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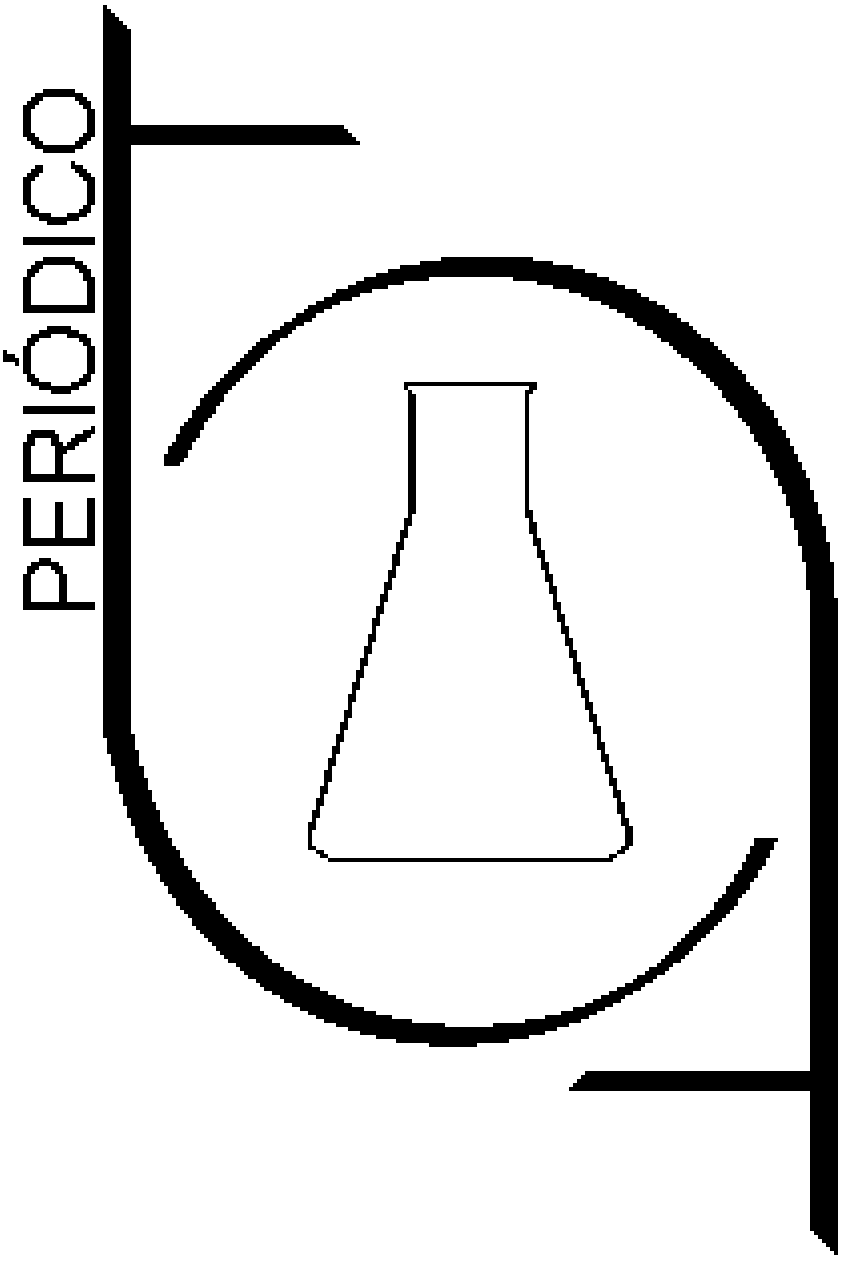

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Índice

Words from the Editors …….. I

1- Artigo / Article

DORSKAIA, E. V.; PESTOV, S. M.; LEYKIN, Y. A.

RÚSSIA

ESTUDO DA PLASMASORÇÃO DE LIPOPROTEÍNA IN VITRO POR SORBENTE POLIMÉRICO COM GRUPOS MONOETANOLAMINA

STUDY OF THE IN VITRO LIPOPROTEIN PLASMASORPTION BY POLYMERIC SORBENT WITH MONOETHANOLAMINE GROUPS

Página – 1

2- Artigo / Article

RUCHIN, A. B.

RÚSSIA

EFEITO DA ILUMINAÇÃO NO CRESCIMENTO E COMPORTAMENTO DE DUAS ESPÉCIES DE PEIXE CARPA (*CARASSIUS GIBELIO E C. CARASSIUS*)

EFFECT OF ILLUMINATION ON GROWTH AND BEHAVIOR OF TWO CARP FISH SPECIES (CARASSIUS GIBELIO AND C. CARASSIUS)

Página – 8

3- Artigo / Article

DE MENEZES, J. C.; GOMES, F. DE C. O.; MACHADO, A. M. R.

BRASIL

ANÁLISE DE COMPOSTOS VOLÁTEIS E CONTROLE DE QUALIDADE EM ESMALTES DE UNHA

ANALYSIS OF VOLATILE AND QUALITY CONTROL IN NAIL POLISH

Página – 18

4- Artigo / Article

ANDREYCHEV, A.

RÚSSIA

NOVOS MÉTODOS PARA ESTUDAR A ATIVIDADE DE MAMÍFEROS SEMIAQUATICOS

NEW METHODS FOR STUDYING THE ACTIVITY OF SEMIAQUATIC MAMMALS

Página – 38

5- Artigo / Article

SCHMIDT, G. R.

BRASIL

PRODUÇÃO LABORATORIAL DA ERVA-MATE (ILEX PARAGUARIENSIS) PARA CHIMARRÃO – UMA COMPARAÇÃO COM AS CARACTERÍSTICAS DE PRODUTOS DISPONÍVEIS NO MERCADO

LABORATORY PRODUCTION OF HERB-MATE (ILEX PARAGUARIENSIS) FOR HOT MATE – A PARALLEL WITH THE CHARACTERISTICS OF PRODUCTS AVAILABLE ON THE MARKET.

Página – 34

6- Artigo / Article

MANTASHLOU, M. J.; PIRI, K. and DELJU, A.

IRÃ

INVESTIGANDO OS EFEITOS DO EXTRATO AQUOSO DE CASCA DE SALGUEIRO (SALICACEAE) EM PARÂMETROS URINÁRIOS, PESO RELATIVO, FÍGADO E ÍNDICES DE FUNÇÃO RENAL EM RATOS

INVESTIGATING THE EFFECTS OF AQUEOUS EXTRACT OF WILLOW BARK (SALICACEAE) ON URINARY PARAMETERS, RELATIVE WEIGHT, LIVER AND RENAL FUNCTION INDICES IN RAT

Página – 42

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7- Artigo / Article

ZAKHAROV, V. L.; ZUBKOVA, T. V.

RÚSSIA.

CONTEÚDO DE SUBSTÂNCIAS BIOLÓGICAMENTE ATIVAS E METAIS PESADOS NAS MAÇÃS DE UMA CADEIA DE VAREJO NA REGIÃO DE LIPETSK (RUSSIA), DEPENDENDO DAS VARIEDADES DE MAÇÃS

THE CONTENT OF BIOLOGICALLY ACTIVE SUBSTANCES AND HEAVY METALS IN THE APPLES OF A RETAIL CHAIN IN THE LIPETSK REGION DEPENDING ON THE APPLE TREES VARIETIES

Página - 51

8- Artigo / Article

TELES, A. C.; FREITAS, A. C. de P.; RODRIGUES, A. C.

BRASIL.

COMPARAÇÃO DE MÉTODOS DE DETECÇÃO DE FALHAS EM PROCESSOS QUÍMICOS UTILIZANDO INTELIGÊNCIA ARTIFICIAL

FAILURES DETECTION METHODS IN CHEMICAL PROCESS USING ARTIFICIAL INTELLIGENCE

Página – 61

9- Artigo / Article

HORA, P. H. A.; SOUSA, A. C.; SERRA, R. B. G.; RODRIGUES, K. K. P.; FIGUÊIREDO, G. J. A.

BRASIL.

OTIMIZAÇÃO DE PROCESSO DE ADSORÇÃO DE METAIS TÓXICOS EM EFLUENTES GERADOS EM LABORATÓRIO ATRAVÉS DE CAULINITA E DERIVADOS

OPTIMIZATION OF PROCESS OF ADSORTION OF TOXIC METALS IN LABORATORY GENERATED EFFLUENTS THROUGH CAULINITE AND DERIVATIVES

Página – 69

10- Artigo / Article

ALMEIDA, M. V. de A.; SILVA, E. M. da; GOMES, N. Â.; NUNES, L. A. O.; CURI, W. F.

BRASIL

QUALIDADE AMBIENTAL DO ATERRO SANITÁRIO DE CAMPINA GRANDE COM BASE EM ASPECTOS TÉCNICOS E OPERACIONAIS

ENVIRONMENTAL QUALITY OF CAMPINA GRANDE LANDFILL BASED ON TECHNICAL AND OPERATIONAL ASPECTS

Página – 77

11- Artigo / Article

PASSOS, M. M. da S.; FERNANDES, E. P.; GUALBERTO, S. A., SILVA, S. L. da C. e DA SILVA, D. C.

BRASIL

DETERMINAÇÃO DE FENÓLICOS E FLAVONOIDES TOTAIS E AVALIAÇÃO DA CAPACIDADE ANTIOXIDANTE DE EXTRATOS DE *POINCIANELLA BRACTEOSA* (FABACEAE)

TOTAL PHENOLICS AND FLAVONOIDS DETERMINATION AND ANTIOXIDANT CAPACITY EVALUATION OF POINCIANELLA BRACTEOSA (FABACEAE) EXTRACTS

Página – 87

12- Artigo / Article

SUVOROVA, Galina N.; VOLOGDINA, Natalia N.; AVVAKUMOV, Nadezhda P.; KRIVOPALOVA, Maria Y.

RÚSSIA.

RESPOSTA DA REGENERAÇÃO PÓS-TRAUMÁTICA DO MÚSCULO ESQUELÉTICO À MEDICAMENTAÇÃO DE PELÓIDE HÚMICA

SKELETAL MUSCLE POSTTRAUMATIC REGENERATION RESPONSE TO HUMIC PELOID MEDICATION

Página – 96

13- Artigo / Article

KLUNK, M. A.; DASGUPTA, S.; DAS, M.; WANDER, P. R.

ÍNDIA / BRASIL.

CÓDIGOS COMPUTACIONAIS DE MODELAGEM GEOQUÍMICA UTILIZADOS PARA INTERAÇÃO ÁGUA-ROCHA EM SISTEMAS SIMPLES E COMPLEXOS

COMPUTER CODES OF GEOCHEMICAL MODELING USED TO WATER-ROCK INTERACTION SIMPLE AND COMPLEX SYSTEMS

Página – 108

14- Artigo / Article

MALEKI HASAN ABADI, H.; DASHTI, H.

IRÃ

LOCALIZAÇÃO IDEAL DE UM SISTEMA FOTOVOLTAICO PARA MELHORAR O PERFIL DE VOLTAGEM, CONSIDERANDO AS LIMITAÇÕES DE POTÊNCIA ATIVA E REATIVA

OPTIMAL LOCATION OF A PHOTOVOLTAIC SYSTEM TO IMPROVE THE VOLTAGE PROFILE CONSIDERING THE ACTIVE AND REACTIVE POWER LIMITATIONS

Página – 119

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15- Artigo / Article

BATALINI, C.; DE GIOVANI, W. F.;

BRASIL

SÍNTESE E CARACTERIZAÇÃO DE UM NOVO AQUACOMPLEXO DIARSÍNICO DE RUTÊNIO (II)

SYNTHESIS AND CHARACTERIZATION OF A NEW RUTHENIUM (II) DIARSINIC AQUACOMPLEX

Página – 130

16- Artigo / Article

ZAKHAROV, V. P.; KHUSNULLIN, A. G.; ZAKHAROVA, E. M.; SHURSHINA, A. S.; KULISH, E. I.;

RÚSSIA

PREPARAÇÃO DE COMPOSIÇÕES DE MISTURAS BASEADAS EM POLIPROPILENO SECUNDÁRIO COM PROPRIEDADES FISICO-MECÂNICAS CONTROLADAS

PREPARATION OF BLENDING COMPOSITIONS BASED ON SECONDARY POLYPROPYLENE WITH CONTROLLED PHYSICO-MECHANICAL PROPERTIES

Página – 139

17- Artigo / Article

LELKOV, K. S.; KURIS, E. D.; STOLYAROV, Y. V.; NIKITENKO, I A.; KRAPIVIN, S. V.;

RÚSSIA

PEQUENO ROBÔ UNIAXIAL DE DUAS RODAS PARA LABORATÓRIO EDUCACIONAL

SMALL-SIZED UNIAXIAL TWO-WHEEL ROBOT FOR EDUCATIONAL LABORATORY

Página – 147

18 - Artigo / Article

MASLENNIKOVA, N. N.; GIBADULINA, I. I.

RÚSSIA

A POSIÇÃO DA COMPETÊNCIA AMBIENTAL NA ESTRUTURA DA PREPARAÇÃO ORIENTADA POR PRÁTICA DE ESTUDANTES DE ENGENHARIA

THE POSITION OF ENVIRONMENTAL COMPETENCE IN THE STRUCTURE OF THE PRACTICE-ORIENTED PREPARATION OF ENGINEERING STUDENTS

Página – 168

19- Artigo / Article

Almahy, H. A.; Abdel-Razik, H. H.; El-Badry, Y. A.

ARÁBIA SAUDITA, SUDÃO, EGITO.

ULTRASONICAÇÃO DE CUCUMIS MELO VERSUS PERCOLAÇÃO: POLIFENOIS, FLAVONÓIDES TOTAIS E EXTRATO DE BETA-CAROTENO COMO CORANTES NATURAIS

ULTRASONICATION OF CUCUMIS MELO VERSUS PERCOLATION: POLY PHENOL, TOTAL FLAVONOID, AND BETA–CAROTENE EXTRACT AS NATURAL DYES

Página – 186

20- Artigo / Article

DE SOUZA, E. F.; SANTOS, M. do S. M.; SILVA, C. A. de A.; FIORUCCI, A. R.; BATISTOTE, M.

BRASIL

CAPACIDADE DEGRADATIVA DE OLEOS VEGETAIS POR BACILLUS SUBTILIS E CARACTERIZAÇÃO FÍSICO-QUÍMICA DE ÓLEOS RESIDUAIS DE FRITURA

VEGETABLE OILS DEGRADING CAPACITY BY BACILLUS SUBTILIS AND PHYSICO-CHEMICAL CHARACTERIZATION OF WASTE FRYING OILS

Página – 196

21- Artigo / Article

FADIAWATI, N.; DIAWATI, C.; SYAMSURI, M. M. F.

INDONÉSIA

CONSTRUINDO UM APARELHO DE DESTILAÇÃO SIMPLES ATRAVÉS DE MATERIAIS USADOS USANDO APRENDIZAGEM BASEADA EM PROJETOS

CONSTRUCTING A SIMPLE DISTILLATION APPARATUS FROM USED GOODS BY USING PROJECT-BASED LEARNING

Página – 207

22- Revisão / Review

CAPARICA, R.; ROZISCA, E. A.; MACENA, J. C.; CAMPOS, L. de A.; GRIGOLETTO, D. F.

BRASIL

APLICAÇÕES FARMACOLÓGICAS DA MELATONINA

PHARMACOLOGICAL APPLICATIONS OF MELATONIN

Página – 214

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23- Artigo / Article

ORDOUEE, B.; HASHEMINEZHAD, H.

IRÃ

MEDIÇÃO E ADSORÇÃO DE IONS DE METAIS PESADOS A PARTIR DE ÁGUA COM NANO-ADSORBENTES POROSOS POR MÉTODO DE ABSORÇÃO ATÔMICA

MEASUREMENT AND ADSORPTION OF HEAVY METALS ION FROM WATER USING POROUS NANO-ADSORBENTS BY ATOMIC ABSORPTION METHOD

Página - 228

24- Artigo / Article

ARAÚJO, S. G.; AMADO, P. A.; PINTO, M. E. A.; CASTRO, A. H. F.; LIMA, L. A. R. dos S.

BRASIL

FENÓLICOS TOTAIS E POTENCIAL ANTIOXIDANTE DE CINCO ESPÉCIES DA FAMÍLIA LAMIACEAE

TOTAL PHENOL AND ANTIOXIDANT POTENTIAL OF FIVE SPECIES OF LAMIACEAE FAMILY

Página – 239

25- Artigo / Article

SYAMSURI, M. M. F.; FADIAWATI, N.

INDONÉSIA

REVELANDO AS CONCEPÇÕES DOS PROFESSORES DE QUÍMICA PRÉ-SERVIÇOS SOBRE ORBITAL ATÔMICO DE HIDROGÊNIO USANDO TESTES ABERTOS: UM ESTUDO DE CASO NA INDONÉSIA

REVEALING PRE-SERVICE CHEMISTRY TEACHERS' CONCEPTIONS OF HYDROGEN ATOMIC ORBITALS USING OPEN-ENDED TESTS: A CASE STUDY IN INDONESIA

Página - 250

26- Artigo / Article

GONÇALVES, T. P. R.; LIMA, W. G.; SILVA, I. C. A.; PARREIRA, A. G.; LIMA, L. A. R. dos S.

BRASIL

ATIVIDADE ANTIBACTERIANA DO EXTRATO ETANÓLICO DE *Eugenia dysenterica* DC (MYRTACEAE)

ANTIBACTERIAL ACTIVITY OF THE ETHANOL EXTRACT OF Eugenia dysenterica DC (MYRTACEAE)

Página – 257

27- Artigo / Article

RAMOS, V. M. B.; RÖHNELT, M. G.; BRAMBILLA, R.

BRASIL

COMPÓSITOS DE PEAD/SÍLICA -PARTE I: PREPARAÇÃO E CARACTERIZAÇÃO DE SÍLICAS ORGANOFUNCIONALIZADAS COM GRUPOS METILSILANO E OCTILSILANO

HDPE/SILICA COMPOSITES- PART I: PREPARATION AND CHARACTERIZATION OF METHYLSILANE AND OCTYLSILANE-MODIFIED SILICAS

Página - 263

28- Artigo / Article

KLUNK, M. A.; SHAH, Z.; WANDER, P. R.

BRASIL

UTILIZAÇÃO DA ARGILA MONTMORILONITA PARA ADSORÇÃO DO CORANTE VERDE MALAQUITA

USE OF MONTMORILLONITE CLAY FOR ADSORPTION MALACHITE GREEN DYE

Página – 279

29- Artigo / Article

RAMOS, V. M. B.; RÖHNELT, M. G.; BRAMBILLA, R.

BRASIL

COMPÓSITOS DE PEAD/SÍLICA-PARTE II: EFEITO DO TAMANHO DE PARTÍCULA E DA MODIFICAÇÃO DA SÍLICA SOBRE AS PROPRIEDADES TÉRMICAS E MECÂNICAS

HDPE/SILICA COMPOSITES-PART II: EFFECT OF SILICA PARTICLE SIZE AND SILICA MODIFICATION ON THE THERMAL AND MECHANICAL PROPERTIES

Página - 287

30- Artigo / Article

SKOROBOGATOVA, Olga N.1; YUMAGULOVA, E. R.; STORCHAK, T. V.; IVANOVA, N. A.

RÚSSIA.

FITOPLÂNCTON DE ÁGUAS DE SUPERFÍCIE SOB A POLUIÇÃO DE ÓLEO (CAMPO DE SAMOTLOR, SIBÉRIA OCIDENTAL)

PHYTOPLANKTON OF SURFACE WATERS UNDER OIL POLLUTION (SAMOTLOR FIELD, WESTERN SIBERIA)

Página – 306

31- Artigo / Article

CASTRO, Douglas A.; PEREIRA, Douglas H.; LEAL, Paulo V. B.

QUIRGUISTÃO

ALGUNS PARÂMETROS DO SISTEMA IMUNE EM LESÕES EM CONDIÇÕES MONTANHOSAS

SOME PARAMETERS OF THE IMMUNE SYSTEM AT INJURIES IN HIGHLAND CONDITIONS

Página – 321

32- Artigo / Article

RABINSKIY, L. N.

RÚSSIA

PROBLEMA NÃO ESTACIONÁRIO DO PLANO DE DIFRAÇÃO DE ONDA DE PRESSÃO OBLÍQUA EM CONCHA FINA NA FORMA DE CILINDRO PARABÓLICO

NON-STATIONARY PROBLEM OF THE PLANE OBLIQUE PRESSURE WAVE DIFFRACTION ON THIN SHELL IN THE SHAPE OF PARABOLIC CYLINDER

Página – 328

33- Artigo / Article

BULYCHEV, N. A.; RABINSKIY, Lev N.

RÚSSIA

MODIFICAÇÃO DE SUPERFÍCIES DE NANOPARTICULAS DE DIÓXIDO DE TITÂNIO COM COPOLÍMERO DE ÁCIDO ACRÍLICO / ISOBUTILENO SOB TRATAMENTO ULTRASÔNICO

SURFACE MODIFICATION OF TITANIUM DIOXIDE NANOPARTICLES WITH ACRYLIC ACID/ISOBUTYLENE COPOLYMER UNDER ULTRASONIC TREATMENT

Página - 338

34- Artigo / Article

UNASPEKOV, B. A.; ZHUMADILOVA, Z. O.; AUELBEKOV, S. S.; TAUBALDIEVA, A. S.; ALDABERGENOVA, Gaziza B.

CAZAQUISTÃO

INVESTIGAÇÃO DOS PROCESSOS DE DISTRIBUIÇÃO DO CALOR NA SUPERFÍCIE INTERNA DA ESTRUTURA DE ENTREGA, TENDO EM CONTA O MOVIMENTO DO AR NA ZONA DE LIMITE ENTRE O DISPOSITIVO E A VEDAÇÃO

INVESTIGATION OF HEAT DISTRIBUTION PROCESSES ON THE INNER SURFACE OF THE ENCLOSING STRUCTURE, TAKING INTO ACCOUNT THE MOVEMENT OF AIR IN THE BOUNDARY AREA BETWEEN THE DEVICE AND FENCING

Página - 345

35- Artigo / Article

PETROV, S. A.; MAMAEVA, N. L.; NARUSHKO, M. V.

RÚSSIA

TECNOLOGIA PROBLEMA-DIÁLOGO DE FORTALECER COMPETÊNCIA AMBIENTAL ENTRE ESPECIALISTAS PARA O TRABALHO NAS CONDIÇÕES ARTÍCAS E SUBARCTICAS DA FEDERAÇÃO DA RÚSSA

PROBLEM-DIALOGUE TECHNOLOGY OF FORMING ENVIRONMENTAL COMPETENCE AMONG SPECIALISTS FOR WORK IN THE ARCTIC AND SUBARCTIC CONDITIONS OF THE RUSSIAN FEDERATION

Página - 362

36- Artigo / Article

ISAKULOV B. R.; JUMABAYEV M. D.; ABDULLAEV H. T.; AKISHEV U. K.; AYMAGANBETOV M. N.

CAZAQUISTÃO

PROPRIEDADES DOS LIGANTES DE ESCÓRIA ALCALINA BASEADOS EM RESÍDUOS INDUSTRIAIS

PROPERTIES OF SLAG-ALKALI BINDERS BASED ON INDUSTRIAL WASTE

Página – 375

37- Artigo / Article

NIKOLAEVA L. P.

RÚSSIA

pH DA MEDULA ÓSSEA

pH OF BONE MARROW

Página - 388

38- Artigo / Article

ALVES, G. de B.; BEVERARI, S. F.; FLORENTINO, L. C.; GUERRERO, A. S.; SILVA, M. A. de A.

BRASIL

BIOSSÍNTESE E CARACTERIZAÇÃO DE CELULOSE BACTERIANA PROVENIENTE DO CHÁ DE KOMBUCHA

BIOSYNTHESIS AND CHARACTERIZATION OF BACTERIAL CELLULOSE FROM THE KOMBUCHA TEA

Página – 395

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39- Artigo / Article

GRIDINA, V. V.; CHEKANUSHKINA, E. N.; KISMETOV, K. L.; AKHTARIEVA, R. F.; SHAPIROVA, R.R.

RÚSSIA

PREPARAÇÃO PROFISSIONAL DE PROFESSORES NOS EUA NA PERSPECTIVA DO PROFISSIONALISMO E DA COMPETÊNCIA

PROFESSIONAL PREPARATION OF TEACHERS IN THE USA FROM THE PERSPECTIVE OF PROFESSIONALISM AND COMPETENCE

Página - 406

40- Artigo / Article

SEVERINA, Natalia S.

RÚSSIA

COMPLEXO DE SOFTWARE PARA RESOLVER AS DIFERENTES TAREFAS DA DINÂMICA DE GÁS FÍSICO

SOFTWARE COMPLEX FOR SOLVING THE DIFFERENT TASKS OF PHYSICAL GAS DYNAMICS

Página – 424

41- Artigo / Article

FEDOROVA T. A.; TAZINA S. I.; SEMENENKO N. A.; MAMONOV A. V.; SOTNIKOVA T. I.

RÚSSIA

O PAPEL DOS MARCADORES INFLAMATÓRIOS NA AVALIAÇÃO DE ALTERAÇÕES DO MIOCÁRDIO, DIAGNÓSTICOS E PROGNÓSTICOS EM PACIENTES COM ENDOCARDITE INFECCIOSA

THE ROLE OF INFLAMMATORY MARKERS IN THE EVALUATION OF MYOCARDIUM ALTERATIONS, DIAGNOSTICS AND PROGNOSIS IN PATIENTS WITH INFECTIVE ENDOCARDITIS

Página - 437

42- Artigo / Article

UMIRBEKOVA, A. K.; TOKSONBAEV, R. N.2; ABITAYEVA, R. Sh.;AKHMETKARIMOVA, K. S.

REPÚBLICA DO QUIRGUIZISTÃO

PREPARAÇÃO DE PROFESSORES FUTUROS PARA A IMPLEMENTAÇÃO DE NOVAS ABORDAGENS PEDAGÓGICAS NAS CONDIÇÕES DO CONTEÚDO RENOVADO DE EDUCAÇÃO ESCOLAR

PREPARATION OF FUTURE TEACHERS TO THE IMPLEMENTATION OF NEW PEDAGOGICAL APPROACHES IN THE CONDITIONS OF THE RENEWED CONTENTS OF SCHOOL EDUCATION

Página – 455

43- Artigo / Article

ARYSTAN, Leila I.; MULDAEVA, Gulmira M.; HAYDARGALIEVA, Leila S.; PAKHOMOVA, Damira K.; ISKAKOV, Yernar B.

CAZAQUISTÃO

O ESTADO DA MEMBRANA DE CÉLULAS VERMELHAS EM ANEMIA DE DEFICIÊNCIA DE FERRO EM MULHERES DE IDADE REPRODUTIVA

THE STATE OF THE RED BLOOD CELL MEMBRANE IN IRON DEFICIENCY ANAEMIA IN WOMEN OF REPRODUCTIVE AGE

Página - 471

44- Artigo / Article

SAVVINOVA, M. S.; PROTODYAKONOVA, G. P.; POPOVA, N. V.; TATARINOVA, Z. G.; PAVLOVA, A. I.

RUSSIA

MÉTODO PARA OBTENÇÃO DE UM CONCENTRADO DE PROTEÍNA-VITAMINA PARA PREVENÇÃO DE DOENÇAS EM ANIMAIS DE FAZENDA

METHOD FOR OBTAINING A PROTEIN-VITAMIN CONCENTRATE FOR DISEASE PREVENTION IN FARM ANIMALS

Página – 478

45- Artigo / Article

ASHARI, Sahar

IRÃ

INVESTIGAÇÃO COMPARATIVA DE TÉCNICAS DE MODELAGEM PARA PREDIÇÃO DO COEFICIENTE DE ATRITO ESTÁTICO DE ALGUMAS SEMENTES DE PLANTAS MEDICINAIS

COMPARATIVE INVESTIGATION OF MODELING TECHNIQUES FOR PREDICTION OF STATIC FRICTION COEFFICIENT OF SOME MEDICINAL PLANT SEEDS

Página – 485

46- Artigo / Article

AGEEVA Natalia M.; BIRYUKOV Aleksandr P.; AWANESIANZ Rafail W.;

RUSSIA.

BIOSSÍNTESE DE PROTEINASES E PECTINASES POR LEVEDURAS DE VINHO

BIOSYNTHESIS OF PROTEINASES AND PECTINASES BY WINE YEASTS

Página – 497

47- Artigo / Article

MAKSIMKINA, E. A.; VASKOVA, L. B.; MUSINA, N. Z.; TIAPKINA, M. V.

RÚSSIA

ANÁLISE DO IMPACTO ORÇAMENTÁRIO DE MEDICAMENTOS ANTIPSICÓTICOS NO TRATAMENTO HOSPITALAR DA ESQUIZOFRENIA

BUDGET IMPACT ANALYSIS OF ANTIPSYCHOTIC DRUGS IN THE HOSPITAL TREATMENT OF SCHIZOPHRENIA

Página - 509

48- Artigo / Article

SHAROV A. V.; PLOTNIKOVA O. M.; EVSEEV V. V.; RYKOVA A. I.

RÚSSIA

PROPRIEDADES TOXICOLÓGICAS DE METAIS PESADOS ADSORVIDOS NA SUPERFÍCIE DE CARVÃO ATIVADO

TOXICOLOGICAL PROPERTIES OF HEAVY METALS ADSORBED ON THE SURFACE OF ACTIVATED CARBON

Página – 516

49- Artigo / Article

KUZNETSOVA, E. L.; MAKARENKO, A. V.

RÚSSIA

MODELO MATEMÁTICO DA EFICIÊNCIA ENERGÉTICA DE MÓDULOS MECATRÔNICOS E FONTES DE ENERGIA PARA OBJETOS MÓVEIS PROSPECTIVOS

MATHEMATICAL MODEL OF ENERGY EFFICIENCY OF MECHATRONIC MODULES AND POWER SOURCES FOR PROSPECTIVE MOBILE OBJECTS

Página – 529

50- Artigo / Article

ANAMOVA, R. R.; NARTOVA, Lidiya G.;

RÚSSIA

HABILIDADE ESPACIAL GEOMÉTRICA COMO ELEMENTO DO PROCESSO COGNITIVO DE APRENDIZAGEM

GEOMETRIC SPATIAL ABILITY AS AN ELEMENT OF COGNITIVE LEARNING PROCESS

Página – 542

51- Artigo / Article

BULYCHEV, N. A.; BODRYSHEV, V. V.; RABINSKIY, L. N.;

RÚSSIA

ANÁLISE DAS CARACTERÍSTICAS GEOMÉTRICAS DO SISTEMA DE SOLVENTE POLIMÉRICO DE DUAS FASES DURANTE A SEPARAÇÃO DE SOLUÇÕES DE ACORDO COM A INTENSIDADE DA IMAGEM DE MICROGRAFIAS

ANALYSIS OF GEOMETRIC CHARACTERISTICS OF TWO-PHASE POLYMER-SOLVENT SYSTEMS DURING THE SEPARATION OF SOLUTIONS ACCORDING TO THE INTENSITY OF THE IMAGE OF MICROGRAPHS

Página – 551

52- Artigo / Article

RUOSO, A. C.; BITENCOURT, L. C.; SUDATI, L. U.; KLUNK, M. A.; CAETANO, N. R.

BRASIL

NOVOS PARAMETROS PARA OTIMIZAR O PROCESSO DE FABRICAÇÃO DE LENHA ECOLÓGICA A PARTIR DE REJEITOS DE BIOMASSA FLORESTAL

NEW PARAMETERS FOR THE FOREST BIOMASS WASTE ECOFIREWOOD MANUFACTURING PROCESS OPTIMIZATION

Página – 560

53- Artigo / Article

FORMALEV, V. F.; KOLESNIK, S. A.; KUZNETSOVA, E. L.;

RÚSSIA

SOLUÇÃO ANALÍTICA APROXIMADA DO PROBLEMA DE TRANSFERÊNCIA CONJUGADA DE CALOR ENTRE A CAMADA DE LIMITE E A TIRA ANISOTRÓPICA

APPROXIMATE ANALYTICAL SOLUTION OF THE PROBLEM OF CONJUGATE HEAT TRANSFER BETWEEN THE BOUNDARY LAYER AND THE ANISOTROPIC STRIP

Página – 572

54- Artigo / Article

NAZAROVA, L. Sh.; DANILKO, K. V.; MALIEVSKY, V. A.; VIKTOROVA, T. V.; RAKHMATULLINA, I. R.;

RÚSSIA

PERFIL DA CITOCINA (TNFA, IL1B, IL6, IL10) E SUA ASSOCIAÇÃO COM CARACTERÍSTICAS CLÍNICAS NA ARTRITE IDIOPÁTICA JUVENIL

CYTOKINE PROFILE (TNFA, IL1B, IL6, IL10) AND ITS ASSOCIATION WITH CLINICAL FEATURES IN JUVENILE IDIOPATHIC ARTHRITIS

Página – 583

55- Artigo / Article

FORMALEV, V. F.; KOLESNIK, S. A.; KUZNETSOVA, E. L.

RÚSSIA

MODELAGEM MATEMÁTICA DO UM NOVO MÉTODO DE PROTEÇÃO TÉRMICA BASEADA NA INJEÇÃO DE REFRIGERANTES ESPECIAIS

MATHEMATICAL MODELING OF A NEW METHOD OF THERMAL PROTECTION BASED ON THE INJECTION OF SPECIAL COOLANTS

Página – 598

56- Artigo / Article

MOSKALEVA N. E.; MESONZHNIK N. V.; KUZNETSOV R. M.; MARKIN P. A.; APPOLONOVA S. A.

RÚSSIA

DETERMINAÇÃO DA TERIFLUNOMIDA ATRAVÉS DE UMA AMPLA GAMA DE CONCENTRAÇÕES DINÂMICAS EM PLASMA HUMANO POR LC-MS/MS

DETERMINATION OF TERIFLUNOMIDE ACROSS A WIDE DYNAMIC CONCENTRATION RANGE IN HUMAN PLASMA BY LC–MS/MS

Página – 608

57- Artigo / Article

BUKHTOYAROV, V. V.; TYNCHENKO, V. S.; PETROVSKIY, E. A.; Buryukin, F. A.

RÚSSIA

ANÁLISE COMPARATIVA DOS MÉTODOS PARA SIMULAÇÃO DA OPERAÇÃO DE POÇOS COM INSTALAÇÕES DE BOMBA SUBMERSÍVEL ELÉTRICA

COMPARATIVE ANALYSIS OF METHODS FOR SIMULATING THE WELL OPERATION WITH ELECTRIC SUBMERSIBLE PUMP INSTALLATIONS

Página – 621

58- Artigo / Article

MOSKALEVA N. E.; KUZNETZOV R. M.; MARKIN P. A.; APPOLONOVA S. A.

RÚSSIA

CARACTERIZAÇÃO POR ESPECTROMETRIA DE MASSA DE METABÓLITOS DE MEBEVERINA PLASMÁTICA E SUA SÍNTESE

MASS SPECTROMETRIC CHARACTERIZATION OF PLASMA MEBEVERINE METABOLITES AND ITS SYNTHESIS

Página – 633

59- Artigo / Article

MAMEDOV, A.; MOROZOVA, N.; YUMASHEV, A.; DYBOV, A.; NIKOLENKO, D.

RÚSSIA

CRITÉRIOS PARA RESTAURAÇÕES PROVISÓRIAS UTILIZADAS NA PREPARAÇÃO PARA A REABILITAÇÃO ABRANGENTE ORTODÔNTICA E ORTOPÉDICA

CRITERIA FOR PROVISIONAL RESTORATIONS USED IN PREPARATION FOR COMPREHENSIVE ORTHODONTIC AND ORTHOPEDIC REHABILITATION

Página – 647

60- Artigo / Article

OMELCHUK, M. V.; KOROTKOVA, Y. S.; VORONTSOVA, E. A.

RÚSSIA

ESTIMATIVA DO TAMANHO DAS ZONAS DE ESTAGNAÇÃO NO TERRITÓRIO DA FAZENDA TANQUE DE PROPANO-BUTANO VISANDO AUMENTAR A SEGURANÇA DA INSTALAÇÃO

ESTIMATION OF THE SIZE OF STAGNATION ZONES ON THE TERRITORY OF THE PROPANE-BUTANE TANK FARM AIMED AT INCREASING THE SAFETY OF THE FACILITY

Página – 656

61- Artigo / Article

IGNATOVICH, L. S.; GINTER, E. V. 2; LYKOV, A. S. 3; KUZMINA, I. Y.; KUSTOVA, S. B.

RÚSSIA

O USO DE ALIMENTOS SUPLEMENTARES NÃO CONVENCIONAIS PARA ALIMENTAÇÃO DE BOVINOS E GALINHAS POEDEIRAS

THE USE OF NON-CONVENTIONAL SUPPLEMENTARY FEEDS IN CATTLE AND LAYER DIET

Página – 668

62- Artigo / Article

ALIBEKOV, R. S.; KAIYPOVA, A. B.; URAZBAYEVA, K. A.; ORTAYEV, A. E.; AZIMOV, A. M.

CAZAQUISTÃO

EFEITO DA SUBSTITUIÇÃO DO AÇÚCAR POR XAROPE DE MILHO ALTA DE FRUTOSE NA GELEIA DE FÍSALIS

EFFECT OF SUBSTITUTION OF SUGAR BY HIGH FRUCTOSE CORN SYRUP OF THE CONFITURE ON THE BASE OF PHYSALIS

Página – 688

63- Artigo / Article

RYNDIN, Vladimir V.

CAZAQUISTÃO

DECLARAÇÃO DA SEGUNDA LEI DA TERMODINÂMICA COM BASE NO POSTULADO DE NÃO-EQUILÍBRIO

STATEMENT OF THE SECOND LAW OF THERMODYNAMICS ON THE BASIS OF THE POSTULATE OF NONEQUILIBRIUM

Página – 698

64- Artigo / Article

DÍEZ, C. M.; SOLANO, C. J.

PERU

LINEARIZAÇÃO DAS TEMPERATURAS DO AR NO OCEANO PACÍFICO NA LINHA EQUATORIAL

LINEARIZATION OF AIR TEMPERATURES ON THE PACIFIC OCEAN ON THE EQUATORIAL LINE

Página – 713

65- Artigo / Article

SALIKHOVA T. R., OMAROV N. S-M.; CHERKESOVA A. U.; GADJIMURADOVA S. M.; ASKERKHANOVA E. R.

RÚSSIA

ASPECTOS CLÍNICO-MORFOLÓGICOS E IMUNOHISTOQUÍMICOS DA PATOGENIA DO POLIPO ENDOMETRIAL NA PÓS-MENOPAUSA

CLINICO-MORPHOLOGICAL AND IMMUNOHISTOCHEMICAL ASPECTS OF ENDOMETRIAL POLYP PATHOGENESIS IN POSTMENOPAUSE

Página – 724

66- Artigo / Article

BULYCHEV, N. A.; RABINSKIY, L. N.; TUSHAVINA, O. V.

RÚSSIA

INVESTIGAÇÃO DA ADSORÇÃO DE UM COPOLÍMERO AMFIPOLAR NA SUPERFÍCIE HIDROFÓBICA DE NANOPARTICULAS DE FTALOCIANINA DE COBRE

INVESTIGATION OF AN AMPHIPOLAR COPOLYMER ADSORPTION ON THE HYDROPHOBIC SURFACE OF COPPER PHTHALOCYANINE NANOPARTICLES

Página – 732

67- Artigo / Article

BALDAEV, L. K.; KHAMITSEV, B. G.; BALDAEV, S. L.; PROKOFIEV, M. V.

RÚSSIA

AS CARACTERÍSTICAS DA TECNOLOGIA DE PULVERIZAÇÃO DE DETONAÇÃO PARA REVESTIMENTOS À BASE DE CARBONETO DE TUNGSTÊNIO

THE FEATURES OF DETONATION SPRAYING TECHNOLOGY FOR TUNGSTEN CARBIDE BASED COATINGS

Página – 739

68- Artigo / Article

RAKHIMZHANOVA, L. B.; ISSABAYEVA, S. N.; ZHUMARTOV, M. A.;

CAZAQUISTÃO

MODELAGEM NO ESTUDO DE GRÁFICOS DE COMPUTADOR NA FUNDAMENTALIZAÇÃO DA INFORMÁTICA

MODELING IN STUDYING COMPUTER GRAPHICS IN THE FUNDAMENTALIZATION OF COMPUTER SCIENCE

Página – 755

69- Artigo / Article

TANIA, L.; DIAWATI, C.; SETYARINI, M.; KADARITNA, N.; SAPUTRA, A.

INDONÉSIA

UTILIZANDO UMA TITULAÇÃO POTENTIOMÉTRICA DE ÁCIDO-BASE PARA DETERMINAR O pKA A PARTIR DO ESTRATO DO PERICARPO DO MANGOSTÃO

USING POTENTIOMETRIC ACID-BASE TITRATION TO DETERMINE pKA FROM MANGOSTEEN PERICARPS EXTRACT

Página – 768

70- Artigo / Article

LIMA, B. T. de M.; CARMO, E. S.; MEDEIROS, F. D.; SOUZA, J. B. P.

BRASIL

CARACTERIZAÇÃO MICROBIOLÓGICA, EFICÁCIA ANTIMICROBIANA E DETERMINAÇÃO DE PARÂMETROS FÍSICO-QUÍMICOS DE TINTURA DE PEGA-PINTO (*Boerhavia diffusa L.*)

MICROBIOLOGICAL CHARACTERIZATION, ANTIMICROBIAL EFFICACY AND DETERMINATION OF PHYSICAL-CHEMICAL PARAMETERS OF PEGA-PINTO TINCTURE (Boerhavia diffusa L.)

Página – 774

71- Artigo / Article

STIVAL, M.; CUNHA, E. J. N. S.; CUNHA, M.; ROCHA, J. R. C.;

BRASIL

APLICAÇÃO DE ATIVIDADE LÚDICA PARA O APRENDIZADO DE CONCEITOS QUÍMICOS: ESTUDO DE CASO

APPLICATION OF LUDIC ACTIVITY FOR LEARNING OF CHEMICAL CONCEPTS: CASE STUDY

Página – 783

72- Artigo / Article

MENEZES, J. S.; ANDRADE JÚNIOR, F. P. de2; SILVA, B. P.

BRASIL

PERFIL DE UTILIZAÇÃO DE MEDICAMENTOS PSICOTRÓPICOS DOS USUÁRIOS DO CENTRO DE ATENÇÃO PSICOSSOCIAL DE CUITÉ-PB

PROFILE OF THE USE OF PSYCHOTROPIC MEDICINES OF THE USERS OF THE PSYCHOSOCIAL ATTENTION CENTER OF CUITÉ-PB

Página – 794

73- Artigo / Article

SILVA, M. P.; MOURA, H. P.; LOPES, G. A. C.; COSTA, J. A.; DA FONSECA FILHO, H. D.

BRASIL

MINERALOGIA DE MATERIAL CONSTRUTIVO DO SÉCULO XVIII: A IGREJA DE PEDRA DE MAZAGÃO VELHO (AMAPÁ-BRASIL)

MINERALOGY OF BUILDING MATERIAL OF THE EIGHTEENTH CENTURY: THE STONE CHURCH IN MAZAGÃO VELHO CITY (AMAPÁ, BRAZIL)

Página – 806

74- Artigo / Article

DELGADO, G. E.; GUILLEN, M.; MORA A. J.

VENEZUELA

ÁCIDO 4-METIL HIPÚRICO: UM CASO DE POLIMORFISMO E SOLVATOMORFISMO

4-METHYL HYPPURIC ACID: A CASE OF POLYMORPHISM AND SOLVATOMORPHISM

Página – 812

75- Artigo / Article

MOURA, A. L.; SILVA, J. F.; DE FREITAS, J. J. R.; FREITAS, J. C. R.; DE FREITAS FILHO, J. R.

BRASIL

EXPERIENCIANDO UMA SÍNTESE ONE-POT DE 1,2,4-OXADIAZOL MEDIADA POR FORNO DE MICRO-ONDAS: QUÍMICA VERDE EM FOCO

EXPERIENCING A SYNTHESIS ONE-POT OF 1,2,4-OXADIAZOLE MEDIATED BY MICROWAVE OVEN: GREEN CHEMISTRY IN FOCUS

Página – 820

76- Artigo / Article

MEDEIROS, M. S.; GOULART, A. C.; PACHECO, I. S.; AMARAL, F. A.; CANOBRE, S. C.

BRASIL

ANÁLISE MULTIVARIADA APLICADA A QUALIDADE DA ÁGUA SUBTERRÂNEA DE ABASTECIMENTO EM ESCOLAS DO CAMPO DE UBERLÂNDIA-MG

MULTIVARIATE ANALYSIS APPLIED AT THE SCHOOL OF THE UBERLAND-AMERICAN FIELD OF CONSUMER UNDERGROUND WATER QUALITY

Página – 833

77- Artigo / Article

DELGADO, Gerzon E.; DELGADO-NIÑO, P., GRIMA-GALLARDO, P.

VENEZUELA

ESTRUTURA CRISTALINA DO COMPOSTO CUATERNÁRIO SEMICONDUTOR $CuFeCrSe_3$

CRYSTAL STRUCTURE OF THE QUATERNARY SEMICONDUCTOR COMPOUND $CuFeCrSe_3$

Página – 848

78- Artigo / Article

FONSECA, J. C.; AMADO, P. A.; CASTRO, A. H. F.; LIMA, L. A. R. S.

BRASIL

ANÁLISE FITOQUÍMICA E AVALIAÇÃO DO EFEITO FITOTÓXICO DA FRAÇÃO HEXÂNICA DAS FOLHAS DE *Smilax brasiliensis* (SMILACACEAE)

PHYTOCHEMICAL ANALYSIS AND EVALUATION OF THE PHYTOTOXIC EFFECT OF THE HEXANE FRACTION FROM THE LEAVES OF Smilax brasiliensis (SMILACACEAE)

Página – 816

79- Artigo / Article

SOUSA, J. A.; MACHADO, I. da C. P.; BARROS, F. de A. A.

BRASIL

REAL INTERESSE DE INSTITUIÇÕES FEDERAL E ESTADUAL EM RELACIONAR O ENSINO DE QUÍMICA COM A FORMAÇÃO PARA CIDADANIA

REAL INTEREST OF FEDERAL AND STATE INSTITUTIONS IN RELATION TO CHEMISTRY EDUCATION WITH CITIZENSHIP TRAINING

Página – 862

80- Artigo / Article

BOAES, T. da S.; ARRUDA, G. L.; FERREIRA, T. P. de S.; CHAGAS JUNIOR, A. F.; CHAPLA, V. M.

BRASIL

VARIAÇÃO DA PRODUÇÃO METABÓLICA DO FUNGO ENDOFÍTICO DIAPORTHE SP. ISOLADO DE CLITORIA GUIANENSIS BENTH UTILIZANDO OSMAC

VARIATION OF THE METABOLIC PRODUCTION OF THE ENDOPHYTIC FUNGUS DIAPORTHE SP. OF CLITORIA GUIANENSIS BENTH USING OSMAC

Página – 870

81- Artigo / Article

DELGADO, G. E.; DELGADO-NIÑO, P.; JAMALIS, J.

VENEZUELA, COLÔMBIA, MALÁSIA

DADOS DE DIFRAÇÃO DE RAIOS-X PARA UM NOVO TIOFENO CHALCONA OBTIDO POR UMA REAÇÃO DE CLAISEN-SCHMIDT

X-RAY POWDER DIFFRACTION DATA FOR A NEW THIOPHENE CHALCONE OBTAINED BY A CLAISEN-SCHMIDT REACTION.

Página – 878

82- Artigo / Article

COSTA, L. T. A.; AGUIAR, A.

BRASIL

ESTUDO CINÉTICO DO EFEITO DO AZUL DE METILENO NA DESCOLORAÇÃO DE OUTROS CORANTES POR PROCESSOS FENTON

KINETIC STUDY OF THE EFFECT OF METHYLENE BLUE ON THE DECOLORIZATION OF OTHER DYES BY FENTON PROCESSES

Página – 885

83- Artigo / Article

SILVA, D. de F.; NETO, H. D.; FERREIRA, M. D. L.; FILHO, A. A. de O.; LIMA, E. de O.

BRASIL

ESTUDO IN SILICO DO PERFIL ANTIMICROBIANO DO β-CITRONELOL: POTENCIALIDADE COMO ANTIFÚNGICO

IN SILICO STUDY OF THE ANTIMICROBIAL PROFILE OF β-CITRONELLOL: POTENTIAL AS AN ANTIFUNGAL

Página – 894

84- Artigo / Article

BERETTA, B. M.; MELO, A. R.; CAMPOS, D. De P.; MORONA, J.; BROLESI, T. M.

BRASIL

CARACTERIZAÇÃO DE DOIS TIPOS DE PILHAS: ALCALINA E ZINCO-MANGANÊS, DE ACORDO COM AS RESOLUÇÕES CONAMA N° 401/2008 E N° 430/2011

CHARACTERIZATION OF TWO TYPES OF BATTERIES: ALKALINE AND ZINC-MANGANES, IN ACCORDANCE WITH CONAMA RESOLUTIONS N ° 401/2008 AND N ° 430/2011

Página - 899

85- Artigo / Article

QUINTERO-RINCÓN, P.; FONTAL-RIVERA, B.; CONTRERAS, R.; FONSECA, Y.; VELÁSQUEZ-GIL, J.

VENEZUELA

SÍNTESE E CARACTERIZAÇÃO DE TRÊS CARBOXILATOS DE ORGANOTINA (IV) DO ÁCIDO ENT-CAURENÓICO: ATIVIDADE ANTIFÚNGICA CONTRA OS TRAMETES VERSICOLOR (L .: FR) PILÀT

SYNTHESIS AND CHARACTERIZATION OF THREE ORGANOTIN(IV) CARBOXYLATE OF ENT-KAURENOIC ACID: ANTIFUNGAL ACTIVITY AGAINST TRAMETES VERSICOLOR (L.: FR) PILÀT

Página – 912

86- Artigo / Article

GOMES, J. V.; DA SILVA, F. V.; DO CARMO, D. F. de M.; MAIA, P. J. S.

BRASIL

AS SÉRIES DE INVESTIGAÇÃO CRIMINAL NO ENSINO DA QUÍMICA POR MEIO DA EXPERIMENTAÇÃO INVESTIGATIVA E LÚDICA

TV SERIES OF CRIMINAL INVESTIGATION IN CHEMISTRY TEACHING THROUGH OF RESEARCH AND LUDIC EXPERIMENTATION

Página – 919

87- Artigo / Article

BABAEE KHOU, G.; ADABI, M. H.; JAHANI, D.; VAZIRI, S. H.

IRÃ

MICROFACIAS E GEOQUÍMICA DA FORMAÇÃO DA RUTEH NA ÁREA DE RUTEH, ALBORZ CENTRAL, IRAN

GEOCHEMISTRY AND MICROFACIES OF THE RUTEH FORMATION IN THE RUTEH AREA, CENTRAL ALBORZ, IRAN

Página – 930

88- Artigo / Article

OVCHINNIKOV V.V.; UCHEVATKINA N.V.; KURBATOVA I.A.; LUKYANENKO E.V.; YAKUTINA S.V.

RUSSIA

AUMENTO DA DURABILIDADE DA LIGA DE TITÂNIO VT6 PELA IMPLANTAÇÃO DE COBRE E IONS DE ALUMÍNIO

VT6 TITANIUM ALLOY WEARABILITY INCREASE VIA IMPLANTATION OF COPPER AND ALUMINUM IONS

Página – 945

89- Artigo / Article

FERREIRA, A. M. V.; PIRES, E. V.; ENDRES, L.; FREGADOLLI, F. L.; SANTANA, A. E. G.

BRASIL

NPERFIL QUÍMICO DOS COMPOSTOS ORGÂNICOS PRESENTES NA CUTÍCULA DE MACHOS E FÊMEAS DA ESPÉCIE Pachycoris torridus (Scopoli, 1772) (Hemiptera: Scutelleridae) SUBMETIDOS OU NÃO A PROCEDIMENTO ANESTÉSICO E EM DIFERENTES TEMPOS

CHEMICAL PROFILE OF ORGANIC COMPOUNDS PRESENTED IN THE CUTTLE OF MALES AND FEMALES OF THE SPECIES Pachycoris torridus (SCOPOLI, 1772) (Hemiptera: Scutelleridae) SUBMITTED OR NOT ANESTHETIC PROCEDURE AND IN DIFFERENT TIMES

Página – 967

90- Artigo / Article

VALENCIA, K.; SANJOSÉ, V.; TORRES, T.

BRASIL

AS ATIVIDADES LABORATORIAIS CONTRIBUEM PARA UMA CONCEPÇÃO CONTEMPORÂNEA DA CIÊNCIA NA FORMAÇÃO INICIAL DE PROFESSORES?

DO LABORATORY ACTIVITIES CONTRIBUTE TO A CONTEMPORARY CONCEPTION OF SCIENCE IN INITIAL TEACHER TRAINING?

Página – 982

91- Artigo / Article

Zhanaliyeva Rashida N.[1*]; Torsykbayeva Bigamila B.[2]; Altynbekova Minash O.[3]; Imangaliyeva Bazarkhan S.[4]; Nazarova Aiman Zh.[5];

CAZAQUISTÃO

SÍNTESE DO 2-(2I - ACILÓXI-ETÓXI) CLORETO DE ETILA E SUA INTERAÇÃO COM AMIDOS E RODANÍDEOS DE METAIS ALCALINOS

SYNTHESIS OF 2- (2I – ACYLOXY-ETHOXY) ETHYL CHLORIDE AND THEIR INTERACTION WITH AMIDES AND ALKALI METAL RHODANIDES

Página – 996

92- Artigo / Article

KRASNENKO A. Yu.; STETSENKO I. F.; RAKITKO A. S.; CHUROV A. V.; ILINSKII V. V.

RÚSSIA

SEQUÊNCIAMENTO DE COBERTURA ULTRA BAIXO É O MÉTODO DE QUANTIFICAÇÃO DE BIBLIOTECA MAIS PRECISA ANTES DO SEQUÊNCIAMENTO DE EXOMA

ULTRALOW COVERAGE SEQUENCING IS THE MOST ACCURATE LIBRARY QUANTIFICATION METHOD PRIOR TO EXOME SEQUENCING

Página – 1010

93- Artigo / Article

SALES, J. B. R.; OLIVEIRA, E. J. A.; NAVARRO, D. M. A. F.; AMORIM, L. B.; RODRIGUES, Sofia S. F. B.

BRASIL

ESTUDO POPULACIONAL DO MOSQUITO AEDES AEGYPTI E MEDIDAS DE INTERVENÇÃO EM CAMPO COM USO DE ÓLEO ESSENCIAL DE CROTON RHAMNIFOLIOIDES COM EFEITO DETERRENTE

POPULATION STUDY OF THE AEDES AEGYPTI MOSQUITO AND MEASURES OF INTERVENTION IN THE FIELD WITH USE OF ESSENTIAL OIL OF CROTON RHAMNIFOLIOIDES WITH DETERRENT EFFECT

Página – 1017

94- Artigo / Article

CERVELIN, A.; DE BONI, L. A. B.

BRASIL

CONSTRUINDO UM ESPECTROFOTÔMETRO COM MATERIAIS RECICLADOS. PARTE I

BUILDING A SPECTROPHOTOMETER WITH RECYCLED MATERIALS. PART I

Página – 1029

95- Artigo / Article

VOSTRIKOVA, T. V. 1; ZEMLYANUKHINA, O. A.; KALAEV, V. N.

RUSSIA

USO DE CARACTERÍSTICAS BIOQUÍMICAS-FISIOLÓGICAS, CELULARES E SUBCELULARES DE BETULA PENDULA COMO MARCADORES DE GERMINAÇÃO DE SEMENTE E MONITORAMENTO DA POLUIÇÃO DO TERRITÓRIO

USE OF PHYSIOLOGICAL-BIOCHEMICAL, CELLULAR AND SUB-CELLAR CHARACTERISTICS OF BETULA PENDULA AS MARKERS OF SEED GERMINATION AND MONITORING TERRITORY POLLUTION

Página – 1034

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Thank you. Editors.

PERIÓDICO TCHÊ QUÍMICA

WORDS FROM THE EDITORS

Dear readers and authors

On behalf of the editors and editorial board, we would like to inform you that we are going to make some important changes in the journal for the next year in order to improve not only the quality of the Journal but also fill some gaps we are facing regarding evaluation, costs, website, and other subjects.

1. **Make official the 100 manuscripts rule**. It is important to have a standard regarding the number of published papers per issue. Nowadays, we do not have any standard, and sometimes we make mistakes.
2. **Increase the periodicity of the journal from 2 to 3 editions per year**. With the implementation of this concept, we will limit ourselves to a maximum of 300 papers per year. Since this is a small journal, 300 papers would be a lot of material to us. At the same time, it will make us more selective. We have been receiving a few thousand manuscripts per year, and we can't publish them all. **After changing the periodicity from 2 to 3 issues per year, in 2020, we are going to launch the issues in March, July, and November**.
3. **We cannot publish every original manuscript that we receive**. Why? Some manuscripts are not related to the journal's scopes or objectives, so if you are an author, please observe it before making a submission. Other manuscripts have problems that when they are pointed out by the review board of the journal, the manuscripts are too hard to improve.
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8. **Letters of acceptance.** We will no longer provide this type of service in this journal. Why? It takes time to produce it, and it's an instrument take can be falsified and used improperly. Instead, we recommend the authors to present the e-mails that we exchange or present the publication itself in the journal.

PERIÓDICO TCHÊ QUÍMICA
ARTIGO ORIGINAL

CONSTRUINDO UM APARELHO DE DESTILAÇÃO SIMPLES ATRAVÉS DE MATERIAIS USADOS USANDO APRENDIZAGEM BASEADA EM PROJETOS

CONSTRUCTING A SIMPLE DISTILLATION APPARATUS FROM USED GOODS BY USING PROJECT-BASED LEARNING

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RESUMO

Os alunos foram desafiados a construir um aparato simples de destilação usando o aprendizado baseado em projetos. Nesses projetos do aparelho, aplicaram-se seus conhecimentos e habilidades para buscarem ferramentas alternativas de substituição, planejar, construir e testar o funcionamento do aparelho. Um aparelho de destilação simples foi projetado e construído por estudantes onde algumas ferramentas poderiam ser substituídas por bens usados, tais como: (1) um bico de bunsen poderia ser substituído por uma lâmpada de parede espírita; (2) uma garrafa de vidro de refrigerante substitui um frasco de Pyrex como um frasco de destilação; (3) uma garrafa plástica modificada com tubo de alumínio e mangueiras de plástico substitui uma tubulação de vidro como um condensador, e (4) um dínamo modificado de brinquedos de carro foi usado como aerador com fonte de corrente elétrica de bateria, banco de potência ou telefone usando eletricidade carregador. O aparelho já poderia ser usado para purificar a água do mar que foi modelada usando água salgada. Os destilados eram mais claros e incolores comparados com a amostra, não acendiam as luzes e não havia bolhas de gás. Este projeto melhorou a compreensão dos alunos nos conceitos de destilação e aumentou as habilidades de pensamento criativo.

Palavras-chave: experimento de laboratório; equipamento de laboratório; um aparelho simples de destilação; aprendizagem baseada em projetos; aprendizagem prática

ABSTRACT

Students had been challenged to build a simple distillation apparatus by using project-based learning. In these project of the apparatus, they were applied their knowledges and skills to look for an alternative replacement tools, plan, build, and test the functioning of the apparatus. A simple distillation apparatus was designed and constructed by students where some tools could be replaced with used goods, such as: (1) a bunsen burner could be replaced with an spirit-wall lamp; (2) a soft drink glass bottle replaces a Pyrex flask as a distilling flask; (3) a modified plastic bottle with alumunium tube and plastic hoses replaces a glass tubing as a condenser, and (4) a modified dynamo from car toys was used as aerator with source of electric current from battery, power bank, or electric using phone charger. The apparatus already could be used to purify sea water that modeled by saline solution. The distillates were clearer and colorless compared to saline solution and did not conduct electricity. Based on that, the project was improved students' understanding and creative thinking skills on the distillation concepts.

Keywords: laboratory experiment; laboratory equipment; a simple distillation apparatus; project-based learning; hands-on learning

1. INTRODUCTION

Distillation is one of the techniques of separating a substance in its mixture physicaly based on the boiling point difference. In the process of separation, the mixture which has a lower boiling point will boil first then the resulting steam melts the condenser and condenses into a liquid again (Day and Underwood, 1986; Kister, 1992; Ledgard, 2006). Distillation is a difficult technique to visualize and even harder to demonstrate without specialized equipment. However, a suitable distillation apparatus easily illustrates the phenomena of evaporation and condensation (Campanizzi, et al., 1999).

According to Regulation of the Minister of Education and Culture of the Republic of Indonesia No. 37 in 2018 year, the learning material of mixed separation with distillation techniques was introduced for the first time in science subjects at the secondary school level (Author team, 2018). Secondary school students are expected to have the competence to do a separate of mixtures based on physical and chemical properties so that students can understand the characteristics of substances, as well as physical and chemical changes in substances that can be used for everyday life. Therefore, to achieve these competencies, it is necessary to carry out mixtures separation practice activities with distillation techniques in learning.

The practical apparatus is one of the supporting factors for the implementation of practice activities in schools. However, practice activities of mixtures separation with distillation techniques in schools are rarely carried out. This is due to constraints due to the lack of availability of practical apparatus. (Fadiawati and Diawati, 2011; Fadiawati, 2013; Fadiawati and Tania, 2014) A commercial simple distillation apparatus use a Pyrex flask as a distilling flask, glass tubing as a condenser, and a cup as the receiver. Components of the apparatus are made of glass, need to be assembled if you want to use, and the price is relatively expensive. In addition, the difficulty of the teacher in assembling the apparatus and the concerns of the teacher and students break the apparatus if they are not careful during practice also a reason (Retug, 2010; Maknun, et al., 2012; Sudargo dan Aisah, 2010).

Students as candidates for chemistry teachers who will later be in school must be able to develop practical apparatus. This is a challenge for the students in order the practice activities of mixtures separation by using distillation techniques in schools can be carried out.

Several studies have been conducted to modify the distillation apparatus (Campanizzi, et al., 1999; Kahl, et al., 2014). The use of modified practice apparatus in the learning process proved to be able to improve mastery of concepts and higher order thinking skills including creative thinking skills (Hooi, et al., 2014; Mott, et al., 2014; Kahl, et. al., 2014). However, these modified apparatus are not the result of copyright or creative thinking of students so that students do not have comprehensive knowledge about the usefulness of each tools and concepts that are followed in the work process of the apparatus.

In this article, we described the results of a modified simple distillation apparatus by students through project-based learning (PjBL). In these project of the apparatus, students applied their knowledges and skills to look for an alternative replacement tools, plan, build, and test the functioning of the apparatus.

Therefore, through the project of modified a practical apparatus is believed that the students' creative thinking skills can be trained (Fisher, 2006; Burke and Williams, 2009; Colcott, et al., 2009; Dyer, et al., 2009; Aubrey, et al., 2012; Diawati, et al., 2018).

This is corresponded with the globalization area, the cotemporary job market demands graduates who are able to work in an ill-defined and ever-changing environment, facing nonroutine and abstract work, make a decisions and responsibility, and working in team (Bergh, et al., 2006). Therefore, students need a number of higher order thinking skills including creative thinking skills.

Through PjBL, students have designed and built a simple and inexpensive distillation apparatus using scrapwares and sodium chloride (NaCl) sollution as the sample that it would be separated.

2. MATERIALS AND METHODS

There are five essential features of PjBL. These are projects (a) engage students in investigating an authentic question or problem that droves activities and organizes concepts and principles; (b) result in students developing a series of artifacts, or products, that address the question or problem; (c) allow students to engage in investigations; (d) involve students, teachres,

and members of society in a community of iquiry as they collaborate about the problems, and (e) promote students using cognitive tools (Krajcik, et al., 1994).

Students designed and built a simple distillation apparatus through four model stages of PjBL which are modified by Diawati, et al. (2018) for 8 weeks. These are (a) identifying and defining project; (b) planning a project; (c) implementing a project; (d) documenting and reporting project findings. Students were provided with worksheet that it contain questions as assitance to guide students to find several alternative solutions.

In the first week, students were oriented in the classroom by the lecturer. The lecturer give an explanation of the project and an importance of communicating and information sharing during collaboration with member of team and the lecturer. After that in the stage of identifying and defining project, students read the problem illustration about distillation and practice related of it in the secondary school. They were given a challenge with the problem: "What should you do so that secondary school students can do distillation experiment without any worry about breaking the apparatus while assembling the tools to complete the practical activities?"

Students planned a project outside of the classroom for 2 weeks. In this stage, students applied their knowledges and skills related to the problem. They were asked to search a simple distillation apparatus that has been developed or modified. Then, they identified the strength and weakness of it. According to the worksheet, they look for various alternative replacement tools for a heating source, a distilling flask, a condenser, and a cup as the receiver. Then, students were asked discuss with the lecture that why they choose these various alternative replacement tools.

At the stage of implementing a project, students were given 4 weeks to design, build, and test the product of a simple distillation apparatus. Regard to design, students were asked to compare with the design of a simple distillation apparatus that has been developed or modified. After students finished determining material alternative replacement tools, they drew a design of a simple distillation apparatus. Then they built and tested the apparatus. During the project, students consulted with the lecturer regularly because implementing design to be an apparatus is not one-time process.

Documenting and reporting project findings stage was done for a week. Students prepared for the project's report. At the weekend they presented the project findings in the classroom.

During the project from designed till finished the apparatus, students' creative thinking skills was assessed using process performance assessment instrument and the product a simple apparatus also was assessed using product assessment instrument.

3. RESULTS AND DISCUSSION:

According to the problem illustration about the constraint in the practice of distillation in the secondary school, students can identify the problems. From the interview, it is represented by the statements of these students:

Student 1: "Any tools of a commercial simple distillation apparatus that can be replaced with other tools?"

Student 2: "Are there alternative replacement tools for a commercial simple distillation apparatus?"

Related to the statements, the lecturer provides directive questions. For example:

Question 1: "What tools of a commercial simple distillation apparatus can be replaced?"

Question 2: "What is the function of each tool in a commercial simple distillation apparatus? Can alternative replacement tools have the same function as tools of a commercial simple distillation apparatus?"

Through reference searching, students found a simple distillation tool that has been developed or modified, such as distillation apparatus using household items (Campanizzi, et al., 1999) and used goods (Widiyatmoko and Pamelasari, 2012). According that, they were interested to modify a commercial simple distillation apparatus using used goods. The use of used goods was expected to reduce the costs, abudant and easy to obtain, and not complicated in the process of realization to become an apparatus.

There were some tools could be replaced with used goods, such as: (1) a bunsen burner could be replaced with an spirit-wall lamp; (2) a soft drink glass bottle replaces a Pyrex flask as a distilling flask; (3) a modified plastic bottle with alumunium tube and plastic hoses replaces a glass tubing as a condenser, and (4) a modified dynamo from car toys was used as aerator with

source of electric current from battery, power bank, or electric using phone charger. According to alternative replacement tools that determined by students, the lecturer give a question to look for the reason that why they choosen it.

A spirits-wall lamp was determined on the grounds that the size of the flame can be adjusted, so that the heating temperature can be adjusted as desired. The fuel used was spirits that were easily obtained, the price wass affordable, and the resulting fire was blue and did not cause soot. A soft drink glass bottle as distilling flask was choosen because transparant so that the sampel could be seen clearly. This distilling flask equipped with alcohol themometer that it was mounted on a distillation flask lid made of used rubber slippers. This used rubber slipper serves to hold the thermometer in order to stand upright and to prevent the discharge of steam. A modified plastic bottle with alumunium tube and plastic hoses was determined because heat resistant, conductor, dan corosion resistant. Modified aerator was determined in order an apparatus could be applied in any where, although in the school without an electric.

3.1. Distillation apparatus design

Design of a simple distillation apparatus using used goods was shown in Figure 1.

Figure 1. *Design of a simple distillation apparatus from used goods*

A simple distillation apparatus constructed by students was shown in Figure 2.

(a)

(b)

Figure 2. *Construction of a simple distillation apparatus from used goods: (a) front view and (b) back view*

All components in these apparatus were assembled into one unit, so that when used it was not necessary to assemble it first. The condenser was located lower than the distillation flask. The condenser hose was threaded and attached to the back of the vertical board where the distillation flask attaches. The condenser was equipped with water circulation. In addition, the condenser was also accompanied by a drain hose so that when finished, it could be opened the lid of the drain hose without having to disassemble the condenser.

A modified simple apparatus was safe and environmentally friendly. This apparatus can also be used in laboratories, inside and outside the classroom. The cost of this student-made a simple distillation apparatus inexpensive, ~ US$6 total (can be seen in Table 1).

Table 1. *Description of alternative replacement tools*

Component	Price/ US$
Wooden board	2.5
Wall lamp	0.5
Dynamo	0.5
Plastic hoses (0.75 inchi)	1
Alcohol thermometer (length: 30cm; Temp. Range: -10 to +110 °C	1
Cable (0.5 inchi)	0.5
Total	**6**

3.2. Performace assessment

As shown in Table 2, students have developed creative problem-solving skill during the project. According to worksheet and interview results, they have written the relevant formulation of problem, identified the function of each tools in a simple distillation apparatus, identified the tools of apparatus that can be replaced, determined and looked for various alternative replacement tools, designed, built, and tested the product of a modified simple distillation apparatus using used goods.

3.3. Apparatus performace

A modified simple distillation apparatus could already be used to purify sea water that modeled saline solution. This was indicated by obtaining distillates that were clearer and colorless compared to the sample. Test results with an electrolyte tester show that the distillate did not turn on the lights and there were no gas bubbles.

The value of the apparatus performance was shown in Figure 3 and 4.

Through this project, students gain valuable experience on how to plan the investigation, solve the problem creatively and analyze the results.

4. CONCLUSIONS:

Through project-based learning, students have successfully designed and built a simple distillation apparatus using used goods. There apparatus was safe and environmentally friendly. This project has facilitated the improvement of students' creative problem-solving skills.

Table 2. *The creative problem-solving in the project-based practice*

No	Item Indicator of Creative Problem-Solving Process	Score
1	Students write the relevant problem formulation	86
2	Students write the varied problem formulation	89
3	Students write the relevant ideas' formulation of the project's purpose	89
4	Students write the relevant ideas' formulation of the project's importance	91
5	Students write the corrected and relevant method or procedure and concept of the project	80
6	Students describe the function of each tools, determine the tools of apparatus that can be replaced, and list less-costly and no hazard alternative replacement tools	92
7	Students draw a design of the apparatus different with a commercial simple distillation apparatus	95
8	Students describe the function of each replacement tools of the apparatus	95
9	Students describe the working principle of each replacement tools of the apparatus	93
10	Students describe the operating principle of each replacement tools of the apparatus	90

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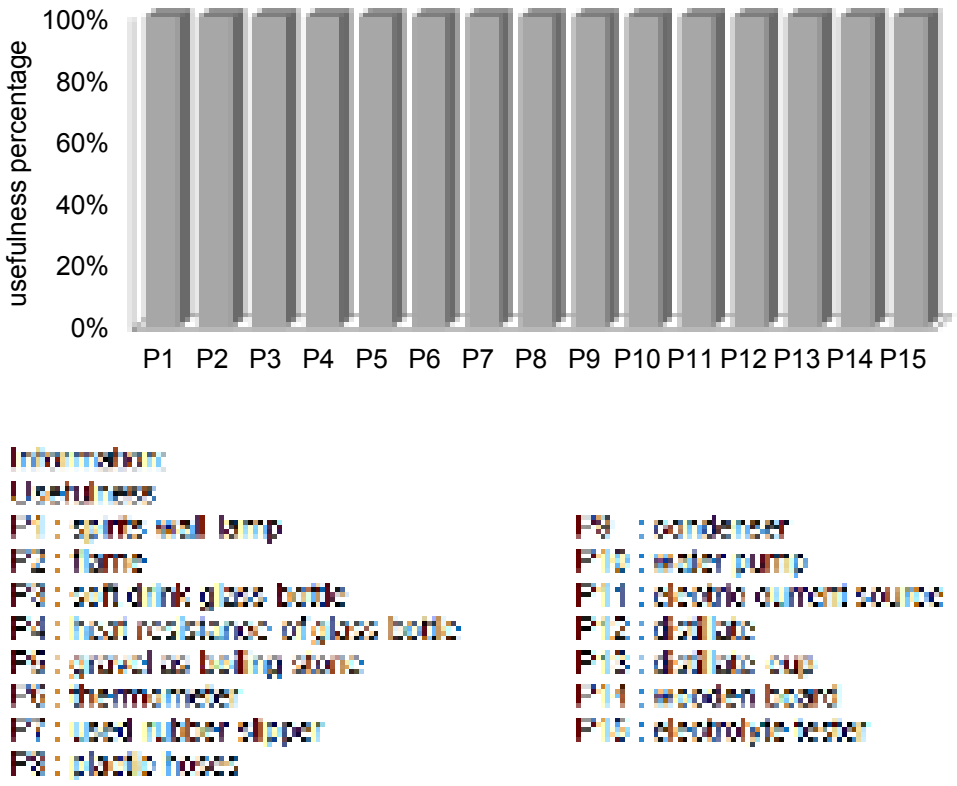

Figure 3. *Graph of usefullness of a simple distillation apparatus from used goods*

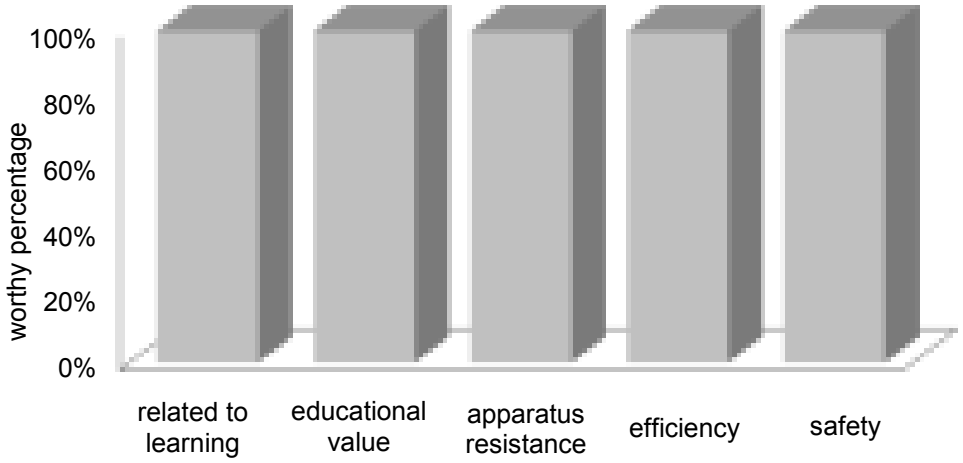

Figure 4*. Graph of worthiness of a simple distillation apparatus from used goods*

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