋₁₆₉₎. Dengan demikian, jumlah molekul lewat dalam selang waktu itu adalah: $s \Delta t \times c$, sehingga:

$$s c = -D \frac{dc}{dx} \quad (16)$$

Jika sekarang kita menyatakan dc/dx dalam ϵ , menggunakan persamaan 15, maka kita memperoleh:

$$s = -\frac{D}{c} \frac{dc}{dx} = \frac{D}{RT} \times \epsilon \quad (17)$$

Terdapat satu kasus ketika kita sudah mengetahui kecepatan hanyut dan gaya efektif yang bekerja pada partikel: ion dalam larutan mempunyai kecepatan hanyut $s =$

μE jika ion itu mengalami gaya ezE , dan zFE per mol, dari medan listrik dengan kuat medan E ⁽¹⁷⁰⁻¹⁷²⁾. Jadi penggantian nilai tersebut ke dalam persamaan di atas, menghasilkan:

$$\mu E = \frac{D}{RT} \times zFE \text{ atau } \mu = \frac{zD}{RT} \quad (18)$$

$$D = \frac{\mu RT}{z} \quad (19)$$

Persamaan ini tertata ulang menjadi hasil yang sangat penting, yang dikenal sebagai hubungan Einstein, antara koefisien difusi dengan mobilitas ion.

l. Kegunaan

1) Pengawet Kayu

Penggunaan⁽⁵¹⁻⁵²⁾ pertama arsenik yaitu sebagai pengawet kayu. Arsenik merupakan racun⁽¹⁷³⁾ yang efektif dan dapat menyingkirkan serangga, jamur, dan bakteri. Pengawet kayu arsenik merupakan satu aplikasi industri yang paling banyak digunakan meskipun sebagian besar negara melarang penggunaannya karena toksisitasnya^(78; 174-182) yang tinggi.

2) Agen Doping solid state

Salah satu penggunaan penting arsenik lainnya yaitu sebagai agen doping^(183; 184) dalam pembuatan perangkat solid state seperti transistor⁽¹⁸⁵⁾.

3) Penyamakan Kulit

Arsenik juga digunakan dalam industri penyamakan kulit sebagai pengawet. Arsenik juga umumnya digunakan sebagai pembunuh gulma serta efektif menangkal serangan rayap.

4) Inteksida

5) Peptisida

6) Herbisida

7) Dalam berbagai Aloy

m. Energi Stability

Energi stabiliti ini didapatkan dari analisis Chem 3D terhadap molekul asam arsenat. Berikut data energi stabiliti asam arsenat :

————MM2 Properties————

Warning: The number of ligands attached does not match the geometry of As(1)

Warning: Some parameters are guessed (Quality = 1).

Stretch : 0.0000

Bend : 449.9080

Stretch-Bend : 0.0000

Torsion : 0.0000

Non-1,4 VDW : 192.0143

1,4 VDW : 2135.9584

Total Energy : 2777.8806 kcal/mol

Note : Due to high VDW interactions, some terms were not

computed.

The total energy for this frame: 2777.881 kcal/mol

5. Kesimpulan

Asam arsenat merupakan senyawa kimia dengan rumus molekul H_3AsO_4 . Asam arsenat juga bisa dikenal dengan rumus molekul $\text{AsO}(\text{OH})_3$. Asam yang tidak berwarna ini merupakan analog asam fosfat, garam arsenat dan fosfat sendiri memiliki reaksi yang serupa. Asam arsenat masih belum diisolasi dan hanya dapat ditemukan di dalam larutan dan disanalah asam ini sangat terionisasi. Bentuk hemihidratnya ($\text{H}_3\text{AsO}_4 \cdot 1/2 \text{H}_2\text{O}$) dapat membentuk kristal yang stabil. Metoda yang digunakan yaitu penelusuran literatur dengan Endnote X7, metode pemodelan dengan menggunakan software *ChemOffice* 15.0, dan juga perhitungan matematis. Asam arsenat juga memiliki total energi yang dapat diketahui menggunakan *Chemoffice* 15.0 yaitu sebesar 85.2948 kcal/mol, stretch 0.0516, bend 66.4930, stretch-bend -0.1025, torsion 23.4363, dan dipol-dipol -2.0437. Untuk mengetahui nilai viskositas, gerakan ion, kecepatan hanyut digunakan pengolahan data dan review jurnal mengenai asam arsenat. Asam arsenat memiliki nilai $\Delta_f G$ -766.75, $\Delta_f H$ -903.45, dan S° 183.07 serta nilai kecepatan hanyut sebesar 3,628 V/cm setelah dihitung menggunakan rumus.

Referensi

1. Patil A, Mohanty HS, Kumar S, Nandikoor S, Meganathan P. 2016. Angioinvasive rhinocerebral mucormycosis with complete unilateral thrombosis of internal carotid artery-case report and review of literature. *BJR case reports* 2:20150448
2. Dahodwala N, Willis AW, Li P, Doshi J A. 2017. Prevalence and Correlates of Anti-Parkinson Drug Use in a Nationally Representative Sample. *Movement disorders clinical practice* 4:335-41
3. Zainul, R. (2016, December 18). Design and Modification of Copper Oxide Electrodes for Improving Conversion Coefficient Indoors Lights (PV-Cell) Photocells. <https://doi.org/10.31227/osf.io/pgn84>
4. Zainul, R. (2016, December 18). Design and Modification of Copper Oxide Electrodes for Improving Conversion Coefficient Indoors Lights (PV-Cell) Photocells. <https://doi.org/10.31227/osf.io/pgn84>
5. Bebbington K, Kingma SA, Fairfield EA, Spurgin LG, Komdeur J, Richardson DS. 2017. Consequences of sibling rivalry vary across life in a passerine bird. *Behavioral ecology : official journal of the International Society for Behavioral Ecology* 28:407-18
6. Yaldizli O, Sethi V, Pardini M, Tur C, Mok KY, et al. 2018. Response to the commentary of Yates RL and DeLuca GC on the study: HLA-DRB1*1501 associations with magnetic resonance imaging measures of grey matter pathology in multiple sclerosis. *Multiple sclerosis and related disorders* 19:168-70
7. Iannitti T, Morales-Medina J C, Coacci A, Palmieri B. 2016. Experimental and Clinical Efficacy of Two Hyaluronic Acid-based Compounds of Different Cross-Linkage and Composition in the Rejuvenation of the Skin. *Pharmaceutical research* 33:2879-90
8. Li H, Liu H, Fu A, Wu G, Xu M, et al. 2016. Synthesis and Characterization of N-Doped Porous TiO_2 Hollow Spheres and Their Photocatalytic and Optical Properties. *Materials* 9
9. Wang H, Revia R, Wang K, Kant RJ, Mu Q, et al. 2017. Paramagnetic Properties of Metal-Free Boron-Doped Graphene Quantum Dots and Their Application for Safe Magnetic Resonance Imaging. *Advanced materials* 29
10. Kratochvilova I, Golan M, Pomeisl K, Richter J, Sedlakova S, et al. 2017. Theoretical and experimental study of the antifreeze protein AFP752, trehalose and dimethyl sulfoxide cryoprotection mechanism: correlation with cryopreserved cell viability. *RSC advances* 7:352-60
11. Zainul, R. (2016, September 24). Determination of the half-life and the quantum yield

- of ZnO semiconductor photocatalyst in humic acid. <https://doi.org/10.31227/osf.io/e8a9x>
12. Tai HC, Li GC, Huang SJ, Jhu CR, Chung JH, et al. 2017. Chemical distinctions between Stradivari's maple and modern tonewood. *Proceedings of the National Academy of Sciences of the United States of America* 114:27-32
 13. Chandrasekaran V, Dilara K, Padmavathi R. 2014. Pulmonary functions in tannery workers—a cross sectional study. *Indian journal of physiology and pharmacology* 58:206-10
 14. Hernandez-Serrano AI, Corzo-Garcia SC, Garcia-Sanchez E, Alfaro M, Castro-Camus E. 2014. Quality control of leather by terahertz time-domain spectroscopy. *Applied optics* 53:7872-6
 15. Chavez-Capilla T, Maher W, Kelly T, Foster S. 2016. Evaluation of the ability of arsenic species to traverse cell membranes by simple diffusion using octanol-water and liposome-water partition coefficients. *Journal of environmental sciences* 49:222-32
 16. Li X, Qian P. 2017. Identification of an exposure risk to heavy metals from pharmaceutical-grade rubber stoppers. *Journal of food and drug analysis* 25:723-30
 17. Ferrer-Blasco T, Dominguez-Vicent A, Esteve-Taboada JJ, Aloy MA, Adsuara JE, Montes-Mico R. 2017. Evaluation of the repeatability of a swept-source ocular biometer for measuring ocular biometric parameters. *Graefes' archive for clinical and experimental ophthalmology = Albrecht von Graefes Archiv für klinische und experimentelle Ophthalmologie* 255:343-9
 18. Farid M, El-Setouhy DA, El-Nabarawi MA, El-Bayomi T. 2016. Particle engineering/different film approaches for earlier absorption of meloxicam. *Drug delivery* 23:2309-17
 19. Dong J, Song X, Lian X, Fu Y, Gong T. 2016. Subcutaneously injected ivermectin-loaded mixed micelles: formulation, pharmacokinetics and local irritation study. *Drug delivery* 23:2220-7
 20. West C, Stanisiz AM, Wong A, Kunze WA. 2016. Effects of *Saccharomyces cerevisiae* or *boulardii* yeasts on acute stress induced intestinal dysmotility. *World journal of gastroenterology* 22:10532-44
 21. Febriani, S. S., Yolanda, T., Arianti, V. A., & Zainul, R. (2018, September 2). A Review Solid Stated : Principles and Methode. <https://doi.org/10.31227/osf.io/7us4x>
 22. Liza, Y. M., Yasin, R. C., Maidani, S. S., & Zainul, R. (2018, September 29). SOL GEL : PRINCIPLE AND TECHNIQUE (A REVIEW). <https://doi.org/10.31227/osf.io/2cuh8>
 23. Nagai T. 2016. Ecological effect assessment by species sensitivity distribution for 68 pesticides used in Japanese paddy fields. *Journal of pesticide science* 41:6-14
 24. Yamaji Y, Honda H, Hanai R, Inoue J. 2016. Soil and environmental factors affecting the efficacy of pyroxasulfone for weed control. *Journal of pesticide science* 41:1-5
 25. M B, N A, A G. 2016. A One-Year Evaluation of a Free Fissure Sealant Program. *Journal of dental biomaterials* 3:306-14
 26. Mistry KA, Bhoil R, Suthar PP, Shukla A. 2016. Iatrogenic watering-can perineum and osteomyelitis of pubic ramus as a complication of post-urethral calculus removal UTI. *BJR case reports* 2:20150045
 27. Hida K, Takano K, Yoshimitsu K, Fukae J, Hokao K. 2017. Inner ear enhancement on gadolinium-enhanced 3D FLAIR images in a patient with Vogt-Koyanagi-Harada disease. *BJR case reports* 3:20160090
 28. Jumeau R, Peguret N, Zulliger C, Moeckli R, Bourhis J, Ozsahin EM. 2016. Optimization of re-irradiation using deformable registration: a case study. *BJR case reports* 2:20150412
 29. Hatakeyama T, Takagi K, Ito K. 2016. Biodegradation of cyromazine by melamine-degrading bacteria. *Journal of pesticide science* 41:20-4
 30. Dueik V, Bouchon P. 2016. Development of polyphenol-enriched vacuum and atmospheric fried matrices: Evaluation of quality parameters and in vitro bioavailability of polyphenols. *Food research international* 88:166-72

31. Zainul, R. (2016, November 19). Effect of Temperature and Particle Motion against the ability of ZnO Semiconductor Photocatalyst in Humic Acid. <https://doi.org/10.31227/osf.io/wnygb>
32. Rahmanpour S, Ashtiyani SM, Ghorghani NF. 2016. Biomonitoring of heavy metals using bottom fish and crab as bioindicator species, the Arvand River. *Toxicology and industrial health* 32:1208-14
33. Charalambous L, von Lieres Und Wilkau HC, Potthast W, Irwin G. 2016. The effects of artificial surface temperature on mechanical properties and player kinematics during landing and acceleration. *Journal of sport and health science* 5:355-60
34. Zufiaurre E, Codesido M, Abba AM, Bilenca D. 2017. The seasonal role of field characteristics on seed-eating bird abundances in agricultural landscapes. *Current zoology* 63:279-86
35. Dinata, A. A., Rosyadi, A. M., Hamid, S., & Zainul, R. (2018, August 31). A Review CHEMICAL VAPOR DEPOSITION : PROCESS AND APPLICATION. <https://doi.org/10.31227/osf.io/yfeau>
36. Gulbrandsen N, De Mieri M, Gupta M, Seiser T, Wiebe C, et al. 2015. Screening of Panamanian Plant Extracts for Pesticidal Properties and HPLC-Based Identification of Active Compounds. *Scientia pharmaceutica* 83:353-67
37. Siva S, Kothai Nayaki S, Rajendiran N. 2017. Spectral and molecular modeling investigations of supramolecular complexes of mefenamic acid and aceclofenac with alpha- and beta-cyclodextrin. *Spectrochimica acta. Part A, Molecular and biomolecular spectroscopy* 174:349-62
38. Zhang ZY, Jilili A, Jiang FQ. 2014. [Source identification and potential ecological hazards assessment of trace metalloid/heavy metals in the soil of Tianshan Mountains, Xinjiang, China]. *Ying yong sheng tai xue bao = The journal of applied ecology* 25:3168-76
39. Farnese FS, Oliveira J A, Lima FS, Leao GA, Gusman GS, Silva LC. 2014. Evaluation of the potential of Pistia stratiotes L. (water lettuce) for bioindication and phytoremediation of aquatic environments contaminated with arsenic. *Brazilian journal of biology = Revista brasleira de biologia* 74:S108-12
40. Putri, D. F., Ritonga, H. M., Murdiati, V., & Zainul, R. (2018, August 31). A REVIEW WHAT IS HYDROTHERMAL ?. <https://doi.org/10.31227/osf.io/dm56c>
41. Stovern M, Felix O, Csavina J, Rine KP, Russell MR, et al. 2014. Simulation of windblown dust transport from a mine tailings impoundment using a computational fluid dynamics model. *Aeolian research* 14:75-83
42. Luthje FL, Hasman H, Aarestrup FM, Alwathnani HA, Rensing C. 2014. Genome Sequences of Two Copper-Resistant Escherichia coli Strains Isolated from Copper-Fed Pigs. *Genome announcements* 2
43. Freitag K, Banh H, Gemel C, Jerabek P, Seidel RW, et al. 2015. Dizinc cation [Zn²⁺](2+) trapped in a homoleptic metalloid coordination environment stabilized by dispersion forces: [Zn₂(GaCp*)₆][Ba₄(F)]₂. *Inorganic chemistry* 54:352-8
44. Awalliyah, A., Ikhwan, H., Nugiasari, V., & Zainul, R. (2018, August 31). A REVIEW PRINSIP DASAR MILLING DALAM SINTESIS MATERIAL. <https://doi.org/10.31227/osf.io/9xsqe>
45. Knight SP. 2014. A paediatric X-ray exposure chart. *Journal of medical radiation sciences* 61:191-201
46. Petroianu GA. 2014. Pharmacists Adolf Schall and Ernst Ratzlaff and the synthesis of tabun-like compounds: a brief history. *Die Pharmazie* 69:780-4
47. Park SW, Noh HM, Moon BK, Choi BC, Jeong JH, Yang HK. 2014. Hydrothermal synthesis and photoluminescence investigation of NaY(MoO₄)₂:Eu³⁺ nanophosphor. *Journal of nanoscience and nanotechnology* 14:8724-8
48. Yu R, Kim Y. 2014. Synthesis and characterization of multi-functional ZnO nano ceramic phosphor. *Journal of nanoscience and nanotechnology* 14:8711-4
49. Jo DS, Linh DT, Masaki T, Yoon DH. 2014. Luminescence properties of nanosized Y₃Al₅O₁₂Ce³⁺ phosphor synthesized by liquid phase precursor method. *Journal of*

- nanoscience and nanotechnology*14:8325-30
50. Kim JS, Kim SW, Jung SC. 2014. Photocatalytic reaction characteristics of the titanium dioxide supported on the long phosphorescent phosphor by a low pressure chemical vapor deposition. *Journal of nanoscience and nanotechnology*14:7751-5
 51. Candani, D., Ulfah, M., Noviana, W., & Zainul, R. (2018, September 1). A Review Pemanfaatan Teknologi Sonikasi. <https://doi.org/10.31227/osf.io/uxknv>
 52. Fatimah, P., Jumalia, R., Novianti, E. R., & Zainul, R. (2018, August 31). A REVIEW Teknik Blended : Prinsip dan Dasar-Dasar. <https://doi.org/10.31227/osf.io/tm2w4>
 53. Kohale RL, Shinde KN, Park K, Dhoble SJ. 2014. Synthesis and luminescence properties of Eu(2+) activated Ca₂P₂O₇ pyrophosphate phosphor. *Journal of nanoscience and nanotechnology*14:5976-8
 54. Shinde KN, Dhoble SJ, Yoon SJ, Park K. 2014. Synthesis and photoluminescence of novel NaLi₂PO₄:Tb(3+) nanophosphors for near-ultraviolet excited light emitting diodes. *Journal of nanoscience and nanotechnology*14:5957-60
 55. Lee DG, Kesavulu CR, Yi SS, Cho S, Jang K, et al. 2014. Photoluminescence properties of Na(Sr,Ca)VO₄:Eu(3+) phosphors. *Journal of nanoscience and nanotechnology*14:5877-80
 56. Hakeem A, Shinde KN, Yoon SJ, Dhoble SJ, Park K. 2014. Synthesis and photoluminescence of novel Ca(1-x)MgP₂O₇:xEu(3+) pyrophosphate phosphor for near ultraviolet light emitting diodes. *Journal of nanoscience and nanotechnology* 14:5873-6
 57. Zainul, R., Oktavia, B., Dewata, I., & efendi, j. (2017, February 4). Studi Dinamika Molekular dan Kinetika Reaksi pada Pembelahan Molekul Air untuk Produksi Gas Hidrogen. <https://doi.org/10.31227/osf.io/876s3>
 58. Ahmed S, Sohail A, Khatoon S, Khan S, Saifullah MK. 2017. Partial purification and characterization of glutathione S-transferase from the somatic tissue of Gastrothylax crumenifer (Trematoda: Digenea). *Veterinary world*10:1493-500
 59. Batool S, Nawaz MS, Mushtaq G, Parvaiz F, Kamal MA. 2017. In silico analysis of glycineamide ribonucleotide transformylase inhibition by PY873, PY899 and DIA. *Saudi journal of biological sciences* 24:1155-61
 60. Panigrahi PN, Mohanty BN, Gupta AR, Patra RC, Dey S. 2016. Concurrent infestation of Notoedres, Sarcoptic and Psoroptic acariasis in rabbit and its management. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:1091-3
 61. Zainul, R., Alif, A., Aziz, H., Arief, S., & s. (2015, October 22). Photoelectrospinning Water Mechanism at Carbon Electrode Surface using Indoor lights. <https://doi.org/10.31227/osf.io/vcxq8>
 62. Zainul, R., Alif, A., Aziz, H., Arief, S., & s. (2015, October 22). Photoelectrospinning Water Mechanism at Carbon Electrode Surface using Indoor lights. <https://doi.org/10.31227/osf.io/vcxq8>
 63. Ahmadian N, Pashaei-Asl R, Ahmadian M, Rahmati-Yamchi M, Shahabi S, Vazini H. 2016. Immune response of newborn BALB/c mice to Cryptosporidium infection. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:1066-70
 64. Jaiswal AK, Sudan V, Pandey V, Singh A, Gaur RS, et al. 2016. Sex dependent alterations in the protein characterization patterns of Haemonchus contortus. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:1006-8
 65. Gillet N, Levy B, Moliner V, Demachy I, de la Lande A. 2014. Electron and Hydrogen Atom Transfers in the Hydride Carrier Protein EmoB. *Journal of chemical theory and computation*10:5036-46
 66. M., Yani, S. R., & Zainul, R. (2017, September 4). Aktivasi Tanah Napa dan Pengaruhnya Terhadap Adsorpsi Ion Timbal (II)/ Pb²⁺. <https://doi.org/10.31227/osf.io/ps523>
 67. P, O. M., A, L. G., S, A. Y. M., & Zainul, R. (2018, September 1). A Review Grinding :

- Teknik dan Prinsip Dasar pada Pengolahan Material.
<https://doi.org/10.31227/osf.io/trv4q>
68. H., Sanjaya, H., & Zainul, R. (2016, August 30). Synthesis and Electrical Properties of ZnO-ITO and Al-ITO thin Film by Spin Coating Technique Through Sol Gel Process.
<https://doi.org/10.31227/osf.io/unrt4>
 69. Hu YW, Zhao J Y, Li S F, Wang Q, Zheng L. 2014. Genome-wide profiling to analyze the effects of Ox-LDL induced THP-1 macrophage-derived foam cells on gene expression. *Genomics data* 2:328-31
 70. Levonen AL. 2014. Activation of stress signaling pathways by oxidized and nitrated lipids. *Free radical biology & medicine* 75 Suppl 1:S8
 71. Gladyshev VN. 2014. Selenium and Methionine Sulfoxide Reduction. *Free radical biology & medicine* 75 Suppl 1:S8-9
 72. Serviddio G, Bellanti F, Vendemiale G. 2014. Oxysterols in the orchestra of liver cell metabolism. *Free radical biology & medicine* 75 Suppl 1:S6
 73. Caldwell S. 2014. NASH (Nonalcoholic steatohepatitis): A case of multiorganelle failure. *Free radical biology & medicine* 75 Suppl 1:S6
 74. Davies KJ. 2014. What Goes Wrong with Lon in Ageing? *Free radical biology & medicine* 75 Suppl 1:S6
 75. Tormos AM, Perez-Garrido S, Talens-Visconti R, Nebreda AR, Sastre J. 2014. Long term p38- α deficiency up-regulates antioxidant enzymes through compensatory NF- κ B activation. *Free radical biology & medicine* 75 Suppl 1:S52
 76. M., Sanjaya, H., & Zainul, R. (2015, December 30). Characterization of napa soil and adsorption of Pb (II) from aqueous solutions using on column method.
<https://doi.org/10.31227/osf.io/t8fh9>
 77. chaidir, z., Fadjria, N., A., & Zainul, R. (2016, December 5). ISOLATION AND MOLECULAR IDENTIFICATION OF FRESHWATER MICROALGAE IN MANINJAU LAKE WEST SUMATERA. <https://doi.org/10.31227/osf.io/nbcuf>
 78. Tveen-Jensen K, Reis A, Spickett CM, Pitt AR. 2014. Targeted mass spectrometry methods for detecting oxidative post-translational modifications. *Free radical biology & medicine* 75 Suppl 1:S52-3
 79. Mladenka P, Filipsky T, Riha M, Vavrova J, Holeckova M, et al. 2014. The relationship of oxidative stress markers and parameters of myocardial function in a rat model of cardiotoxicity. *Free radical biology & medicine* 75 Suppl 1:S42
 80. Ly A, Schone C, Becker M, Rattke J, Meding S, et al. 2015. High-resolution MALDI mass spectrometric imaging of lipids in the mammalian retina. *Histochemistry and cell biology* 143:453-62
 81. Malavolti L, Lanzilotto V, Ninova S, Poggini L, Cimatti I, et al. 2015. Magnetic bistability in a submonolayer of sublimated Fe₄ single-molecule magnets. *Nano letters* 15:535-41
 82. Gajewski K, Kopiec D, Moczala M, Piotrowicz A, Zielony M, et al. 2015. Scanning probe microscopy investigations of the electrical properties of chemical vapor deposited graphene grown on a 6H-SiC substrate. *Micron* 68:17-22
 83. Klar D, Candini A, Joly L, Klyatskaya S, Krumme B, et al. 2014. Hysteretic behaviour in a vacuum deposited submonolayer of single ion magnets. *Dalton transactions* 43:10686-9
 84. Wu X, Zhang Z, Meng F, Yu Y, Han L, et al. 2014. Core-shell-like Y₂O₃:(Tb³⁺-Yb³⁺), Li⁺/CdZnS heterostructure synthesized by super-close-space sublimation for broadband down-conversion. *Nanoscale* 6:4745-9
 85. chaidir, z., Zainul, R., Nurakhbari, D., & Salim, M. (2016, September 24). Optimization of Spirulina Platensis Culture for Antioxidant Production.
<https://doi.org/10.17605/OSF.IO/FD6E4>
 86. Zainul R, Oktavia B, Dewata I, Efendi J. Thermal and Surface Evaluation on The Process of Forming a Cu₂O/CuO Semiconductor Photocatalyst on a Thin Copper Plate. Proc. IOP Conference Series: Materials Science and Engineering, 2018, 335:012039: IOP Publishing

87. Galabura Y, Soliani AP, Giammarco J, Zdyrko B, Luzinov I. 2014. Temperature controlled shape change of grafted nanofoams. *Soft matter*10:2567-73
88. Vernula SK, Vangala M. 2014. Formulation Development and Characterization of Meclizine Hydrochloride Sublimated Fast Dissolving Tablets. *International scholarly research notices* 2014:281376
89. Panthani MG, Kurley J M, Crisp RW, Dietz TC, Ezzyat T, et al. 2014. High efficiency solution processed sintered CdTe nanocrystal solar cells: the role of interfaces. *Nano letters* 14:670-5
90. Thomten J, Linton SJ. 2014. When sex hurts: Female genital pain with sexual consequences deserves attention: A position paper. *Scandinavian journal of pain* 5:202-5
91. Zainul R, Alif A, Aziz H, Arief S, Dradjad S, Munaf E. 2015. Design of photovoltaic cell with copper oxide electrode by using indoor lights. *RESEARCH JOURNAL OF PHARMACEUTICAL BIOLOGICAL AND CHEMICAL SCIENCES* 6:353-61
92. Mawardi M, Deyundha D, Zainul R. Characterization of PCC Cement by Addition of Napa Soil from Subdistrict Sarilamak 50 Kota District as Alternative Additional Material for Semen Padang. *Proc. IOP Conference Series: Materials Science and Engineering*, 2018, 335:012034: IOP Publishing
93. Anhar A, Sumarmin R, Zainul R. 2016. Measurement of Glycemic Index of West Sumatera Local Rice Genotypes for Healthy Food Selection. <https://doi.org/10.31227/osf.io/tgy8h>
94. Loving S, Thomsen T, Jaszczak P, Nordling J. 2014. Female chronic pelvic pain is highly prevalent in Denmark. A cross-sectional population-based study with randomly selected participants. *Scandinavian journal of pain* 5:93-101
95. Kuivalainen AM, Ebeling F, Rosenberg P. 2014. Warmed and buffered lidocaine for pain relief during bone marrow aspiration and biopsy. A randomized and controlled trial. *Scandinavian journal of pain* 5:43-7
96. Janssen B, Szende A, Ramos-Goni J M. 2014. Data and Methods. In *Self-Reported Population Health: An International Perspective based on EQ-5D*, ed. A Szende, B Janssen, J Cabases:7-17. Dordrecht. Number of 7-17 pp.
97. Zainul R, Dewata I. 2015. Determination of pH-BOD-COD and degradation in batang arau watersheds at Padang city. [10.31227/osf.io/efdzj](https://doi.org/10.31227/osf.io/efdzj)
98. Zainul R, Alif A, Aziz H, Arief S. 2015. DISAIN GEOMETRI REAKTOR FOTOSEL CAHAYA RUANG. *Jurnal Riset Kimia* 8:131 <https://doi.org/10.25077/jrk.v8i2.230>
99. Zainul R, Alif A, Aziz H, Arief S, Darajat S. 2015. Modifikasi dan Karakteristik IV Sel Fotovoltaik Cu₂O/Cu-Gel Na₂SO₄ Melalui Iluminasi Lampu Neon. *EKSAKTA* 2:50
100. Szende A, Janssen B. 2014. Socio-demographic Indicators Based on EQ-5D. In *Self-Reported Population Health: An International Perspective based on EQ-5D*, ed. A Szende, B Janssen, J Cabases:37-46. Dordrecht. Number of 37-46 pp.
101. Cohen SB. 2001. Differentials in the Concentration of Health Expenditures across Population Subgroups in the U.S., 2012. In *Statistical Brief (Medical Expenditure Panel Survey (US))*. Rockville (MD). Number of.
102. Cohen SB. 2001. The Concentration and Persistence in the Level of Health Expenditures over Time: Estimates for the U.S. Population, 2011-2012. In *Statistical Brief (Medical Expenditure Panel Survey (US))*. Rockville (MD). Number of.
103. Cohen SB. 2001. The Concentration of Health Care Expenditures and Related Expenses for Costly Medical Conditions, 2012. In *Statistical Brief (Medical Expenditure Panel Survey (US))*. Rockville (MD). Number of.
105. Cohen SB. 2001. Differentials in the Concentration in Out-of-Pocket Health Expenditures across Population Subgroups in the U.S., 2012. In *Statistical Brief (Medical Expenditure Panel Survey (US))*. Rockville (MD). Number of.
106. Yasthopi A. 2015. Photoelectrospitting water for hydrogen production using illumination of indoor lights. *Journal of Chemical and Pharmaceutical Research* 7:246-56
107. Zainul R. 2015. Disain dan Modifikasi Kolektor dan Reflektor Cahaya pada Panel Sel

- Surya Al/ Cu₂O-Gel Na₂SO₄. <http://repository.unp.ac.id/id/eprint/610>
108. Mawardi Anwar E, Kosela S, Wibowo W, Zainul R. 2015. Study of Pb (II) biosorption from aqueous solution using immobilized *Spirogyra subsals* biomass. *Journal of Chemical and Pharmaceutical Research* 7:715-22
 109. Malar S, Shivendra Vikram S, J c Favas P, Perumal V. 2016. Lead heavy metal toxicity induced changes on growth and antioxidative enzymes level in water hyacinths [*Eichhornia crassipes* (Mart.)]. *Botanical studies* 55:54
 110. Farghly AM, Mohamed SM, Abdel-Rahman SA, Mohammed FE, El-Bahaie ES, El-Shafey MA. 2016. The relation between the prevalence of soil transmitted parasites in the soil and among school children in Zagazig district, Sharkyia Governorate, Egypt. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:1021-9
 111. Sheikh J H, Chishti MZ, Rasheed M, Tak IU, Dar SA, et al. 2016. Population analysis of the genera buildup on some commercially important vegetable crops grown in Kashmir Valley. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:877-80
 112. Chanu LB, Meitei NM, Shah MM. 2016. Two new species of soil nematodes from Manipur, India. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:674-8
 113. Sadaghian M, Amani S, Jafari R. 2016. Prevalence of toxoplasmosis and related risk factors among humans referred to main laboratories of Urmia city, North West of Iran, 2013. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:520-3
 114. Etewa SE, Abdel-Rahman SA, Abd El-Aal NF, Fathy GM, El-Shafey MA, Ewis AM. 2016. Geohelminths distribution as affected by soil properties, physicochemical factors and climate in Sharkyia governorate Egypt. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:496-504
 115. Desy Kurniawati I, Harmiwati SS, Chaidir Z, Munaf E. Rahmiana Zein, Hermansyah Aziz, Rahadian Zainul. 2015. Biosorption of Pb (II) from Aqueous Solutions Using Column Method by Lengkeng (*Euphoria logan lour*) Seed and Shell. *Journal of Chemical and Pharmaceutical Research* 7:872-7
 116. chaidir, z., Zainul, R., Nurakhbari, D., & Salim, M. (2016, September 24). Optimization of *Spirulina Platensis* Culture for Antioxidant Production. <https://doi.org/10.17605/OSF.IO/FD6E4>
 117. Zainul, R., & Prima, C. B. (2017, June 29). Desain Geometri Sel PV. <https://doi.org/10.31227/osf.io/7n8t4>
 118. Ismail KA, Ibrahim AN, Ahmed MA, Hetta MH. 2016. Comparison between the effect of *Lawsonia inermis* and flubendazole on *Strongyloides* species using scanning electron microscopy. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:415-22
 119. Yu Z, Wu F, Chen L, Li Q, Wang C, et al. 2014. ETME, a novel beta-elemene derivative, synergizes with arsenic trioxide in inducing apoptosis and cell cycle arrest in hepatocarcinoma cells via a p53-dependent pathway. *Acta pharmaceutica Sinica. B* 4:424-9
 120. Luo HL, Lin DF, Shieh SI, You YF. 2015. Micro-observations of different types of nano-Al₂O₃ on the hydration of cement paste with sludge ash replacement. *Environmental technology* 36:2967-76
 121. Yu B, Zhang H, Chen T, Mou Y, Wu Z. 2015. Heavy metal pollution in soils from abandoned Taizhou Chemical Industry Zone in Zhejiang province. *Environmental technology* 36:2944-51
 122. Signes-Pastor AJ, Carey M, Meharg AA. 2016. Inorganic arsenic in rice-based products for infants and young children. *Food chemistry* 191:128-34
 123. Daley-Bowles T, Liguori J, Razuri F, Hubschmitt A, Litchauer J, et al. 2014. Foundation products have a measureable impact on moisturization. *Journal of cosmetic science* 65:359-64

124. Sakalli I, Schoberl J, Knapp EW. 2014. mFES: A Robust Molecular Finite Element Solver for Electrostatic Energy Computations. *Journal of chemical theory and computation* 10:5095-112
125. Zainul R. 2016. Design and Modification of Copper Oxide Electrodes for Improving Conversion Coefficient Indoors Lights (PV-Cell) Photocells. <https://doi.org/10.31227/osf.io/pgn84>
126. Kandemir N, Vuralli D, Taskiran E, Gonc N, Ozon A, et al. 2012. Frequency of mutations in PROP-1 gene in Turkish children with combined pituitary hormone deficiency. *The Turkish journal of pediatrics* 54:570-5
127. Demirbilek H, Gonc EN, Ozon A, Alikasifoglu A, Kandemir N. 2012. Evaluation of serum kisspeptin levels in girls in the diagnosis of central precocious puberty and in the assessment of pubertal suppression. *Journal of pediatric endocrinology & metabolism : JPEM* 25:313-6
- Horiza, H., Azhar, M. and Efendi, J. (2017) "EKSTRAKSI DAN KARAKTERISASI INULIN DARI UMBI DAHLIA (*Dahlia* sp.L) SEGAR DAN DISIMPAN", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 31-39. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/14>.
128. Iryani, I., Iswendi, I. and Katrina, I. T. (2017) "UJI AKTIVITAS ANTI DIABETES MELLITUS SENYAWA METABOLIT SEKUNDER FRAKSI AIR DARI BERAS KETAN HITAM (*Oryza sativa* L. Var *glutinosa*) PADA MENCIT PUTIH", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 54-60. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/17>.
129. Suryelita, S., Etika, S. B. and Kurnia, N. S. (2017) "ISOLASI DAN KARAKTERISASI SENYAWA STEROID DARI DAUN CEMARA NATAL (*Cupressus funebris* Endl.)", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 86-94. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/23>.
130. Iskandar, I., Horiza, H. and Fauzi, N. (2017) "EFEKTIVITAS BUBUK BIJI PEPAYA (*Carica Papaya* Linnaeus) SEBAGAI LARVASIDA ALAMI TERHADAP KEMATIAN LARVA *Aedes Aegypti* TAHUN 2015", *EKSAKTA: Berkala Ilmiah Bidang MIPA*, 18(01), pp. 12-18. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/12>.
131. Ossai EK, Iwegbue CM, Nwajei GE. 2014. Trace elements in water, soil, earthworm and fishes from Otokutu end of Warri River, Delta State, Nigeria. *Pakistan journal of biological sciences : PJB* 17:1136-40
132. Tang BP, Yang SJ, Wang DZ, Rao W, Zhang YN, et al. 2014. [Effect of sulfur on the species of Fe and As under redox condition in paddy soil]. *Huan jing ke xue= Huanjing kexue* 35:3851-61
133. Hamamura N, Itai T, Liu Y, Reysenbach AL, Damdinsuren N, Inskeep WP. 2014. Identification of anaerobic arsenite-oxidizing and arsenate-reducing bacteria associated with an alkaline saline lake in Khovsgol, Mongolia. *Environmental microbiology reports* 6:476-82
134. Lenoble V, Dang DH, Loustau Cazalet M, Mounier S, Pfeifer HR, Garnier C. 2015. Evaluation and modelling of dissolved organic matter reactivity toward As(III) and As(V) - implication in environmental arsenic speciation. *Talanta* 134:530-7
135. Lloyd J, Patterson T, Muers J. 2016. The positive aspects of caregiving in dementia: A critical review of the qualitative literature. *Dementia* 15:1534-61
136. Cheung K, Das DB. 2016. Microneedles for drug delivery: trends and progress. *Drug delivery* 23:2338-54
137. Surampalli G, Nanjwade BK, Patil PA, Chilla R. 2016. Novel tablet formulation of amorphous candesartan cilexetil solid dispersions involving P-gp inhibition for optimal drug delivery: in vitro and in vivo evaluation. *Drug delivery* 23:2124-38
138. Place BJ, Perkins MJ, Sinclair E, Barsamian AL, Blakemore PR, Field JA. 2016. Trace Analysis of Surfactants in Corexit Oil Dispersant Formulations and Seawater. *Deep-sea research. Part II, Topical studies in oceanography* 129:273-81
139. Chen G, Sung PT. 2014. Gingival and localized alveolar bone necrosis related to the use of arsenic trioxide paste—two case reports. *Journal of the Formosan Medical Association = Taiwan yi zhi* 113:187-90

140. Wang JY, Zhao XQ, Wang CM, Mo BW, Jiang M, Chen F. 2012. [Arsenic trioxide enhances TRAIL inducing human lung cancer cell line A549 cells apoptosis by down-regulate the expression of NF-kappaB]. *Sichuan da xue xue bao. Yi xue ban = Journal of Sichuan University. Medical science edition*43:834-8
141. Zainul R, Alif A, Aziz H, Arief S, Dradjad S, Munaf E. 2015. Design of photovoltaic cell with copper oxide electrode by using indoor lights. *RESEARCH JOURNAL OF PHARMACEUTICAL BIOLOGICAL AND CHEMICAL SCIENCES* 6:353-61
142. Ramli, R., Jonuarti, R. and Hartono, A. (2017) "ANALISIS STRUKTUR NANO DARI LAPISAN TIPIS COBALT FERRITE YANG DIPREPARASI DENGAN METODE SPUTTERING", EKSAKTA: Berkala Ilmiah Bidang MIPA, 18(01), pp. 46-53. doi: <https://doi.org/10.24036/eksakta/vol18-iss01/16>.
143. Sanjaya, H. (2017) "DEGRADASI METHYLENE BLUE MENGGUNAKAN KATALIS ZnO-PEG DENGAN METODE FOTOSONOLISIS", EKSAKTA: Berkala Ilmiah Bidang MIPA, 18(02), pp. 21-29. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/45>.
144. Ningsih, S. K. (2017) "SINTESIS DAN KARAKTERISASI NANOPARTIKEL ZnO DOPED Cu²⁺ MELALUI METODA SOL-GEL", EKSAKTA: Berkala Ilmiah Bidang MIPA, 18(02), pp. 39-51. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/51>.
145. Hajhashemi Z, Nasirpour A, Scher J, Desobry S. 2014. Interactions among lactose, beta-lactoglobulin and starch in co-lyophilized mixtures as determined by Fourier Transform Infrared Spectroscopy. *Journal of food science and technology*51:3376-82
146. Selvamuthukumaran M, Khanum F. 2014. Optimization of spray drying process for developing seabuckthorn fruit juice powder using response surface methodology. *Journal of food science and technology*51:3731-9
147. Sonwai S, Kaphueakngam P, Flood A. 2014. Blending of mango kernel fat and palm oil mid-fraction to obtain cocoa butter equivalent. *Journal of food science and technology*51:2357-69
148. Zainul R, Oktavia B, Dewata I, Efendi J. Thermal and Surface Evaluation on The Process of Forming a Cu₂O/CuO Semiconductor Photocatalyst on a Thin Copper Plate. *Proc. IOP Conference Series: Materials Science and Engineering, 2018*, 335:012039: IOP Publishing
149. Agrawal D, Gupta AS, Newaskar V, Gupta A, Garg S, Jain D. 2014. Narrow ridge management with ridge splitting with piezotome for implant placement: report of 2 cases. *Journal of Indian Prosthodontic Society*14:305-9
150. Zaid AN, Al-Ramahi RJ, Ghoush AA, Qaddumi A, Zaaror YA. 2013. Weight and content uniformity of lorazepam half-tablets: A study of correlation of a low drug content product. *Saudi pharmaceutical journal : SPJ : the official publication of the Saudi Pharmaceutical Society*21:71-5
151. Heydari M, Hashempur MH, Shams M. 2012. Inappropriate time splitting among endocrine topics in undergraduate medical education. *Education for health*25:131-2
152. Comlekoglu ME, Paken G, Tan F, Dundar-Comlekoglu M, Ozcan M, et al. 2016. Evaluation of Different Thickness, Die Color, and Resin Cement Shade for Veneers of Multilayered CAD/CAM Blocks. *Journal of prosthodontics : official journal of the American College of Prosthodontists* 25:563-9
153. Nedeltchev S, Rabha S, Hampel U, Schubert M. 2015. A New Statistical Parameter for Identifying the Main Transition Velocities in Bubble Columns. *Chemical engineering & technology*38:1940-6
154. Saiya, A. (2017) "ANALISIS RESIDU Klorpirifos dalam Sayuran KUBIS DENGAN METODE HPLC DI BEBERAPA PASAR TRADISIONAL DI SULAWESI UTARA", EKSAKTA: Berkala Ilmiah Bidang MIPA, 18(02), pp. 77-85. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/57>.
155. Syafei, N. (2017) "ANALISA FENOMENA KOROSI PELAT PIPA BAJA KARBON API 5L-X65 DALAM LARUTAN 250 ML ASAM ASETAT DAN 4750 ML AQUADES PADA KONDISI GAS CO₂ DAN H₂S JENUH PADA SUHU RUANG", EKSAKTA: Berkala Ilmiah Bidang MIPA, 18(02), pp. 113-120. doi:

- <https://doi.org/10.24036/eksakta/vol18-iss02/63>.
156. Tutuarima, T. (2017) "SIFAT FISIK DAN KIMIA MARMALADE JERUK KALAMANSI (Citrus microcarpa) : KAJIAN KONSENTRASI PEKTIN DAN SUKROSA Physical and Chemical Properties of Marmalade Citrus of Calamondin (Citrus microcarpa) : Study of Pectin and Sucrose Concentrations", EKSakta: Berkala Ilmiah Bidang MIPA, 18(02), pp. 164-172. doi: <https://doi.org/10.24036/eksakta/vol18-iss02/73>.
 157. Wang B, Truhlar DG. 2014. Screened Electrostatic Interactions in Molecular Mechanics. *Journal of chemical theory and computation* 10:4480-7
 158. Ho J, Newcomer MB, Ragain CM, Gascon J A, Batista ER, et al. 2014. MoD-QM/MM Structural Refinement Method: Characterization of Hydrogen Bonding in the Oxytricha nova G-Quadruplex. *Journal of chemical theory and computation* 10:5125-35
 159. Araujo AR, Ribeiro AJ, Fernandes PA, Ramos MJ. 2014. Catalytic Mechanism of Retroviral Integrase for the Strand Transfer Reaction Explored by QM/MM Calculations. *Journal of chemical theory and computation* 10:5458-66
 160. Li Z, Wu Y, Feng LJ, Wu R, Luo HB. 2014. Ab Initio QM/MM Study Shows a Highly Dissociated SN2 Hydrolysis Mechanism for the cGMP-Specific Phosphodiesterase-5. *Journal of chemical theory and computation* 10:5448-57
 161. Park JW, Rhee YM. 2014. Diabatic Population Matrix Formalism for Performing Molecular Mechanics Style Simulations with Multiple Electronic States. *Journal of chemical theory and computation* 10:5238-53
 162. Elward JM, Irudayanathan FJ, Nangia S, Chakraborty A. 2014. Optical Signature of Formation of Protein Corona in the Firefly Luciferase-CdSe Quantum Dot Complex. *Journal of chemical theory and computation* 10:5224-8
 163. Ruswandi, R. (2018) "Determination of Fructose Content resulted by Inulin Hydrolysis with DNS as Oxidizer", EKSakta: Berkala Ilmiah Bidang MIPA, 19(1), pp. 14-23. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/102>.
 164. Sanjaya, H. (2018) "DEGRADASI METIL VIOLET MENGGUNAKAN KATALIS ZnO-TiO₂ SECARA FOTOSONOLISIS", EKSakta: Berkala Ilmiah Bidang MIPA, 19(1), pp. 91-99. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/131>.
 165. Hidayani, T. (2018) "GRAFTING POLIPROPILENA DENGAN MALEAT ANHIDRIDA SEBAGAI PENGIKAT SILANG DENGAN INISIATOR BENZOIL PEROKSIDA", EKSakta: Berkala Ilmiah Bidang MIPA, 19(1), pp. 56-62. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/127>.
 166. Prabowo, H. (2018) "PENYELIDIKAN KELAYAKAN KIMIA DAN PENYEBARAN CADANGAN PASIR BESI DAERAH TIKU KABUPATEN AGAM UNTUK BAHAN BAKU SEMEN PADA PT. SEMEN PADANG", EKSakta: Berkala Ilmiah Bidang MIPA, 19(1), pp. 39-42. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/121>.
 167. Syafei, N. (2018) "Riset Material ANALISA FENOMENA KOROSI PELAT PIPA BAJA KARBON API 5L-X65 DALAM LARUTAN 7900 ML AIR LAUT DAN 100 ML AMONIAK PADA KONDISI GAS CO₂ DAN H₂S JENUH PADA SUHU RUANG.", EKSakta: Berkala Ilmiah Bidang MIPA, 19(1), pp. 7-13. doi: <https://doi.org/10.24036/eksakta/vol19-iss1/83>.
 168. Fang J, Wu P, Yang R, Gao L, Li C, et al. 2014. Inhibition of acetylcholinesterase by two genistein derivatives: kinetic analysis, molecular docking and molecular dynamics simulation. *Acta pharmaceutica Sinica*. B4:430-7
 169. van de Streek J, Neumann MA. 2014. Validation of molecular crystal structures from powder diffraction data with dispersion-corrected density functional theory (DFT-D). *Acta crystallographica Section B, Structural science, crystal engineering and materials* 70:1020-32
 170. Rinaldelli M, Carlon A, Ravera E, Parigi G, Luchinat C. 2015. FANTEN: a new web-based interface for the analysis of magnetic anisotropy-induced NMR data. *Journal of biomolecular NMR* 61:21-34
 171. Strutynski K, Gomes JA, Melle-Franco M. 2014. Accuracy of dispersion interactions in semiempirical and molecular mechanics models: the benzene dimer case. *The*

- journal of physical chemistry. A* 118:9561-7
172. Korkosh VS, Zhorov BS, Tikhonov DB. 2014. Folding similarity of the outer pore region in prokaryotic and eukaryotic sodium channels revealed by docking of conotoxins GIIIA, PIIIA, and KIIIA in a NavAb-based model of Nav1.4. *The Journal of general physiology* 144:231-44
 173. Babu CS, Lee YM, Dudev T, Lim C. 2014. Modeling Zn(2)(+) release from metallothionein. *The journal of physical chemistry. A* 118:9244-52
 174. Lexa KW, Goh GB, Carlson HA. 2014. Parameter choice matters: validating probe parameters for use in mixed-solvent simulations. *Journal of chemical information and modeling* 54:2190-9
 175. Parbuntari, H., Prestica, Y., Gunawan, R., Nurman, M. and Adella, F. (2018) "Preliminary Phytochemical Screening (Qualitative Analysis) of Cacao Leaves (*Theobroma cacao* L.)", EKSAKTA: Berkala Ilmiah Bidang MIPA, 19(2), pp. 40-45. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/142>.
 176. Dinata, M. and Soehardi, F. (2018) "Factor Analysis of Physics Chemistry Waters that Affects Damage Safety Cliff on the Outskirts of River Siak", EKSAKTA: Berkala Ilmiah Bidang MIPA, 19(2), pp. 46-49. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/143>.
 177. Sofyanita, S. and Octaria, Z. (2018) "Fenthion Compound Degradation in the Pesticide Bayleton 500 ec in Sonolysis, Ozonolysis and Sonozolysis with Addition of TiO₂-anatase", EKSAKTA: Berkala Ilmiah Bidang MIPA, 19(2), pp. 70-79. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/153>.
 178. Harahap, F. and Lubis, L. (2018) "Analysis of Heavy Metals Distribution in the River Town of Hamasaki's Rod Padangsidimpuan", EKSAKTA: Berkala Ilmiah Bidang MIPA, 19(2), pp. 50-56. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/149>.
 179. Syafei, N., Hidayat, D., Emilliano, E. and Men, L. (2018) "Analysis Cracking Corrosion on Carbon Steel Pipes API 5L-X65 In Solution 7700 ml Aquades, 250 ml Acetic Acid and 50 ml Ammonia with Gas CO₂ and H₂S in Saturation Condition", EKSAKTA: Berkala Ilmiah Bidang MIPA, 19(2), pp. 21-31. doi: <https://doi.org/10.24036/eksakta/vol19-iss2/138>.
 180. Wu Q. 2014. Variational nature of the frozen density energy in density-based energy decomposition analysis and its application to torsional potentials. *The Journal of chemical physics* 140:244109
 181. Semperebon C, Forsberg P, Priest C, Brinkmann M. 2014. Pinning and wicking in regular pillar arrays. *Soft matter* 10:5739-48
 182. Zille P, Corpetti T, Shao L, Chen X. 2014. Observation model based on scale interactions for optical flow estimation. *IEEE transactions on image processing : a publication of the IEEE Signal Processing Society* 23:3281-93
 183. Zhu L, Niu T, Petrongolo M. 2014. Iterative CT reconstruction via minimizing adaptively reweighted total variation. *Journal of X-ray science and technology* 22:227-40
 184. Hargis J C, White J K, Chen Y, Woodcock HL. 2014. Can molecular dynamics and QM/MM solve the penicillin binding protein protonation puzzle? *Journal of chemical information and modeling* 54:1412-24
 185. Teteruk J L, Glinnemann J, Gorelik TE, Linden A, Schmidt MU. 2014. Explanation of the stacking disorder in the beta-phase of Pigment Red 170. *Acta crystallographica Section B, Structural science, crystal engineering and materials* 70:296-305
 186. Greco J A, Rossi A, Birge RR, Bruckner C. 2014. A spectroscopic and theoretical investigation of a free-base meso-trithienylcorrole. *Photochemistry and photobiology* 90:402-14
 187. Hatfield MP, Lovas S. 2014. Conformational sampling techniques. *Current pharmaceutical design* 20:3303-13
 188. Arumugam K, Crouzy S, Chevigne A, Seguin-Devaux C, Schmit J C. 2014. Structure prediction of GPCRs using piecewise homologs and application to the human CCR5 chemokine receptor: validation through agonist and antagonist docking. *Journal of*

- biomolecular structure & dynamics* 32:1274-89
189. Cohen SB. 2001. Transitions in Health Insurance Coverage Over Time, 2009-2013 (Selected Intervals): Estimates for the U.S. Civilian Noninstitutionalized Adult Population under Age 65. In *Statistical Brief (Medical Expenditure Panel Survey (US))*. Rockville (MD). Number of.
 190. Guclu CY, Meco BC, Karamustafa M, Kecik Y. 2017. Maintenance of balance between airway pressure and intracranial pressure in a patient with tracheal stenosis undergoing craniotomy: a case report. *Brazilian journal of anesthesiology* 67:92-4
 191. Law C, Cole T, Cummins S, Fagg J, Morris S, Roberts H. 2014. In *A pragmatic evaluation of a family-based intervention for childhood overweight and obesity*. Southampton (UK). Number of.
 192. Margolis KL, Fosco GM, Stormshak EA. 2016. Circle of Care: Extending Beyond Primary Caregivers to Examine Collaborative Caretaking in Adolescent Development. *Journal of family issues* 37:1179-202
 193. Tennekoon V, Rosenman R. 2016. Systematically Misclassified Binary Dependent Variables. *Communications in statistics: theory and methods* 45:2538-55
 194. Cooley PC, Clark RF, Folsom RE. 2014. In *Assessing Gene-Environment Interactions in Genome-Wide Association Studies: Statistical Approaches*. Research Triangle Park (NC). Number of.
 195. Vecchio SL, Petersen LJ, Finocchietti S, Gazerani P, Arendt-Nielsen L, Graven-Nielsen T. 2014. Hyperalgesia and allodynia to superficial and deep-tissue mechanical stimulation within and outside of the UVB irradiated area in human skin. *Scandinavian journal of pain* 5:258-67
 196. Sigveland J, Sundseth OO, Dalsbo TK, Harboe I, Leiknes K. 2014. In *Psychometric Assessment of the Norwegian Version of the California Verbal Learning Test II (CVLT-II)*. Oslo, Norway. Number of.
 197. Gitimbwa SS. 2014. Caring Mental Patients Sharing the Same Rooms with Somatic Patients in General and Referral Hospitals in Rwanda: Analysis of Disadvantages and Advantages. *Online international interdisciplinary research journal : an international multidisciplinary journal* 4:14-27
 198. Hu J, Yan J, Rao G, Latha K, Overwijk WW, et al. 2016. The Duality of Fgl2 - Secreted Immune Checkpoint Regulator Versus Membrane-Associated Procoagulant: Therapeutic Potential and Implications. *International reviews of immunology* 35:325-39
 199. 2014. In *Canagliflozin / Metformin – Benefit Assessment According to section sign35a Social Code Book V*. Cologne, Germany. Number of.
 200. 2014. In *Dapagliflozin / Metformin – Benefit Assessment According to section sign35a Social Code Book V*. Cologne, Germany. Number of.
 201. Obdeijn MC, Horeman T, de Boer LL, van Baalen SJ, Livermeaux P, Tuijthof GJ. 2016. Navigation forces during wrist arthroscopy: assessment of expert levels. *Knee surgery, sports traumatology, arthroscopy: official journal of the ESSKA* 24:3684-92
 202. Muhuri PK. 2013. Serious Psychological Distress and Mortality among Adults in the U.S. Household Population: Highlights. In *The CBHSQ Report*:1-6. Rockville (MD). Number of 1-6 pp.
 203. Balakrishnan S, Srinivasan M, Mohanraj J. 2016. Biosynthesis of silver nanoparticles from mangrove plant (*Avicennia marina*) extract and their potential mosquito larvicidal property. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:991-6
 204. Rameshkumar G, Ramesh M, Ravichandran S, Trilles J P. 2016. Parasitic isopods from marine fishes off Nagapattinam coast, India. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:940-4
 205. Khan YA, Khan MA, Abidi SM. 2016. 2D-PAGE analysis of the soluble proteins of the tropical liver fluke, *Fasciola gigantica* and biliary amphistome, *Gigantocotyle explanatum*, concurrently infecting *Bubalus bubalis*. *Journal of parasitic diseases :*

- official organ of the Indian Society for Parasitology*40:910-3
206. Lone BA, Chishti MZ, Ahmad F, Tak H, Bandh SA, Khan A. 2016. A field survey on the status of gastrointestinal helminth parasites in hangul (*Cervus elaphus hanglu*) in Dachigam National Park of Kashmir. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology*40:750-5
 207. Chen M, Pendrill R, Widmalm G, Brady JW, Wohler J. 2014. Molecular Dynamics Simulations of the Ionic Liquid 1-n-Butyl-3-Methylimidazolium Chloride and Its Binary Mixtures with Ethanol. *Journal of chemical theory and computation*10:4465-79
 208. Crowell KL, Baker ES, Payne SH, Ibrahim YM, Monroe ME, et al. 2013. Increasing Confidence of LC-MS Identifications by Utilizing Ion Mobility Spectrometry. *International journal of mass spectrometry*354-355:312-7
 209. Zhao H, Zhai S. 2013. The Influence of Dielectric Decrement on Electrokinetics. *Journal of fluid mechanics*724:69-94
 210. Downs PW, Massoudi N, Dick A, Kabore A, Rothrock G, Blough B. 2017. In *New Tools for the Schistosomiasis Elimination Toolbox: Barriers and Opportunities for the Development of a Topical Cercarial Anti-Penetrant*. Research Triangle Park (NC). Number of.
 211. Shen GC, Eaton J, Snowden LR. 2017. Mainstreaming Mental Health Care in 42 Countries. *Health systems and reform*3:313-24
 212. Silva D, Ribeiro GE, Castilho GL, Mantovani JC. 2018. Outcomes of Automated Auditory Evoked Potential Performed in Different Settings and the Factors Associated with Referred Cases. *International archives of otorhinolaryngology*22:342-7
 213. Gabriel LB, Vernier LS, Ferreira M, Silveira AL, Machado MS. 2018. Parameters for Applying the Brainstem Auditory Evoked Potential with Speech Stimulus: Systematic Review. *International archives of otorhinolaryngology*22:460-8
 214. de Ponte AM, Guirro EC, Pletsch AH, Dibai-Filho AV, Brandino HE, Guirro RR. 2015. The forearm positioning changes electromyographic activity of upper limb muscles and handgrip strength in the task of pushing a load cart. *Journal of bodywork and movement therapies*19:597-603
 215. Sundar ST, Latha BR, Vijayashanthi R, Pandian SS. 2016. (Z)-9-Tricosene based *Musca domestica* lure study on a garbage dump yard using plywood sticky trap baited with fish meal. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology*40:32-5
 216. George BP, Parimelazhagan T, Kumar YT, Sajeesh T. 2015. Antitumor and Wound Healing Properties of *Rubus ellipticus* Smith. *Journal of acupuncture and meridian studies*8:134-41
 217. Lobato DC, Lacerda AB, Goncalves CG, Coifman H. 2014. Auditory effects of exposure to noise and solvents: a comparative study. *International archives of otorhinolaryngology*18:136-41
 218. Paes AT, Dias BF, Eleuterio GN, Paula VP. 2018. Profile of medical students in the first group of the Faculdade Israelita de Ciencias da Saude Albert Einstein. *Einstein*16:eAO4228
 219. Schwartz CE, Zhang J, Rapkin BD, Finkelstein JA. 2018. Reconsidering the minimally important difference: evidence of instability over time and across groups. *The spine journal : official journal of the North American Spine Society*
 220. Wang T, Hosgood HD, Lan Q, Xue X. 2018. The Relationship Between Population Attributable Fraction and Heritability in Genetic Studies. *Frontiers in genetics*9:352
 221. Katz MJ, Wang C, Derby CA, Lipton RB, Zimmerman ME, et al. 2018. Subjective Cognitive Decline Prediction of Mortality: Results from the Einstein Aging Study. *Journal of Alzheimer's disease : JAD*66:239-48
 222. Gellhorn AC, Stumph JM, Zikry HE, Creelman CA, Welbel R. 2018. Ultrasound measures of muscle thickness may be superior to strength testing in adults with knee osteoarthritis: a cross-sectional study. *BMC musculoskeletal disorders*19:350

223. Seixas AA, Vallon J, Barnes-Grant A, Butler M, Langford AT, et al. 2018. Mediating effects of body mass index, physical activity, and emotional distress on the relationship between short sleep and cardiovascular disease. *Medicine* 97:e11939
224. Ren Y, Korom M, Truong R, Chan D, Huang SH, et al. 2018. Susceptibility to Neutralization by Broadly Neutralizing Antibodies Generally Correlates with Infected Cell Binding for a Panel of Clade B HIV Reactivated from Latent Reservoirs. *Journal of virology*
225. Luque Ruiz I, Gomez-Nieto MA. 2018. Regression Modelability Index: A New Index for Prediction of the Modelability of Data Sets in the Development of QSAR Regression Models. *Journal of chemical information and modeling* 58:2069-84
226. Ok HE, Kang YW, Kim M, Chun HS. 2013. T-2 and HT-2 toxins in cereals and cereal-based products in South Korea. *Food additives & contaminants. Part B, Surveillance* 6:103-9
227. Zhu Y, Pan L, Hong M, Liu W, Qiao C, et al. 2016. The combination therapy of imatinib and dasatinib achieves long-term molecular response in two imatinib-resistant and dasatinibintolerant patients with advanced chronic myeloid leukemia. *Journal of biomedical research* 30:525-8
228. Singh A, Hemal A, Agarwal S, Dubey NK, Buxi G. 2016. A prospective study of haematological changes after switching from stavudine to zidovudine-based antiretroviral treatment in HIV-infected children. *International journal of STD & AIDS* 27:1145-52
229. Singh VK, Subudhi BB. 2016. Development and characterization of lysine-methotrexate conjugate for enhanced brain delivery. *Drug delivery* 23:2327-37
230. Ahmad N, Ahmad I, Umar S, Iqbal Z, Samim M, Ahmad FJ. 2016. PNIPAM nanoparticles for targeted and enhanced nose-to-brain delivery of curcuminoids: UPLC/ESI-Q-ToF-MS/MS-based pharmacokinetics and pharmacodynamic evaluation in cerebral ischemia model. *Drug delivery* 23:2095-114
231. ElMeshad AN, Mohsen AM. 2016. Enhanced corneal permeation and antimycotic activity of itraconazole against *Candida albicans* via a novel nanosystem vesicle. *Drug delivery* 23:2115-23
232. Bhattacharya P, Ali N. 2016. Treatment of visceral leishmaniasis: anomalous pricing and distribution of AmBisome and emergence of an indigenous liposomal amphotericin B, FUNGISOME. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:1094-5
233. Aminou HA, Alam-Eldin YH, Hashem HA. 2016. Effect of *Nigella sativa* alcoholic extract and oil, as well as *Phaseolus vulgaris* (kidney bean) lectin on the ultrastructure of *Trichomonas vaginalis* trophozoites. *Journal of parasitic diseases : official organ of the Indian Society for Parasitology* 40:707-13
234. Yoon U, Marinelli L, Ali S, Huberfeld S, Barrera R, Chang J B. 2016. Early Amiodarone-Induced Pulmonary Toxicity after Endovascular Aneurysm Repair: A Case Report. *The International journal of angiology : official publication of the International College of Angiology, Inc* 25:189-92
235. Soni A, Kanaujia SK, Kaushik S. 2016. Brainstem Evoked Response Audiometry (BERA) in Neonates with Hyperbilirubinemia. *Indian journal of otolaryngology and head and neck surgery : official publication of the Association of Otolaryngologists of India* 68:334-8
236. Grandhi GK, Swathi K, Narayan KS, Viswanatha R. 2014. Cu Doping in Ligand Free CdS Nanocrystals: Conductivity and Electronic Structure Study. *The journal of physical chemistry letters* 5:2382-9
237. Tandon B, Shanker GS, Nag A. 2014. Multifunctional Sn- and Fe-Codoped In₂O₃ Colloidal Nanocrystals: Plasmonics and Magnetism. *The journal of physical chemistry letters* 5:2306-11
238. Hutchins DO, Acton O, Weidner T, Cernetic N, Baio J E, et al. 2012. Solid-State Densification of Spun-Cast Self-Assembled Monolayers for Use in Ultra-Thin Hybrid Dielectrics. *Applied surface science* 261