
ASSOCIATION OF PUBLIC ANALYSTS

Association of Public Analysts

Study Guide

for the

Mastership in

Chemical Analysis

(3rd Edition)

February 2012

ACKNOWLEDGEMENTS
This guide has been prepared by the Training Committee of the Association of Public Analysts. The
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Third Edition: February 2012

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The publication of this guide has been written with the support of APA Educational Trust. The Trust (Registered Charity Number 328086) was established in 1988 'to advance training and education in the field of scientific analysis and examination'. Correspondence relating to this training guide should be sent to the committee secretary at the address given below:

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Studying for the Mastership in Chemical Analysis Examination

CONTENTS

FOREWORD

I have great pleasure in commending the third edition of this study guide to the profession of Public Analysts and Scientific Advisers. In particular I trust that candidates for the Mastership in Chemical Analysis (MChemA) examination, their counsellors and others involved with training scientists will find it to be a helpful manual.

The MChemA is the post-graduate qualification prescribed by the Food Safety (Sampling and Qualifications) Regulations 1990 for a person to be appointed as a Public Analyst in the UK. Responsibility for the examination and the award of a Mastership remain with the Royal Society of Chemistry, from whom copies of current regulations and syllabus for the examination may be obtained.

The first edition of this guide was published in 1991 and the second in 2001. This third edition has been prepared following changes in analytical techniques, legislation and the presentation of scientific information.

This study guide is one of a series of booklets produced by the Association's Training Committee for those preparing for the MChemA examination. Other booklets in the series are 'Legislation', 'Microscopy', 'Candidate's Record of Study and Progress', 'Certificate Writing', 'Microbiology' and 'Food Complaints'. These publications complement the study guide but are published separately.

The Training Committee would welcome corrections to the text if necessary and constructive comment on ways of improving future editions of this study guide. Correspondence should be sent to the Secretary at the address given at the foot of the acknowledgements page.

The Training Committee would like to emphasise that the information in this guide is not exhaustive and candidates are still required to thoroughly read all subject matter specific to the role of the Public Analyst.

Jon Griffin
Training Committee Chairman
Association of Public Analysts

INTRODUCTION

The Public Analyst

There is no organisation which actually bears the name “the Public Analyst Service”. Public Analysts are individuals who are appointed by Food Authorities to carry out responsibilities entrusted to them by the Food Safety Act 1990. They are qualified to do so by virtue of having passed an examination in the chemistry, microbiology and microscopy of food, water and agricultural fertilisers and feeding stuffs originated in 1898 by the then Institute of Chemistry, and accepted by the Local Government Board as the required qualification for Public Analysts. This examination eventually became, first the Branch E of the Fellowship Examination, and then the Mastership of Chemical Analysis of the Royal Society of Chemistry. As the latter, it is incorporated in the Food Safety (Sampling and Qualifications) Regulations 1990 as the qualification certifying the competence of Public Analysts.
Although the examination originated with the analysis of food, drugs and water, in practice Public Analysts undertake work in many other fields and are named in some other legislation as the appropriate persons to carry out analytical work. These areas include consumer protection, pollution and drink-driving offences and a full list of this legislation is given in the appendix attached at the end of this study guide. Many Public Analysts are also appointed as Agricultural Analysts.
The reference to the ‘appropriateness’ of Public Analysts to be involved in such a range of additional analysis is as a result of the comprehensive training that is carried out in obtaining the MChemA qualification.

The characteristic which is unique to the Public Analyst profession is the involvement in the analysis of materials linked to an interpretation of the law relating to those materials. This is exemplified in the Public Analyst’s Certificate, the format of which is now defined in the Food Safety (Sampling and Qualifications) Regulations 1990. The certificate is a legal document which declares the result of an analysis of a food and which, unless challenged, will be accepted as evidence in a court of law. This is a right which Public Analysts have won over many years and which should be the aim of all candidates to respect and retain. The importance of the certificate has always been recognised by the examiners and by the members of the profession. Two former Presidents of the Association of Public Analysts have thought it sufficiently important to write papers on the subject in the Association’s journal and candidates should read and understand these papers early on in their preparation. They will learn that brevity is a desirable quality in the preparation of certificates, for the more that is said the greater the chance that counsel will find some irrelevant point on which to criticise the certificate and challenge its soundness.
A clear understanding of the laws relating to the sample being analysed is necessary if the course of the analysis is to be properly planned. At the outset the candidate will be unable to carry out this planning unaided, but should be prepared to assume responsibility as experience is gained. From the start it is essential to learn to observe all the facts concerning the sample and its labelling and description and to make clear records of relevant details.

The Fundamentals

As an educational background, the new entrant requires the following:

(a) To register as a candidate for the MChemA you must be an Associate Member (AMRSC), Member (MRSC) or Fellow (FRSC) of the Royal Society of Chemistry. If you are AMRSC, you can take Parts A and B, but you must achieve MRSC or FRSC by the time of application for the Part C examination. You can join the RSC with qualifications and/or experience in chemistry or chemical science, and you can find the requirements on the RSC website at www.rsc.org/members.

You require postgraduate-level knowledge of analytical chemistry, and Part A of the MChemA is one paper on the theory of general analytical chemistry. You can claim exemption from the Part A exam if you have an appropriate MSc in analytical chemistry or the NVQ level 5 in analytical chemistry.

All candidates take the Part B and Part C examinations.

The MChemA Regulations, Syllabus and Guidance Notes are on the RSC website at www.rsc.org/mchema, where you can also find past exam papers.

b) in addition, some knowledge of physics, microbiology, biochemistry, molecular biology, botany, mycology, entomology, physiology, food technology and statistics is important. At least one of these subjects may have been studied to 'A' level or higher but it is very unlikely that more than two would have been. Some knowledge of all will eventually be very useful and it may be better if formal instruction at a basic level can be obtained early on. Together with experience gained in the laboratory, a candidate should be able to acquire the necessary expertise.

Chemists/chemical scientists are welcomed as members of The Royal Society of Chemistry regardless of how they have acquired their chemistry knowledge .There are a number of degree titles which contain sufficient chemical science to meet the minimum entrance requirements. The Royal Society of Chemistry will individually assess 'candidates' qualifications and experience, and non-graduates will also be considered, for MRSC status, "*Those who do not possess a degree but have progressed to an equivalent professional standard can be considered on an exceptional basis*".

The Applications of Analytical Chemistry

For Part B, the Association of Public Analysts is taking a leading role in the formal training of Public Analysts through regular courses and through the publication of this study guide which aims to assist candidates to carry out their training in their own laboratories. Over the years with advances in analytical chemistry and their applications through instrumentation, the examination has been brought more in line with practice in the laboratories. Training in these new techniques, where necessary, has been organised by the Association through work-shops. A more general training is carried out in a residential course arranged by the Association in a two year cycle, held once per year and covering the main aspects of the MChemA syllabus. The study guide aims to fit into this pattern by providing guidance for the continuing training programme, with personal guidance from the counsellors.

The study guide includes bibliographies compiled from literature recommendations which Public Analysts have found to be useful in their work, and supplied by RSC for Part A.
It was decided that web-sites should not be included in the bibliographies. Although they clearly can be a very useful information source it would be difficult to produce a list which would remain current. As an alternative, relevant web-sites with information for candidates will be identified and listed in sections of the Association's web-site which can be found at (http://www.publicanalyst.com/)

http://www.publicanalyst.com/training/

Further information can also be found on the web site of The Royal Society of Chemistry (http://www.rsc.org/Education/Qualifications/MChemA/Index.asp).

THE ASSOCIATION OF PUBLIC ANALYSTS

In the mid-nineteenth century Arthur Hill Hassall, a physician and microscopist, brought to the notice of a wide audience the state of foodstuffs on general retail sale in London. He found among other things that spices were bulked with flour, sawdust and bone ash, milk was watered and toxic pigments of lead, arsenic and mercury were being used to colour confectionery, tea, pickles, bottled fruits and many other foods.

Hassall's work led to the formation in 1857 of a Parliamentary Committee to investigate food adulteration and the Committee's report resulted in 1860 in the first ever Food Act - "An Act for Preventing the Adulteration of Articles of Food or Drink".

Local Authorities were responsible for the administration of this Act (and a succeeding one in 1872 which also included drugs) and the authorities were empowered to appoint Public Analysts to examine the purity of articles of food and drink. However, it was not until the Food and Drugs Act of 1875 that the authorities were *compelled* to appoint Public Analysts. This 1875 Act made it an offence to sell any food which was not of the nature, substance or quality demanded and this provision, which is the cornerstone of food enforcement law, has been reproduced in every Act up to and including the Food Safety Act 1990.

In order to promote their work, to exchange methods of analysis and agree consistency in enforcement and food standards, Public Analysts formed the Society of Public Analysts in 1874 and one year later they published the Society's Journal known as *The Analyst* of which the aim stated on the frontispiece was "A monthly journal devoted to the advancement of analytical chemistry".

Interestingly, because of the Society's precarious financial state, *The Analyst* was run as a commercial concern by two of the members and only taken back into Society ownership in 1904.

The pioneering work of the Society and of many of its individual analytical chemists led to the virtual elimination of the grosser forms of food adulteration by the turn of the 20th century.

Many of the early Public Analysts had originally had skills in other branches of analysis, in medicine or engineering, and the Society decided to institute an examination to be a sign of minimum competence to practice as a Public Analyst. This examination was established in 1898 under the auspices of the Royal Institute of Chemistry.

The Society grew in membership as the Society of Public Analysts and other Analytical Chemists (SPAOAC) until it consisted predominantly of non-Public Analysts and *The Analyst* was publishing very little of direct relevance to the food law enforcement scientist. In order to regain control of their own destiny, Public Analysts broke away from the SPAOAC in 1953 and formed The Association of Public Analysts. The remaining analytical chemists formed the Society for Analytical Chemistry which later merged into the Royal Society of Chemistry.

One of the aims of the Association of Public Analysts is to promote the interests of Public Analysts and to maintain the status of the profession. This is carried out by representation of Public Analysts or the Association of Public Analysts on:

Local Bodies - such as regional groups with Trading Standards and Environmental Health Officers

National Bodies - such as British Standards Institution (BSI) and the Food Standards Agency (FSA) and the Local Government Association (LGA)

International Bodies - such as the European Standards body (CEN), Food Law Enforcement Practitioners (FLEP), European Food Law Association (EFLA) and CODEX.

The following organisations have no representation by the APA but their existence should be known: European Food Safety Authority (EFSA) and Standing Committee on the Food Chain and Animal Health (SCoFCAH).

The UK also have National Reference Laboratories (NRLs) whose network is responsible for setting up EU-wide standards for routine procedures and reliable testing methods in the areas of feed and food and animal health. Core functions of the appointed UK NRLs are effectively those cited in Article 33 of the EC Regulation 882/2004. Public Analyst laboratories are required to work with the NRLs as official control laboratories (OCLs) for the purposes of chemical analysis or microbiological examination of feed or food samples taken by enforcement practitioners. Designation may only be granted if the laboratory meets certain standards (i.e. is accredited to the European Standards specified in Article 12 of Regulation (EC) No 882/2004). In the UK, accreditation is undertaken by the United Kingdom Accreditation Service (UKAS).

Part A Theory of General Analytical Chemistry

1 Analysis

For the candidate who needs to take the Part A examination, reference to the Regulations, Syllabus and Guidance Notes 2012 published by the Royal Society of Chemistry is Essential http://www.rsc.org/images/MChemARegsSyllabus2012_tcm18-107499.pdf
It is not possible in this guide to give more than an indication of the range of knowledge required of each section of the syllabus.
The object of Part A is to build up a solid foundation of the science on which the applications are based so that the candidate appreciates the reason why certain procedures are insisted on and that short cuts are not taken. Ideally this should be completed before work is started in the laboratory but candidates can aid themselves and other laboratory staff by developing an inquiring mind to find the reasons behind the procedures followed. Above all, it is important to cultivate the art of observation and clear recording of facts as they are encountered. It is necessary for new entrants to the profession to learn to observe and record facts about samples, from submission details, sample labels, and condition of the sample when received, to facts about the analysis itself and the result.

1.1 Basic Methodology
Basic principles underlying analytical chemistry are stated in the following laws or equations:
Law of Mass Action
Le Chatelier Principle
Beer - Lambert Law
Nernst Equation
Study of the texts given in the bibliography at the end of this Part will help the candidate to master the principles.

1.2 Calibration and Standardisation
Absolute methods
Comparative methods
Traceability to national standards
Calibration of volumetric glassware
Checking of balance accuracy
Wavelength and absorption scale checks on spectrophotometers
Temperature measurements

1.3 Critical Examination of Source of Error and Interference in Analytical Chemistry
Accuracy, precision and error
Classification of errors
Methods of expressing precision of a set of results
Confidence limits
Rules for significant figures

Errors due to interference and means of avoidance
Uncertainty of measurement

1.4 Cryoscopy

1.5 DNA Amplification Techniques

'Lab on a Chip'
Isolation of DNA from cellular components
Factors influencing degradation
Purification
Removal of RNA
Quantification of DNA
Spectrophotometric
Chemical
Enzymic
Detection of specific DNA sequences
Complementary DNA Probes
Southern blotting (DNA fragments)
Northern blotting (mRNA fragments)
DNA sequencing
Polymerase Chain Reaction (PCR)
Selection and use of primers
Competitive or MIMIC PCR
Nested PCR
Real time PCR
Random amplification of polymorphic DNA (RAPD)
Restriction enzymes

1.6 Electrochemistry

Basic principles
Galvanic cells
Electrolysis
Conductance methods
Potentiometry
Voltammetry
Coulometry
Pulsed Amperometric Detection (PAD)
Ion selective electrodes

1.7 Enzyme and Immunological Techniques

Enzyme methods
Methods to assess activity of enzymes, e g test for previously frozen poultry/meat, diastase activity in honey, phosphatase
Enzymes as an analytical tool, e g assays of sugars, alcohol, ascorbic acid and other organic acids
Immunological techniques
Enzyme linked immunosorbent assays
Radio-immunoassay (RIA)
Immunoaffinity chromatography
Serotyping of micro-organisms
Identification of cryptosporidia and other pathogens
Immunohistochemical staining

1.8 Gravimetry

Solubility and solubility product
Formation and properties of precipitates
Co-precipitation phenomena
Water in solids

1.9 Mass Spectrometry

Mass Spectrometry
Formation of the mass spectra
Types of mass analysers
Structural elucidation of simple spectra
HPLC/MS
HPLC/MS interfaces
Methods of ionisation
GC/MS
GC/MS interfaces
Methods of ionisation
Other hyphenated techniques

1.10 Methods of Measurement including the Determination of Mass

Mass and weight
Equal arm and substitution balances
Errors in weighing

1.11 Polarimetry

Specific rotation
Mutarotation
Double polarisation methods

1.12 Radiochemistry

Properties of ionising radiations
Application of radiotracers to analysis

1.13 Refractometry

1.14 Separation Techniques

Distillation
Solvent extraction, partition coefficients
Chromatography, paper, thin-layer, gas, high performance liquid, ion-exchange
Electrophoresis, including capillary
Gel permeation chromatography
Solid phase micro extraction

1.15 Spectrometric Techniques

Origins of vibration-rotation and other spectra
Beer-Lambert law, derivation and applications
Infra red, including FTIR
Ultra-violet/visible spectroscopy, including diode array detection
Fluorescence techniques including XRF
Flame emission
Atomic emission
Atomic absorption
Inductively coupled plasmas
ICP/MS
NMR

1.16 Titrimetry

Acidimetry and alkalimetry
Precipitation processes
Oxidation/reduction reactions
Non-aqueous titrations
Chelate titrations
Complexiметry

1.17 Bibliography

The following book list is recommended by the Royal Society of Chemistry:

Skoog D A, West D M, Holler F J, *Analytical Chemistry: an Introduction,* 6th Edition, Saunders College Publishing, (Hartcourt Brace), 1994, ISBN 003097285X

Skoog D A, Holler F J, Neiman T A, *Principles of Instrumental Analysis*, 5th Edition, Saunders College Publishing (Hartcourt Brace), 1997, ISBN 0030020786

Robards, Haddard, Jackson, *Principles and Practice of Modern Chromatographic Methods*, Academic Press, 1994

Lajunen L H J, *Spectrochemical Analysis by Atomic Absorption and Emission*, Royal Society of Chemistry, 1992, ISBN 0851868738

Miller J C and Miller J N, *Statistics for Analytical Chemistry*, 3rd Edition, Ellis Horwood, 1997, ISBN 0130309907

Fifield F W and Kealey D, *Principles and Practice of Analytical Chemistry*, 3rd Edition, Blackwell Science, 1990, ISBN 0632053844

In addition some techniques and methods not covered by this list should be included in the candidate's reading:

DNA techniques

Enzyme linked immunoassay (ELISA) techniques

Current affairs in analytical chemistry

Current developments in data quality

Part B Theory of Applications of Analytical Chemistry

1 Food (See also section 5),

1.1 Analysis with analytical quality assurance (including statistics and measurement reliability)

1.1.1 Sampling, sample preparation, storage of samples and analytical strategy.
Lot, aggregate and incremental samples
Informal and formal sampling strategies
Bulk sample preparation
Sampling for contaminants
Perishable samples and analytes

1.1.2 Choice of method of analysis
Degree of accuracy required
Equipment available
Preparation of the sample solution
Presence of interfering materials
Methods of confirmation of result
Measurement uncertainty

1.1.3 Analysis, calculation and checking of results
Fitness for purpose of methodology
Limits of detection and quantification
Expression of results
Continuity of paperwork

1.2 Composition and Chemistry

1.2.1 The major chemical components of food: carbohydrates, fats, nucleic acids and proteins; their structure, properties, reactivity and occurrence in food

1.2.2 The minor naturally occurring chemical components: minerals, vitamins, dietary fibre, omatic substances, natural colours, toxic substances and anti-metabolites

1.2.3 Food additives; the nature, properties and function of the various classes of food additives
1.2.4 Contaminants of common occurrence which may present a serious hazard in food; substances used in agriculture which may find their way into food

1.2.5 The properties of water and of aqueous solutions; water activity; reactions between water and food components

1.2.6 The major chemical reactions involving food components induced by enzymes or by processes used in the manufacture of food

1.2.7 The chemistry of spoilage; influence of air, light and temperature

The Main Classes of Food

1.2.8 Meat and meat products

Methods of determination of added water
Processes which affect water content
Meat content; the Stubbs and More method, QUID
(http://search.food.gov.uk/search?q=meat+content+calculator&sort=date%3AD%3AL%3Ad1&client=fsa_gov&entqr=2&oe=UTF-8&ie=UTF-8&ud=1&proxystylesheet=fsa_gov&output=xml_no_dtd&site=default_collection)
http://www.meatcontent.com/meatprodbakersguid.pdf
http://tna.europarchive.org/20110615133801/http://www.food.gov.uk/multimedia/pdfs/meatguidance.pdf
and the Clitravi equation
Identification of species
Detection of non-meat nitrogenous matter
Preservatives in meat
Meat spoilage
Identification of offals in admixture with muscle
Mechanically recovered meat/desinewed meat
Quality evaluation
Connective tissue assessment
Recognition of frozen and thawed poultry
Water content of poultry
Meat and yeast extract
Hydrolysed protein
Formed and reformed meat products

1.2.9 Fish and fish products including crustacean

Methods of determination of added water
Methods of determination of ice-glaze
Identification of species
Fish content
Spoilage of fish and its detection
Physical form of cores (coated products)
Marine Biotoxins

1.2.10 Milk and dairy products

Liquid milk, composition and analysis, determination of added water, heat treatment
Antibiotics in milk
Contamination and taints in milk, both chemical and bacteriological
Condensed milk, analysis, categories of condensed and dried milk, filled milk
Cream
Cheese
Cheese and dairy analogues
Vegetarian cheese
Yogurt
Whey proteins and other whey-based products
Casein
Butter
Butter milk
Butter oil
Ice cream
Milk based drinks
Rennet and chymoisin (“vegetarian rennet”)
Modern milk production
Other animal milks

1.2.11 Sugar and preserves

Classical methods of analysis - copper reduction, polarimetry, refractometry
Separation of sugars by chromatography
Enzymic methods
Identification of brown sugars
Analysis of honey, detection of adulteration
Jams and preserves
Sugar confectionery

1.2.12 Chocolate and chocolate products

Beans, Nibs, etc
White chocolate
Plain (dark) chocolate
Milk chocolate
Family milk chocolate
Liqueur chocolates
Chocolate bloom
Cocoa and fat reduced cocoa
Cocoa and chocolate drinks
Drinking chocolate

Chocolate (flavoured) drinks
Triglyceride analysis
Cocoa butter equivalents (substitutes)
Sugar free chocolate
Milk (lactose) free chocolate

1.2.13 Cereals and flour

Composition, grades of flour
Improvers and bleaching agents
Mineral additions
Self-raising flour
Dietary fibre
Bread and pasta
Wheat germ
Vitamins
Canned milk puddings
Biscuits
Flour confectionery
Other grain products from barley, oats etc
Durum wheat
Gluten
Folic acid fortification

1.2.14 Oils and fats

Classical methods - iodine value, saponification value, acid value, peroxide value, density, refractive index, thiocyanogen value, hydroxyl value, acetyl value
Detection and determination of saturated, mono-, and poly-unsaturated fats
Detection of cis-cis, cis-trans isomers in oils
Hydrogenated vegetable oils
Cholesterol and other sterols
Solvent contamination and other processing contamination
Shelf life, methods of determination
Rancidity, acid value, peroxide value, Kreis test
Antioxidants
Erucic acid
Fatty acid profiles, identification, omega and trans fats
Lard
Spreadable fats
Olive oil (EC methods of analysis)
Modified fats e g olestra, plant stanol esters

1.2.15 Fruits and vegetables and their products

Identification of species
Estimation of fruit content of fruit products (determination of parameters and proportions of mixed fruit)
Soft drinks, fruit juices and nectars
Tomato products, mould counts

1.2.16 Fermentation products

Wine - alcohol content, acidity, contaminants, preservatives, characterisation
Herb/Fruit/Vegetable wines
Mead
Fortified wines
Natural deposits
Beer and lager - alcohol, original gravity, flavour components, characterisation
Spirits - alcohol, brand identity, congeners and other authenticity markers e.g. botanical congeners (gin) and sugars
Cider and perry
Alcopops
Vinegar and non-brewed condiment and substitutes

1.2.17 Spices, herbs and condiments

Chemical characteristics - essential oils, ash, silica, water/alcohol soluble residue
Adulteration and contaminants
Curry powder
Mixtures and stuffing
Salt
Iodised salt
Sea salt
Salt substitutes
Low sodium salt

1.2.18 Beverages

Tea
Adulterants
Simulated teas
Herb teas (Rooibosch, Maté, Camomile and other herb teas)
Coffee
Coffee products and mixtures
Adulterants

Substitution (dandelion and chicory)
Instant coffee (including extraction rates)
Quality of coffee bean e g robusta, Arabica
Soft drinks (see bottled water and natural mineral water-section 4)

1.2.19 Functional foods and Nutraceuticals

Lycopene
Fish oils and omega-3 fatty acids
Phyto-oestrogens
Inulin
Probiotics e g bifidus
Prebiotics e g fructo-oligosaccharides
Vitamin and/or mineral supplements
Slimming products
Carotinoids
Medicated foods

PARNUTS

Novel foods
Plant sterols, stanols and stanol esters (see section 1.2.14)

1.2.20 Foods containing GMO's

Detection
Quantification
Threshold values
Licensing and authorisations
Effects of processing
Ethical issues
Substantial equivalence

1.2.21 Other miscellaneous foods (non exhaustive list)

Soups
Table jellies
Starch products
Baking powder
Baby foods
Egg and egg products, salad cream, mayonnaise
Nuts
Pickles and sauces
Snack foods
Sandwiches

Additives and Contaminants

1.2.22 Assay of additives for purity

1.2.23 Detection and determination of the following additives in foods:
Acids and acidity regulators
Anti-caking and anti-foaming agents
Antioxidants
Bulking agents
Colours
Emulsifiers, emulsifying salts and stabilisers
Firming agents
Flavour enhancers
Flavourings, natural, nature identical, artificial
Flour treatment agents
Freezants
Gelling and glazing agents
Humectants
Mineral oils
Modified starch
Modified atmospheres
Preservatives
Propellant gas
Processing aids
Raising agents
Solvents
Stabilisers
Sweeteners
Thickeners

1.2.24 Detection and determination of contaminants and residues

Materials in contact with food
Fluorides
Mycotoxins (aflatoxins, deoxynivalenol, zearalenone, T-2/HT-2, ochratoxin A, fumonisins and patulin)
Odours and taints
Pesticide residues (see 4)
Trace poisonous metals (lead, cadmium, arsenic and inorganic arsenic, mercury and tin)
Emetic metals (iron, zinc and copper)
Polycyclic aromatic hydrocarbons (PAH)
Dioxins and PCB's
3-MCPD
Nitrate

Veterinary residues
Radioactive nuclides
Spirit contaminants e.g. methanol and denaturants
Sudan and other non food dyes
Melamine
Histamine

1.2.25 Detection and determination of allergens

Cereals containing gluten
Crustaceans
Egg
Fish
Peanuts
Other nuts
Soybeans
Milk
Celery
Mustard
Sesame seeds
Sulphur dioxide
Lupin
Molluscs

1.3 Microbiology and microbiological examination

1.3.1 Basic microbiology

Microbial morphology
Bacteria, yeasts, fungi, viruses, protozoa
Factors affecting growth
Nutrients
Temperature
Relative humidity
pH
Presence and concentration of environmental gases
Pathogenicity
Infective dosage
Exotoxins, endotoxins

1.3.2 Characteristics of food that affect microbiological growth

pH value
Moisture content and water activity
Oxidation/reduction potential
Nutrient content of food
Anti-microbial constituents
Biological structure

1.3.3 Determination of numbers of micro-organisms in foods

Classical methods
Direct microscopic counts of viable and non-viable cells
Standard plate counts (pour plates v spread plates)
Most probable numbers (MPN)
Dye reduction methods
Enrichment methods
Advanced methods
Fluorescent antibody techniques
Gram negative endotoxins
Electrical impedance
Serotyping
Immunomagnetic separation
PCR
Other methods

1.3.4 Factors affecting microbiological condition of food

Processing treatment and initial bacteriological load
Storage temperature and atmosphere
Hygiene conditions under which the food is processed
Adequacy of packaging, handling and storage

Effects of freezing

1.3.5 Indicators of food quality

Coliform bacteria
Use as indicator of standard of quality of water
Use in dairy and other food products
Total aerobic counts as indicators of hygiene quality
Significance of spoilage organisms such as Pseudomonas species and Lactic Acid bacteria
Yeast and mould count

1.3.6 Microbiological standards criteria

Advisory Committee on Microbiological Safety of Food
Statement of micro-organisms of concern
Class Plan Sampling
Number and size of samples to be examined
Appropriate limits for the food in question
Proportion of samples to conform to the limit

1.3.7 Bacterial food poisoning

Gram positive cocci
Staphylococci
Streptococci
Gram positive spore-bearing bacteria
Cl. perfringens (welchii)
Cl. botulinum
B. cereus
Gram positive non-sporing bacteria
Listeria monocytogenes
Gram negative bacteria
Salmonella
Escherichia coli
Vibrio parahaemolyticus
Campylobacter jejuni
Yersinia enterocolitica

1.3.8 Microbiological assays
General principles
Antibiotic assays
Vitamin assays

1.3.9 Microbiological significance of specific food processes

Preservation
Pasteurisation, sterilisation, smoking, etc.
Temperature control systems
Cook/chill, Sous-vide
Animal husbandry residues
Irradiation
Modified atmosphere packaging
Fermentation

1.4 Human Nutrition

1.4.1 General

Food and its passage through the gastro-intestinal tract, digestion, absorption of nutrients and excretion of residues
The water balance; food as a source of energy and essential nutrients; nutrient contents of raw foods and their natural variation

1.4.2 Classes of substances of dietary value; their nutritive and energy contribution to food

Proteins, peptides and amino acids
Carbohydrates
Lipids
Dietary fibre
Polyols
Ethanol
Organic acids
Polydextrose
Vitamins
Minerals and trace elements

1.4.3 Processing and nutrient content

The effect of processing, distribution and storage on the nutrient content of food

1.4.4 Nutrition and health
Diet related diseases
Food intolerance
Food allergies
School meal standards

1.4.5 Nutritional labelling

Official factors for conversion of protein, fat and carbohydrate to energy values
Recommended Daily Allowances (RDA)
Guideline Daily Amounts (GDA)
Health and medicinal claims
Nutrition claims
Dietary fibre

1.5 Food Storage and Spoilage

1.5.1 The requirements of the food package and of materials used in its production in relation to the food being packaged

1.5.2 Identification and properties of packaging materials

1.5.3 Methods used for the assessment of specified characteristics
Barrier properties, coating weights, grease resistance, colour, finish, flaws, visual defects, dimensions, integrity of seams and seals

1.5.4 Problems of migration and taint

1.5.5 Analysis of headspace gases taken from closed containers
Methods for measuring vacua in vacuum packed products
Pressure in cans

1.5.6 Minimum durability
Approaches to product shelf life evaluation
Factors affecting shelf life
Sensory testing

Processing, Manufacture, Distribution

1.5.7 Food raw materials are subjected to various processes during manufacture in order to present them to the market in a sound, attractive and safe condition. During manufacture of compound foods and meals, other processes can be used so that the finished product may present a different character from that expected from a consideration of the original constituents

1.5.8 The standard for comparison
The Public Analyst is required to certify that a sample is of the nature, substance or quality demanded by the purchaser though with the advent of many regulations this is often reduced to ensuring that the sample complies with any relevant statutory requirements. Processing will produce changes in the characteristics of the food concerned and the analyst must know something of the processes involved

1.5.9 The principal processing procedures used in this respect are as follows:
Preparation of raw materials
Preservation by a variety of methods including:
Heating (pasteurising, sterilising)
Cooling (chilling, freezing)
Drying
Osmotic preservation (use of sugar or salt)
Acidifying
Chemical preservation
Controlled atmospheres
Irradiation
Combinations of these processes
Other physical processes designed to reduce in size, separate mechanically, form, mix, emulsify, extract, membrane concentrate, distil, bake, roast, fry, coat, fill
Chemical, bio-chemical (including genetic manipulation) and enzyme techniques used to effect conversions and produce new products

1.5.10 Chemical reactions during preparation and processing
During the processing operations changes in the nature of the food may occur; these may include the following:
Auto-oxidation of fats
Protein denaturation and hydrolysis
Non-enzymic reactions causing colour or flavour changes
Lipolysis
Surface absorption
Maillard reaction

1.5.11 Quality assurance and control
Principles of, and approaches to, QA and QC in the food industry
Hazard Analysis and Critical Control Points (HACCP)
Good Manufacturing Practice
Accreditation
ISO 9000 series
BRC and other accreditation bodies

1.5.12 Materials and articles intended to be brought in contact with food
Food contact materials
Active and intelligent materials and articles (AIMS)
Testing compliance with migration limits
Simulants
Total migration limits
Business documentation
Traceablilty
Good manufacturing practice (GMP)
Declarations of compliance (DoC)

1.6 Safety Aspects of Food

1.6.1 Food Hygiene
HACCP
Personal hygiene
Premises hygiene
Premises registration
Scores on the doors
Authorised premises-categories and frequency of inspection

Toxicological Aspects

1.6.2 Toxins naturally present in food

1.6.3 Food contaminated by contact with the environment
Pollution by industrial discharge
By application of agricultural sprays
Chemicals transferred from wrappings/containers
Chemicals introduced during processing or from additives/cooking vessels

1.6.4 Development of toxins by microbiological growth
Bacteria - see section 1.3.7
Fungi e g aflatoxins
Algae

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Part B: Theory of Applications of Analytical Chemistry:

2 Agriculture

2.1 Fertilisers

2.1.1 An Agricultural Analyst must be proficient in the application of statutory analytical methods to the analysis of fertilisers and be able to report on results of analysis in the manner required by the Regulations

2.1.2 The methods of analysis of fertilisers are based on general, classical and instrumental techniques. Methods of analysis and the permitted limits of variation between the results obtained and the declared values, are set out in Statutory Instruments which implement European Directives and regulations on fertilisers. The legislation also specifies compositional and labelling and analysis requirements

2.1.3 Analysis of fertiliser samples can include:
Major nutrients
Nitrogen: total, nitric, ammoniacal, urea
Phosphorus pentoxide: total, soluble in various media
Potassium oxide: total and water soluble
Secondary Nutrients: Calcium, Magnesium, Sodium and Sulphur
Trace elements: boron, cobalt, copper, iron, manganese, molybdenum and zinc
Pesticides and herbicides
Particle size
Neutralising value
Contaminants

2.2 Plant Nutrition

2.2.1 General biology
Photosynthesis
Autotropism
Biochemistry of plants

2.2.2 Factors affecting growth
Nutrient requirements
Nutrient uptake
pH values
Molecular bonding effects and aspects of soil chemistry related to plant nutrition
Recommended levels of nutrients and fertilisers
Water and nutrient availability

2.2.3 Trace elements
Control of concentration is essential
Essential minimum levels
Phytotoxicity threshold

2.3 Feeding Stuffs

2.3.1 The analysis of feeding stuffs involves the use of statutory methods where these are available. In the absence of an appropriate statutory method, other suitably validated methods may be used. Invariably, feeding stuffs need some assessment of their nutrient, additive and contaminant content.

2.3.2 Analysis of feeding stuffs can include:
Major components: oil, protein, fibre, starch, sugar, ash, moisture
Minor nutrients: calcium, magnesium, manganese, iron, copper, selenium, iodine
Vitamins and pro-vitamins: vitamins A, E and D
Additives: anti-oxidants, colourants, preservatives, emulsifiers, stabilisers and, in pet food, acidity regulators
Heavy/dangerous metals: arsenic, inorganic arsenic, cadmium, lead and mercury
Other metals: zinc
Anions: fluoride, nitrate
Undesirable substances: aflatoxin B1, castor plant, ergot, gossypol, hydrocyanic acid, pesticide residues, foreign seeds, theobromine, volatile mustard oil, dioxins and PCB's.
Other mycotoxins: Zearalenone, deoxynivalenol, T-2, HT-2, fumonisins and ochratoxin A

2.4 Animal Nutrition

2.4.1 Animal dietetics
Feeds for particular nutritional purposes
Dependence on food in organic form (ultimately from plants)
Traditional feeding, herbivorous and/or omnivorous
Effects of conversion to omnivorous feeding

2.4.2 Essential factors of animal diets
Adequacy of diet; balance of major and minor nutrients, diseases and conditions associated with individual species.
Relative advantages of diet of meat or vegetable produce
Energy lost from diet; efficiency of conversion of diet to useful human food

2.4.3 Additives to animal feeds
Purpose of addition
Legislative implications

2.4.4 Toxicity of feeding stuffs
Presence of plant material toxic to animals e.g. ragwort
Potential harm from other additions to the diet e.g. prohibited materials (e.g. Regulation (EC) 767/2009, ANNEX III) and TSE (Transmissible spongiform encephalopathy).
2.4.5 Organic production methods

2.5 Bibliography

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Part B: Theory of Application of Analytical Chemistry:

3 Water for Human Consumption

3.1 General Introduction

3.1.1 Water cycle
Inter-relationships of all water; evapotranspiration, soil moisture deficit, water table, discharge and abstractions, aquifer recharge and compensation flows

3.1.2 Groundwater
Basic geology, sandstone and limestone aquifers; boreholes, wells and springs; general composition,
Possible advantages such as reliable quality, low temperature and protection From surface pollution
Possible disadvantages such as limited yield, fissuring and ingress of chemical or microbial pollution
Spa and mineral waters: origin and characterisation including unusual constituents
Influence of industry, farming and other activities on quality; nitrates, pesticide residues, solvents and other trace organics
Salinity and hardness
Uses of groundwater; domestic, commercial food premises
Legislation and quality
Natural mineral waters/spring waters

3.1.3 Surface waters
Basic composition and variability; vulnerability to quality changes due to weather, agriculture, industry and other activities
Agriculture threats; run off, nutrient enrichment, slurry disposal, pesticide use, special wastes e g from fish farms
Industrial and other threats; run-off from urban or industrial premises, trade effluents, sewage effluents, storm overflows, tip leachates
Classification of surface waters
Uses of surface water; water supplies, irrigation, cooling, dilution, navigation and recreation/amenity; influence on quality for human consumption
Legislation and quality

3.1.4 Bottled Water
Legislation and quality

3.1.5 Special issues
Basic virology, Giardia and Cryptosporidia protozoan parasites and water supplies
Legionella
Amoeba and water supplies; blue green algae and toxins in raw water reservoirs
Biofilms
Radioactivity and water

3.2 Water Treatment and Distribution

3.2.1 Simple treatment
Disinfection, types of disinfectant such as chlorine, chloramine, bromine, ozone, ultraviolet, advantages and disadvantages, principles of use and action, values, modes of application and control

3.2.2 Conventional surface water treatments
Pre-treatment, flocculation and sedimentation, rapid filtration, slow sand filtration, flotation, principles, advantages and disadvantages, role of chemical additions, pH control

3.2.3 Advanced treatments
Activated carbon and ozone, ion-exchange, reverse osmosis, desalination, principles, advantages and disadvantages

3.2.4 Fluoridation
Principles, methods and controls

3.2.5 Process and pipe materials including domestic plumbing
Influence on water quality, advantages and disadvantages, cement mortar relining, epoxy lining, other organic lining

3.2.6 Mixing of treated waters
Advantages and disadvantages
Corrosion, precipitation, taste and odour etc

3.3 Water Analysis

3.3.1 General
Sampling techniques including importance of container and sample pre-treatments Factors in selecting analytical method: accuracy, bias, interference etc
Quality control and statistical analysis of results

3.3.2 Chemical analysis for gross constituents
Hardness, minerals, nitrates, etc

3.3.3 Chemical analysis for trace constituents:
metals, pesticides, polyaromatic hydrocarbons, trihalomethanes, solvents etc

3.3.4 Special analysis
Taste and odour
Toxicity testing
Role of gas chromatography and mass spectrometry

3.4 Water Microbiology

3.4.1 Organisms indicative of faecal pollution
Enumeration and interpretation of results, most probable number (MPN), statistical approach
Other micro-organisms
Colony counts and their significance
Pseudomonas group
Nuisance organisms
Pathogenic organisms

3.4.2 Standards of bacteriological quality
Water entering the distribution system
Surface water, clarified and disinfected
Ground water, disinfected
Samples from the distribution system
Private supplies
Supplies for particular locations or uses
Emergency procedures
Special samples and consumer complaints
European Community: requirements of the Water Directive

3.4.3 Sampling
Frequency of sampling for bacteriological examination
Collection, storage and transport of samples
Sampling techniques

3.4.4 Methods of examination
Laboratory hygiene and safety
Preparation of samples
Determination of indicator organisms
Multiple tube method
Membrane filtration
Rapid methods

3.5 Bibliography

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Part B: Theory of Applications of Analytical Chemistry:

4 Pesticide Residues

4.1 Definitions of pesticides

4.2 Definitions of Acceptable Daily Intake and Maximum Residue Limit (MRL)
Implications of the differences between the two. Risk Assessment of pesticides found above an MRL and the assessment of MRL values assigned.

4.3 Sampling procedures
Recommended method of sampling for the determination of pesticide residues

4.4 Portion of produce to be examined, sample preparation and storage of prepared samples

4.5 Major classes of pesticides
Organochlorine
Organophosphorus
Thiocarbamates
Chlorophenoxy acids
Triazines
Miscellaneous pesticides

4.6 Pesticide/commodity combinations
Choice of range of pesticides to determine
Detection limits/reporting limits
Non Permitted pesticides within certain produce
Application of recovery and uncertainty
Safety implications of pesticides found above the MRL

4.7 Analytical procedures
Extraction of pesticides from specimen
QUECHERS techniques
Choice of solvent systems
Continuous hot extraction
Continuous cold extraction
Manual extraction
Co-distillation
Supercritical fluid extraction
Safety precautions in handling solvents
Clean-up procedures
Need for clean-up
Solvent partitioning
Matrix matching

Internal standards
Sample revoveries
Use of ‘protectants’
Column chromatography; silica, alumina, carbon, fluorosil, use of silver nitrate
Large columns, micro columns, solid phase extraction techniques
Gel permeation chromatography
Chemical techniques
Co-sweep distillation techniques
Final determination
Choice of procedure to use
Gas liquid chromatography/GCMS; choice of columns, choice of detectors, detector types, derivatisation techniques
HPLC/LCMS; choice of columns, choice of detectors, optimisation of detectors, choice of solvent systems
Colorimetric techniques

4.8 Confirmation
Need for confirmation, false positive results, matrix effects and matrix matching
Use of alternative gas liquid chromatography columns
Use of alternative gas liquid chromatography detector systems
Use of alternative methods
Chemical techniques
Diode array detector techniques and spectral matching
Mass spectrometry by full scan and selective ion (theoretical understanding only) and library searching

Part B: Theory of Applications of Analytical Chemistry:

5 Statistics and Quality Assurance

5.1 Statistics
Types of error
Mean, Standard Deviations and Distribution
Confidence limits
Propagation
Significance tests
Quality control and sampling
Errors associated with instrumentation
Non-parametric errors
Robust methods
Experimental design, optimisation and pattern recognition
Proficiency testing
Measurement Uncertainty

5.2 Quality Assurance
The development of a quality assurance system
Accreditation of laboratories for various functions
Standardisation of methods
Eurachem-Fitness for purpose of analytical methods
ISO 9000 Series
BS EN ISO/IEC 17025:2005 - standard for Official Food & Feed Control Laboratories
The APA protocol on quality assurance
External quality assurance schemes e g FAPAS, FEPAS, GeMMA, LEAP, PhytoPAS, Aquacheck and LGC Proficiency Testing.
Drinking Water Technical Standard (DWTS)
APA approved methods of analysis

5.3 Bibliography

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Part B: Theory of Applications of Analytical Chemistry:

6 Policy and Law

6.1 The Law relating to Food, Agriculture and Water for Human Consumption

6.1.1 It is of importance for the Public Analyst to have a thorough working knowledge of the law as applied to the various fields of work. Such knowledge will have primary influence upon the selection of work to be carried out on samples submitted for analysis and examination, the planning of scientific investigations and surveys to be undertaken and the interpretation of scientific results with a view to report and possible legislative action

6.1.2 Candidates must appreciate that legislation is in a state of continual evolution and it is therefore important to keep abreast of the potential, and actual, changes in the law by regular attention to case law reports, the enactment of relevant new legislation, EC Regulations and Directives, recommendations of advisory bodies such as the Food Advisory Committee together with a knowledge of proposals for regulations as issued from time to time by the various government ministries and departments

6.1.3 Principle legislation involved: The Food Safety Act, 1990
Candidates should have a good overall understanding of the entire Act but the following sections are of particular importance:
Section 1: Meaning of food and other basic expressions
Section 2: Meaning of sale etc
Section 5: Food authorities and authorised officers
Section 7: Rendering food injurious to health
Section 8: Selling food not complying with food safety requirements
Section 9: Inspection and seizure of suspected food
Section 14: Selling food not of the nature or substance or quality demanded
Section 15: Falsely describing or presenting food
Section 21: Defence of due diligence
Section 27: Appointment of Public Analysts
Section 28: Provision of facilities for examinations
Section 29: Procurement of samples
Section 30: Analysis etc of samples (including issue of certificates of analysis)
Section 31: Regulation of sampling and analysis etc
Section 34: Time limit for prosecutions
Section 40: Power to issue Codes of Practice
Section 41: Power to require returns
Section 42: Default powers

Section 53: General interpretation

The act is much shorter than the predecessor Food Act 1984 but candidates should be aware of the powers conferred on Ministers to make Regulations and to issue Codes of Practice. A good working knowledge of, and understanding of the principles of, the various Regulations made under the Act will be required

6.1.4 Subordinate Regulations of the Food Safety Act
Regulations will include those relating to food composition, food additives, contaminants, labelling, food treatments, hygiene and miscellaneous matters such as materials and articles in contact with food and Regulations covering the appointment and functions of Public Analysts. Examples of these are the General Food Regulations 2004 and EC No 178/2002.

6.1.5 The European Communities Act, 1972
Certain subordinate regulations made under this Act have a direct bearing on the work of the Public Analyst, particularly in the fields of food and water, e g milk and milk products, water content of frozen poultry meat.
In addition to EC Regulations, students should also be familiar with the various EC Directives which generally become implemented by enactment through national Regulations

6.1.6 The Food and Environment Protection Act, 1985
In particular its importance in relation to pesticide usage and pesticide residues

6.1.7 The Agriculture Act, 1970
Part IV of the Act governs the sale, composition and labelling of fertilisers and feeding stuffs and provides for the appointment of Agricultural Analysts. Subordinate Regulations made under the Act deal separately with fertilisers and animal feeding stuffs, and lay down prescribed methods of analysis and reporting requirements, by way of prescribed certificates, for such articles

6.1.8 The Trade Descriptions Act
Provision of analytical and advisory services are frequently required in support of proceedings taken by Local Authorities under the Acts

6.1.9 The Water Act, 2003
An understanding of the Act, its associated EC Directive and the Water Supply (Water Quality) Regulations, is necessary

6.1.10 The Consumer Protection Act, 1987
This is a UK Act on consumer law covering product liability, government powers to regulate safety criminal offences.

6.1.11 Further Study
It is strongly recommended that the prime source of study should be the original documents, i.e. Acts, Regulations, Committee Reports, etc themselves. Additionally this should be supported by the study of appropriate law reports as appearing in various publications. Of value in this respect are the monthly Bulletins of the APA, which also provide information in respect of new legislation
Note: A separate guide listing relevant primary and secondary legislation has been published by the Training Committee of the Association of Public Analysts. It is entitled "Legislation" and is upgraded on a regular basis. A link to this is given below
http://www.publicanalyst.com/training/training_guides

6.2 Policy Relating to Scientific Enforcement and Practice

6.2.1 Current situation
Food
Areas to consider are:
Regulations under the Food Safety Act 1990: few prescribed methods of analysis, value of compositional standards, views for and against.
Enforcement through food authorities: in England and Wales these are the London boroughs, district councils, metropolitan authorities and unitary authorities; in Scotland the authorities are the islands or district councils.
Food Law devolved in Scotland, Wales and N. Ireland.
UKAS (United Kingdom Accreditation Service)
Formal sampling
Government Chemist role http://www.governmentchemist.org.uk/
The Food Standards Agency (Competent Authority)
National Reference and Official Control Laboratories.
Advisory Groups
Local liaison and industry Committees
Home and Primary Authority.
Role of the Environmental Health and Trading Standards Officer.
Agricultural materials
Enforcement of Agriculture Act 1970 by similar authorities as above; analysis by prescribed methods
Role of the Royal Pharmaceutical Society
Veterinary Medicines Directorate (VMD)
Water for human consumption
Water Board Role
Appointment of Public Analysts and Agricultural Analysts by relevant authorities
The role of the Food Examiner

6.2.2 Future development
Awareness of continuing and new developments
EC legislation in form of regulations and directives; directives incorporated into statutory instruments
Changes in emphasis under EC legislation from compositional standards to informative labelling
Developments in food analysis
Change in emphasis from retail to factory sampling; desirability of retention of some retail sampling; application of scientific expertise to factory inspection, problems arising from unequal distribution of factories to be inspected between food authorities, primary authority role.
Developments in food law enforcement
The framework agreement on local authority food law enforcement

6.2.3 National Reference and Official Control Laboratories
The UK National Reference Laboratories (NRLs) network is responsible for setting up EU-wide standards for routine procedures and reliable testing methods in the areas of feed and food and animal health. Core functions of the appointed UK NRLs are effectively those cited in Article 33 of the EC Regulation 882/2004. Competent authorities designate official laboratories for the purposes of chemical analysis or microbiological examination of feed or food samples taken by enforcement practitioners. Designation may only be granted if the laboratory meets certain standards (i.e. is accredited to the European Standards specified in Article 12 of Regulation (EC) No 882/2004).

6.2.4 Competent Authority and European Reference laboratories
The Food Standards Agency (FSA) is designated as a 'Competent Authority' for the purposes of Regulation (EC) 882/2004 on Official Feed and Food Controls in the UK. In order to provide technical and scientific support for the official control framework, the European Commission has created a network of European Union Reference Laboratories (EU-RLs). Individual EU Member States designate one or more NRLs for each EU-RL.
The NRLs within the UK are divided into:

NRLs for feed and food (FSA and Defra)

NRLS for animal health and live animals (Defra)

6.3 Bibliography

Atwood B, *Butterworths Food Law,* 2nd Edition, Butterworths, Reed Elsevier (UK), 2000, ISBN 0406895481

Rowell R, General Editor, *Butterworths Law of Food and Drugs,* Butterworths, London, 1999, ISBN 0406996474

Part C: Practical: Scope of Study

Part C Practical

The Part C examination consists of:
the submission of a **portfolio of evidence** which demonstrates
(i) practical analytical experience
(ii) proficiency in preparation of certificates and reports
(iii)knowledge of product labelling
and an **examination** involving the candidate in
(iv) microscopic identification of unknown materials
(v) interactive exercises
(vi) certificate writing

Guidance is also given by the Royal Society of Chemistry Mastership in Chemical Analysis (MChemA), Regulations, Syllabus and Guidance Notes 2012 a link to which is given below:
http://www.rsc.org/images/MChemARegsSyllabus2012_tcm18-107499.pdf

1 Scope of Study

1.1 Practical Analytical Experience

Evidence of practical experience across a range of analytical techniques. It is not necessary to have competence in all the techniques listed below, but candidates should be able to demonstrate involvement in a cross-section during the course of their career:
Classical wet chemistry
Mass Spectrometry
Atomic Absorption/Emission Spectroscopy
Inductively Coupled Plasma Spectrometry
High Performance Liquid Chromatography
Gas Chromatography
Ion Chromatography
Non-instrumental Chromatography
ELISA
Microscopy
Infra Red Spectrometry
Materials and Articles in Contact with Food
Electrophoresis
DNA measurement techniques
The depth of involvement in each technique should be declared, e g authorised analyst, method validation, research, etc. The examiners will usually verify the contents of this part of the portfolio via verification by the Internal Councillor. For the interactive exercises candidates will be expected to have knowledge of the following topics and to be able to apply that knowledge and their experience in completing the various exercises and questions.

1.2 Food
Analysis of and interpretation of analytical data for the main categories of foods for general chemical composition, additives and contaminants:
Meat and meat products
Fish and fish products
Milk and dairy products
Sugars and preserves
Cereals and flour
Oils and fats
Fruits and vegetables and products
Fermentation products
Spices, herbs and condiments
Beverages
Other miscellaneous foods
Additionally candidates will be expected to have the ability to identify chemically or microscopically the various foods and food ingredients and appropriate additives and contaminants. They should be proficient in carrying our food complaint analysis and competent in preparing informal, formal and food complaint reports.

1.3 Agriculture
Candidates will be expected to be familiar with methods found in relevant regulations made under the Agriculture Act and the EC Communities Act and be able to interpret results from these methods and use them in preparation of appropriate reports and certificates.

1.4 Water for Human Consumption
Candidates will be expected to be familiar with a range of methods used for analysis of water for human consumption such as those published by the Standing Committee of Analysts (Blue Book methods). They will also be expected to be able to demonstrate knowledge of the microbiological examination of water and to be able to interpret the results of both chemical analysis and microbiological examination and prepare reports.

1.5 Microscopy

1.5.1 The application of microscopy in the fields of botany, zoology, microbiology, histology, entomology, mycology. In particular, applications in these fields which are necessary for the investigation of a wide range of complaints relating to food, agriculture and drinking waters.

1.5.2 Analytical microscopy procedures
Mounting slides; techniques and mountants
Chemical reactions and microphysical techniques
Staining techniques
Quantitative procedures
Use of polarised light, dispersion staining, reflected and transmitted light

1.5.3 Vegetable microscopy
Botanical structures of plants; roots and rhizomes, stems, woods and barks, leaves, flowers, seeds and fruits. Identification of specific cellular and vascular material and other structures including terminology.
Powdered vegetable material; pollen, starches, cereals, spices, ground food substances, paper and packing material
Moulds, yeasts and fungi (edible and inedible)

1.5.4 Animal microscopy
Histology of animal tissues (edible and inedible)
Animal hairs, feathers
Basic entomological structures and distinguishing features, common pests
Microscopy of water, aquatic species, animal culae, fish scales, cryptosporidium
Parasites, internal and external, bacteria
Potential food and water contaminants

1.5.5 Mineral and some other organic aspects
Fibres- glass, mineral wool, man-made fibres, plastics and asbestos. Note: In order to identify asbestos a P401 certificate issued by the British Occupational Hygiene Society or equivalent must be held and laboratories must be accredited to ISO17025 for this analysis (as per the Control of Asbestos Regulations and UKAS Lab 30).
Dusts

1.5.6 In addition, microscopical examintion is required for the identification of components of feeds and for the recognition of vegetable contaminants or weed seeds. The analyst must also be able
to detect any deterioration and infestation in a feeding stuff
Note: Detailed lists of specimens for study are given in the separate guide 'Specimens
for Microscopy' published by the Training Committee of the Association of Public Analysts

Part C: Practical: Preparing Reports for Legal Purposes

2 Preparing Reports for Legal Purposes

2.1 Introduction

Competence in certificate writing will need to be demonstrated in both the portfolio of evidence and during the practical examination. For the portfolio of evidence between 40 and 60 examples of the candidate's best efforts should be submitted. The certificates should cover all areas of the syllabus including food, agriculture, water, food complaints and microbiology.

An appreciation is required of the role of the Certificate as a legal document which may, under prescribed circumstances, be offered in Court as evidence and be sufficient evidence of the facts contained therein. The Certificate must be drawn up in a manner such as to offer no chance for its validity to be questioned. The need must be recognised for its wording to be direct, factual and concise, ignoring all irrelevant matter, while providing sufficient information such that a court may be enabled to come to a judgement regarding the case before it. A contrast has to be seen between this and the more general style of report which serves largely as a communicative document e.g. complaint reports which may be much more expansive and of a discursive nature as occasion demands.

Proficiency in the drafting of official certificates may best be achieved by regular practice involving simulated conditions, taking advice from counsellors and senior colleagues, together with the establishment of a close rapport with regard to certificates issued from the candidate's own laboratory. In addition, the candidate should be aware of how to construct a statement of witness and how to incorporate a certificate produced.

2.2 The Certificate of a Public Analyst or Food Examiner

A knowledge and appreciation is required of:

The provisions of the Food Safety Act 1990 and Regulations made there under governing the various requirements and use of the Certificate of Public Analyst or Food Examiner.

The prescribed form of Certificate as laid down in the Food Safety (Sampling and Qualifications) Regulations 1990

2.3 Agriculture Act Certificates

Prescribed forms of certificates of analysis for fertilisers and feeding stuffs are required by Section 77(4) of Part IV of the Agriculture Act 1970. Familiarity with the structure and application of such certificates is necessary, separate certificate forms being prescribed for fertilisers and for feeding stuffs.

For fertilisers, the prescribed form of certificate is laid down by Regulation 7 and Schedule 3 of the Fertilisers (Sampling and Analysis) Regulations 1996 (SI 1996 No 1342). A full understanding is also required of the guidance notes which accompany the prescribed form, such understanding being directly dependent upon awareness of the requirements of the Fertilisers Regulations 1991 (SI 1991 No 2197), particularly with regard to the prescribed statement of certain compositional details (the statutory

statement) and specified limits of variation. In conjunction with this, the requirements of the EC Fertilisers (England & Wales) Regulations 2006 (2006, No 2486).

For feeding stuffs, the prescribed form of certificate is laid down by Regulation 7 and Schedule 1 of the Feed (Sampling and Analysis and Specified Undesirable Substances) Regulations (England) 2010 No 2280. See also (Wales) Regulations No 2287, (Scotland) Regulations No 354 and (N Ireland) Regulations No 323. Note that the regulation referring to the certificate in the N Ireland Regulations is regulation 6. Also refer to the appropriate guidance notes for each.
A proper understanding of these is required together with the related requirements of the Feeding Stuffs (England) Regulations 2005, SI 2005 No 3281 (Also Feeding Stuffs (Wales) Regulations 2006, Feeding Stuffs (Scotland) Regulations 2005, No 605 and the Feeding Stuffs (N Ireland) Regulations 2005 No 545) with regard to statutory statements and limits of variation.

2.4 Water Reports
The is no prescribed format for the reporting of water results, although UKAS standards apply, but the same principles are applicable namely:
(i) What is the result?
(ii) What is the standard?
(iii)What is the deviation?
The information should be presented in a clear format easily followed by the client and be compliant with UKAS requirements.

2.5 Criminal Justice Act 1967 - Proof by written statement
The general provisions of Section 9 of the Act for proof by written statement should be understood, together with an understanding of the conditions laid down for the admissibility of such a statement as evidence.
Recognition should be accorded to the value and application of such a statement in circumstances where no specific prescribed certificate is laid down including its use in relation to articles of foodstuffs (e g consumer complaints) not sampled in accordance with the Food Safety Act, articles analysed under The Trade Descriptions Act/The Consumer Protection from Unfair Trading Regulations 2008 and
articles analysed under Consumer Protection/Consumer Safety legislation.
Note: A separate guide entitled "Certificate Writing" has been published by the Training Committee of the Association of Public Analysts.

2.6 Bibliography

Moir D D, *The Certificate of the Public Analyst*, J Assoc Publ Analysts, 1965, 3, 3
Hamence J H, *The History of the Public Analyst's Certificate and Present Day Requirements*, J Assoc Publ Analysts, 1973, 11, 59
Painter A A, Editor, *Butterworths Law of Food and Drugs*, (as amended), Butterworth, London, 1980
Certificate Writing - Training Guide, Association of Public Analysts,

APPENDIX

STATUTES IN WHICH THE PUBLIC/AGRICULTURAL ANALYST IS MENTIONED AS THE AUTHORISED ANALYST

Primary Legislation

1. **Agriculture Act 1970**
   1.
2. **Farm and Garden Chemicals Act 1967**
3. **Food Safety Act 1990**
4. **Hydrocarbons Oil Duties Act 1979**
5. **Medicines Act 1968**
6. **Poisons Act 1972**
7. **Road Traffic Offenders Act 1988**
8. **Transport and Works Act 1992**

Secondary Legislation

1. **Ammonium Nitrate Materials (High Nitrogen Content) Safety Regulations 2003**
2. **Animal and Animal Products (Examination for Residues and Maximum Residue Limits) Regulations 1997**
3. **Arsenic in Food Regulations 1959**
4. **Chloroform in Food Regulations 1980**
5. **Controlled Drugs (Drug Precursors) (Intra-Community Trade) Regulations 2008**
6. **Feed (Hygiene and Enforcement) Regulations 2005**
7. **Feed (Sampling and Analysis and Specified Undesirable Substances) (England) Regulations 2010**

8. Feeding Stuffs (Establishments and Intermediaries) Regulations 1999

9. Fertilisers (Sampling and Analysis) Regulations 1996

10. Food Additives Regulations (England) 2009

11. Food Enzymes Regulations 2009

12. Food Safety (Sampling and Qualifications) Regulations 1990

13. Food Hygiene Regulations (England) 2006

14. Materials and Articles in Contact with Food (England) Regulations 2010

15. Medicines (Certificates of Analysis) Regulations 1977

16. Mineral Hydrocarbons in Food Regulations 1966

17. Misuse of Drugs Regulations 2001

18. Natural Mineral Water, Spring Water and Bottled Drinking Water Regulations (England) 2007

19. Official Feed and Food Controls Regulations (England) 2009

20. Organic Products Regulations 2009

21. Plastic Materials and Articles in Contact with Food Regulations (England) 2009

22. Poultry Meat (Water Content) Regulations 1984

23. Sea Fishing (Illegal, Unreported and Unregulated Fishing) Order 2009

24. Trytophan in Food Regulations (England) 2005

25. Wine Regulations 2009